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By
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External author addresses:

M.A.F. Fedikow
Mount Morgan Resources Ltd.
34 Wellesley Court
Winnipeg, Manitoba R3P 1X8
(204) 487-9627
E-mail: mfedikow@mts.net

H.J. Abercrombie
Birch Mountain Resources Ltd.
250 Sixth Avenue SW, Suite 300
Calgary, Alberta T2P 3H7
(403) 262-1838
abercrombie@birchmountain.com

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	(204) 945-4154 (Publication Sales)
Fax:	(204) 945-8427
E-mail:	minesinfo@gov.mb.ca
Website:	www.gov.mb.ca/itm/mrd

Cover photos:

Upper photo: A prominent bedrock peninsula called 'The Big Rock' in Dawson Bay, Lake Winnipegosis. It consists of Devonian carbonates from the Souris River Formation. Evidence of solution collapse is present in the foreground (odd-shaped promontory jutting out of the face of the rock). View is to the northwest.

Lower photo: Salt spring: large saline brine pond at Salt Point, with near surface outcrop present where trees are growing, station 88-97-DB53, (see Table 1 for station details). Trees in background (right-hand corner) provide scale.

ABSTRACT

A new mineral-deposit type, termed 'Prairie-type microdisseminated mineralization', has been discovered in west-central Manitoba. The mineralization comprises micrometre-size precious and base-metal assemblages hosted within the Upper Devonian Point Wilkins Member of the Souris River Formation. The Manitoba prototype for this style of mineralization was first documented in a high-Ca limestone quarry 16 km north of the town of Mafeking. At this site, inverted cones of strongly altered and silicified features, termed 'solution chimneys', occur in buff-yellow, mottled, micritic and fossiliferous limestone and an overlying unit of strongly oxidized, rusty red to brown, fossiliferous dolomitic limestone. These units have an aggregate thickness of 6–10 m and represent the hosts to Prairie-type mineralization. The individual components of the solution chimneys have distinctive chemistries and textures, with the siderite-rich outer rind consisting of elevated Au, Zn, Ni, Co and Fe concentrations relative to the silicified limestone, termed 'sinter'.

Geological, geophysical, and soil- and rock-geochemical studies provide a detailed setting for this new style of mineralization, and present viable exploration tools for assessment of repetitions of microdisseminated mineralization in this area. The formation of solution chimneys and their contained mineralization is attributed to oxygenated, chloride-rich brines, containing bitumen and dissolved metals that moved through induced zones of permeability resulting from dissolution of the Prairie Evaporite and attendant collapse, as well as structural readjustment above the Superior Boundary Zone. Metals were precipitated at redox boundaries and/or as a result of microbial oxidation of organic material and reduction of sulphate. Geological and geochemical characteristics of modern-day equivalents to Prairie-type mineralization in the Mafeking area are elucidated.

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Introduction

This report attempts to build on the foundation laid by Abercrombie and Feng (1994, 1997), Feng and Abercrombie (1994) and Abercrombie (1996), who described Prairie-type microdisseminated mineralization and the mechanisms of its formation in Alberta. In Manitoba, the initial investigation of this mineralization type was presented by Fedikow et al. (1996) and Bamburak et al. (1997). The widespread nature of this type of mineral deposit through the Western Canada Sedimentary Basin (WCSB) section in northeastern Alberta, the relative ease of access for purposes of exploration in Manitoba, and the discovery of the first Manitoba examples of Prairie-type mineralization in a location predicted by the depositional model combine to bring exciting potential to this area of the province.

Despite recognition of the importance of formation waters or brines in sedimentary rocks for mobilizing and accumulating metals and hydrocarbons, Phanerozoic rocks in Manitoba have primarily been viewed as hosts for oil, gas and industrial minerals. Sporadic attempts have been initiated, and to some degree maintained, to explore for Pb-Zn deposits and document the chemistry of potential host rocks (cf. Gale et al., 1981, 1984; Nielsen and Gale, 1983) and formation waters and their precipitates (Tyrrell, 1892; Cole, 1914, 1915; Cameron, 1949; Stephenson, 1973; Wadien, 1984; McRitchie, 1989, 1994, 1995, 1996; Betcher, 1991; McRitchie and Kaszycki, 1997). Formation waters and organic-rich precipitates from Manitoba's salt springs were first sampled by Tyrrell (1892), who described the springs and analyzed for K, Na, Ca, Mg, Fe, Al, Li, Br, I, Ba, Sr, Cl and SO_4. Cole (1914, 1915) resampled and analyzed the springs previously visited by Tyrrell. The springs were again resampled in 1948 by the Manitoba Mines Branch, the analyses showing considerable variation from previous studies (Cameron, 1949). Brine springs and their precipitates were resampled by Stephenson in 1973. Wadien (1984) sampled the same springs for a geochemical analysis of the brines, and Bezys et al. (1997a) sampled the brine sediments associated with these salt springs.

It is worth noting that Pb-Zn mineralization has been discovered in significant quantities at Pine Point (Rhodes et al., 1984), within the WCSB. The Pine Point mining district is located 800 km north of Edmonton on the south side of Great Slave Lake in the Northwest Territories. Within the district, over 87 deposits of Pb-Zn mineralization were defined within a 65 by 24 km area. A minimum of 36 orebodies were mined from these deposits by Pine Point Mines Ltd., from late 1964 until June 1987. Milling continued until April 1988, and total production was 64.3 million tonnes averaging 3.0% Pb and 6.9% Zn. An additional 8 million tonnes of similar grade were not mined because they were deemed uneconomic at 1986 prices.

At Pine Point, 350–600 m of Ordovician to Devonian sedimentary rocks overlie a basement of Archean crystalline rocks and Proterozoic sedimentary rocks. The Pine Point orebodies, hosted by solution-induced (paleokarst) features, occur in flat-lying, unmetamorphosed Devonian carbonate. The trends of maximum solution and the geometry of the karst structures are the same as those of the orebodies they host (Rhodes et al., 1984).

Olson et al. (1994) documented similar mineral occurrences within the WCSB in Alberta. Recent studies of potential base and precious metal source rocks within the WCSB have identified Ordovician metal-rich black shale at Black Island (Fedikow et al., 1995; Schmidtke and Fedikow, 1996), as well as other Phanerozoic sequences within the WCSB (Fedikow et al., 1997; Fedikow et al., 1998). Accordingly, the recognition of a new precious and base-metal mineral-deposit type (Prairie type) in the WCSB in Alberta, together with recently discovered Manitoba examples of similarly mineralized zones, underscore the need for a review of the metallogenic potential of the relatively underexplored Phanerozoic stratigraphy in Manitoba and, in particular, the potential of those sedimentary rocks overlying the Superior Boundary Zone (SBZ).

Previous work

A review of previous exploration and research work directed towards Mississippi Valley–type (MVT) deposits and disseminated sulphide mineralization was deemed applicable to this study of microdisseminated mineralization at Mafeking. Techniques previously researched can provide a wealth of information for subsequent studies directed towards exploration and other mineral-deposit studies. Moreover, it was unclear at the time of writing whether the microdisseminated mineralization discovered at Mafeking is a standalone mineral-deposit type or a transition or variation of a previously recognized style of deposit. Therefore, all available data need to be reviewed, synthesized and assessed for application to this study.

Industry geochemical surveys

Geochemical prospecting techniques were utilized in the early to mid-1980s in the Bell River Bay area, 18 km east-northeast of Mafeking (Figure 1; in back pocket), and in an area southwest of Pelican Rapids and west of the Shoal River (Assessment File 92932, Manitoba Industry, Economic Development and Mines, Winnipeg). Determination of He and Rn in soils and rocks, ^{210}Po in soils and a 'total heavy metal index' (THMI; reflecting a bulk or composite metal signature in the soil) were undertaken in these two areas. This exploration work was based on the premise that a deep-seated uranium orebody occurs in the area and that He and Rn anomalies are produced in the overlying soil through radioactive decay. Associated heavy-metal soil-geochemical anomalies were assessed using onsite field methods.

Methods and results

Soil-geochemical surveys

Samples of B-horizon soil were collected at approximately 200 m intervals along east-west lines in each of the two areas of interest. Although the term ‘B-horizon soil’ was not used, the description of the sample collection procedures indicated that “the samples were taken from below any organic or leached layer of the topsoil and from the same soil horizon represented by fine grained clay or silty clay…” (A.F. 92932). Soils were dried, pulverized and sieved, with the -80 mesh size fraction used for analysis. The analytical method was based on titration and consisted of measuring 200 mg of -80 mesh soil into a 25 ml test tube and adding 3 ml of hydroxylamine hydrochloride buffer at pH 8.9. Dithiocarbazone solution was added incrementally; the test tube being shaken between each step. The reaction produced a coloured complex that is indicative of the amount of ‘total heavy metal’ present in the sample. Metal content is quantified by the volume of dithiocarbazone required to produce a coloured complex and then to reduce the colour back to the original emerald green colour of the testing solution. The number of millilitres of dithiocarbazone solution used for each sample was termed the ‘total heavy metal index’ (THMI) of the sample. A THMI of 2–8 was considered to be a low response, 10–12 reflected average values, and 14–22 was anomalous. Most results based on this method were nondefinitive; however, in the German Lake area (Figure 1; in back pocket), THM indices define a somewhat elevated response of 11–12 over a salt flat, compared to values of 2–8 in soil samples collected away from the salt flat.

Soil and rock-gas surveys

Helium and radon soil-gas surveys were conducted in the same areas as the soil THMI surveys. For He surveys, gas was collected by driving a 1.6 cm (5/8-inch) diameter steel rod into the soil to a depth of 0.60 m (2 feet) and then slowly removing it to avoid disturbing the balance of mixed soil gas in the hole. The hole was sealed using a rubber-lined cap, through which a sampling tube connected to an evacuated steel cylinder had been attached. Gas in the hole was allowed to stabilize for 20 minutes before the valve on the evacuated sample contained was opened. The container was sealed after a fixed time, on the assumption that the soil gas had flooded the container. Samples were analyzed by mass spectrometer (Varian mass spectrometer model 925-40) at the University of Calgary and by gas chromatograph at Core Laboratories Ltd. (Calgary).

Results were generally nondefinitive, except for samples collected over and immediately adjacent to the salt flat from the German Lake area, where ‘above average’ contents of 11–12 ppm He were obtained. The location of these values correlates with that of the highest THMI results for the area.

A survey of Rn in soil gas was also undertaken using an RD-2000 radon detector, in conjunction with sampling and analytical methods developed by the Geological Survey of Canada (Dyck, 1969).

During this survey, Rn measurements were taken at ground level beneath snow. The gas probe was inserted vertically through the snow cover to within 4 mm of the snow-soil interface and the gas was measured. A total of 38 ground-level Rn measurements were taken and a ‘high radon area’, corresponding to the high THMI and He values in soil gas, was defined over the German Lake salt flat. The Rn response was interpreted to be twice the regional average of Rn in the study area.

Surveys of He in rock gas were undertaken to complement the He and Rn soil-gas studies. Samples were obtained by drilling a 1.8 cm diameter hole to a depth of 38 cm using a rotary jackhammer. Rock chips were cleared from the hole and the holes sealed for 24 hours using wooden plugs and silicone sealant. Gas from these drillholes was collected using an evacuated 1000 cc steel gas-sampling cylinder. Analyses were conducted at the University of Calgary using the Varian model 925-40 mass spectrometer. Results from this survey were nondefinitive.

Surveys of ^{210}Po in soil and radiometric surveys using a Precision model 111B scintillometer produced “no anomalous sites” in the study areas (A.F. 92645).

Summary

This multidisciplinary approach to assessing the Bell River Bay area for geochemical indications of deeply buried uranium mineralization was generally unsuccessful. The surveys documented somewhat higher THMI in soil samples collected over an area of active saline brine characterized by a broad salt flat, relative to soils away from this feature. The same area is characterized by above average He and Rn in soil gas. These results prompted the conclusion that the migration of He, Rn and associated heavy metals proceeds from sources in the substrate that are not limited to the passageways or vents of the artesian saline brines (*see* A.F. 92647, 92648, 92801, 92931, 92933, 92935, 92936 and 92938).

Other industry surveys

In the 1930s, Hudson Bay Mining and Smelting Co., Limited put down a diamond-drill hole on one of the Dawson Bay domes in Steeprock Bay (Dawson Bay). Although the drillhole penetrated the Precambrian, no other information on the hole or the program exists.

Inland Cement Company Limited carried out exploratory drilling for high-Ca limestone before 1956, which led to production from the South Mafeking Quarry (Bezys et al., 1997c).

In 1970, Husky Oil Ltd. performed an airborne electromagnetic survey in parts of NTS 63C to investigate base-metal potential and concluded that the four Input® targets drilled were produced by conductive brackish water derived from Devonian aquifers (A.F. 92239). The most interesting feature from this work was the discovery of a circular conductivity 'high' just south of the southeast corner of Red Deer Lake. From this high, a sinuous channel of conductivity was traced through the area of saline springs and out to Dawson Bay. There was no apparent correlation between conductivity and the present surface-drainage patterns. These observations led Husky to believe that the anomalous conductivity was produced by variations at depth related to basement uplift. The aeromagnetic map for NTS 63C14 (Geological Survey of Canada, 1969a) shows a slight bulge in the contours in the area of the circular conductivity.

Additional Pb-Zn exploration activity was conducted by Gulf Minerals Canada Ltd. in 1976. Four coreholes were drilled in the Swan River area subsequent to nondestructive analysis of chips from Manitoba wells. The holes were located approximately 75 km south of Dawson Bay in Twp. 36, Rge. 25 and 26, W 1st Mer. The holes were drilled to obtain better control on the stratigraphy over the projected boundary of the SBZ; to determine the distribution and abundance of sulphide mineralization; and to compare lithology and geochemistry analyses for Cu, Zn and Pb in more favourable detail than was available from well cuttings. Core was sampled over 3.05 m (10-foot) intervals and analyzed by Technical Services Laboratories Ltd. for Cu, Pb and Zn (by atomic absorption spectroscopy). The maximum base-metal values came from samples of a sandy and shaly bed within the Silurian Interlake Group (Figure 2). The highest Cu value (182 ppm) was from the Devonian Winnipegosis Formation. Results were disappointing and Gulf eventually abandoned the program (A.F. 92116).

In 1979, Canadian Nickel Company Ltd. (a subsidiary of Inco Limited) began to look for Pine Point–type deposits in Manitoba by utilizing the hypothesis that the MacDonald Fault at Pine Point (Northwest Territories) played a key role in localizing the deposit. The area targeted in Manitoba occurred north of Swan River in the Dawson Bay area of Lake Winnipegosis, where the SBZ was interpreted to pass beneath the Paleozoic and Mesozoic sequences. A series of Devonian reefs are proximal to the boundary and also reflect its southwest-northeast trend. The distribution of reefs supported the concept that the boundary may have been an active fault zone during Devonian time. The fault could also have acted as a channelway for mineralizing solutions.

In 1980, Inco Limited collected 1000 soil, rock and water samples over a 7-week period in the Dawson Bay area. Sample sites were located at 200 m intervals on lines spaced 400 m apart. Samples were analyzed for Pb, Zn and Ag. Results were sufficiently encouraging to justify continuation of the project and, in 1981, Inco collected 1600 samples. Anomalies detected in 1980 were sampled in detail and reconnaissance sampling was completed. Samples were also collected from the islands within the permit area in Dawson Bay and in areas where airphoto interpretation suggested domal and collapse structures. Samples were analyzed for Pb, Zn, Ag and Hg, and additional anomalies were located. A reconnaissance airborne-electromagnetic survey demonstrated that the area was characterized by high conductivity. A seismic-reflection survey, carried out over the water-covered portions of the permit areas, failed to penetrate the Devonian bedrock and therefore did not provide useful information (A.F. 93877).

In 1982, Inco conducted resistivity and induced-polarization (IP) surveys to determine if this method would be effective in locating sulphide deposits in the highly conductive environment of brine springs. The surveys indicated that valid results could be obtained. A time-domain IP survey was later conducted on a geochemically anomalous area on Salt Point on Dawson Bay. Only one line was surveyed and an anomaly was indicated. A basal-till sampling program was conducted in an anomalous area previously defined by geochemistry. Sixty-three samples were collected and the results confirmed the earlier geochemical anomalies (A.F. 93877).

In 1983, Canadian Nickel Company Ltd. conducted an extensive program, consisting of IP, magnetometer and detailed geochemical surveys, in the Dawson Bay area (A.F. 92829). In 1985, numerous IP anomalies and well-defined zones of anomalous Pb and Zn were found on all grids laid out by the 1983 program. Five drillholes, all drilled to a depth of 80 m, were put down to test well-defined IP anomalies and/or areas anomalous in Pb and Zn. Pyrite and marcasite were found in the core, but results were disappointing. No further work was recommended (A.F. 92830).

Government work

Interest in the Mafeking area was initiated in 1970 with the drilling of two coreholes by the Manitoba Department of Mines and Natural Resources to evaluate high-Ca limestone resources (McCabe and Bannatyne, 1970; Bannatyne, 1970a). Two holes were drilled in the vicinity of what later was to become the South Mafeking Quarry. The first hole penetrated a solution cavern filled with silica sand and clay at a depth of 12.5 m, and the second hole hit artesian water and had to be abandoned at a depth of 15.8 m (Bannatyne, 1975). See Appendix 1 for further information on the coreholes.

The Manitoba Department of Mines and Natural Resources drilled three holes in 1971 and five holes in 1972 in the Dawson Bay area for the High-Calcium Limestone Project. Results of the drilling indicated that the rock was badly fractured or had anomalously thick sections of Devonian Winnipegosis Formation beds (Bannatyne, 1971; McCabe and Bannatyne, 1971; McCabe, 1971a, b; McCabe, 1972).

In 1972, A.W. Norris of the Geological Survey of Canada found that core from Husky Baden corehole no. 2 (drilled in 1971 in 4-33-44-26W) contained Lower Cretaceous (Aptian) spores within black lignitic shale. The shale occupied a channel within the Devonian outcrop belt. In the same year, the Manitoba Mines Branch began to compile geochemical trace-element data from outcrop samples of various rock types to assess mineral-deposit potential. Samples from brine springs and salt meadows along the

ERA	PERIOD	FORMATION	MEMBER	MAXIMUM THICKNESS (m)	BASIC LITHOLOGY
CENOZOIC	QUATERNARY	(Recent)			Topsoil, dune sand, lake clay, peat
CENOZOIC	QUATERNARY	Glacial drift		140	Clay, sand, gravel, boulders, till
CENOZOIC	TERTIARY				
CENOZOIC	TERTIARY	Turtle Mountain	Peace Garden Goodlands	160	Shale, clay, sand, lignite
MESOZOIC	CRETACEOUS	Boissevain		45	Sand, sandstone, greenish grey
MESOZOIC	CRETACEOUS	Pierre Shale	Coulter Odanah Millwood Pembina Gammon Ferruginous	400	Grey shale, noncalcareous, local ironstone, bentonitic, carbonaceous
MESOZOIC	CRETACEOUS	Niobrara (First White Specks)		75	Grey speckled shale, calcareous, bentonitic
MESOZOIC	CRETACEOUS	Morden Shale		55	Dark grey shale, noncalcareous, concretions, local sand and silt
MESOZOIC	CRETACEOUS	Favel (Second White Specks)	Assiniboine Keld	45	Grey shale with calcareous specks, bands of limestone and bentonite
MESOZOIC	CRETACEOUS	Ashville	Belle Fourche Shale Westgate Newcastle Skull Creek	80	Dark grey shale, noncalcareous, silty, Newcastle (sand zone) quartz sandstone
MESOZOIC	CRETACEOUS	Swan River		150	Sandstone and sand, quartzose, pyritic shale, noncalcareous
MESOZOIC	JURASSIC	Waskada		60	Banded green shale and calcareous sandstone, bands of limestone, varicoloured shale
MESOZOIC	JURASSIC	Melita		145	
MESOZOIC	JURASSIC	Reston		45	Buff limestone and grey shale
MESOZOIC	JURASSIC	Amaranth: Upper	Evaporite	55	White anhydrite and/or gypsum and banded dolomite and shale
MESOZOIC	TRIASSIC	Amaranth: Lower	Red Beds	45	Red shale to siltstone, dolomitic
PALEOZOIC	PERMIAN PENNSYLVANIAN	St. Martin Complex		265(+)	Carbonate breccia, trachyandesite (crypto-explosion structure?)
PALEOZOIC	MISSISSIPPIAN	Madison Group: Charles		20	Massive anhydrite and dolomite
PALEOZOIC	MISSISSIPPIAN	Madison Group: Mission Canyon	MC-5 MC-4 MC-3 MC-2 MC-1	120	Light buff limestone, oolitic, fossiliferous, fragmental, cherty, bands of shale and anhydrite
PALEOZOIC	MISSISSIPPIAN	Madison Group: Lodgepole	Flossie Lake Whitewater Lake Virden Scallion Daly	185	Limestone and argillaceous limestone, light brown and reddish mottled, zones of shaly, oolitic, crinoidal and cherty limestone
PALEOZOIC	MISSISSIPPIAN	Bakken	Upper Middle Lower	20	Two black shale zones separated by siltstone
PALEOZOIC	DEVONIAN	Qu'Appelle Group: Three Forks		55	Red siltstone and shale, dolomitic
PALEOZOIC	DEVONIAN	Sask. Group: Birdbear		40	Limestone and dolomite, yellow-grey, fossiliferous, porous, some anhydrite
PALEOZOIC	DEVONIAN	Sask. Group: Duperow		120	Limestone and dolomite, argillaceous and anhydritic in places
PALEOZOIC	DEVONIAN	Man. Group: Souris River (First Red)		90	Cyclical shale, limestone and dolomite, anhydritic *
PALEOZOIC	DEVONIAN	Man. Group: Dawson Bay (Second Red)		50	Limestone and dolomite, porous, anhydritic, local red and green shale
PALEOZOIC	DEVONIAN	Elk Point Group: Prairie Evap.		120	Halite, potash and anhydrite, interbedded dolomite
PALEOZOIC	DEVONIAN	Elk Point Group: Winnipegosis		75	Dolomite, yellow-brown, reefy
PALEOZOIC	DEVONIAN	Elk Point Group: Elm Point			Limestone, fossiliferous, high calcium
PALEOZOIC	DEVONIAN	Elk Point Group: Ashern		12	Dolomite and shale, brick red
PALEOZOIC	SILURIAN	Interlake Group		110	Dolomite, yellow-buff, fossiliferous, several argillaceous marker beds
PALEOZOIC	SILURIAN	Stonewall	t-marker zone	25	Dolomite, sparsely fossiliferous, t-marker defines Ordovician-Silurian boundary
PALEOZOIC	ORDOVICIAN	Stony Mountain	Williams Gunton Penitentiary Gunn	45	Dolomite, yellow-buff Dolomite, dusky yellow, fossiliferous, red shale, green fossiliferous limestone bands (Gunn)
PALEOZOIC	ORDOVICIAN	Red River	Fort Garry Selkirk ? Cat Head Dog Head	170	Dolomitic limestone and dolomite, mottled (Tyndall Stone within Selkirk)
PALEOZOIC	ORDOVICIAN	Winnipeg	Upper Unit	65	Green shale, waxy, interbedded sandstone
PALEOZOIC	ORDOVICIAN	Winnipeg	Lower Unit		Sand, sandstone and quartzose
PALEOZOIC	CAMBRIAN	Deadwood		25	Black to green-grey sand, waxy, glauconitic siltstone and shale
PRECAMBRIAN					Metamorphic and crystalline rock

* Rock host for Prairie-type mineralization

Figure 2: Geological formations in Manitoba; the Souris River Formation is the hostrock for Prairie-type microdisseminated mineralization.

Devonian outcrop belt were collected and trace-element analyses proposed (McCabe, 1972).

In 1973, the Manitoba Exploration Operations Branch examined 46 brine-spring and seepage locations (Stephenson, 1973). The possibility of Mississippi Valley– or Pine Point–type Pb-Zn deposits in the Dawson Bay–Pelican Bay area, and the importance of the Precambrian SBZ in the formation of this deposit type, were noted by Stephenson. Hole M-3-73 was drilled in the Pelican Lake area to check on the reported occurrence of sulphides (pyrite), but only traces were found.

In 1975, a seismic-reflection survey was completed along the old Pelican Rapids road (Dawson Bay), under contract to the Department of Earth Sciences, University of Manitoba, to define stratigraphic and structural features that may be favourable loci for massive sulphide–type deposits (McCabe, 1984).

The Manitoba Exploration Operations Branch undertook an orientation pedogeochemical and biogeochemical survey in the Red Deer River area in May 1976, to determine the effectiveness of near-surface sampling as an exploration aid. Enrichments of Pb and Zn in soils and twigs were noted at two places on a 2750 m traverse along a winter road on the north bank of the Red Deer River. Two exploration drillholes put down by the branch failed to locate Pb-Zn mineralization or alteration zones (Evans, 1976). Encouraging base-metal anomalies from brine-spring analyses were noted in the Salt Point and Red Deer River areas by Evans (1976).

In 1977, a geochemical anomaly along the Red Deer River was drilled (hole M-18-77), but only pyrite was observed in the core. McCabe (1977) undertook a boat traverse down the Red Deer River from Red Deer Lake to Highway 10, looking for additional outcrops that would aid geological mapping. The absence of outcrop was attributed to high water levels.

Quaternary mapping of the Swan River area was initiated in 1978 by Nielsen and Matile (1978). Three holes were drilled in the Overflowing River and Swan Lake areas. Hole M-6A-78 penetrated Mesozoic channel or karst infill and hole M-7-78 encountered Devonian collapse breccia (McCabe, 1978).

In 1981, seven outcrops in the Dawson Bay area were drilled by the Manitoba Mineral Resources Division to determine stratigraphic relationships. The drilling indicated that Winnipegosis reefs are more common between the Steeprock and Red Deer rivers than previously thought. The presence of these reefs suggested that detailed mapping and drilling was necessary to determine high-Ca limestone reserves in the Dawson Bay area because of complex structural irregularities caused by possible salt dissolution and collapse (Bannatyne, 1981; McCabe, 1981). In the same year, a study to determine the base-metal content of various Phanerozoic rock types in drillcore was initiated. Core from hole M-14-71, drilled in the Dawson Bay area, was selected for the study (Gale et al., 1981). Results from this study have been published (Gale and Conley, 2000) and indicate anomalous concentrations (defined as twice the standard deviation on the arithmetic mean) of a variety of metals in the formations sampled for the survey.

In August 1982, an incentive to the search for Pb-Zn mineralization in Paleozoic carbonate rocks was provided when a galena pebble was found by R. Kostiuk in the Porcupine Hills (Nielsen, 1982). The following year, an investigation into the source of the Kostiuk pebble (supposedly from Mudlen Creek, north of Swan River) was initiated and resulted in 159 till samples being collected from 79 backhoe pits and 6 hand-dug holes. Pits were dug from Hart Mountain to Highway 10 and northeast of Birch River (Nielsen and Gale, 1983). In 1984, 48 till samples were collected southeast of Bellsite on the east side of the Porcupine Hills (Gale et al., 1984). According to Nielsen and Gale (1985), no anomalous values of Pb, Zn, Ni or Co were found in this sampling project. Nielsen and Gale (1989) reinforced this conclusion.

Silica sand from the Swan River valley was collected by Watson (1982) for use in a silica-sand assessment project. The presence of the sand in the area had been initially reported by Tyrrell (1892). Glauconite was also reported in some of the samples, resulting in several coreholes being drilled with an Atlas Copco Minuteman drill in 1984 (Watson and Kohuska, 1984). In 1985, the glauconite occurrences were examined by Watson (1985), who believed that a 25 m thick glauconite section in the Steeprock River area was tectonically thickened during emplacement. Samples of gas from the old Red Deer River McArdle salt works, analyzed by the Saskatchewan Research Council, contained a 1000-fold enrichment of He over normal atmospheric concentrations (Watson, 1985).

In 1984, two coreholes were drilled at the Bell River dome, on the old Pelican Rapids road, to test the accuracy of the 1975 seismic profile done by the Department of Earth Sciences, University of Manitoba. The profile was found to be in error, by a factor of about 3 (McCabe, 1984). The following year, McCabe (1985) indicated that the basic seismic data were accurate and the problems were due to the velocity anomalies attributed to the stratigraphic units or to variations occurring within the units. Stratigraphic corehole M-3-85 was drilled at the Bell River dome in 1985 (McCabe, 1985), and 68 till samples were collected from 52 backhoe pits established along the old Pelican Rapids road. By 1985, a total of eight drillcores from the Dawson Bay and Swan Lake areas had been split and sampled for bedrock geochemistry (Nielsen and Gale, 1985).

A sample from the Mafeking quarries was tested by Jones (1986) for aggregate and was deemed suitable for concrete, bituminous, base course A, base course B and surface gravel, and marginal for ballast. In the same year, the Steeprock Bridge reef was drilled to provide a four-hole stratigraphic profile at approximately 100 m intervals (McCabe, 1986).

Two deeper stratigraphic coreholes were drilled in 1987 on Salt Point (McCabe, 1987) as a follow-up to the three shallow mineral-exploration coreholes drilled in 1985 by Inco Limited (A.F. 92830). These two holes provided an accurate frame of reference for the Inco holes by providing true structure, reef thickness and the nature of the lower part of the reef and the platform beds.

In 1988, five coreholes were drilled by Manitoba Energy and Mines on The Bluff, a small peninsula on the west shore of Dawson Bay. Three of the holes had to be abandoned because of ‘sanding in’ of the holes (McCabe, 1988). Three additional holes were drilled each year in 1990, 1991 and 1992 on The Bluff, in support of an M.Sc. thesis by J. Minto of the University of Regina (Bezys, 1990, 1991, 1992). Kent et al. (1992) speculated that the trend of the reef development on The Bluff might be related to basement tectonics associated with the SBZ.

Industrial minerals were investigated by Gunter (1989) in the Swan River valley, along the slopes of the Porcupine Hills and at Salt Point. Silica sand and kaolinitic clay were sampled along the Swan and Roaring rivers, and samples of Cretaceous shale were collected on the south and northwest corners of the Porcupine Hills. Salt Point was remapped, with large areas of Devonian

Dawson Bay Formation ‘B’ beds being identified where Winnipegosis Formation dolomite had been previously documented. Large areas of a dolomite cap rock overlying the Point Wilkins Member (Souris River Formation) and a new Point Wilkins high-Ca limestone occurrence west of Pelican Rapids were reported. Three coreholes were drilled on the west shore of Swan Lake to delineate the subsurface extent of a breccia zone in the Souris River Formation, previously identified in corehole M-7-78, for Pb-Zn mineralization. All three holes failed to penetrate the breccia zone (Bezys, 1989). Two additional holes were drilled at Swan Lake in 1992 (Bezys, 1992).

In 1993, twelve channel samples of silica sand were collected over 1 m intervals from the Cretaceous Swan River Formation on the north side of the Swan River. The channels had spacings of greater than 1 m. Samples were submitted for purity testing (Schmidtke and Bamburak, 1993). Ash Associates (1996) reviewed the results of these tests and indicated that problems of particle-size distribution, impurity levels and low product recoveries of silica sand from the Swan River Formation were significant obstacles to sodium-silicate production.

Rounded to subrounded, lightweight, highly vesicular and variously red, brown and black scoriaceous clasts, between 2 and 10 cm in diameter, were found in 1994 in the Hubbell Creek gravel pit, 14 km northwest of Swan River (Matile and Nielsen, 1994). It was suggested that the clasts were pumiceous and indicative of Phanerozoic volcanism. The south side of the Porcupine Hills was interpreted as the possible source of this material. Argon dating of one of the scoriaceous clasts by M. Villeneuve of the Geological Survey of Canada indicated an age of 470 ±50 Ka (Bamburak and Nielsen, 1996). Two years later, larger and more angular scoriaceous clasts were documented from the Renwer pit (46 km southeast of the Hubbell Creek pit). The largest clast measured 29 by 21 by 17 cm. The multicoloured clasts are associated with angular red and purple shale cobbles and well-rounded boulders and cobbles of Precambrian granite and Paleozoic limestone and dolomite.

During a Geological Association of Canada field trip in May 1996, a highly silicified rock associated with rusty weathered, high-Ca limestone was identified in the North Mafeking Quarry by R. Bezys of the Manitoba Geological Services Branch. This feature and associated structures were subsequently identified as paleo–brine-venting sites by H. Abercrombie (formerly Geological Survey of Canada–Calgary; currently Birch Mountain Resources Ltd., Calgary). Scanning electron microscopic evaluation of these rock types by Abercrombie established the presence of a diverse suite of native metals, including Au, base-metal alloys and associated compounds. This unique assemblage was interpreted to represent deposition from saline brines (Fedikow et al., 1996). In August 1996, subsequent to detailed mapping in the North and South Mafeking quarries, a total of 23 conical structures, termed ‘solution chimneys’, were located, mapped and sampled (Bezys et al., 1997b, c). The chimneys are found singly or in clusters as inverted, conical structures, 10–25 m in width. Samples of the altered limestone components of the chimneys, including siderite-rich rind and siliceous sinter, as well as marcasite-bearing wallrock, were collected from each chimney. Vertical and lateral sampling transects were completed along the relatively unaltered beds of the Point Wilkins Member (Souris River Formation) at solution chimney 2 (SC2).

Mapping and sampling of Devonian and Cretaceous strata in the vicinity of the Mafeking quarries and the Porcupine Hills were carried out in 1997 by the Geological Services Branch of Manitoba Industry, Trade and Mines, under a Memorandum of Understanding with Birch Mountain Resources Ltd., the holder of an exploration lease in the area surrounding, and including, the Mafeking quarries. The program was augmented by geochemical and geophysical surveys, and brine-spring, soil and stream sampling. Eleven short stratigraphic coreholes were also drilled (Bamburak et al., 1997). The results of this work form the basis of this report. Subsequent work was conducted by Birch Mountain on their permit area in Manitoba. The assessment work is available for viewing (A.F. 94432, 94430, 94429, 94547, 94431).

Prairie-type microdisseminated mineralization

The discovery of microdisseminated Au-Ag-Cu mineralization in the Fort MacKay area of northeastern Alberta, in sedimentary rocks of the Western Canada Sedimentary Basin (WCSB) and the underlying granitic basement, represents a significant new type of low-temperature polymetallic mineral deposit (Abercrombie and Feng, 1994, 1997; Feng and Abercrombie, 1994; Birch Mountain Resources Ltd., written comm., 2003). The Fort MacKay mineralization has been called ‘Prairie type’ by Abercrombie (1996) and consists of 0.5–5.0 µm assemblages of native and alloyed Au, Ag, Cu, Pb, Zn, Cd, Fe, Cr, Ni, Sb and Bi in argillaceous limestone (Upper Devonian Waterways Formation). Mineralization can be in the form of oxides, chlorides and carbonates, and can be accompanied by native sulphur and marcasite.

Prairie-type mineralization at this location in Alberta occurs throughout the stratigraphic sequence at or near the intersection of the Sewetakun and Muskeg River faults, which appear to have provided ground preparation for the migration of mineralizing brines. Evidence to support this hypothesis is provided by altered and mineralized brittle-ductile shears within the basement granitic gneiss. Widespread Au, Pb, Ag, Cu, Zn, Sb, Sn, W, Bi and Cl, as well as two alteration facies, have been documented from the granitic rocks. The older phase of alteration is Precambrian in age and comprises potassium feldspar, chlorite and disseminated hematite±Fe-epidote. The younger phase consists of Ce-bearing minerals, carbonate, quartz, hematite and pyrite/marcasite. Monazite and Ce-enriched carbonate microveinlets are widespread.

The formation of polymetallic Prairie-type mineralization and associated alteration is attributed to oxygenated brines derived from halite evaporites within the Devonian Prairie Evaporite (Elk Point Group; Figure 3). Brine movement was driven by downward density flow through metal-enriched redbeds, evaporites and sheared granite-gneiss basement rocks. Metal-bearing brines subsequently discharged at the eastern margin of the WCSB following updip migration and cross-strata migration due to fractures and faulting. The precipitation of Au and associated metals was constrained by oxidation-reduction reactions that involved oxidation of organic material (bitumen) and hydrocarbon and reduction of sulphate to locally produce abundant native sulphur (Abercrombie, 1996; Abercrombie and Feng, 1997).

The presence of Au, Ag, Pb, Bi, Cr, Cu and Fe chlorides in the mineralization indicates that Cl was important in the mineralizing fluids. Therefore, they were probably Cl-rich brines or formation waters. The main alteration-mineral assemblages of calcite, NaCl, KCl, clay minerals and quartz indicate that the mineralizing fluids were enriched in Cl, CO_3^{2-}, Si, Na and K. The widespread occurrence of Ce-bearing minerals in all rocks suggests oxidizing conditions, since Ce^{4+} can only be decoupled from other rare

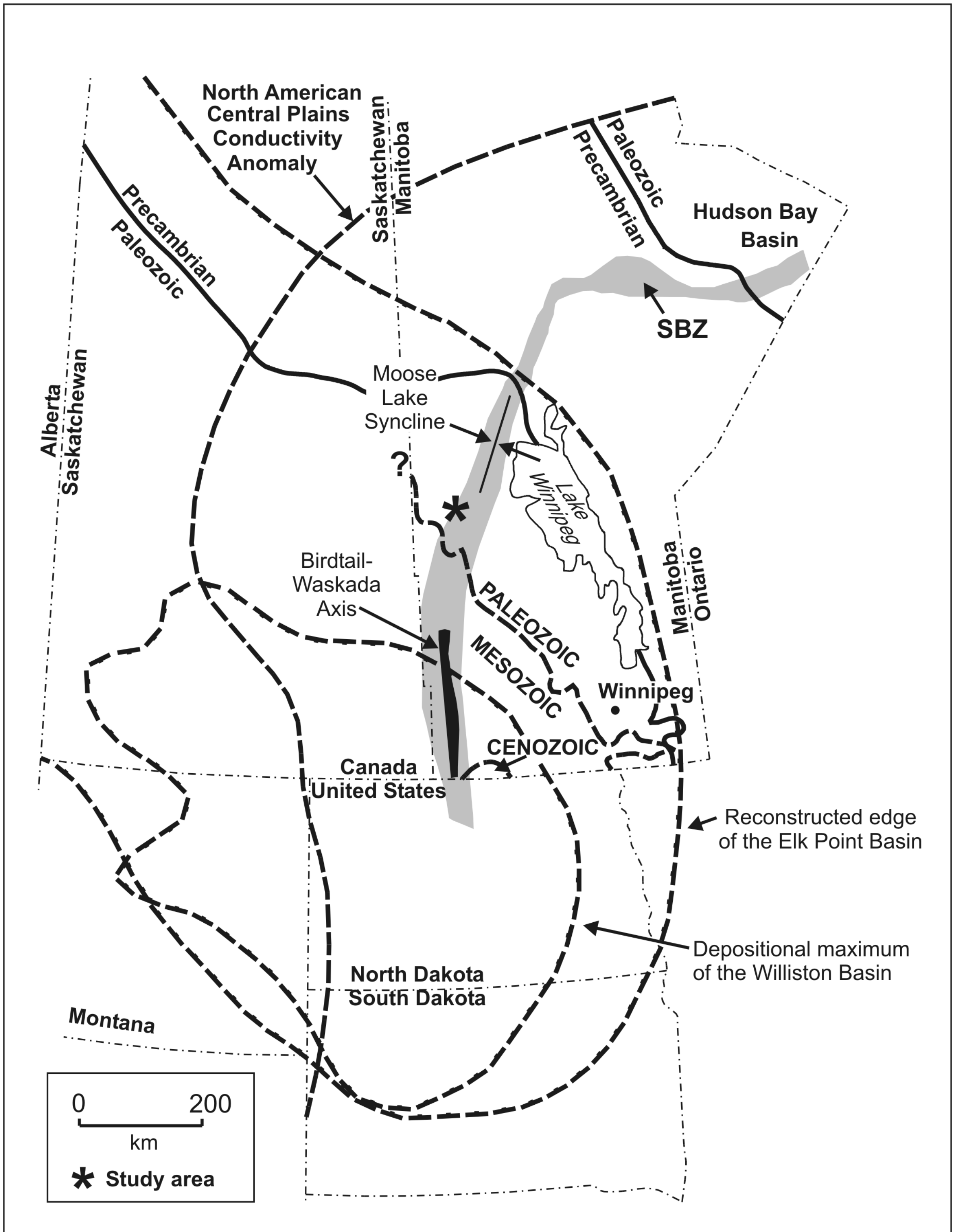

Figure 3: Major structural features and geology of the Williston and Elk Point basins, Manitoba and vicinity.

earth elements under oxidizing conditions. The small grain size, the disseminated nature of Prairie-type mineralization, the alteration-mineral assemblages, and the wide distribution of bitumen in the host sedimentary rocks all indicate that the temperature of deposition of the mineralization probably did not exceed 100°C (Abercrombie and Feng, 1997). This overall style of mineralization is similar in genesis to redbed Cu and unconformity-related Au–platinum group element–U mineralization in Australia (Bloom et al., 1992), to sediment-hosted Cu-Pb-Zn deposits in general (Eugster, 1989) and to sediment-hosted Cu deposits related to the migration of oilfield brines (Sverjensky, 1987). In an independent sampling survey conducted by APEX Geoscience Ltd. on the Athabasca property of Birch Mountain Resources Ltd. in northeastern Alberta, it was concluded that the rocks had been subjected to epigenetic precious-metal mineralizing processes similar to those proposed in Birch Mountain's 'Prairie gold model'. They showed that potentially economic concentrations of Au and Pt occur in Devonian limestone on the Athabasca property (Birch Mountain Resources Ltd., written comm., 2003).

In this report, the process responsible for Prairie-type mineralization in northeastern Alberta will be demonstrated to be active in west-central Manitoba, where similar styles of mineralization have been documented.

Tectonic and depositional framework of the Phanerozoic in southwestern Manitoba

The northeastern periphery of the WCSB in Manitoba is characterized by Paleozoic and Mesozoic outcrop belts (Figures 1 and 2; Figure 1 in back pocket). The WCSB is a composite feature that includes both the Williston and Elk Point Basins. The Williston Basin, centred in northwestern North Dakota, was the site of most Phanerozoic sedimentation. During Devonian time, the Elk Point Basin, centred in south-central Saskatchewan, was the predominant site of sedimentation (Figure 3). Structural disruption of these basins has been effected by both Precambrian and Paleozoic tectonics. The principal basement tectonic feature affecting the stratigraphy of both basins in Manitoba is the Superior Boundary Zone (SBZ; Figure 3). The SBZ separates the Superior Craton to the east and the Trans-Hudson Orogen to the west, and was established on the basis of gravity and aeromagnetic geophysical surveys (Geological Survey of Canada, 1969b) and seismic surveys (Dietrich et al., 1997). The southern extension of the SBZ in southwestern Manitoba is called the Birdtail-Waskada Axis. Here it is a north-trending zone, located approximately 32 km east of the Saskatchewan border (McCabe, 1967). This axis is the locus of a large number of local structure and isopach anomalies in Devonian and later strata. It also marks the western edge of the Winnipegosis Formation fringing reef and is coincident with the projected SBZ. The northern extension of the SBZ into the Canadian Shield is referred to as the Thompson Nickel Belt.

McCabe (1967) considered the SBZ as having exerted a significant effect on sedimentation patterns in the Manitoba portion of the WCSB, as well as localizing Paleozoic structures (such as salt-collapse features) that produced stratigraphic anomalies arising from compaction and salt dissolution of the Devonian Prairie Evaporite. Evidence for this occurs in the form of structure contour and isopach maps of individual stratigraphic horizons (Bezys and McCabe, 1996). McCabe (1967) also considered the east-trending orogenic zones of the Superior Craton to have contributed to the disruption of the depositional framework of the Paleozoic rocks, albeit to a lesser extent than the SBZ.

The most prominent Paleozoic structural feature affecting WCSB stratigraphy is the dissolution edge of the Prairie Evaporite salt basin (Figure 4). The present salt-basin edge is aligned with the SBZ–Birdtail-Waskada Axis trend. This axis is also coincident with the trend of Winnipegosis Formation reef development in the Dawson Bay and Swan River areas (NTS 63C) that probably reflects basement involvement (Norris et al., 1982). The axis has also had a significant effect on local permeability of the sedimentary rocks, which is reflected by the apparent control of oil accumulations in Mississippian strata in Manitoba (McCabe, 1967).

The SBZ also provides a locus for Paleozoic tectonic features, such as structural and stratigraphic anomalies associated with the dissolution front of the Prairie Evaporite, as well as a possible source of metals. Chloride-rich brines, bitumen laminites and redbed sequences also contribute to a depositional environment that satisfies the requirements for the formation of Prairie-type microdisseminated mineralization.

The Moose Lake Syncline, located north and west of the north end of Lake Winnipeg (Figure 3), represents another prominent tectonic feature that coincides with the SBZ. This syncline represents a flexure in the Ordovician and Silurian outcrop belt and has been used as evidence to support post-Precambrian structural movement along the SBZ (McCabe, 1967).

Stratigraphic and structural framework of the Dawson Bay area

Stratigraphy

The Devonian outcrop belt in the Dawson Bay area forms the northeastern truncated edge of the Middle and Upper Devonian Elk Point Basin (Figure 3). Devonian rocks rest with slight angular unconformity on Silurian (Interlake Group) dolomite (Figures 2, 5). To the southwest, Cretaceous clastic and marine rocks overlie the Devonian with angular unconformity in the Porcupine Hills area (Figure 6).

The outcropping portion of the Devonian sequence comprises a series of complex carbonate-evaporite cycles, although the evaporites have subsequently been dissolved from the outcrop area (Figure 5). The first cycle is the Elk Point Group: the Ashern–Winnipegosis–Prairie Evaporite succession. The second cycle is represented by the Dawson Bay Formation, initiated by

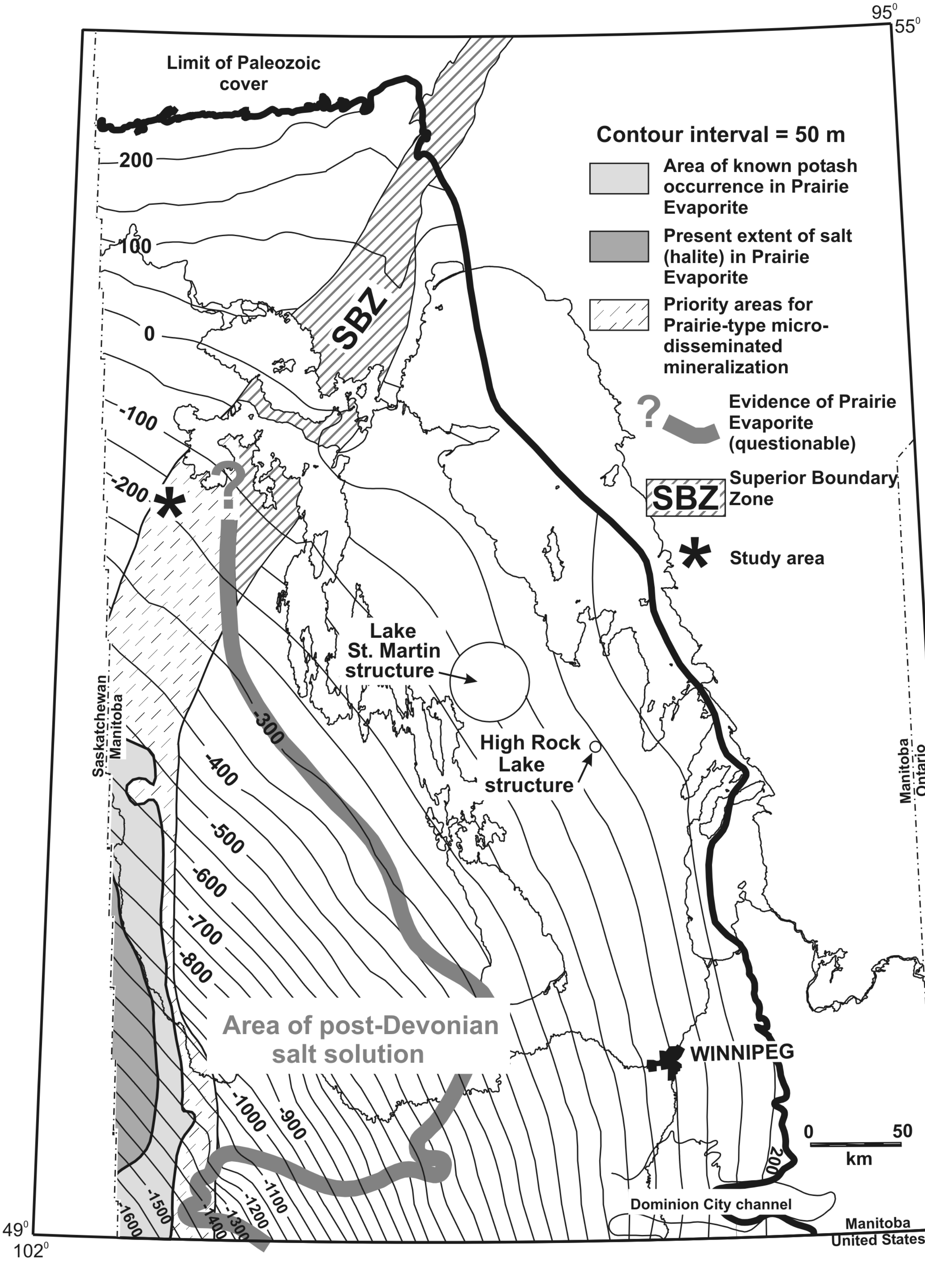

Figure 4: Precambrian structure contour map of southern Manitoba, showing regional controls and priority areas for localization of Prairie-type microdisseminated mineralization in the Phanerozoic section.

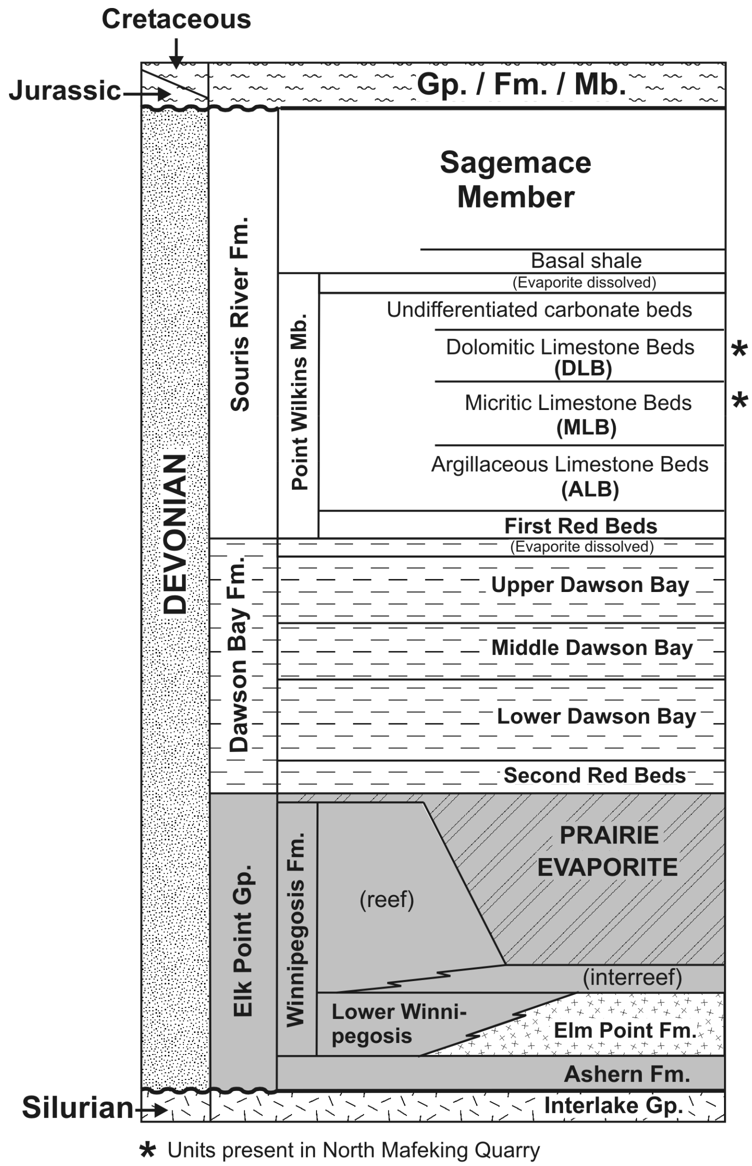

Figure 5: Detailed stratigraphic section of Devonian formations (modified after Norris et al., 1982).

the Second Red Beds and culminating with the Hubbard Evaporite. The third cycle is the Point Wilkins Member of the Souris River Formation, initiated by the First Red Beds and culminating with the Davidson Evaporite. The Sagemace Member of the Souris River Formation may have been the start of a fourth cycle, the top of which has subsequently been eroded.

The Souris River Formation consists of the Point Wilkins Member, overlain by the Sagemace Member (not present in the Dawson Bay area). The Point Wilkins Member was redefined by Norris et al. (1982) and consists of four rock types, in ascending stratigraphic order: a red and green calcareous shale (First Red Beds); a fossiliferous, argillaceous limestone; a dense, micritic and fragmental fossiliferous limestone; and a yellowish brown, finely crystalline dolomite and dolomitic limestone. These four rock units are informally referred to as the First Red Beds, the Argillaceous Limestone Beds (ALB), the Micritic Limestone Beds (MLB) and the Dolomitic Limestone Beds (DLB) of the Point Wilkins Member. The following is a detailed description of the formations outcropping within the study area.

Cretaceous

The lowermost Mesozoic unit that typically overlies the Devonian in the Dawson Bay area is the clastic Swan River Formation (Figure 2). It is a highly variable sequence of fine- to coarse-grained sandstone, pyritic sandstone, shale and lignite. It overlies the Devonian strata with slight angular unconformity and pronounced erosional channelling. Good exposures of the Swan River Formation occur along the Swan River (NTS 63C). Outcrops are rare and expose only the upper part of the formation. Swan River Formation outcrops are composed of medium to light grey clay and silt that are laminated or massive and associated with minor amounts of fine-grained sand, pyrite nodules and carbonized plant fragments (McNeil and Caldwell, 1981). Bannatyne (1970b) reported kaolinitic clay along the Swan River valley, northeast of the town of Swan River.

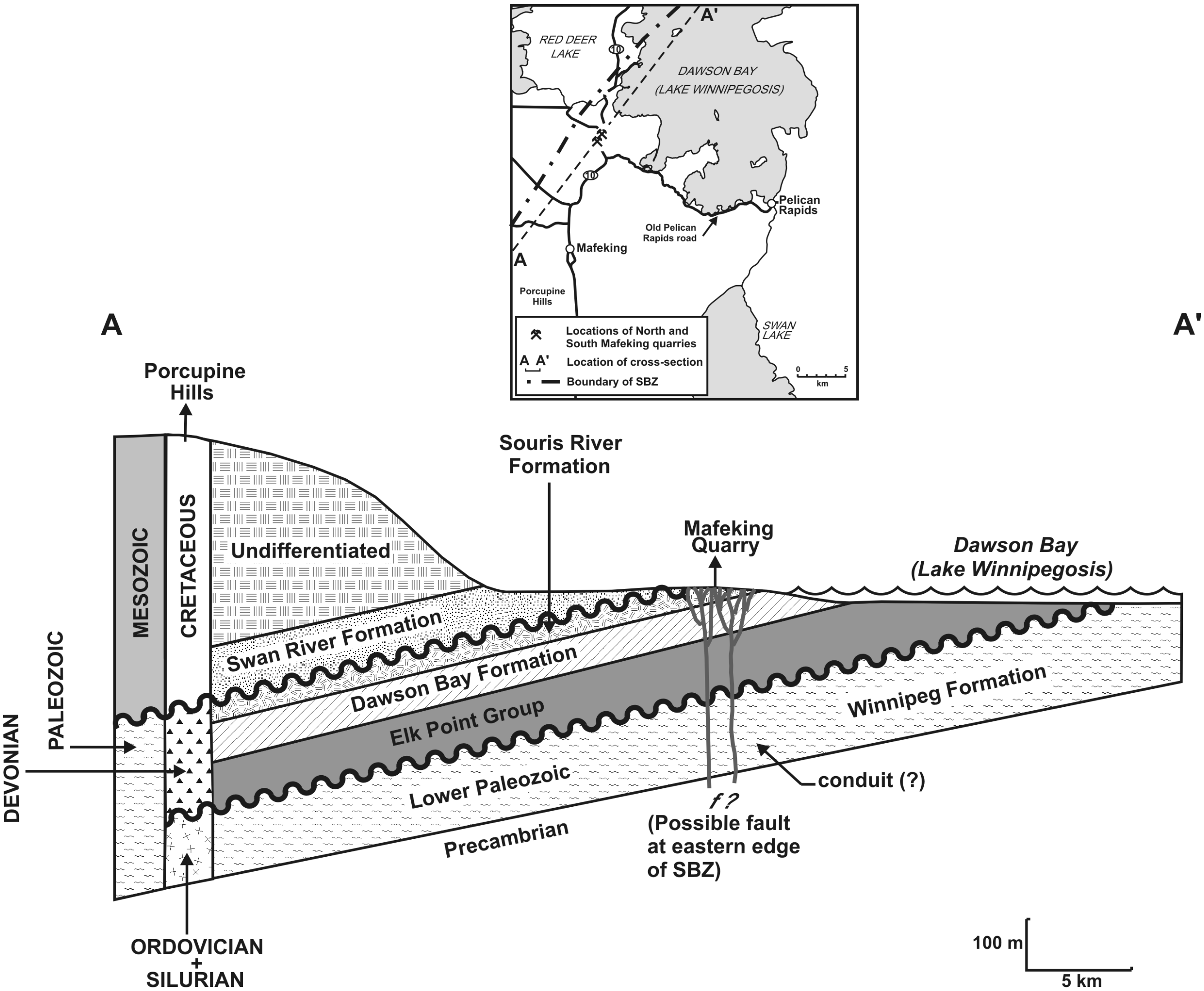

Figure 6: Schematic structural cross-section of west-central Manitoba, including the Mafeking quarries area.

Younger Cretaceous sedimentary rocks overlie the Swan River Formation and form the core of the Porcupine Hills (Figure 6) southwest of Dawson Bay. The formations present include the Ashville, Favel, Morden, Niobrara and Pierre, and the rocks consist of sand and shale (Figure 2). The highest stratigraphic bed is the Millwood Member of the Pierre Shale.

Devonian

Souris River Formation (Point Wilkins Member)

Dolomitic Limestone Beds (DLB): This unit consists of mottled orange to brown, thin- to medium-bedded, finely granular dolomitic limestone, locally containing stromatoporoids. It is best developed at the Mafeking quarries and at the junction of Highway 10 and the Old Pelican Rapids road, and has a maximum thickness of approximately 5 m. The upper surface in the Dawson Bay area is erosional. This is a hostrock for Prairie-type mineralization.

Micritic Limestone Beds (MLB): This unit consists of resistant, thick-bedded, light grey to yellow-buff micritic limestone with some minor dolomitic limestone. It is typically developed in the Big Rock area (Dawson Bay) and in the Mafeking quarries, and is recognizable on islands on Swan Lake. It ranges in thickness from 18 to 21 m and is a host rock for Prairie-type mineralization.

Argillaceous Limestone Beds (ALB): This unit consists of grey to brown, argillaceous limestone with shaly partings. It is recognizable at Big Rock and a small exposure is present in the South Mafeking Quarry. It is typically 11–15 m in thickness.

First Red Beds: This nonfossiliferous unit consists of red to green, calcareous and noncalcareous shale with some interbeds of argillaceous dolomite. Minor breccia is present and it is typically 2–14 m in thickness.

Dawson Bay Formation

Upper Member (D): This yellow-brown saccharoidal and fragmental limestone contains abundant fossils. It ranges in thickness from 6 to 18 m, and outcrops in the vicinity of the Steeprock River bridge.

Middle Member (C): This blue-grey to green-grey argillaceous limestone with calcareous shale is very fossiliferous. It is typically 8–16 m thick.

Lower Member (B): This is a yellow-grey, thin-bedded, nodular, fossiliferous limestone and dolomitic limestone that contains some shaly partings. It ranges in thickness from 6 to 24 m.

Second Red Beds: This red to green-grey, noncalcareous shale with some argillaceous limestone and limestone can be brecciated and is barren of fossils. It ranges in thickness from 6 to 17 m.

Winnipegosis Formation

Transitional Beds: Where present, these beds consist of dark grey, laminated, brecciated, calcareous dolomite (mudstone). It probably represents the material remaining after dissolution of the Prairie Evaporite. Its thickness ranges from 0 to 12 m.

Upper Member: This member consists of massive to thick-bedded, yellow-grey, vuggy dolomite with abundant fossils. Steeply dipping beds flank some carbonate mounds. Scattered reef mounds occur in the Dawson Bay area. Maximum thickness of the Upper Member is 54 m. In areas of intercarbonate mound development, the Upper Member is relatively thin and consists of grey, thin-bedded and laminated bituminous dolomite. It ranges in thickness from 1 to 13 m.

Lower Member: This member consists of a ‘platform’ carbonate facies of light brown, bedded, granular dolomite. It ranges in thickness from 11 to 18 m.

Structure

Superior Boundary Zone–Birdtail-Waskada Axis

An important feature that possibly affects deposition of Devonian sedimentary rocks in the outcrop belt, including the Dawson Bay area, has been referred to by McCabe (1967) as the Birdtail-Waskada Axis (Figures 7, 8). This axis is a continuation in the subsurface of the boundary between the Trans-Hudson Orogen (to the west) and Superior Province (to the east). The zone between these boundaries is called the Superior Boundary Zone (SBZ). The southern extension of this boundary is found to underlie the northern part of the Devonian outcrop belt in the vicinity of Dawson Bay. It coincides with the edge of the Devonian Winnipegosis Formation fringing bank and with the present eastern solution edge of the salt beds of the Prairie Evaporite.

Winnipegosis Formation reefs in the Dawson Bay and Swan River areas seem to be present along the boundary zone and probably reflect some basement involvement (such as fault reactivation). Dietrich et al. (1997) undertook a detailed analysis of the Birdtail-Waskada Axis and the underlying Precambrian basement as part of a regional study of basement-cover relationships in the Williston Basin that incorporated potential-field, seismic-reflection and well data. Seismic reflection profiles (Figures 7, 8) indicate that the boundary zone is marked by anomalous basement surface features, including faults and fault blocks, monadnocks, and a low-angle (west-side-down) hinge line. The Birdtail-Waskada Axis occurs over the SBZ. Activation of basement-controlled faults, in particular, probably affected regional hydrodynamic patterns, in turn controlling dissolution of Devonian evaporite and dolomitization of Lower Paleozoic carbonate rocks. Accordingly, Phanerozoic strata overlying the SBZ may have significant mineral-resource potential.

Salt dissolution and collapse have occurred throughout the entire Devonian outcrop belt (Figure 4), from The Narrows area of Lake Manitoba to the Dawson Bay area of Lake Winnipegosis. Norris et al. (1982) documented a minimum of 90 m of salt removed in the Dawson Bay area and suggested that all salt dissolution and collapse occurred in post-Devonian, or at least in post–Souris River Formation, time.

Numerous coreholes in the Dawson Bay area have penetrated the base of the Ashern Formation. From these data, it was possible to determine a strike of N35°W and a dip of approximately 1.7 m/km to the southwest of the Ashern Formation in the map area. In contrast, immediately west of the Manitoba-Saskatchewan boundary in Saskatchewan, the regional trend of the Ashern Formation is N65°W. These data indicate a relatively sharp structural flexure, immediately west of the map area, that is believed to be a synclinal axis. This feature appears to represent the southwestward extension of the Moose Lake Syncline (Figure 3; McCabe, 1967).

For much of the route of the old Pelican Rapids road (Figure 1; in back pocket) across the proximal end of the Salt Point peninsula, the road bed consists of bedding plane surfaces of hard, resistant beds with pronounced undulations consisting of closely spaced reef mounds in the underlying Winnipegosis Formation. Local relief on these reefs is at least 46 to 52 m and may reach a maximum of 76 to 91 m above the level of the interreef beds (Norris et al., 1982). In sharp contrast to this structurally complex area is an area of relatively flat lying Souris River Formation that outcrops in the area of The Big Rock peninsula (an area of high relief), including the Mafeking quarries area. It is possible that the entire Dawson Bay area may represent a single large bank or reef complex, and its location on the subsurface trend of the SBZ may be an important factor.

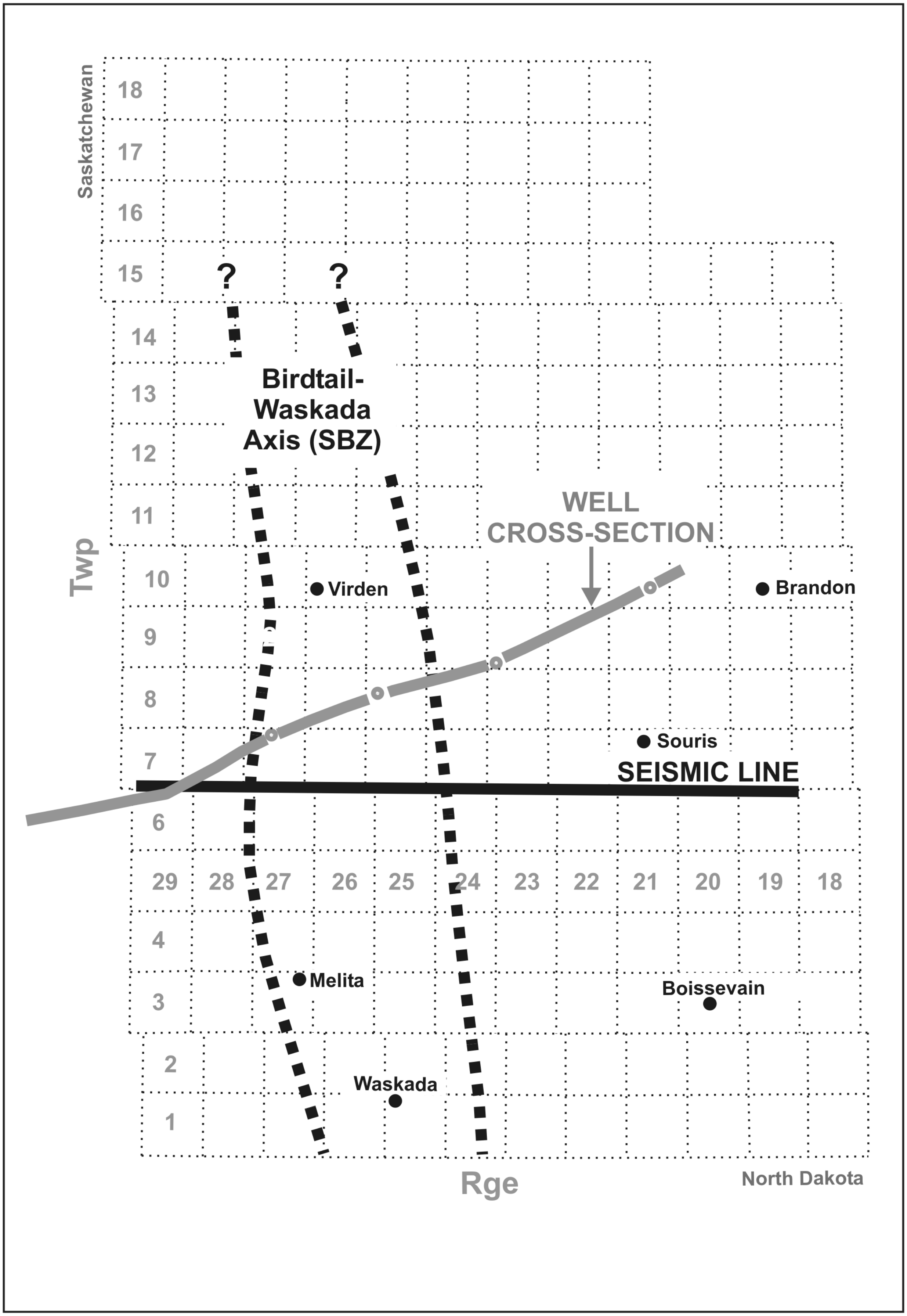

Figure 7: Location of well cross-section and seismic line in southwestern Manitoba (Dietrich et al., 1997).

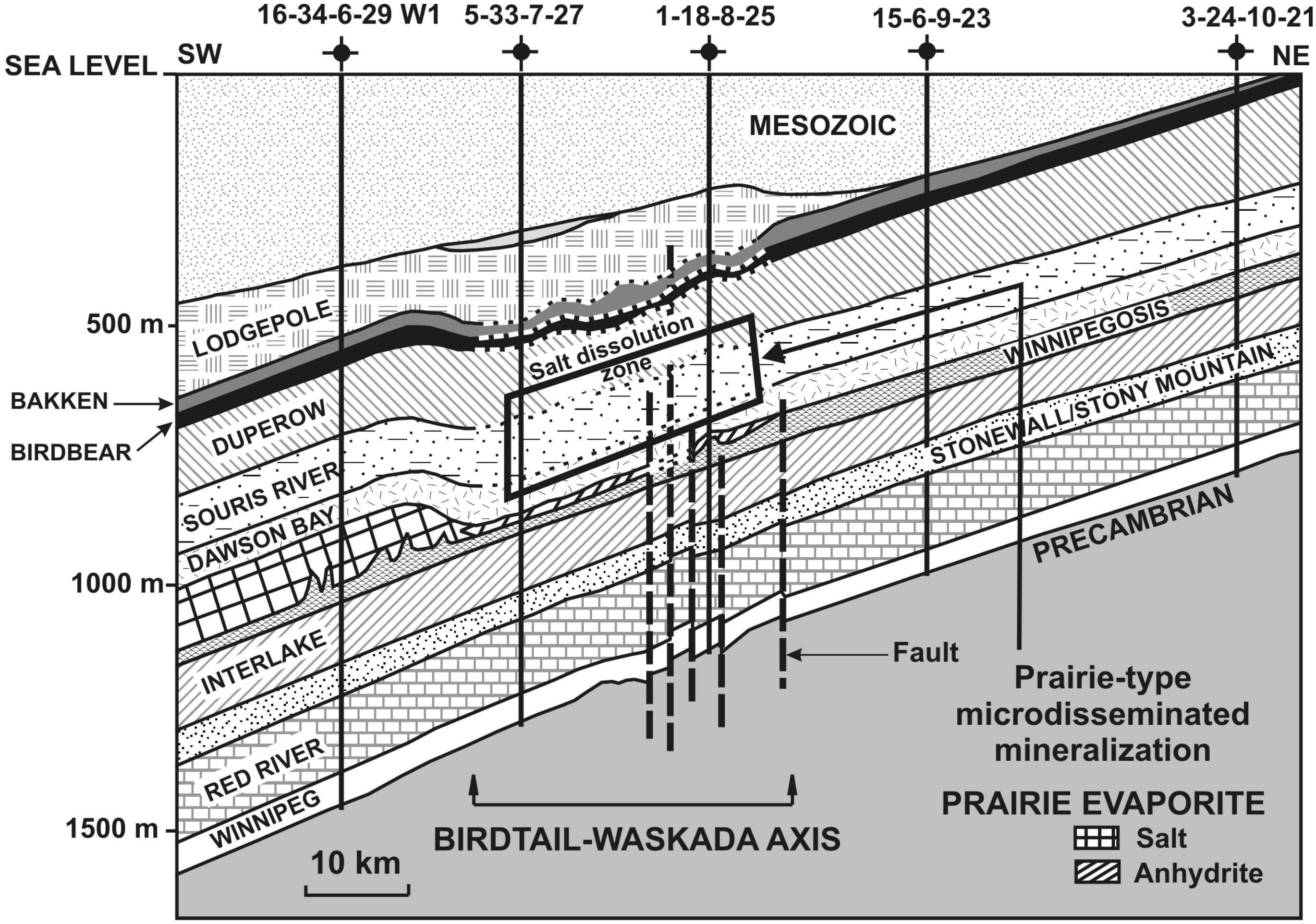

Figure 8: Structural cross-section of southwestern Manitoba, based on seismic and corehole data (Dietrich et al., 1997).

Structural lineaments and other anomalies

Abundant Phanerozoic drillcore data from above the SBZ in the William Lake area (140 km northeast of Dawson Bay) suggest that tectonism was active during Lower Paleozoic time (Bezys, 1996a). Relief differences on the surface of the Precambrian are as much as 29 m between drillholes spaced half a kilometre apart. Some of these structures are aligned with northeast-trending topographic lineaments evident on airphotos. A possible driving force is basement reactivation along old fault surfaces, as suggested by Dietrich et al. (1997) along the Birdtail-Waskada Axis in southwestern Manitoba. Other anomalous structures present along the trend of the SBZ (between William Lake and Dawson Bay) include Ochre Lake (Bezys, 1996b), a post-Silurian disruption of in situ bedrock, and Mesozoic accretionary lapilli tuff in the Denbeigh Point area (Bezys et al., 1996). This suggests that, during Phanerozoic time, the SBZ may have been active and was accompanied by reactivation of basement structures.

Evidence of prominent lineament structures that may reflect reactivated faults in the Dawson Bay area is presented in Figures 9 to 12 (Figures 10 and 11 in back pocket). Figure 9 depicts the location of cross-section B-B’. Stratigraphic cross-section B-B’ (Figure 10; in back pocket) displays the relatively flat lying Devonian stratigraphy of the area when reconstructed using the top of the Ashern Formation as datum. A slight synclinal flexure in the stratigraphy is present at the Red Deer River, which is the approximate location of the western boundary of the SBZ. In contrast, the structural cross-section B-B’ (Figure 11; in back pocket), which represents present-day topography, shows numerous undulations in the stratigraphy. Defined and questionable faults are indicated on both cross-sections, as determined by geophysics (*see* ‘Geophysics’ section for further information).

Figure 12 depicts prominent lineament trends in the Dawson Bay area that indicate basement reactivation along faults. These are the Rice River, Red Deer River, Mafeking Creek, Steeprock River and Bell River fault zones. The Red Deer River fault zone is indicated in cross-section B-B’ (Figures 10, 11; in back pocket) and also represents the western boundary of the SBZ. Aeromagnetic map 7724G (Geological Survey of Canada, 1969b) clearly displays the boundary between highly magnetic, possibly mafic rock types and low-magnetic, possibly granitic rock types along the Red Deer River fault zone.

Prairie-type microdisseminated mineralization in the Dawson Bay area

Mafeking quarries

The bedrock at the Mafeking quarries consists of the Point Wilkins Member of the Upper Devonian Souris River Formation

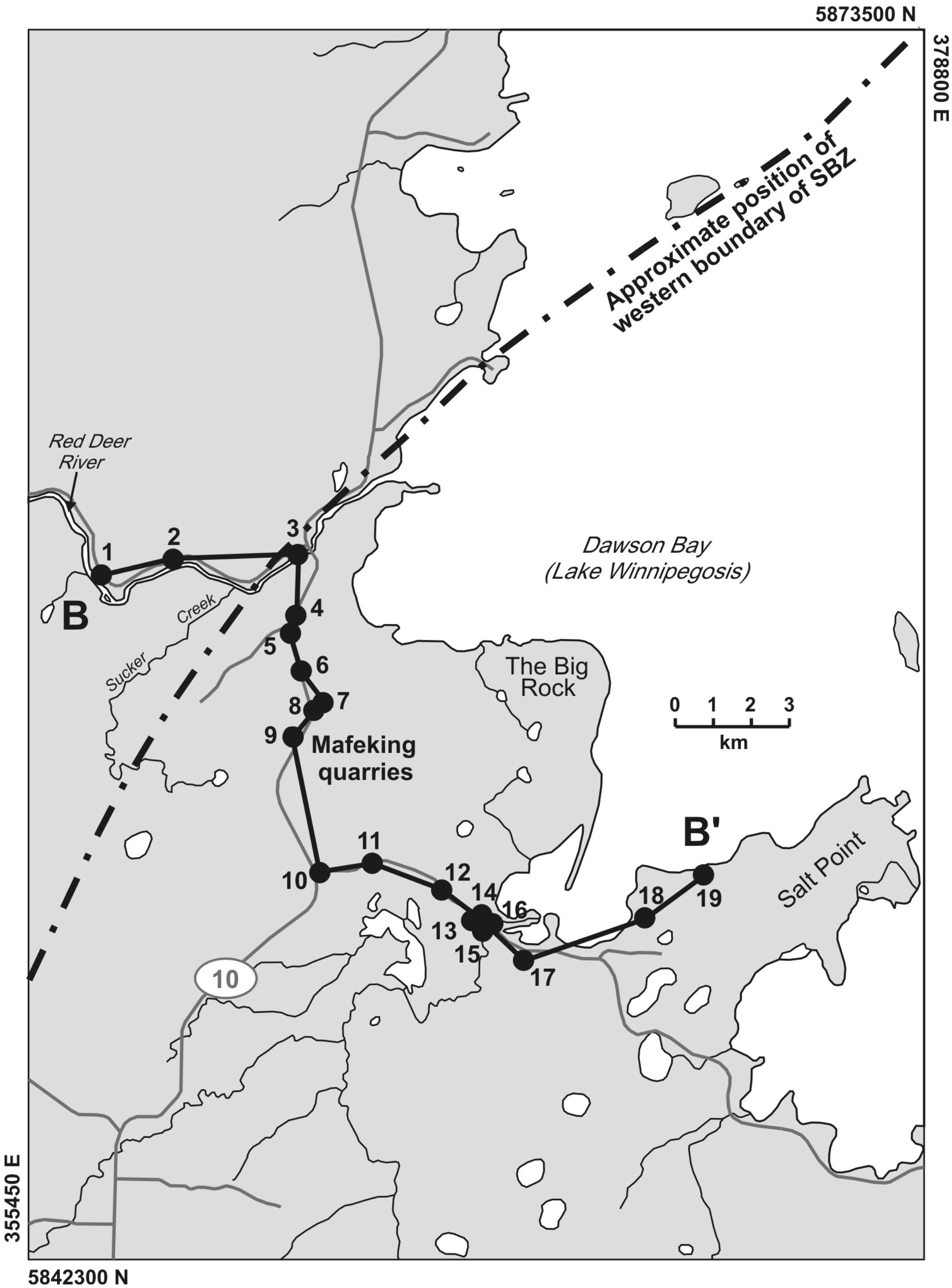

Figure 9: Location of stratigraphic and structural cross-sections B-B’, Dawson Bay area.

(Figure 5), a buff-yellow, mottled, micritic and fossiliferous limestone (MLB) that has been quarried for high-Ca limestone. These beds are overlain by a strongly oxidized, rusty red to brown, altered, mottled, fossiliferous dolomitic limestone (DLB), referred to as the ‘oxide cap’. The units vary in thickness in the North Mafeking Quarry from 5 to 10 m and from 1 to 5 m, respectively. These two rocks types are the hostrocks for Prairie-type microdisseminated mineralization. In the South Mafeking Quarry, a small exposure of the underlying Argillaceous Limestone Beds (ALB) is present.

The two quarries examined for this study are situated 16 km north of the town of Mafeking and were operated by CBR Cement Ltd. (Regina) for the extraction of high-Ca limestone (Figure 1; in back pocket). Within the quarries, a total of 23 solution chimneys has been located, mapped and sampled since 1996 (Figures 13, 14). Twenty-one of these chimneys were located in the North Quarry, whereas only two were identified in the rehabilitated South Quarry. Rehabilitation of the South Quarry and extensive till infill may have concealed further examples of solution chimneys. Detailed maps of the quarries can be found in Bezys et al. (1997b, c). Table 1 is a list of brine-spring sampling sites visited in NTS areas 63C and 63F3 in 1997.

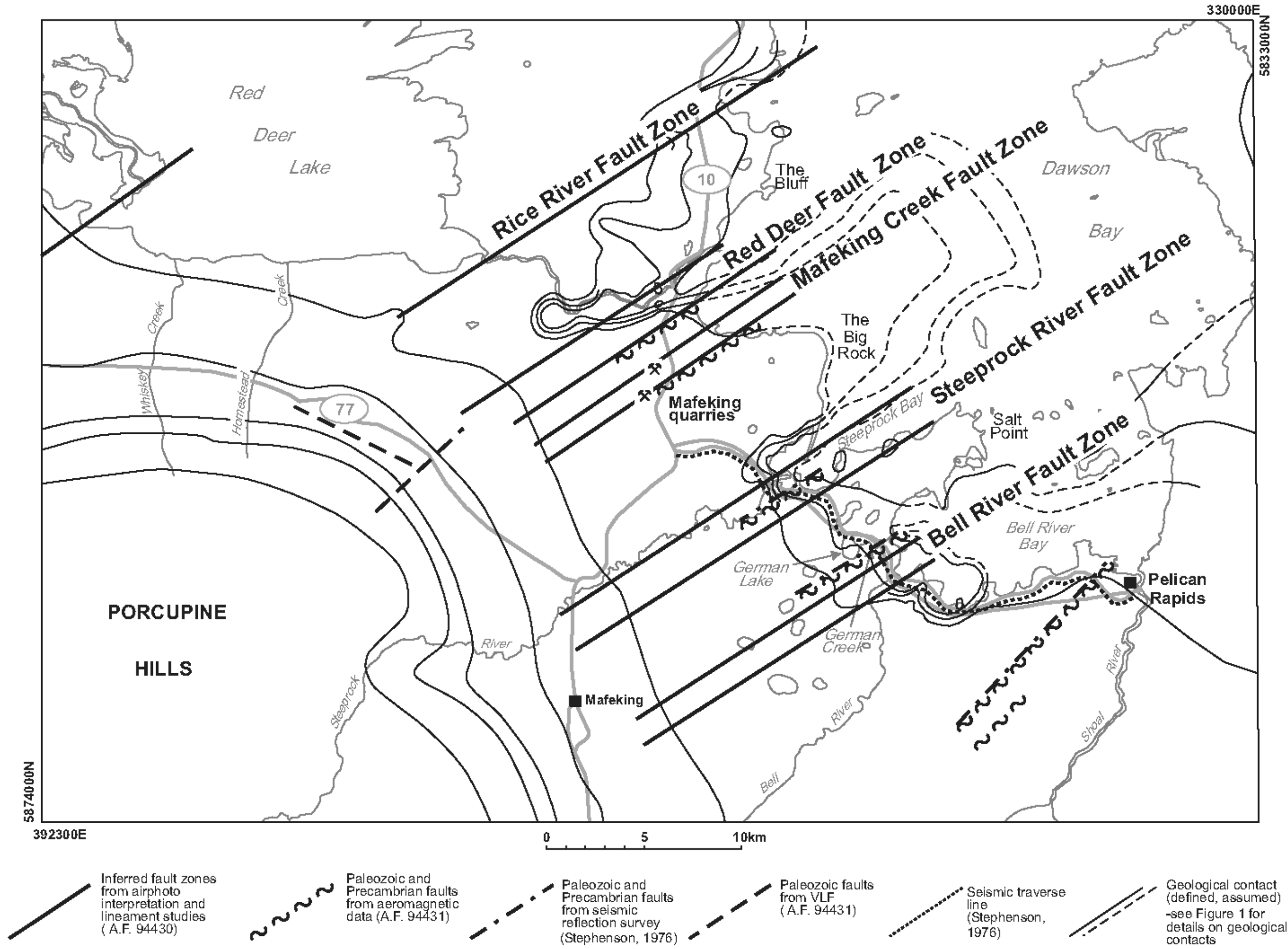

Figure 12: Major lineaments, Dawson Bay area.

Solution chimneys

The solution chimneys are primarily developed within the relatively nonoxidized high-Ca limestone (MLB) of the Point Wilkins Member, although good examples of these features have been documented within the overlying oxidized member (DLB). The relative paucity of these features in the oxidized member may be a function of erosion and removal during quarry development. The oxidized nature of the DLB is attributed to fluid flow from the solution chimneys laterally through the more permeable and oxidized unit. The MLB, although described as relatively unaltered, are locally characterized by disseminated marcasite nodules (ranging from <1 to 10 cm in diameter), greenish grey argillic alteration, and mottling that intensifies with proximity to the solution chimneys.

Solution chimneys occur singly or in clusters as inverted, conical features with a 1–8 cm thick siderite-rich rind that represents one type of alteration in the MLB and DLB carbonate units (Figure 15). The solution chimneys range in width from 10 to 25 m. They appear to be 10 m in height, although it should be noted that the lower 10 m of the North Mafeking Quarry is flooded. In cross-section, the solution chimneys exhibit a relatively consistent lithological progression from an outer, siderite-altered carbonate rind to greenish, banded clay infill with inclusions of elongate, cobble-sized, silica-rich rocks near the rind-clay interface. The siliceous rocks are referred to as sinter. Barite rosettes have been reported from sand infilling the cores of solution chimneys (G. Lammers, pers. comm., 1988), as well as in sand/clay cavities to the east of the North Quarry. Figures 16 and 17 depict observed and reconstructed views, respectively, of a solution chimney. The original conduit was probably a fracture or fault that allowed for the eventual dissolution of the carbonate host rocks by upward brine flow (Figure 6). These brines also transported metals. Figure 18 depicts the difference in metal concentration (ppm) between various rock types from the solution chimneys within the North Quarry.

The siliceous sinter is cherty at its outer edge and porous in its core, or has a dense core with concentric banding. It is commonly rusty weathered, contains finely disseminated marcasite and/or pyrite, and is coated with green clay. The sinter is only observed within the solution chimneys.

The cores of solution chimneys are often filled with grey-white sand and green-grey clay that were originally interpreted to represent Cretaceous Swan River Formation ‘infill’ and, for many years, the solution chimneys were described as karst features or

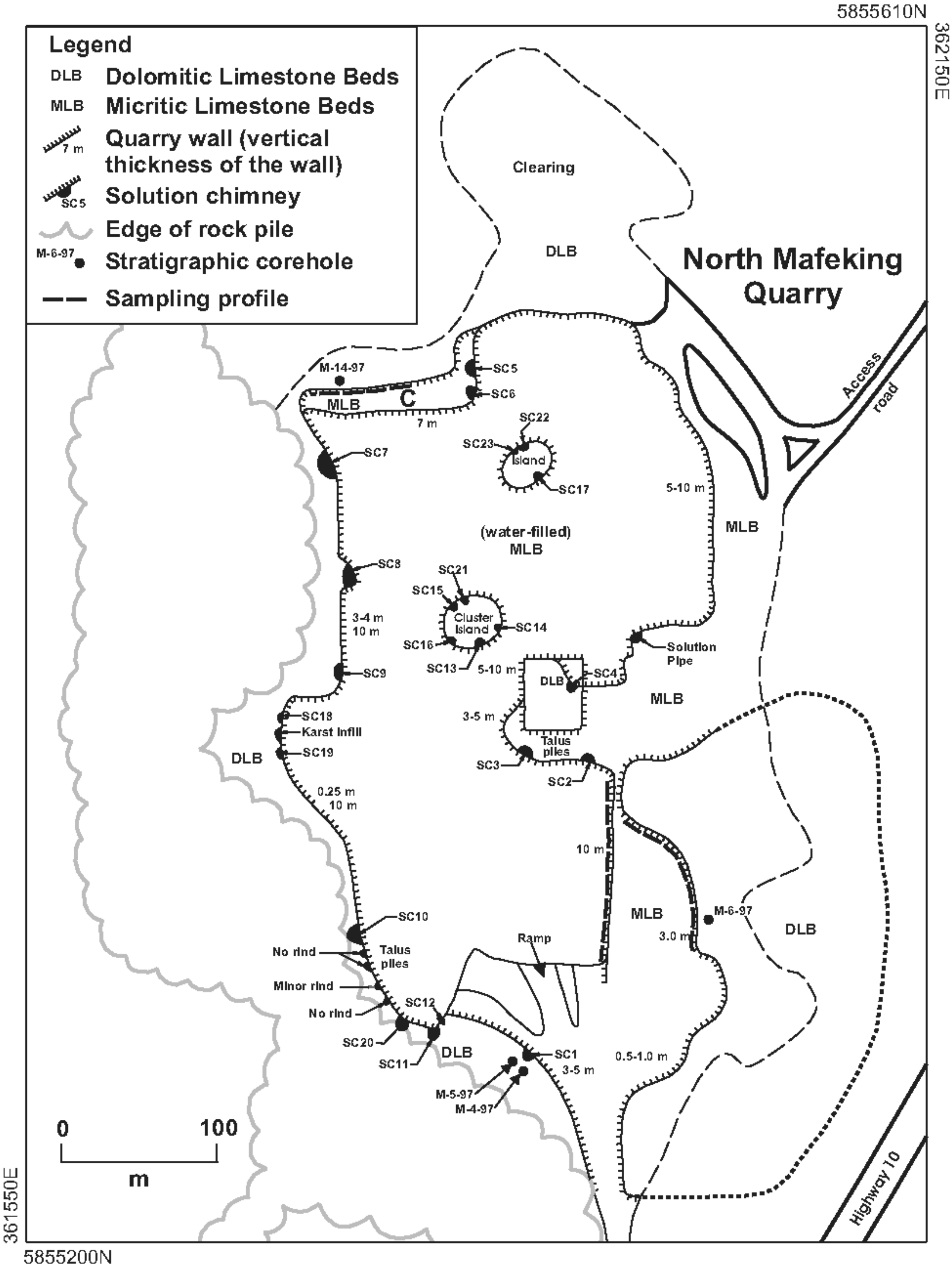

Figure 13: Detailed map of the North Mafeking Quarry, indicating solution-chimney locations.

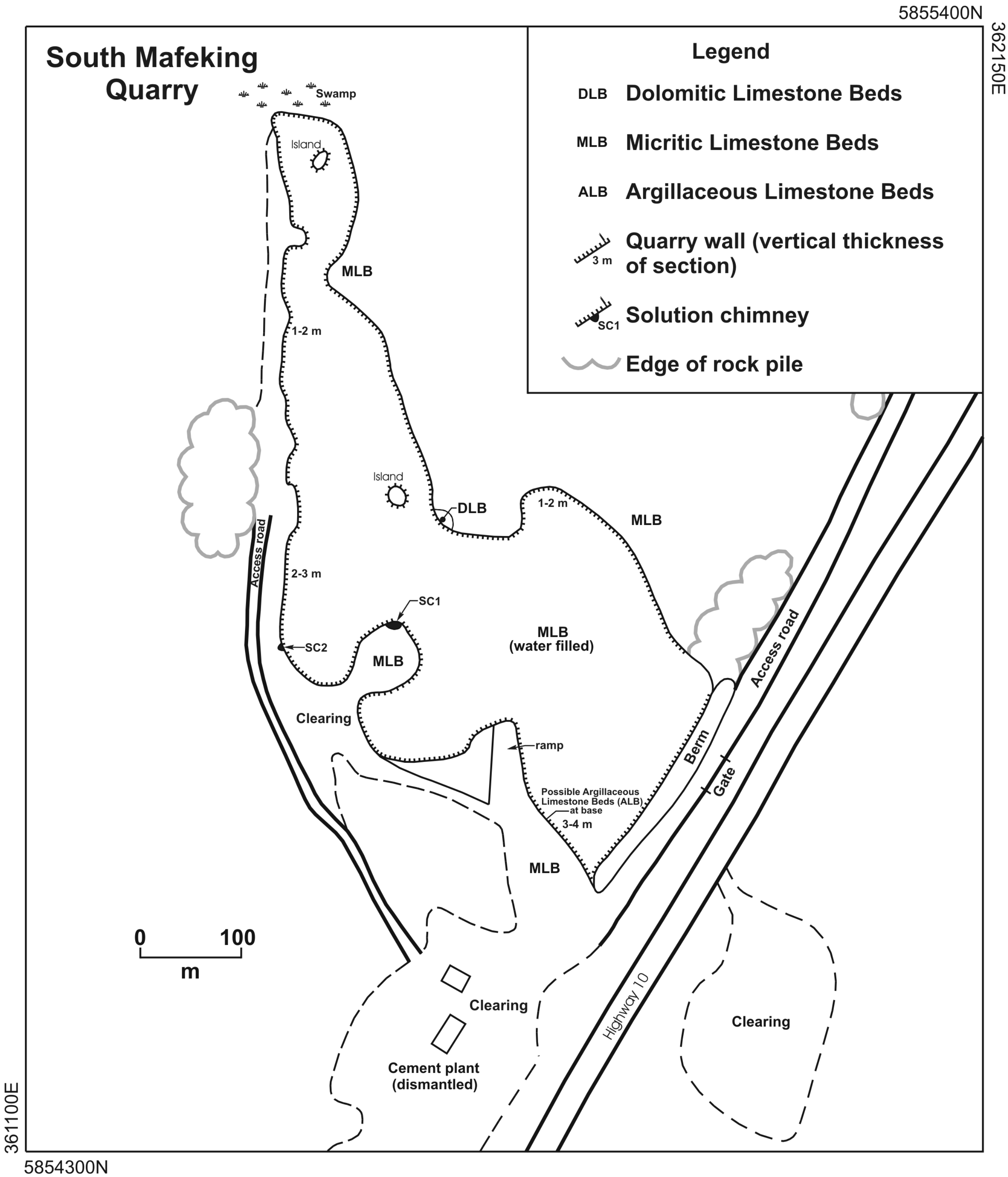

Figure 14: Detailed map of the South Mafeking Quarry, indicating solution-chimney locations.

caves (Bezys and McCabe, 1996). Recent micropaleontological work on the clay residuum, however, indicates a Late Devonian age based on the conodont assemblage (McCracken, 1996, 1999), and the clay is now interpreted to represent argillaceous residue from the dissolution of a decalcified Devonian limestone (Fedikow et al., 1996). Two samples sent to the Geological Survey of Canada in 1996 contained conodonts; of the five samples sent in 1998, three were barren.

The samples were initially processed using micropaleontological (foraminifer) techniques (McNeil, 1996). Unfortunately, an age could not be determined using these techniques. Another fraction of the samples was then processed for conodonts (McCracken, 1996, 1999). The residue remaining consisted of the following: unconsolidated, fine-grained quartzose sand, notably rounded to subrounded; muscovite, abundant to common; minor secondary (?) calcite; minor amounts of pale greyish green clay; common euhedral crystals of quartz; rare fragments of brown organic-rich or coaly clay; and rare cubic crystals of pyrite or

Table 1: Brine-spring sampling sites, Dawson Bay area, 1997.

Sample no.	UTM location	UTM zone	NTS map sheet
88-97-DB14	5856231N, 362648E	14	63C14
88-97-DB19	5858025N, 362175E	14	63C14
88-97-DB24	5849525N, 367325E	14	63C15
88-97-DB27	5863125N, 364125E	14	63C14
88-97-DB28	5862650N, 363250E	14	63C14
88-97-DB30	5859550N, 360575E	14	63C14
88-97-DB31	5859875N, 358725E	14	63C14
88-97-DB33	5856675N, 357175E	14	63C14
88-97-DB34	5857725N, 356425E	14	63C14
88-97-DB35	5860800N, 362500E	14	63C14
88-97-DB36	5860300N, 362163E	14	63C14
88-97-DB38	5860692N, 363400E	14	63C14
88-97-DB39	5859300N, 361500E	14	63C14
88-97-DB40	5858750N, 361400E	14	63C14
88-97-DB44	5859650N, 356125E	14	63C14
88-97-DB45	5859150N, 356250E	14	63C14
88-97-DB47	5858950N, 356350E	14	63C14
88-97-DB51	5859000N, 359275E	14	63C14
88-97-DB52	5857200N, 358325E	14	63C14
88-97-DB53	5851500N, 377725E	14	63C15
88-97-DB54	5846063N, 372969E	14	63C15
88-97-DB55	5850775N, 373625E	14	63C15
88-97-DB57	5858000N, 356375E	14	63C14
88-97-DB58	5851425N, 371060E	14	63C14
88-97-DB59	5870225N, 364000E	14	63C14
88-97-DB60	5871450N, 367450E	14	63C14
88-97-DB92	5851825N, 371060E	14	63C15
88-97-DB94	5851925N, 368125E	14	63C15
88-97-DB97	5851600N, 367100E	14	63C15
88-97-DB100	5852400N, 367200E	14	63C15
88-97-DB117	5846750N, 372100E	14	63C15
88-97-DB123	5843350N, 375400E	14	63C10
88-97-DB127	5848840N, 369550E	14	63C15
88-97-DB131	5883025N, 358720E	14	63F03

marcasite (McNeil, 1996). McNeil further stated that there is no evidence in the microfossil recovery to indicate that the conodont assemblage might have been reworked. McCracken (1996, 1999) also noted that the conodont fauna show good preservation with no visible weathering or erosion. The conodont fauna present were identified by Uyeno (*in* Norris et al., 1982) as being from the lower Frasnian (Devonian) Point Wilkins Member (Souris River Formation) of southwestern Manitoba. McCracken (1999) stated:

> The conodonts are predominantly unaltered (Conodont Alteration Index = 1) and some elements are almost white and appear bleached. The colour change varies from almost completely white to partly white and the surfaces of these elements still have a shiny appearance, indicating the colour change is not due to recrystallization. This type of colour alteration (within a sample of conodonts, and within a conodont) is found in hydrothermally altered conodonts (Rejebian et al., 1987).

Scanning electron microscope evaluation of samples of rind and siliceous sinter, collected from the study area, established the presence of a diverse suite of native metals, including Au and base-metal alloys and compounds (Figure 19, Table 2). In addition to the metals, the presence of compounds such as KCl and NaCl indicates a probable brine origin for the metals and associated compounds.

Drilling results

Eleven stratigraphic coreholes, totalling of 376.5 m, were drilled in the Dawson Bay area in 1997. Precambrian basement was not intersected. Of the four coreholes drilled in the North Mafeking Quarry (Figure 13), three were to intersect a solution chimney

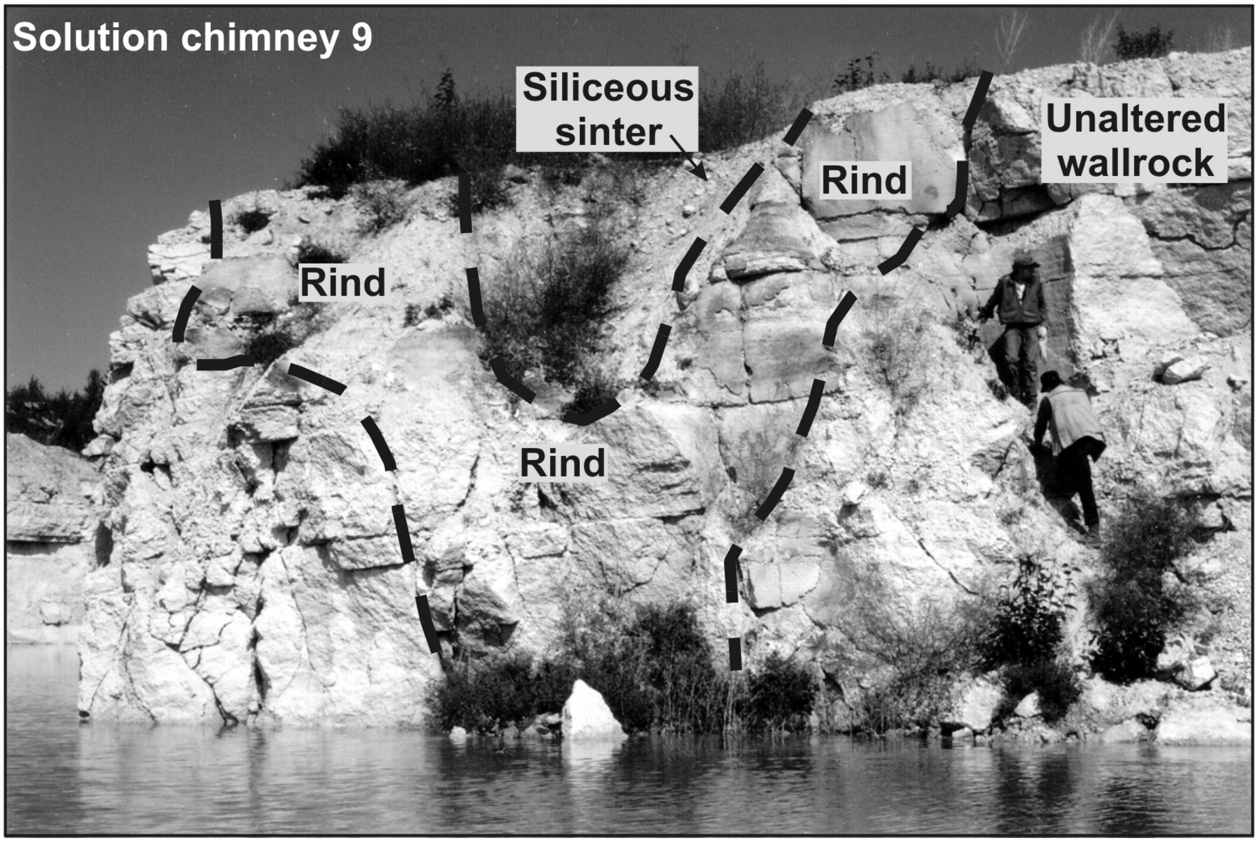

Figure 15: Photograph of solution chimney SC9, North Mafeking Quarry.

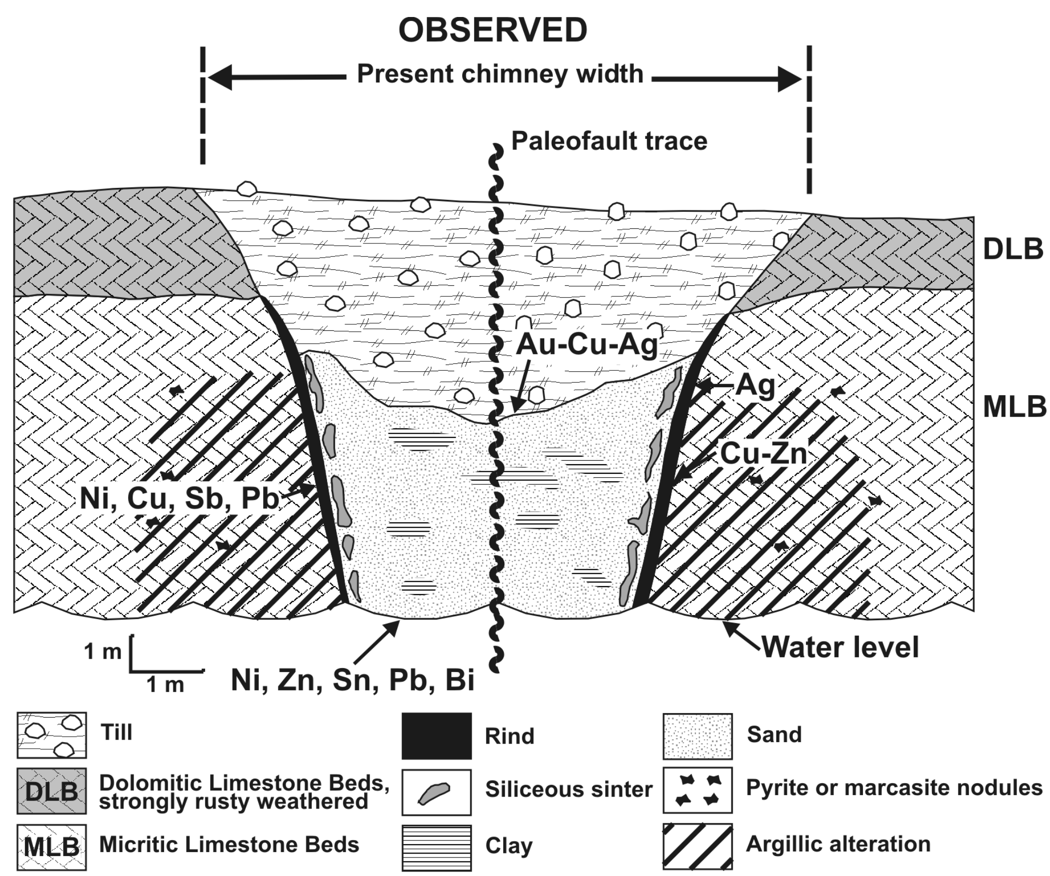

Figure 16: Observed cross-section of a typical solution chimney.

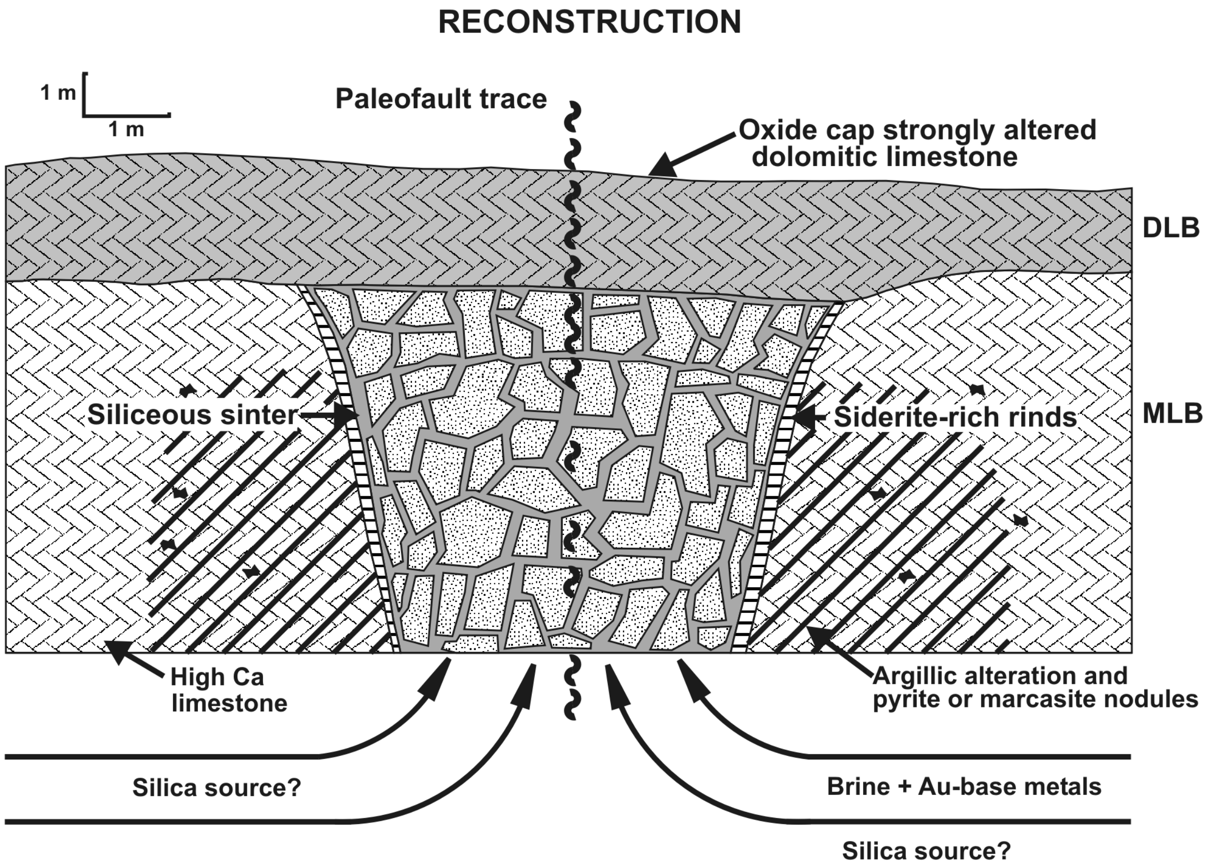

Figure 17: Reconstructed cross-section of a typical solution chimney.

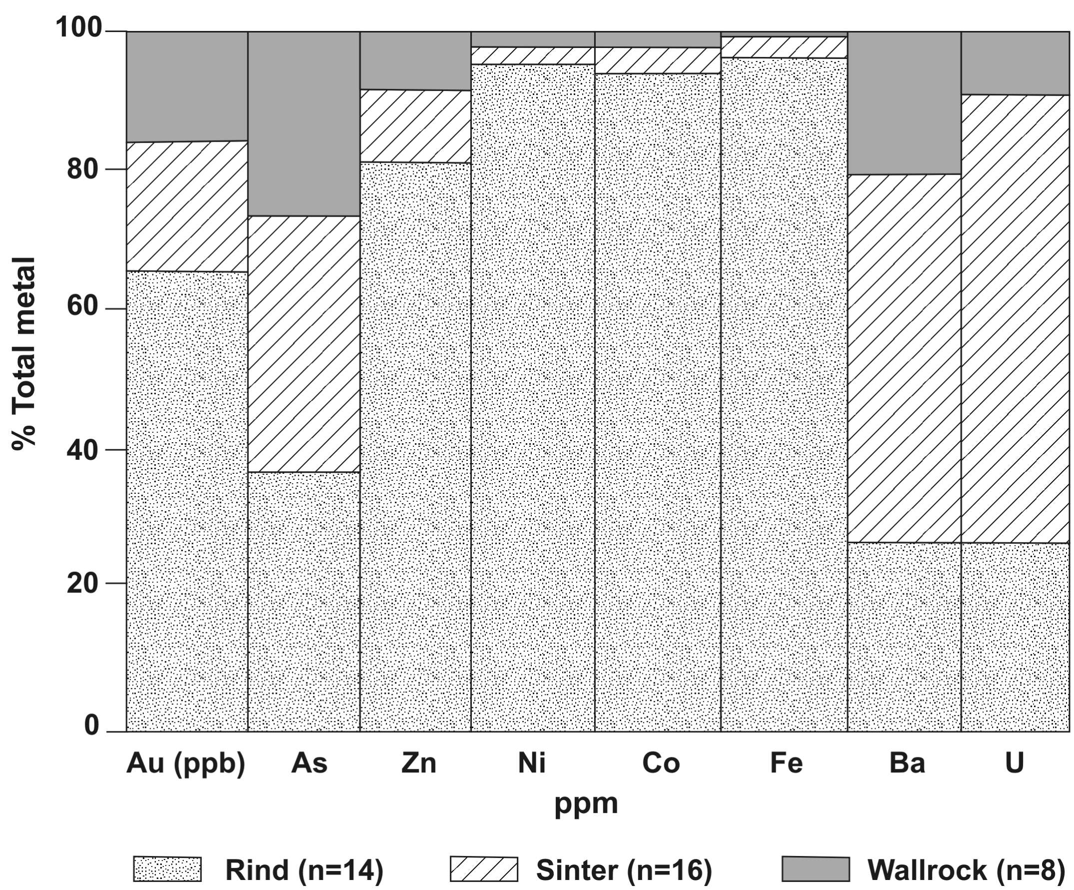

Figure 18: Metal variations (ppm except for Au, which is ppb) among various rock types (rind, siliceous sinter and wallrock), North Mafeking Quarry.

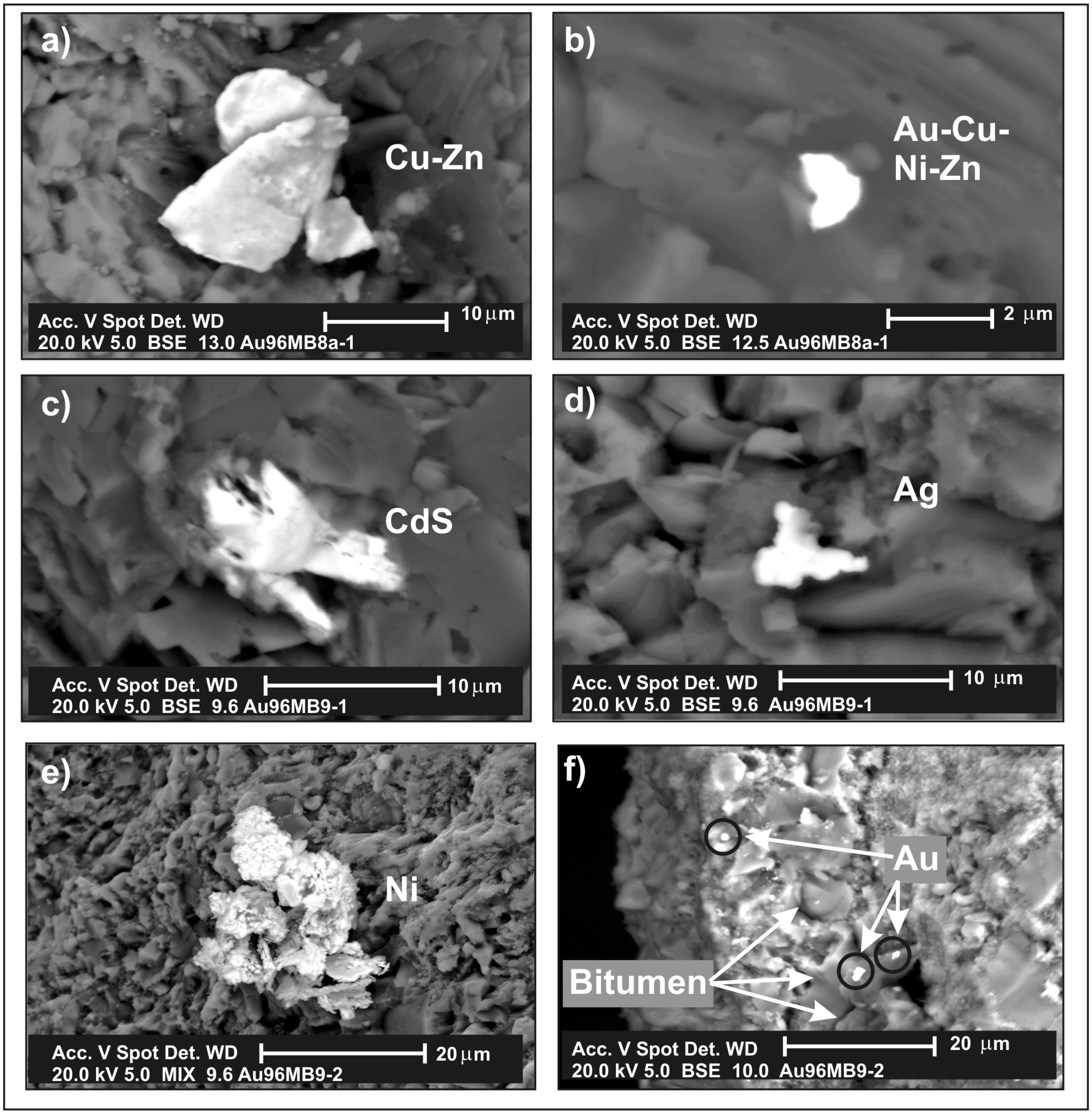

*Figure 19: Scanning electron micrographs of Prairie-type mineralization: **a)** group of three Cu-Zn particles in sample AU96MB8a-1, an iron oxide–coated cobble of Dawson Bay Formation dolomite taken from float in the Red Deer River salt spring; the dolomite has been partly dissolved and locally contains up to 15% marcasite, hematite or halite infilling dissolution pores. **b)** single 3 µm Au-Cu-Ni-Zn particle in dolomite sample AU96MB8a-1 (which also contains Ag-Fe-Ni-Cu) from a site of contemporary brine discharge, indicating that Prairie-type mineralizing processes are active at present; energy dispersive X-ray spectrometry (EDS) showed that Au is alloyed with Cu, Ni and Zn; an alternative explanation is that Au and Cu-Ni-Zn may be physically intermixed at submicron scales. **c)** abundant 3-10 µm CdS (greenockite or hawleyite) particles with marcasite, sphalerite, chalcopyrite, Cu-Zn alloy and native Ag, Ni, Cu, Sb and Pb in sample AU96MB9-1, a partly sideritized 'rind' developed in limestone of the Devonian Souris River Formation at the immediate margin of solution chimney SC1 at the south end of the North Mafeking Quarry. **d)** 5 µm native Ag particle in sample AU96MB9-1, a sideritized limestone of the Souris River Formation. **e)** 25 µm composite particle of native Ni in sample AU96MB9-2, a siliceous sinter boulder from the margin of solution cavity SC1 at the south end of the North Mafeking Quarry; the composite particle consists of numerous small (<1–5 µm) Ni particles that have coalesced to form a larger, sintered Ni particle; EDS analysis of some sintered Ni particles showed P, O and, less commonly, Al peaks, indicating the presence of a Ni (Al) phosphate mineral with native Ni in some cases. **f)** native Au particles associated with type I bitumen in sample AU96MB9-2; EDS analysis characterized the type I bitumen as predominantly C with minor peaks of some or all of Na, Al, P, S, Cl, K and Ca; a second bitumen, type II, is composed predominantly of C and S and may contain small amounts of Cl; the presence of two types of bitumen in many samples may indicate that two hydrocarbon systems were active in this region, an interpretation that is consistent with microbial reduction of metal-bearing oxyhalide complexes in brines and concomitant oxidation of organic material as a mechanism for formation of Prairie-type mineralization.*

Table 2: Summary of scanning electron microscope investigations on broken surfaces of samples from west-central Manitoba; samples were broken and rock chips were mounted and carbon-coated prior to analysis.

Sample	Location[1]/formation	Rock type	Mineralogy		Microdisseminated mineralogy[2]			Bitumen
			Major	Minor	Base metals	Precious metals	Others	
AU96MB8a-1	Red Deer River salt spring/Dawson Bay Formation (Lower Member)	Dolomite	Dolomite	Fe-S: *marcasite* Fe-O: *hematite* halite	Cu-S: *chalcocite* Cu-Zn: *alloy* Pb: *native* Zn: *native* Sn: *native*	Au-Cu-Ni-Zn: *alloy (1x3μm)* Ag-Fe-Ni-Cu: *alloy (1x2μm)*	Ba-S-O: *barite* La-Ce carbonate	C (Na, Al, P, S, Cl, K, Ca): *type I* C-S (Cl): *type II*
AU96MB8e-1	Highway 10 roadcut/ Dawson Bay Formation (Upper Member)	Dolomitic limestone	Calcite Dolomite	Fe-O: *hematite* Fe-O: *limonite* Fe-S: *pyrite* Fe-S: *marcasite*	Pb-Zn-P-O: Pb-Zn phosphate Cu-Cl: *$CuCl_2$* Cu-Zn: *alloy* Sn-Pb: *alloy* Pb: *native* Ni: *native*	none observed	Zr-Si-O: *zircon* Ce-La-Nd-P-O: *monazite* Ce-La-Nd carbonate	C (Al, S, Cl): *type I* C-S: *type II*
AU96MB8e-2	Highway 10 roadcut/ Dawson Bay Formation (Upper Member)	Partly silicified limestone	Calcite	Fe-S: *marcasite* Fe-O: *hematite*	Cu-Zn: *alloy* Pb (Cr): *native* Cd: *native*	none observed	Ce-La-Nd carbonate Ba-S-O: *barite* Ca-S-O: *gypsum* K-Al-Si-O: *K feldspar* Si-O: *quartz* Zr-Si-O: *zircon*	C (Na, Cl, K): *type I* C-S: *type II*

and one hole was drilled through the Devonian Souris River Formation Dolomitic Limestone Beds into the Dawson Bay Formation. The remaining seven holes were drilled at various locations in NTS 63C. Schematic cross-sections of the stratigraphy of the Dawson Bay area are depicted in Figures 9 to 11 (Figures 10 and 11 in back pocket). See Table 3 for a list of drillholes in NTS 63C, Appendix 1 for detailed core logs, and Figure 1 (in back pocket) for corehole locations.

Table 3: Drillholes in NTS 63C.

Drillhole no.	Well name	Location	Easting	Northing	NTS	Sheet	Elev. (m)	Period at top	Gp./fm. at top	Fm./mb. at top	Period at base	Fm. at base
M-14-71	Steeprock Road	04-23-044-25W1	365125	5851625	63C	15	280.4	Devonian	Souris River	Middle Point Wilkins	Devonian	Dawson Bay
M-10-71A	Steeprock Junction	04-21-044-25W1	362550	5851825	63C	14	282.0	Devonian	Souris River	Point Wilkins	Devonian	Dawson Bay
M-10-71	Steeprock Junction	04-21-044-25W1	362565	5851850	63C	14	282.0	Devonian	Souris River	Point Wilkins	Devonian	Dawson Bay
M-11-71	McArdle #1	07-08-045-25W1	361850	5858575	63C	14	274.0	Devonian	Elk Point Group	First Red Beds	Devonian	First Red Beds
M-13-71	McArdle Quarry	07-08-045-25W1	361950	5858500	63C	14	274.0	Devonian	Elk Point Group	First Red Beds	Devonian	Dawson Bay
M-07-72	Steeprock River Road	07-14-044-25W1	366550	5850450	63C	15	275.8	Devonian	Elk Point Group	Upper Dawson Bay	Devonian	Winnipegosis
M-08-73	Duck Bay	04-08-037-19W1	421453	5779006	63C	1	256.0	Devonian	Elk Point Group	Winnipegosis	Devonian	Winnipegosis
M-10-72	Red Deer River	08-17-045-25W1	362250	5860300	63C	14	259.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
M-08-72	Steeprock Bridge	05-13-044-25W1	367375	5850375	63C	15	254.5	Devonian	Manitoba Group	Upper Dawson Bay	Devonian	Second Red Beds
M-07-72	Steeprock River Road	07-14-044-25W1	366550	5850450	63C	15	275.8	Devonian	Manitoba Group	Upper Dawson Bay	Devonian	Winnipegosis
M-09-72	Bell River Road	16-27-043-24W1	374750	5844700	63C	10	271.3	Devonian	Manitoba Group	Upper Dawson Bay	Devonian	Dawson Bay
M-11-72	Dawson Bay Road	02-21-046-25W1	364050	5871175	63C	14	266.7	Devonian	Souris River	Upper Point Wilkins	Devonian	Dawson Bay
M-2-73	Pelican Bay	09-33-43-21W1	402800	5845125	63C	9	257.6	Devonian	Manitoba Group	Lower Dawson Bay	Silurian	Interlake Group
M-3-73	Cameron Bay	09-16-46-22W1	393539	5869704	63C	15	261.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
S-04-75	Steeprock Bridge Dome	03-01-044-25W1	367830	5846850	63C	15	275.0	?	breccia	breccia	Devonian	?
S-05-75	Steeprock Bridge Dome	03-01-044-25W1	367600	5846630	63C	15	255.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
M-26-92	Swan Lake (Bellsite)	02-21-041-24W1	373768	5822605	63C	10	259.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
M-25-92	Swan Lake (Bellsite)	02-21-041-24W1	373785	5822625	63C	10	259.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
M-06-92	Highway 10 Dome	02-28-045-25W1	363995	5863200	63C	14	261.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
M-27-92	Highway 10 Dome	02-28-045-25W1	363980	5863225	63C	14	261.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
M-01-91	The Bluff East	07-35-045-25W1	367475	5865150	63C	15	258.5	Devonian	Elk Point Group	Upper Winnipegosis	Devonian	Winnipegosis
M-02-91	The Bluff	07-35-045-25W1	367300	5865225	63C	15	263.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Ashern
M-09-90	The Bluff #5	08-35-045-25W1	367325	5864950	63C	11	262.1	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Ashern
M-08-90	The Bluff #4	01-35-045-25W1	367225	5864750	63C	15	259.1	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Ashern
M-08-89	Bellsite #1	02-21-044-24W1	373900	5822225	63C	10	259.0	Devonian	Souris River	Point Wilkins	Devonian	Souris River
M-10-89	Bellsite	02-21-041-24W1	374025	5822150	63C	10	259.0	Devonian	Souris River	Point Wilkins	Devonian	Souris River
M-05-88	The Bluff #2	08-35-045-25W1	356700	5865010	63C	15	260.7	Devonian	Elk Point Group	Upper Winnipegosis	Devonian	Winnipegosis
M-04-88	The Bluff #1	08-35-045-25W1	367415	5865015	63C	15	261.0	Devonian	Elk Point Group	Upper Winnipegosis	Devonian	Winnipegosis
M-06-88	The Bluff #3	09-35-045-25W1	367425	5865750	63C	15	261.6	Devonian	Elk Point Group	Upper Winnipegosis	Devonian	Winnipegosis
M-04-87	Salt Point E.	06-21-044-24W1	372610	5851900	63C	15	266.7	Devonian	Manitoba Group	Lower Dawson Bay	Silurian	Interlake Group
M-05-87	Salt Point W.	06-17-044-24W1	371010	5850350	63C	15	274.0	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Ashern
M-07-86	Steeprock Bridge	100/05-13-044-25W1/00	367375	5850375	63C	15	254.5	Devonian	Manitoba Group	Lower Dawson Bay	Silurian	Interlake Group
M-08-86	Steeprock River Park	100/08-14-044-25W1/00	367025	5850450	63C	15	254.6	Devonian	Manitoba Group	First Red Beds	Silurian	Interlake Group
M-03-85	Bell River	09-33-043-24W1	373325	5846100	63C	15	269.1	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Ashern
M-02-84	Bell River	16-33-043-24W1	373225	5846175	63C	15	264.3	Devonian	Manitoba Group	Middle Dawson Bay	Devonian	Winnipegosis

Table 3: Drillholes in NTS 63C. *(continued)*

Drillhole no.	Well name	Location	Easting	Northing	NTS	Sheet	Elev. (m)	Period at top	Gp./fm. at top	Fm./mb. at top	Period at base	Fm. at base
M-03-84	Bell River	09-33-043-24W1	373450	5845800	63C	10	268.2	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Winnipegosis
M-17-81	Steeprock Bridge	08-14-044-25W1	367000	5850475	63C	15	254.5	Devonian	Manitoba Group	First Red Beds	Devonian	Winnipegosis
HM-01-76	Devil's Point	01-24-045-19W1	427450	5850250	63C	16	262.4	Devonian	Elk Point Group	Winnipegosis	Devonian	Ashern
HM-03-76	Grenon Point	12-05-044-19W1	419850	5856250	63C	16	266.7	Devonian	Elk Point Group	Winnipegosis	Devonian	Ashern
HM-02-76	Rod Pt	13-14-044-19W1	424320	5849875	63C	16	254.5	Devonian	Elk Point Group	Winnipegosis	Devonian	Winnipegosis
Gulf Minerals Minitonas Prov.		100/03-29-036-25W1/00	362686	5765803	63C	3	313.6	Mesozoic	Mesozoic	Mesozoic	Ordovician	Winnipeg
Gulf Minerals Minitonas Prov.		100/13-10-036-26W1/00	353981	5772369	63C	3	328.0	Mesozoic	Mesozoic	Mesozoic	Ordovician	Winnipeg
Gulf Minerals Minitonas Prov.		100/01-28-036-26W1/00	355504	5775732	63C	3	313.6	Mesozoic	Mesozoic	Mesozoic	Ordovician	Red River
Gulf Minerals Minitonas Prov.		100/15-32-036-26W1/00	351749	5778790	63C	3	309.1	Mesozoic	Mesozoic	Mesozoic	Ordovician	Winnipeg
Sweet Grass Oil Structure Test Hole No. 16		100/06-07-036-27W1/00	341450	5771995	63C	3	342.9	Mesozoic	Mesozoic	Mesozoic	Cretaceous	Swan River
Shell Swan River		100/09-01-037-28W1/00	340852	5780343	63C	3	361.5	Mesozoic	Swan River	Swan River	Precambrian	Precambrian, weathered
M-07-78	Swan Lake	100/02-21-041-24W1/00	373780	5822525	63C	10	259.0	Devonian	Souris River	Souris River	Devonian	Ashern
M-09-89	Bellsite #2	102/02-21-041-24W1/00	373975	5822200	63C	10	259.0	Devonian	Souris River	Upper Point Wilkins	Devonian	Winnipegosis
Mafeking No. 2	N. MB. Oil Co	100/12-02-043-26W1/00	355525	5838225	63C	11	358.1	Mesozoic	Mesozoic	Mesozoic	Silurian	Interlake
Mafeking No. 3		102/12-02-043-26W1/00	355675	5838341	63C	12	347.5	Mesozoic	Mesozoic	Mesozoic	Precambrian	Precambrian
Granges Den-2		100/09-07-044-19W1/00	419225	5848200	63C	16	266.7	Devonian	Devonian	Devonian	Precambrian	Precambrian
Inco 63548	Salt Point West	100/03-20-044-24W1/00	371200	5851400	63C	15	266.7	Devonian	Elk Point Group	Upper Dawson Bay	Devonian	Dawson Bay
Inco 63547	Salt Point	100/09-21-044-24W1/00	373650	5852275	63C	15	266.7	Devonian	Elk Point Group	Upper Dawson Bay	Devonian	Winnipegosis
Husky Mafeking No. 1	South Pelican Rapids Road	100/06-16-044-25W1/00	363000	5851000	63C	14	273.7	Mesozoic	Mesozoic	Mesozoic	Silurian	Interlake
M-13-81	Pelican Rapids Road	100/02-21-044-25W1/00	363500	5851875	63C	14	282.0	Devonian	Elk Point Group	Upper Dawson Bay	Devonian	Dawson Bay
HBMS Mafeking No. 1	Steeprock Bay	100/06-24-044-25W1/00	368050	5851850	63C	15	281.9	Devonian	Manitoba Group	Dawson Bay	Silurian	Interlake
Cominco RP-3	Grand Is. Lake Winnipegosis	100/13-09-045-18W1/00	431200	5857875	63C	16	262.2	Devonian	Elk Point Group	Ashern	Precambrian	Precambrian
Cominco RP-92-6	Grand Is. Lake Winnipegosis	102/13-09-045-18W1/00	431550	5857775	63C	16	268.2	Devonian	Elk Point Group	Ashern	Precambrian	Precambrian, weathered
M-14-81	Highway 10 Roadcut	100/01-05-045-25W1/00	362210	5856775	63C	14	274.3	Devonian	Manitoba Group	Upper Dawson Bay	Silurian	Dawson Bay
M-11-81	NW of Mafeking Quarry	100/03-06-045-25W1/00	360000	5856875	63C	14	283.5	Devonian	Manitoba Group	Upper Dawson Bay	Silurian	Dawson Bay
M-12-81	NW of Mafeking Quarry	100/09-06-045-25W1/00	360550	5857280	63C	14	282.0	Devonian	Manitoba Group	Upper Dawson Bay	Silurian	Dawson Bay
M-15-81	NW of Mafeking Quarry	100/03-08-045-25W1/00	361740	5858100	63C	14	275.8	Devonian	Souris River	Lower Point Wilkins	Silurian	Dawson Bay
Husky Mafeking Prov. (STH)	South Red Deer river	100/11-08-045-25W1/00	361552	5859205	63C	13	266.7	Mesozoic	Mesozoic	Mesozoic	Precambrian	Precambrian, weathered
M-18-77	Red Deer Dome	100/03-17-045-25W1/00	361620	5859900	63C	14	270.0	Devonian	Manitoba Group	Lower Dawson Bay	Silurian	Ashern
Inco 63549	Smith Point	100/01-21-045-25W1/00	364000	5861500	63C	14	257.6	Devonian	Manitoba Group	First Red Beds	Silurian	Winnipegosis
Inco 63550	West of Bluff	100/10-32-045-25W1/00	362125	5865625	63C	14	274.3	Devonian	Manitoba Group	Upper Dawson Bay	Silurian	Winnipegosis
M-07-90	The Bluff #6	100/10-35-045-25W1/00	367000	5865490	63C	15	256.0	Overburden	Overburden	Overburden	Overburden	Overburden
D-47-76-2	Red Deer River #2	100/10-11-045-26W1/00	357000	5859300	63C	14	265.0	Devonian	Manitoba Group	First Red Beds	Silurian	Silurian
D-47-76-1	Red Deer River #1	100/14-12-045-26W1/00	358325	5859750	63C	14	265.0	Devonian	Manitoba Group	First Red Beds	Silurian	Silurian
M-03-73	Cameron Bay	100/09-19-046-22W1/00	393539	5869704	63C	15	261.0	Devonian	Manitoba Group	Lower Dawson Bay	Silurian	Interlake
Huskey Baden #3	North Porcupine Hills	10-31-044-26W1	350500	5856150	63C	14	269.7	Mesozoic	Mesozoic	Mesozoic	Silurian	Interlake
Huskey Baden #2	North Porcupine Hills	04-33-044-26W1	352875	5855250	63C	14	274.6	Mesozoic	Mesozoic	Mesozoic	Silurian	Interlake
Huskey Baden #4	North Porcupine Hills	14-36-044-27W1	348450	5856750	63C	14	271.9	Mesozoic	Mesozoic	Mesozoic	Devonian	Devonian
M-18-81	North of Hwy 10 Roadcut	07-05-045-25W1	362100	5857250	63C	14	274.3	Devonian	Manitoba Group	First Red Beds	Devonian	Upper Dawson Bay
Inco 63546	Salt Point East	11-22-044-24W1	374100	5852850	63C	15	274.3	Devonian	Manitoba Group	Lower Dawson Bay	Devonian	Upper Winnipegosis
M-04-97	North Mafeking Quarry	07-32-044-25W1	361965	5855308	63C	14	279.0	Devonian	Souris River	Middle Point Wilkins	Devonian	Middle Point Wilkins

Table 3: Drillholes in NTS 63C. *(continued)*

Drillhole no.	Well name	Location	Easting	Northing	NTS	Sheet	Elev. (m)	Period at top	Gp./fm. at top	Fm./mb. at top	Period at base	Fm. at base
M-05-97	North Mafeking Quarry	08-33-044-25W1	363929	5855302	63C	14	274.0	Devonian	Souris River	Middle Point Wilkins	Devonian	Middle Point Wilkins
M-06-97	North Mafeking Quarry	07-32-044-25W1	361777	5855463	63C	14	279.0	Devonian	Souris River	Middle Point Wilkins	Devonian	Second Red Beds
M-07-97	Dawson Bay	12-33-044-25W1	362619	5855935	63C	14	276.0	Devonian	Manitoba Group	Souris River	Devonian	Middle Point Wilkins
M-08-97	Dawson Bay Borrow Pit	12-33-044-25W1	362619	5855935	63C	14	276.0	Devonian	Souris River	Middle Point Wilkins	Devonian	Middle Point Wilkins
M-09-97	Tower Outcrop	02-08-045-25W1	361895	5858490	63C	14	274.0	Devonian	Souris River	Lower Point Wilkins	Devonian	Second Red Beds
M-10-97	Dawson Bay	15-12-044-25W1	368079	5849594	63C	15	263.0	Devonian	Dawson Bay	Second Red Beds	Devonian	Lower Winnipegosis
M-11-97	Dawson Bay	10-05-045-25W1	362112	5851289	63C	14	282.0	Devonian	Dawson Bay	Middle Dawson Bay	Devonian	Second Red Beds
M-12-97	Dawson Bay	04-21-044-25W1	362550	5851850	63C	14	283.5	Devonian	Souris River	Middle Point Wilkins	Devonian	Second Red Beds
M-13-97	West Swan Lake	02-30-041-24W1	370600	5823840	63C	10	269.0	Devonian	Souris River	Middle Point Wilkins	Devonian	Middle Point Wilkins
M-14-97	North Mafeking Quarry	07-32-044-25W1	361825	5855750	63C	14	278.0	Devonian	Souris River	Middle Point Wilkins	Devonian	Middle Point Wilkins
85-01	Steel Brothers	10-14-044-25W1	366625	5850550	63C	15	266.7	Devonian	Manitoba Group	Upper Dawson Bay	Devonian	Middle Dawson Bay
85-02	Steel Brothers	10-14-044-25W1	366475	5850850	63C	15	274.3	Devonian	Manitoba Group	Upper Dawson Bay	Devonian	Middle Dawson Bay
85-03	Steel Brothers	14-14-044-25W1	366100	5851100	63C	15	278.9	Devonian	Manitoba Group	Upper Dawson Bay	Devonian	Middle Dawson Bay
85-04	Steel Brothers	12-14-044-25W1	365800	5850675	63C	15	281.9	Devonian	Manitoba Group	Middle Dawson Bay	Devonian	Middle Dawson Bay

Geophysics

In 1997, four days were spent undertaking EM-31 and VLF-EM-16 geophysical surveys in the North Mafeking Quarry and surrounding areas to determine the response of electromagnetic techniques to mineralized solution chimneys.

The EM-31 and EM-16 units each require single operators and can resolve geophysical signatures to depths of approximately 6 and 20 m, respectively. These depths were considered adequate for the project. The EM-31 is a noncontacting terrain-conductivity meter, with the transmitter and receiver located at either end of a 4 m rod. The transmitting frequency is 9.8 kHz and measurements are recorded in siemens per metre (S/m). The accuracy of measurement is ±5% at 20 S/m. The instrument weighs 9 kg. In most cases, the conductivity itself is not diagnostic, but the way in which conductivity varies laterally and with depth is of great importance, since this permits the recognition of features as a result of their shape rather than their actual resistivity values. Table 4 gives the average conductivities of some sedimentary rocks. Readings can be recorded at regular station intervals, or continuous measurements can be recorded by leaving the instrument in the operating mode while traversing.

The EM-16 is a receiving electromagnetic unit and employs the transmitters of the various bases used for communicating with American submarines, which operate at frequencies of 15–25 kHz. The instrument weighs 1.6 kg and records both in-phase and quadrature components. Because the transmitters are usually situated at large distances from the test site, the surrounding material influences the results and large structures are delineated. The large transmitter-receiver separations should result in deeper penetration of the electromagnetic waves, but the higher frequencies employed limit the depth of investigation.

Table 4: Average conductivities of some sedimentary rocks.

Rock type	Conductivity (siemens per metre - S/m)
Limestone	2-3
Sand	11-12
Clay (dry)	19-20
Clay (wet)	45-50

Traverses were carried out over outcropping chimneys and/or the associated rubble. A traverse around the rim of the North Mafeking Quarry incorporated the discovery chimney (SC1). Figure 20 shows the locations of the traverses and the resulting data are shown in Figure 21. There is a definite decrease in conductivity over the chimneys, compared to the adjacent area, of approximately 1 S/m. This could be caused by the lower bulk density of the rubble compared to the surrounding solid rock. Although this drop in conductivity is noticeable in the EM-31 results, it was not detected with the EM-16 unit. The reason for this is that the EM-31 is capable of detecting smaller targets and is more sensitive to variations in conductivity. An outcropping karst structure was detected with the EM-31, based on its higher conductivity relative to the surrounding area. An area of high conductivity (up to 20 S/m), outlined along the ledge on the north rim of the quarry, could be caused by conductive material within a karst structure. Although the EM-16 survey did not contribute directly in locating the solution chimneys, it could be useful in delineating channels that transport the fluids.

Both methods have been demonstrated to be helpful in exploration. Induced-polarization surveys would be very useful methods, since the resistivity is measured along with the chargeability, which would be helpful in locating disseminated sulphides that could contain gold and other metals.

In 1997, Birch Mountain Resources Ltd. had topographic lineament studies carried out in their permit area in the Dawson Bay area (A.F. 94429, 'Structural Lineament Map'; 'Subcrop Geology and Inferred Structure Map'). In 1998, they carried out aeromagnetic and VLF surveys in the same area (A.F. 94430). This information, plus data from a previous seismic survey (Stephenson, 1976), provided positive identification of basement faulting in and around the areas of Salt Point and the Red Deer River (Figure 12). Figure 12 depicts fault zones that were originally interpreted by means of lineament studies and geophysics. A second look at the aeromagnetic and VLF data submitted by Birch Mountain Resources Ltd. (A.F. 99431) found faulting only in the areas indicated. What was most interesting was the correlation between the Birch Mountain aeromagnetic and VLF data and the seismic-reflection survey conducted in 1976 by the University of Manitoba (Stephenson, 1976). Three areas of faulting crosscut

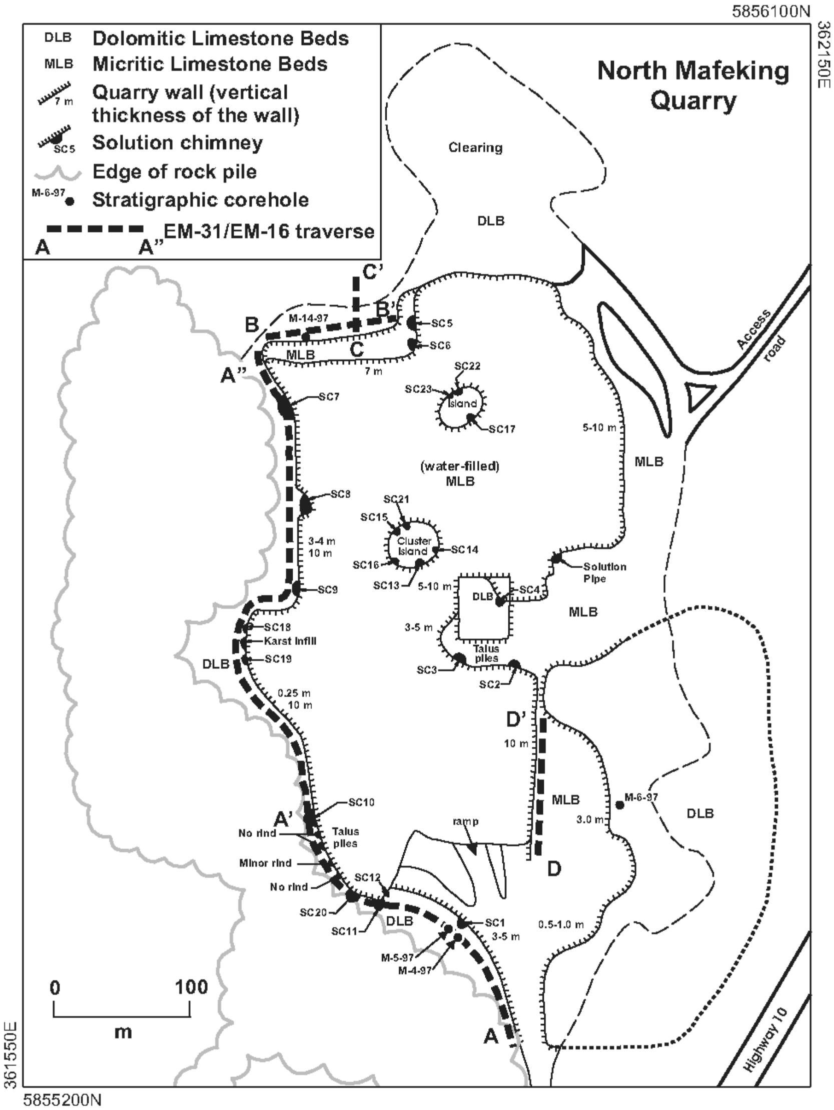

Figure 20: Locations of EM-31 and EM-16 transects, North Mafeking Quarry.

the Paleozoic and penetrate the Precambrian units: 1) the Steeprock River fault zone, 2) the Bell River fault zone, and 3) an unnamed fault zone southeast of the Bell River fault zone. Two other zones of faulting that penetrate through Paleozoic and Precambrian strata, the Red Deer River and Mafeking Creek fault zones, are based only on aeromagnetic and VLF data because the seismic-reflection survey did not cover these areas.

Paleozoic faulting, indicated only by VLF data, is inferred along Highway 77 (Figure 12). Interestingly, the Rice River, Red Deer River, Mafeking Creek, Steeprock River and Bell River fault zones bracket distinct Dawson Bay promontories called ‘The Bluff’, ‘The Big Rock’ and ‘Salt Point’. The geology map (Figure 1; in back pocket) has the formation contacts bending sharply around this peninsula. This could be due to block faulting caused by salt dissolution (Prairie Evaporite) due to basement faulting. Coincidently, these fault zones are parallel to the western boundary of the SBZ. For the sub-Phanerozoic buried length of the SBZ, there is known evidence of basement faulting affecting the overlying Paleozoic sequence in two areas: 1) in Silurian bedrock north of Grand Rapids, northeast of Dawson Bay (Bezys, 1996a); and 2) in the southwestern corner of Manitoba (Figures 7, 8; Dietrich et al., 1997).

Geochemistry

The analytical portion of the Prairie-type investigations has been focused on rock, soil (B-horizon), brine and brine-pool euxinic sediment geochemistry, and has utilized a diverse suite of analytical techniques. The lithological components of the solution chimneys have been examined using a combination of instrumental neutron activation analysis (INAA) and inductively coupled plasma–atomic emission spectrometry (ICP-AES) to quantify metal abundances in siliceous sinters, rind and adjacent wallrock.

Attempts to quantify Au in siliceous sinter using large (300–500 g) samples and INAA produced uncertain results. Ongoing investigations into an appropriate analytical approach to quantifying Au and Pt in this type of mineralization in a reproducible manner have been successful in northeastern Alberta. Birch Mountain Resources Ltd. established that a modified fire-assay

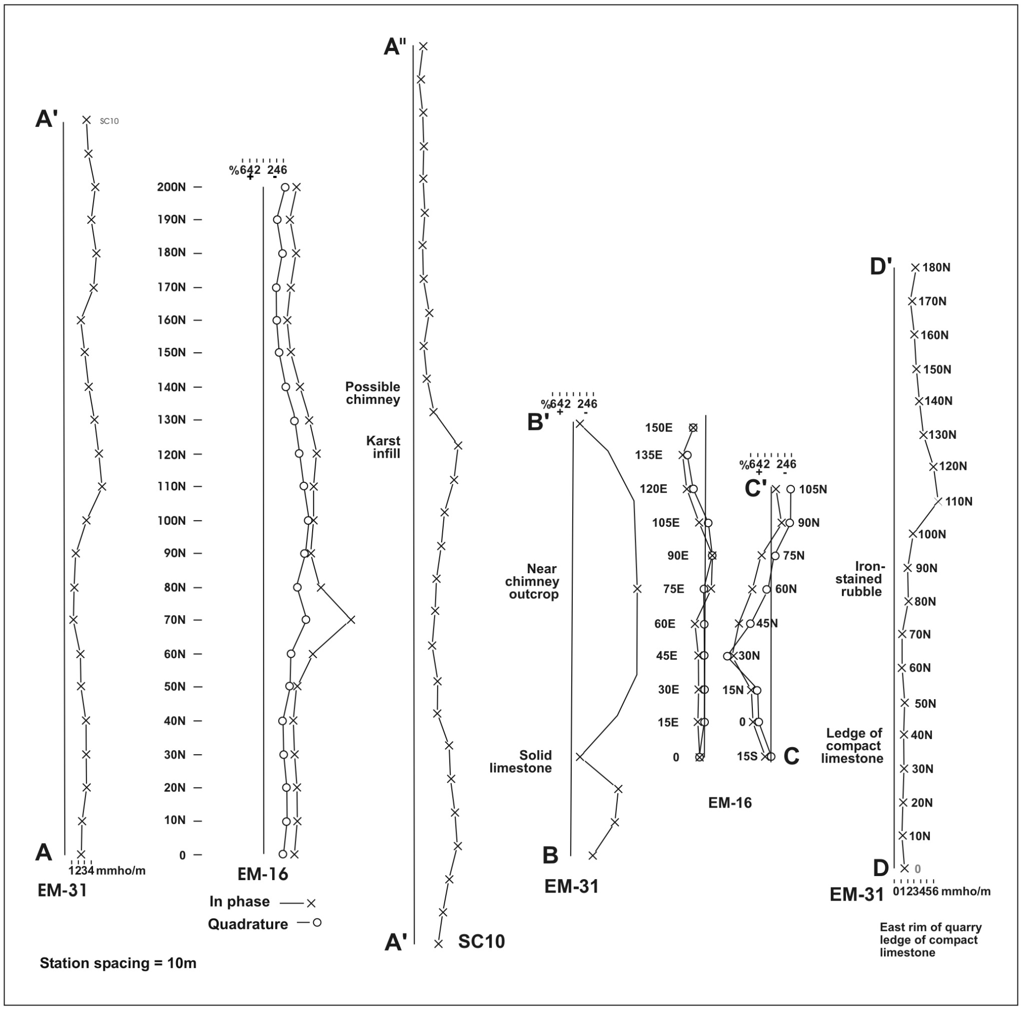

Figure 21: Data from EM-31 and EM-16 transects, North Mafeking Quarry.

technique can successfully quantify both Au and Pt in Prairie-type mineralization. These data, based on assay work undertaken by Activation Laboratories Ltd. and Bondar-Clegg Ltd., are both accurate and reproducible.

Euxinic brine-pool sediments, precipitated at the site of actively venting brine pools, were sampled and analyzed using INAA and ICP-AES techniques. The survey results presented below demonstrate that these sediments contain elevated metal contents and that these signatures can successfully reduce large survey areas to localized 'hot spots', characterized by high As, Sb, Mo, Ni, Co, Cr, Cu, Pb, Zn and U.

The applicability of the Enzyme Leach^{SM} method to the detection of Prairie-type mineralization has been tested with the collection of 117 B-horizon soil samples from six transects in the area of the Mafeking quarries. This survey serves as an orientation for subsequent soil-geochemical exploration.

Comparative geochemistry of solution-chimney components and relatively unaltered host rocks (MLB)

The geochemistry of sinter and rind samples was compared to that of relatively unaltered wallrock samples from most of the solution chimneys mapped in the North Mafeking Quarry. Samples were analyzed by X-ray fluorescence (XRF) and INAA for a large suite of major and trace elements. The data are presented in Appendix 2 (Parts 1 and 2). A comparative summary for trace elements determined by INAA is given in Table 5.

Table 5: Summary of trace elements determined by instrumental neutron activation analysis in components of the solution chimneys, North Mafeking Quarry.

Component	Au (ppb)	As (ppm)	Zn (ppm)	Ni (ppm)	Co (ppm)	Fe (%)	Ba (ppm)	U (ppm)
Sinter	1.0–4.0	1.2–18.0	25–65	10	0.5–12	0.13–0.68	25–550	0.5–7.3
Rind	1.0–28	1.3–16	69–640	60-89	3–270	0.94–40.8	25–170	0.7–5.3
Wallrock	1.0–4.0	0.25–4.3	25–67	10	0.5–4	0.11–1.41	25–74	0.25–1.6

Results

Visual examination of silicate whole-rock data for solution-chimney samples (Appendix 2, Part 2) reveals significant chemical variability among the various components. Sinters, interpreted to represent highly silicified, high-Ca limestone, are predominantly SiO_2 (98.41–100.17%). The sinter with the lowest SiO_2 content (98.41%), from solution chimney SC11, is characterized as 'mineralized', indicating the presence of finely disseminated pyrite. This is reflected in the Fe_2O_3 content of 1.12% for this sample. The Al_2O_3 values for the sinters are interpreted to represent residual clay-rich alteration in the high-Ca limestone. Values for CaO of 0.02–0.19% are interpreted to represent residual carbonate minerals in the sinters.

Comparison of the siliceous sinters and relatively unaltered wallrock indicates the extraordinary chemical changes that have occurred during limestone alteration. In most samples, CaO has been effectively removed, having been replaced by SiO_2. This is similarly reflected by the loss-on-ignition (LOI) values for sinters (0.26–0.64%) compared to those of limestone wallrock (41.95–43.16%), and reflects the absence of carbonate minerals in the sinters.

The siderite-rich rinds contain less SiO_2 but more Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, TiO_2 and P_2O_5 than the sinters. The rinds are also elevated in SiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, K_2O, TiO_2 and P_2O_5 relative to unaltered wallrock. The major chemical change in the rinds has been the replacement of Ca by Fe during alteration and the formation of siderite. Relative to wallrock, both sinters and rind are enriched in Ba, and sinters contain higher Sr, Ba and U than siderite-rich rinds. In terms of 'ore' and 'ore-related' elements, the rinds are enriched in Au, Zn, Ni, Co and Fe compared to the sinters. These relationships are depicted in Figure 18.

Quantification of gold in the siliceous sinters

Scanning electron microscopy (SEM) and energy dispersive X-ray spectrometry (EDS) were used to identify native precious and base metals in samples of rind and siliceous sinter (Fedikow et al., 1996). Since that time, attempts to quantify Au in the various components of the solution chimneys have been undertaken by Birch Mountain Resources Ltd. The result of one attempt by the Manitoba Geological Survey is presented in Table 6. Large (527.5–881.3 g) samples of siliceous sinter were analyzed by INAA in an attempt to measure Au content. The samples were a mixture of 3 mm chips and more finely ground material, which was produced as a result of one pass through a jaw crusher. This material was then encapsulated and analyzed at Activation Laboratories Ltd. (Ancaster, Ontario). Results were disappointingly low, not exceeding 3 ppb Au.

An accurate and reproducible method of quantifying Au and Pt was established by Birch Mountain Resources Ltd., using commercial laboratories. A duplicate 1.6 m drillcore sample from diamond-drill hole 11-7-AE-9610 (Twp. 96, Rge. 10, W 4th Mer.), drilled in the Fort McMurray area of Alberta, was sent to Bondar-Clegg Laboratories Ltd. and Activation Laboratories Ltd. for assay. The results, summarized in Table 7, indicate reproducible assay results for Au and Pt with good interlaboratory agreement.

Table 6: Instrumental neutron activation analysis of siliceous sinter samples, North Mafeking Quarry.

Solution chimney (SC)	Au (ppb)[1]	Mass (g)
SC1	-2	864.5
SC2	-2	709.0
SC3	-2	797.0
SC4	-2	863.3
SC7A	-2	800.6
SC7B	-2	858.4
SC8	-2	808.0
SC9	-2	836.0
SC10	-2	832.8
SC11 (mineralized)[2]	3	527.5
SC11	3	801.0
SC12	-2	851.4
SC13	-2	848.4
SC15	-2	881.3
SC17	-2	833.8

1 lower limit of detection is 2 ppb

2 sinter from SC11 labelled as 'mineralized' contains 1-3% fine-grained disseminated iron sulphide

Rock geochemical profiles (MLB) at solution chimney SC2

Representative rock-chip samples were collected from two transects at solution chimney SC2. A vertical profile of seven samples was collected from the exposed MLB beds at the top of this chimney, from near the contact with the overlying DLB down to the exposed base of the chimney. A horizontal or lateral profile of nine samples began 5 m from the edge of SC2 at the outer siderite rind and visually unaltered MLB host rock, and extended to a point 125 m south of the chimney (Figure 13). Samples were mainly collected from a boat due to flooding in the North Mafeking Quarry. Figure 22 provides a schematic representation of the vertical and lateral sample locations.

Approximately 1 kg of representative rock chips was collected at each site, with care taken to note mineralogical or alteration characteristics in each sample. Little variation was noted, except for the presence of 1) fine-grained (generally <1 mm) pyrite and marcasite grains in the MLB close to SC2, and 2) occasional variably sized vugs in the MLB wallrock that may be filled/lined with calcite crystals.

Samples were prepared in the laboratories of the Manitoba Geological Survey by first jaw crushing to an approximate 5 mm size and then pulverizing in a tungsten carbide mill. After rolling and quartering, powders were shipped to Activation Laboratories Ltd. (Ancaster, Ontario) for analysis by INAA and XRF. Dolomitic and argillaceous limestone standards were used to monitor analytical accuracy. Analytical results for standards are presented in Table 8.

Results

The elements Ag, Ba, Be, Cs, Hf, Hg, Ir, Mo, Ni, Rb, Sb, Se, Sn, Sr, Ta, U, V, W, Zn, Nd, Eu, Tb, Yb, Lu, Ca, Co, Cr, Na and Th were all at or below the lower limit of detection (LLD) or did not exhibit significant geochemical variability along the two sampling transects (Appendix 3, Parts 1a, 1b and 2). These elements are therefore not considered further in this report.

Vertical transect

Some geochemical variability was noted on both vertical and lateral sample profiles for Au, As, Br, Fe, Sc, La, Ce and Sm (by INAA), and for Be, Sr, Y, Sc and Zr (by XRF). Trends were noted for the major-element oxides SiO_2, Al_2O_3, K_2O, TiO_2, MnO and for loss-on-ignition (LOI).

Table 7: Accurate and reproducible Au and Pt assays for siliceous sinter from the Aurora mine of Syncrude Ltd., northeastern Alberta; duplicate sample from a 1.6 m interval of drillcore from diamond-drill hole 11-7-AE-9610 (Twp. 96, Rge. 10, W 4th Mer.).

Assay	Bondar Clegg	Bondar Clegg	Activation Laboratories
Gold (g/t)	0.2	0.19	0.21
Platinum (g/t)	4.94	2.21	2.21

Instrumental neutron activation analysis (INAA)

Au: Concentrations vary from 3 to 4 ppb at or within 2 m of the top of the section, near the MLB-DLB contact. All remaining values are less than the lower limit of detection (LLD).

As: An erratic profile consists of a single high response of 3.4 ppm at the top of the section and a range of values between 0.9–3 ppm near the base of SC2. Three of the seven samples collected are <LLD.

Br: Concentrations increase steadily from 0.8 ppm at the top of the section to a high of 3.1 ppm at the base of the solution chimney. These results represent one of the most consistent geochemical trends in the vertical sampling profile.

Fe: Two relatively high responses (0.38 and 0.66%) do not define a recognizable trend through the section. The remaining five samples have a restricted range in concentration of 0.17–0.19%.

Sc: There is a low-level but consistent trend of increasing concentrations, from 0.3 ppm at the base of the section to 2.1 ppm at the top.

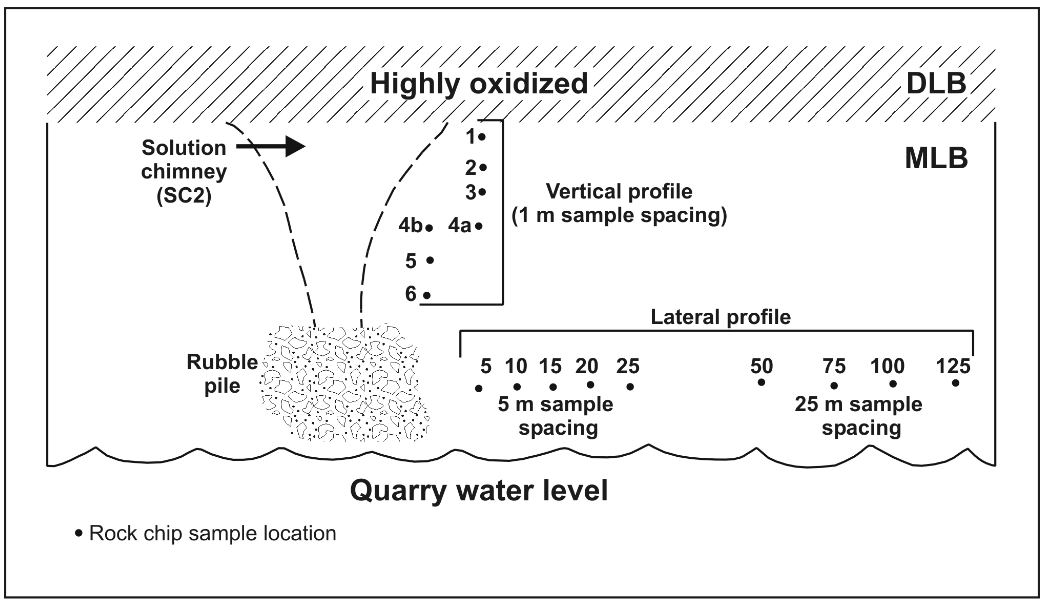

Figure 22: Schematic diagram of the locations of vertical and lateral rock-chip samples, showing their spatial relationships to solution chimney SC2, North Mafeking Quarry. Abbreviations: DLB, Dolomitic Limestone Beds; MLB, Micritic Limestone Beds.

Table 8: Analytical results (indicated by *) and recommended values for dolomitic and argillaceous limestone standards SRM 88b and SRM Ic.

Standard	Oxide content (wt. %)										
	SiO_2	Al_2O_3	CaO	Na_2O	Fe_2O_3	MgO	K_2O	P_2O_5	TiO_2	LOI	TOTAL
SRM 88b (dolomitic limestone)	1.13±0.02	0.336±0.013	29.95±0.05	0.0290±0.0007	0.277±0.002	21.03±0.07	0.1030±0.0024	0.0044±0.0003			
88-SC2SEL-125A* (SRM 88b)	1.05	0.32	29.41	0.02	0.27	21.8	0.10	<0.01	<0.01	46.65	99.62
SRM Ic (argillaceous limestone)	6.84±0.08	1.30±0.03	50.3±0.3	0.02±0.01	0.55±0.03	0.42±0.04	0.28±0.01	0.04±0.01	0.07±0.01	39.9±0.1	
88-56A-96* (SRM 1c)	6.50	1.23	49.56	0.02	0.63	0.36	0.27	0.03	0.06	39.85	98.55

La, Ce and Sm: These rare earth elements define a trend similar to that of Sc, with increases in concentration from base to top of section. The La+Ce+Sm total ranges from 2.8 ppm at the base to 9.5 ppm at the top, with La defining this trend most consistently.

X-ray fluorescence analysis (XRF): trace elements

Ba: A slight decrease occurs in samples 5 and 6, collected from the base of the exposed chimney. These samples contain 8 ppm, compared to a range of 11–15 ppm for the remainder of the samples.

Y: Samples 5 and 6 have Y contents of <1 ppm. Sample 1, collected close to the overlying DLB, contains 5 ppm, and there is a steady decrease from 5 ppm (sample 1) to <1 ppm at the base of SC2.

Sc: This has a profile similar to that of Y, with low-level enrichment at sample site 1 (3 ppm). All other samples are <1 ppm.

Zr: A possible low-contrast enrichment occurs from the base of the section (2 and 3 ppm) to the top (4–6 ppm).

Sr: This has a consistent, moderately high contrast trend in the vertical profile from top to bottom of section, increasing from 65 ppm (sample 1) to 120 ppm (sample 6).

X-ray fluorescence analysis (XRF): major elements

The major-element oxides Fe_2O_3, MgO, CaO, Na_2O and P_2O_5 do not define a consistent trend in vertical profile. Values of Na_2O and P_2O_5 are generally below the LLD and single-sample Fe_2O_3 enrichments are interpreted to represent the presence of disseminated pyrite in the samples. Trends in enrichment and depletion in vertical section are defined by the remainder of the major-element oxides and LOI.

Decreases in concentration, from the top to the base of the section, are observed for SiO_2 (1.61–2.23% vs. 0.88–0.90%), Al_2O_3 (0.45–0.59% vs. 0.27%), K_2O (0.18–0.24% vs. 0.12%), TiO_2 (0.02% to <0.01%) and MnO (0.07% vs. 0.02%). A reversal in this trend is observed for LOI, which varies from 41.07 to 42.88% at the top of the section and from 43.09 to 43.12% at the base.

The MLB at the top of the vertical sampling profile, near the contact with the highly altered DLB, contain moderate to slight enrichments in Au, Sc, La, Ce and Sm (by INAA) and in Ba, Y, Sc, Zr, SiO_2, Al_2O_3, K_2O, TiO_2 and MnO (by XRF). The parameters Sr, Br and LOI all increase toward the base of the section.

These trends can be defined in terms of two processes that have affected the stratigraphic succession exposed in the North Mafeking Quarry. If the DLB-MLB contact is at or close to an unconformable erosion surface, then the chemistry of the underlying MLB should reflect a more resistate and authigenic mineralogy. This is, in fact, evidenced by the enrichment of Zr, Y, Sc, Ba, SiO_2, Al_2O_3, TiO_2, K_2O and MnO.

A second process that produced a chemical overprint on the MLB is that of the passage of paleo–metal-enriched saline brines through the fractured MLB to produce the observed solution chimneys. This alteration effect introduced Au, La, Ce, Sm and probably Ba at the venting surface or at a point where saline brines intersected a redox boundary and subsequently precipitated metals. The reduction in the vertical 'carrying' capacity of the saline brines may be reflected in the reduction of Br and Sr toward the top of the section. Slightly higher LOI values at the base of the section are curious and may be influenced by elevated FeO attributable to disseminated iron sulphides in the sample.

The observed pattern of increasing Au, Sc, La, Ce and Sm contents from the exposed and sampled base to the top of the section are in sharp contrast to the trend observed for Br, which decreases toward the top of the section. This trend may reflect an evolving brine composition toward the depositional site at the MLB-DLB contact.

Lateral transect

There is little evidence of consistent lateral geochemical relief that would indicate either enrichment or depletion of metals in MLB host rocks close to SC2. Arsenic contents reflect a low-level enrichment of 1.8 to 3.4 ppm within 15 m of the solution chimney, although the sample collected closest to the chimney contains no measurable As; however, a second mineralized sample of wallrock contains 1.9 ppm As (Appendix 2, Part 1). Arsenic contents greater than 15 m from the chimney are <LLD.

This pattern may reflect the presence of elevated As in a disseminated iron sulphide halo that is developed in the MLB adjacent to individual solution chimneys. This observation is substantiated by small increases in Fe_2O_3 (0.42–0.66%) adjacent to the solution chimney–MLB contact, compared to a range of 0.12–0.27% Fe_2O_3 more than 20 m from the contact. Laterally from the MLB–solution chimney contact, there are modest increases in SiO_2 (0.92–0.99% vs. 0.96–1.33%), Al_2O_3 (0.28–0.32% vs. 0.32–0.42%) and possibly Sr (122–142 ppm vs. 125–152 ppm); MnO is elevated adjacent to the solution chimney (0.01–0.03% vs. <0.01%). Most enrichment and depletion zones are developed for a distance of approximately 20 m from the MLB–chimney contact. Local erratic highs of 2.97–3.38% MgO are present in the transect and may reflect localized areas of more intense alteration within the overall pervasive, clay-rich, argillic style of alteration that appears to have affected the MLB in the North Mafeking Quarry.

Both lateral and vertical geochemical transects have defined low-level and low-contrast, multisample geochemical trends in the MLB adjacent to and laterally south of SC2. The trend of elevated As with proximity to SC2 is probably related to mineralogical-chemical zonation in the MLB, albeit at low concentration levels and on such a scale that application to exploration may be restricted to detailed and/or local investigations in which individual solution chimneys are being sought in an area of high potential.

Observations based on element enrichments and depletions adjacent to SC2, as reflected in the results of the vertical geochemical transect, are suggestive of evolving brine compositions from lower in the stratigraphic section to a point where precipitation-effervescence occurs within the chimney or at the erosional surface. This may be supported by the observation of the degassing of saline brines at actively venting sites. A variety of gases is generated at these locations, indicating changing brine compositions. Schematic representation of these trends is given in Figure 23.

Oxidized dolomitic limestone beds ('oxide cap' DLB)

The Micritic Limestone Beds (MLB), host to numerous solution chimneys in the Mafeking quarries, are overlain by highly oxidized, brecciated to massive Dolomitic Limestone Beds (DLB). Bannatyne (1975) indicated that the DLB are present in outcrop east of the North Mafeking Quarry as an orange-stained, mottled, saccharoidal dolomite, which grades laterally into a 'red ochre' mixed with dolomite. More recent exposures in the North Mafeking Quarry show that considerable textural, compositional and colour changes occur laterally along profiles of the DLB, away from the immediate vicinity of the solution chimneys. Generally, this change is gradational from strongly oxidized, reddish brown dolomite nearest the chimneys, to buff, nonoxidized, dolomitic limestone approximately 100 m away.

The solution chimneys occur in groups associated with broad synclinal dips (3–6°) within the strata, and the surrounding DLB have been intensely altered, destroying primary sedimentary structures, such as laminations and fossils. In contrast, the DLB associated with the anticlinal domes are nonoxidized but may exhibit a yellow-mottled texture, possibly resulting from diagenesis. Transitional facies between these end members are reddish orange–mottled dolomite grading to a yellow-orange dolomitic limestone (termed 'leopard rock'). Occasionally, a few metres of bleached (beige-coloured) rock may be present near fractures, joints and cavities infilled with sand and clay within the DLB.

As indicated previously, the upper surface of the DLB is erosional. At the North Mafeking Quarry and along the old and new Pelican Rapids roads, the oxide cap is usually preserved in the basins or synclines between domes. On the crests of the domes, the essentially nonoxidized DLB are usually stripped bare.

Geochemical assessment of the Dolomitic Limestone Beds

A 108 m long rock-chip sampling profile of the DLB (called the 'southeast profile') was completed along the southeast side of the North Mafeking Quarry to assess geochemical changes in the DLB–oxide cap that occur with increasing distance southeastward from solution chimney SC2 (Figure 13). Samples 99-97-DB-4-1-1A to DB-5-1-9B were collected, approximately every 5 m and occasionally with a vertical separation of about 1 m, along this transect, which was located immediately west of corehole M-6-97. A total of 36 samples were analyzed by INAA and ICP-AES (*see* Appendix 4, Parts 1 and 2 for analytical data).

A second series of samples (DB-11-2-1B to DB-11-2-11B) was collected, at approximately 5 m intervals for a distance of 55 m, along the 'northwest profile', situated at the northwest corner of the North Mafeking Quarry (Figure 13), near the site of corehole M-14-97. Solution chimneys SC5 and SC6 are located 50 m east of the east end of this profile. Eleven samples were analyzed by INAA and ICP-AES (*see* Appendix 4, Parts 1 and 2 for analytical data).

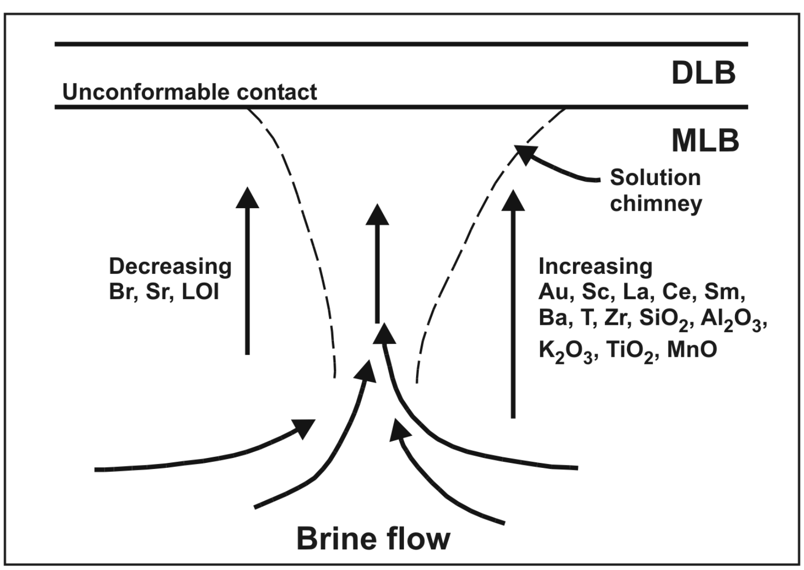

Figure 23: Summary of the observed trends in rock-chip geochemical samples collected from a vertical profile, solution chimney SC2, North Mafeking Quarry. Abbreviations: DLB, Dolomitic Limestone Beds; MLB, Micritic Limestone Beds.

Trace-element geochemistry of the DLB along the southeast profile is summarized in Table 9. Arithmetic means for the DLB, calculated from the data in Appendix 4, are provided in Table 10. Values for Au, Ba, Co, Cr, Cs, Hf, Rb, Sb, Th, U, Ce, Nd, Pb, Ag, V, Ti were at or below the detection limits for INAA and ICP-AES and were therefore excluded from Table 9.

Table 9: Trace-element geochemistry (by instrumental neutron activation analysis) of the Dolomitic Limestone Beds (DLB) along the southeast profile, North Mafeking Quarry.

Lithology	Distance from south end (m)	Au (ppb)	As (ppm)	Ba (ppm)	Br (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Fe (%)	Hf (ppm)	Na (%)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Th (ppm)	U (ppm)	La (ppm)	Ce (ppm)	Nd (ppm)	Sm (ppm)
Detection limit		2	0.5	50	0.5	1	5	1	0.01	1	0.01	15	0.1	0.1	0.2	0.5	0.5	3	5	0.1
Unoxidized DLB DB-4-1-1A	0	<2	<0.5	<50	2	<1	<5	<1	0.38	<1	0.03	<15	<0.1	0.3	0.2	<0.5	0.8	<3	<5	0.1
Average DLB	n/a	<2	<0.5	<50	1.4	1	<5	<1	1.88	<1	0.04	<15	<0.1	0.3	0.2	0.5	0.8	<3	<5	0.1
Oxidized DLB DB-5-1-1C	81	<2	5	<50	<0.5	3	<5	<1	4.15	<1	0.02	<15	<0.1	0.3	0.2	0.8	1.1	<3	<5	0.2
Altered DLB DB-5-1-6C	96	<2	1.5	58	<0.5	2	<5	<1	2.13	<1	0.04	<15	<0.1	0.4	<0.2	0.8	0.9	<3	<5	0.1
Clay[1] DB-4-1-13C	49	7	<0.5	210	0.9	15	61	4	1.93	7	0.06	110	0.6	8.5	6.8	10	28	46	24	4.6
Sand[1] DB-4-1-15C	54	<2	1.4	55	<0.5	1	8	<1	0.18	5	<0.01	<15	0.1	1	2.6	0.9	16	26	10	1.9
Sand[1] DB-5-1-6D	96	<2	<0.5	150	<0.5	<1	<5	<1	0.19	<1	<0.01	<15	<0.1	1.2	3.6	0.8	29	47	20	3.6

Lithology	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppm)	Ni (ppm)	Mn (ppm)	Sr (ppm)	V (ppm)	Ca (%)	P (%)	Mg (%)	Ti (%)	Al (%)	K (%)	Y (ppm)
Detection limit	0.2	0.5	0.2	0.05	1	4	1	0.4	1	1	1	2	0.01	0	0.01	0.01	0.01	0.01	2
Unoxidized DLB DB-4-1-1A	<0.2	<0.5	<0.2	<0.05	3	<4	6	0.5	3	123	140	3	34.92	0.007	4.69	0.01	0.16	0.09	5
Average DLB	<0.2	<0.5	<0.2	<0.05	2	4	7	0.4	3	540	91	2	32.89	0.007	5.38	0.01	0.11	0.09	5
Oxidized DLB DB-5-1-1C	<0.2	<0.5	0.2	<0.5	4	<4	9	<0.4	7	1001	46	4	35.82	0.013	2.71	0.01	0.17	0.11	6
Altered DLB DB-5-1-6C	<0.2	<0.5	<0.2	<0.5	2	<4	10	0.4	4	663	61	5	36.07	0.009	5.09	0.01	0.11	0.05	5
Clay[1] DB-4-1-13C	1.2	0.8	3.6	0.65	12	7	40	0.9	66	275	51	75	18.7	1.038	1.11	0.28	5.23	2.11	42
Sand[1] DB-4-1-15C	0.5	<0.5	0.6	0.12	3	5	8	<0.4	3	20	48	11	0.22	0.016	0.06	0.11	0.82	0.09	4
Sand[1] DB-5-1-6D	0.9	0.6	0.6	0.12	2	10	4	<0.4	3	15	90	11	0.2	0.024	0.04	0.1	1.13	0.07	6

[1] from sand- and clay-filled cavity in oxide cap

Table 10: Arithmetic means for analytical data from the Dolomitic Limestone Beds (DLB), North Mafeking Quarry.

Element	Mean	Element	Mean
As	5 ppm	Sr	91 ppm
Ba	1.4 ppm	Ca	32.89%
Fe	1.88%	P	0.007%
Na	0.04%	Mg	5.38% Mg
Sc	0.3 ppm	Al	0.11%
La	0.8 ppm	K	0.09%
Cu	2 ppm	Y	4 ppm
Zn	7 ppm	Ni	3 ppm
Mn	540 ppm		

Results

In general, Ca and Mg contents (Appendix 4, Part 1) vary inversely along the southeast profile (Figure 24), without any apparent relationship to the position of chimney SC2. The northwest profile (Figure 25) shows a slight decrease in Ca and increase in Mg moving from west to east toward chimneys SC5 and SC6. Concentrations of Al and K (Figures 26, 27) mirror that of Mg. This covariation suggests that Ca, Mg, Al, and K were original components of the original sediment, or were introduced during diagenetic and/or focused saline brine flow that produced the mottled dolomitic limestone.

Concentrations of Fe and Mn along both profiles generally increase toward the chimneys (Appendix 4, Parts 1 and 2). For the southeast profile, Fe is 0.38% at 0 m, 4.51% at 81 m and 2.30% at 108 m (Figure 28). For the northwest profile, Fe is 0.34% at 0 m, 1.91% at 45 m and 1.28% at 55 m (Figure 29). Manganese varies from 123 ppm at 0 m to 1001 ppm at 81 m and 660 ppm at 108 m (Figure 30) on the southeast profile and from 108 ppm at 0 m to 542 ppm at 45 m and 550 ppm at 55 m (Figure 31). There is a suggestion that Fe and Mn are covariant with the changes in Mg. A portion of the Fe and Mn may be related to dolomitization, but some Fe and Mn appears to have been introduced as a halo around the cluster of chimneys SC2 to SC4 on the southeast profile and chimneys SC5 and SC6 on the northwest profile.

Concentrations of Sr and Br along both profiles (Figures 32, 33) generally decrease toward the chimneys (Appendix 4, Part 1). Strontium decreases from 140 to 84 ppm along the southeast profile toward chimney SC2; this pattern is less well developed along the northwest profile. The Sr depletion observed close to the chimneys is interpreted to be the result of alteration, including Fe and Mn enrichments, facilitated by saline brine flow through the rocks. The decrease in Sr and Br was also documented in the MLB, upward along the vertical transect shown in Figure 23.

Sand- and clay-filled cavities

Sand and clay samples were collected from cavities in the DLB at 49, 54 and 96 m (measured from the south end) along the southeast profile (Appendix 4, Parts 1 and 2). The sand and clay samples usually have significantly higher values of trace elements (Table 9) than the oxidized dolomitic limestone in the DLB (Table 11). In Table 11, the sand/clay concentration for each element is the highest of the three samples and the DLB value is the average of 31 samples.

Compared to the oxidized dolomitic limestone of the DLB, the sand/clay from the cavities has lower values of Fe (0.18% vs. 4.15%), Ca (0.2% vs. 35.8%) and Mg (0.04% vs. 2.71%) (Table 9).

The cavities appear to have been conduits that may have formed at a different time than the chimneys but also permitted the passage of fluids through the sand and silty clay. These fluids may also have altered the surrounding dolomitic limestone by removing Fe (from 4.15% to 2.13%) and Mn (from 1001 ppm to 663 ppm). This is suggested by the visible bleaching of the country rock, adjacent to these cavities, to a chalky beige colour from the more typical, strongly oxidized, reddish brown DLB, and by the increase in Mg (from 2.71% to 5.09%) and minor increase in Ca (from 35.8% to 36.1%).

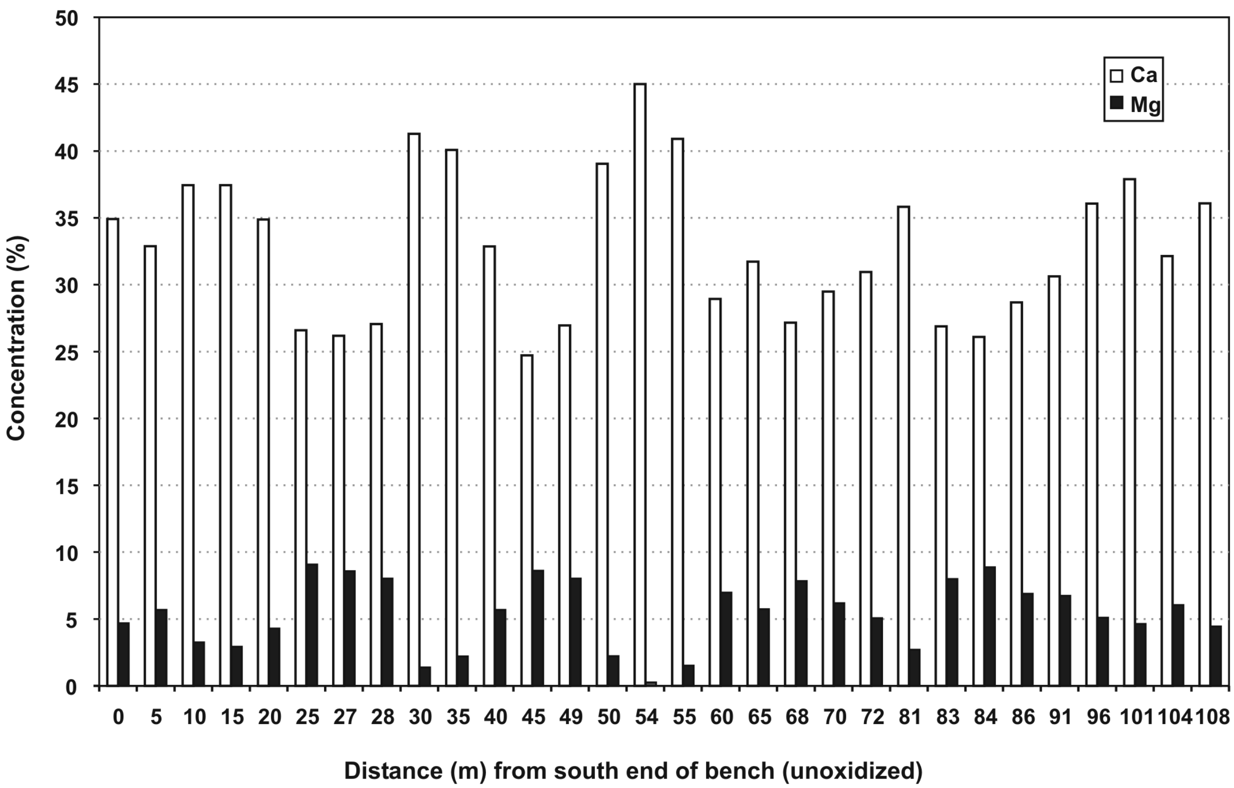

Figure 24: Variation in Ca and Mg concentrations in rock-chip samples on the southeast profile across the oxide cap, North Mafeking Quarry.

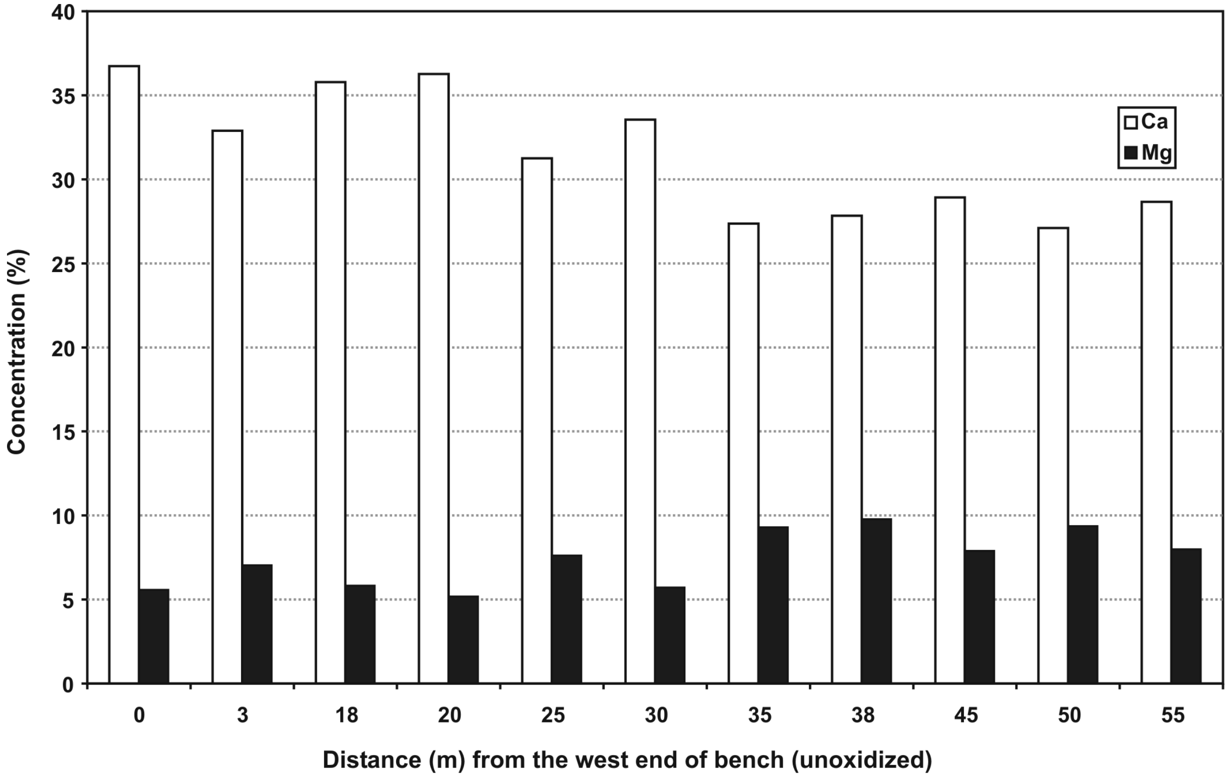

Figure 25: Variation in Ca and Mg concentrations in rock-chip samples on the northwest profile across the oxide cap, North Mafeking Quarry.

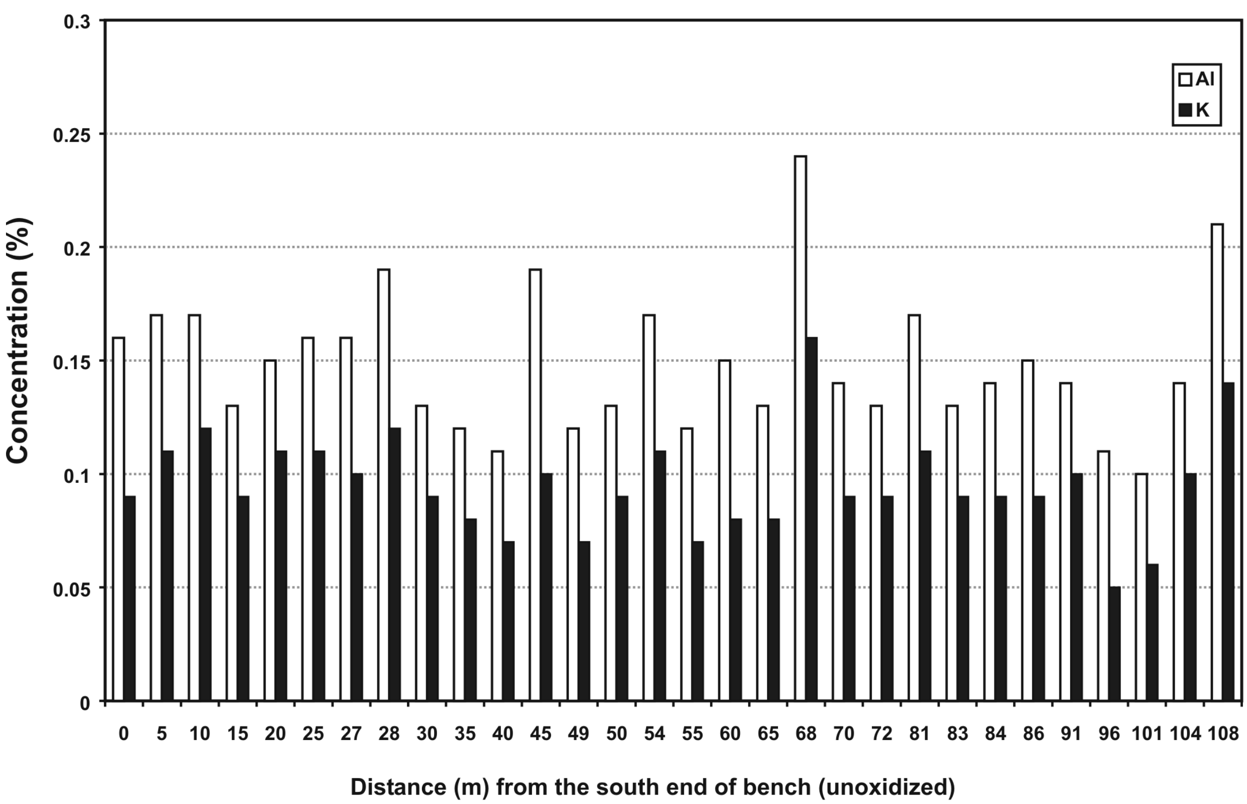

Figure 26: Variation in Al and K concentrations in rock-chip samples on the southeast profile across the oxide cap, North Mafeking Quarry.

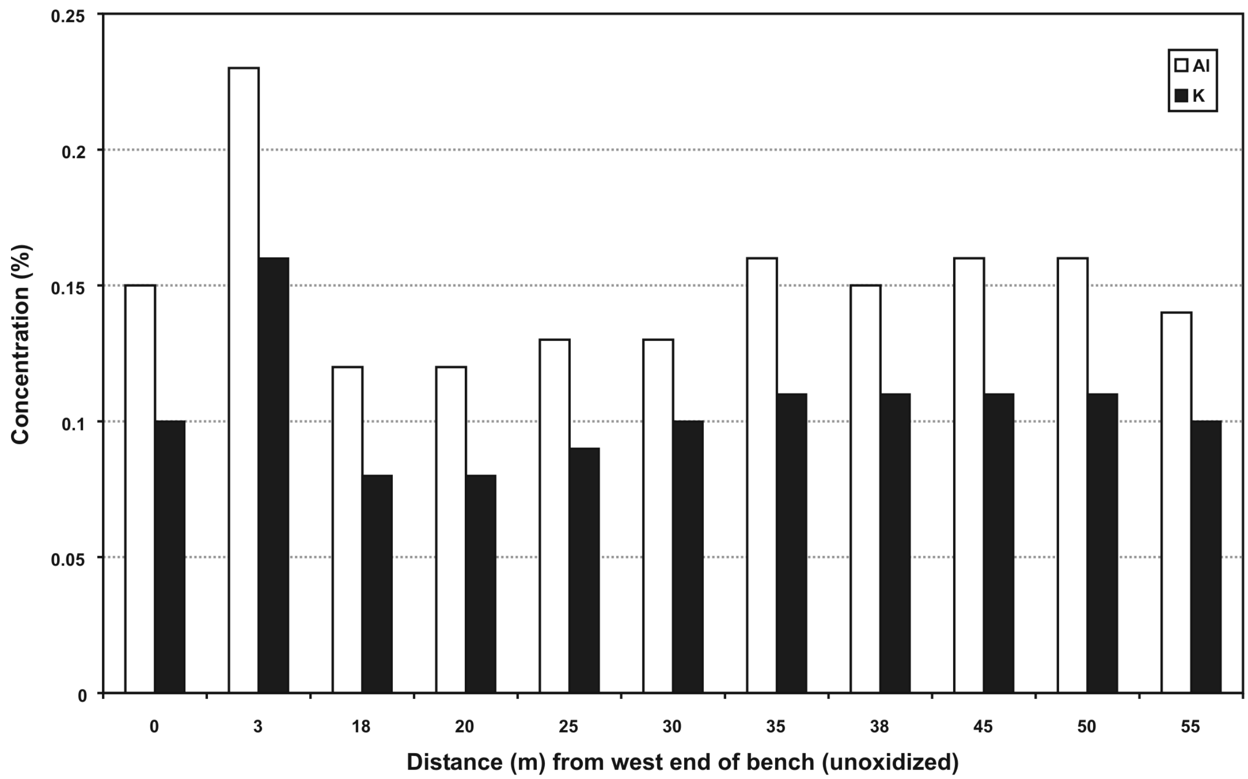

Figure 27: Variation in Al and K concentrations in rock-chip samples on the northwest profile across the oxide cap, North Mafeking Quarry.

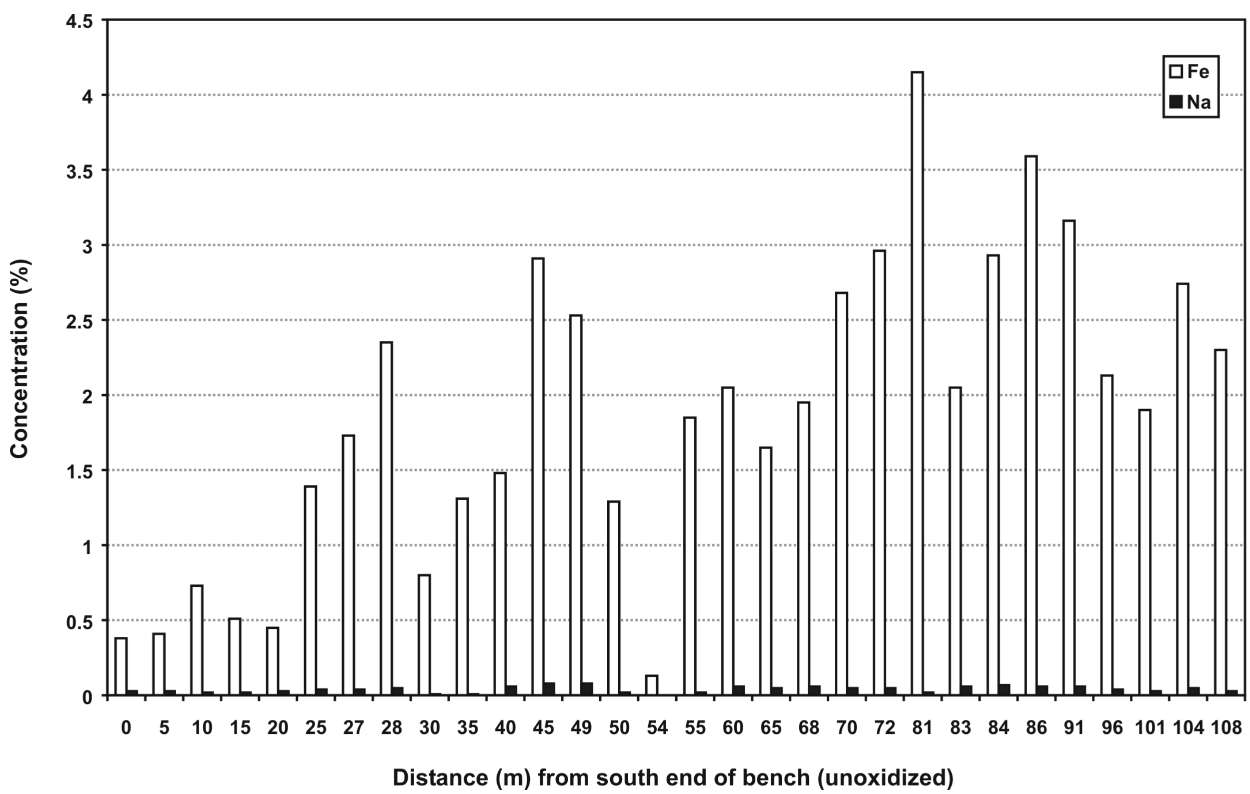

Figure 28: Variation in Fe and Na concentrations in rock-chip samples on the southeast profile across the oxide cap, North Mafeking Quarry.

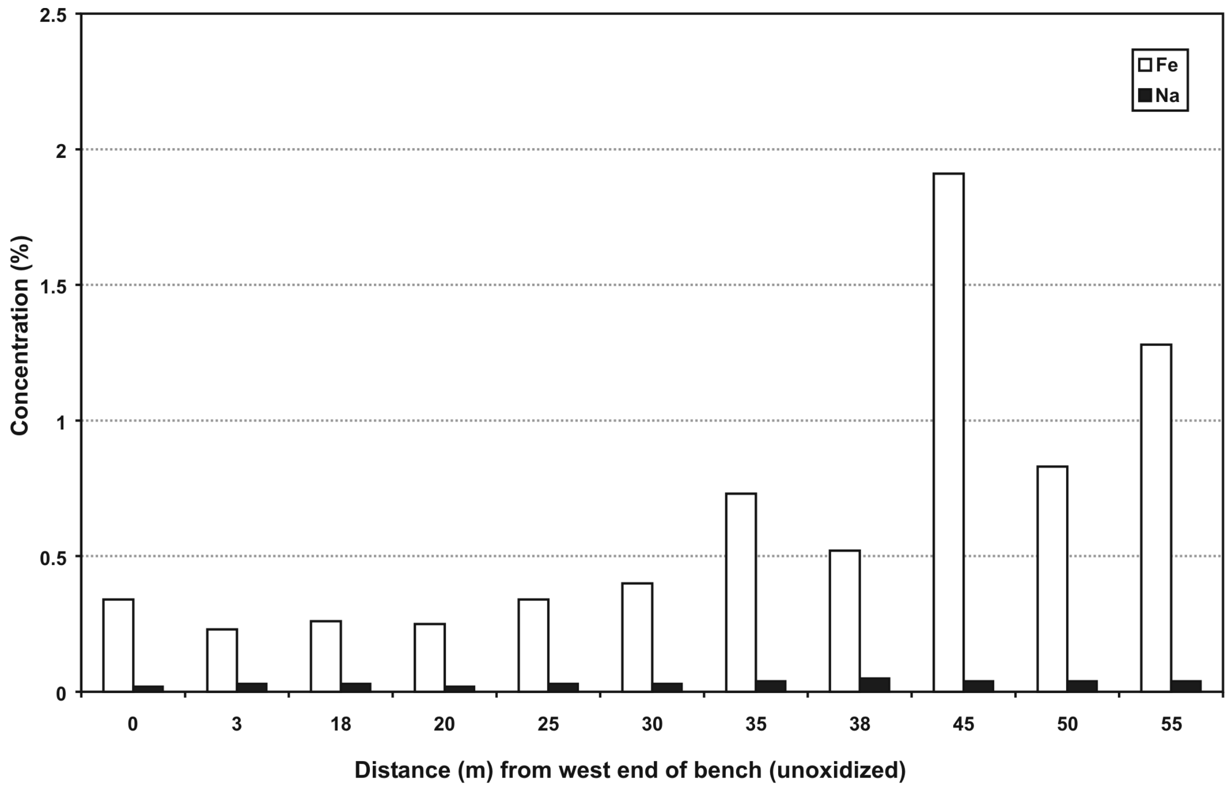

Figure 29: Variation in Fe and Na concentrations in rock-chip samples on the northwest profile across the oxide cap, North Mafeking Quarry.

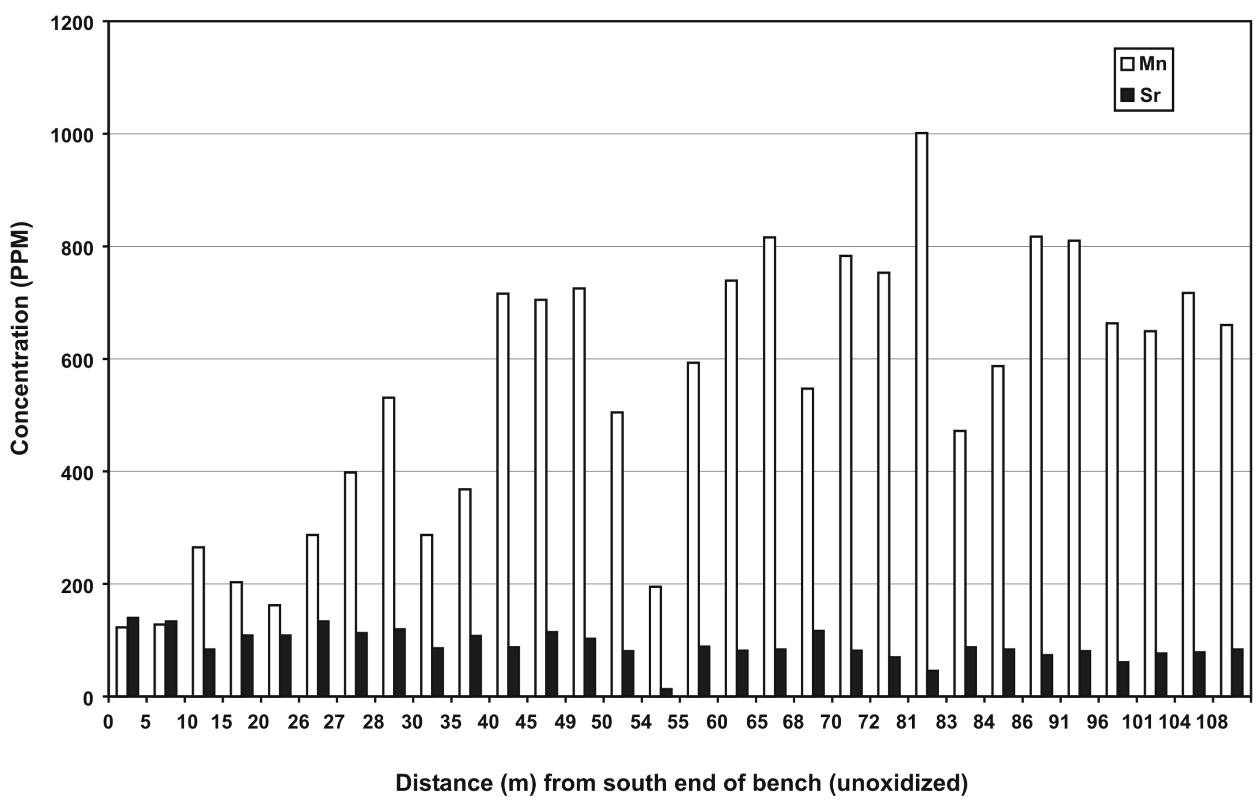

Figure 30: Variation in Mg and Sr concentrations in rock-chip samples on the southeast profile across the oxide cap, North Mafeking Quarry.

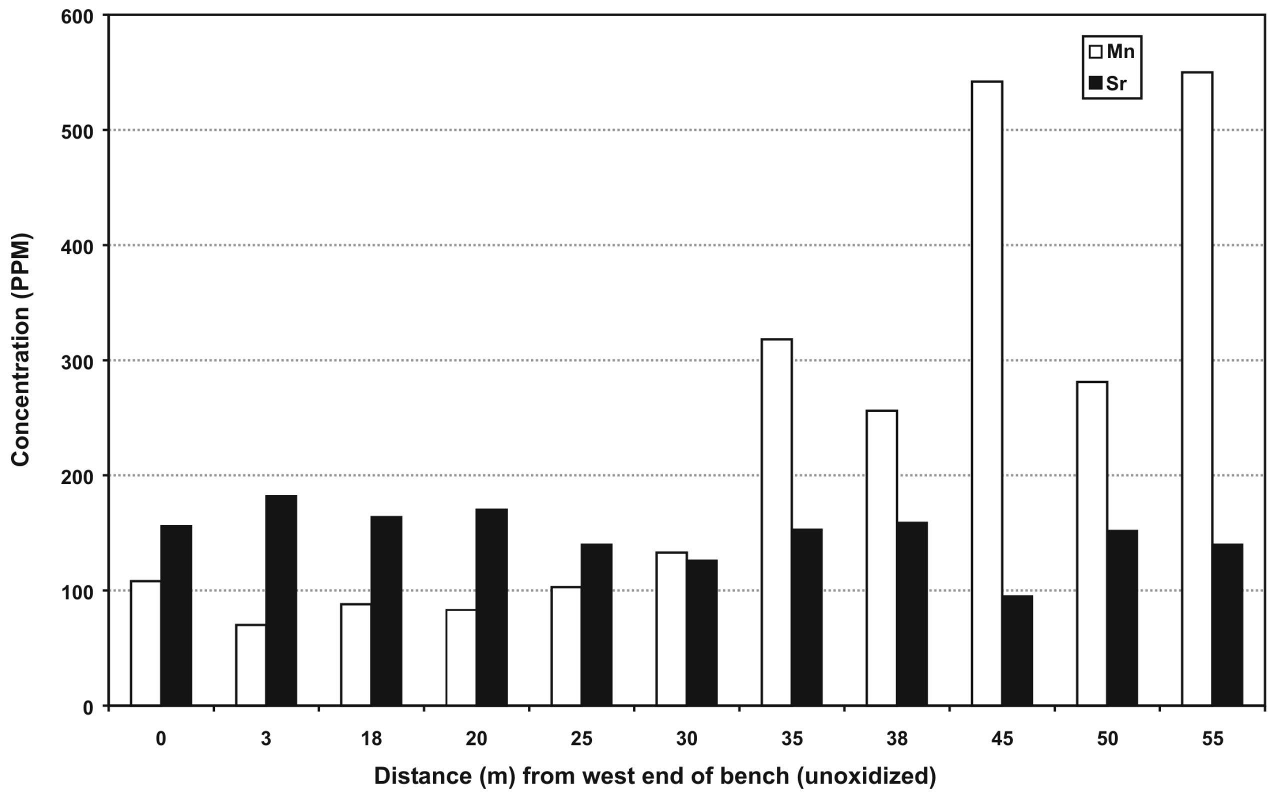

Figure 31: Variation in Mg and Sr concentrations in rock-chip samples on the northwest profile across the oxide cap, North Mafeking Quarry.

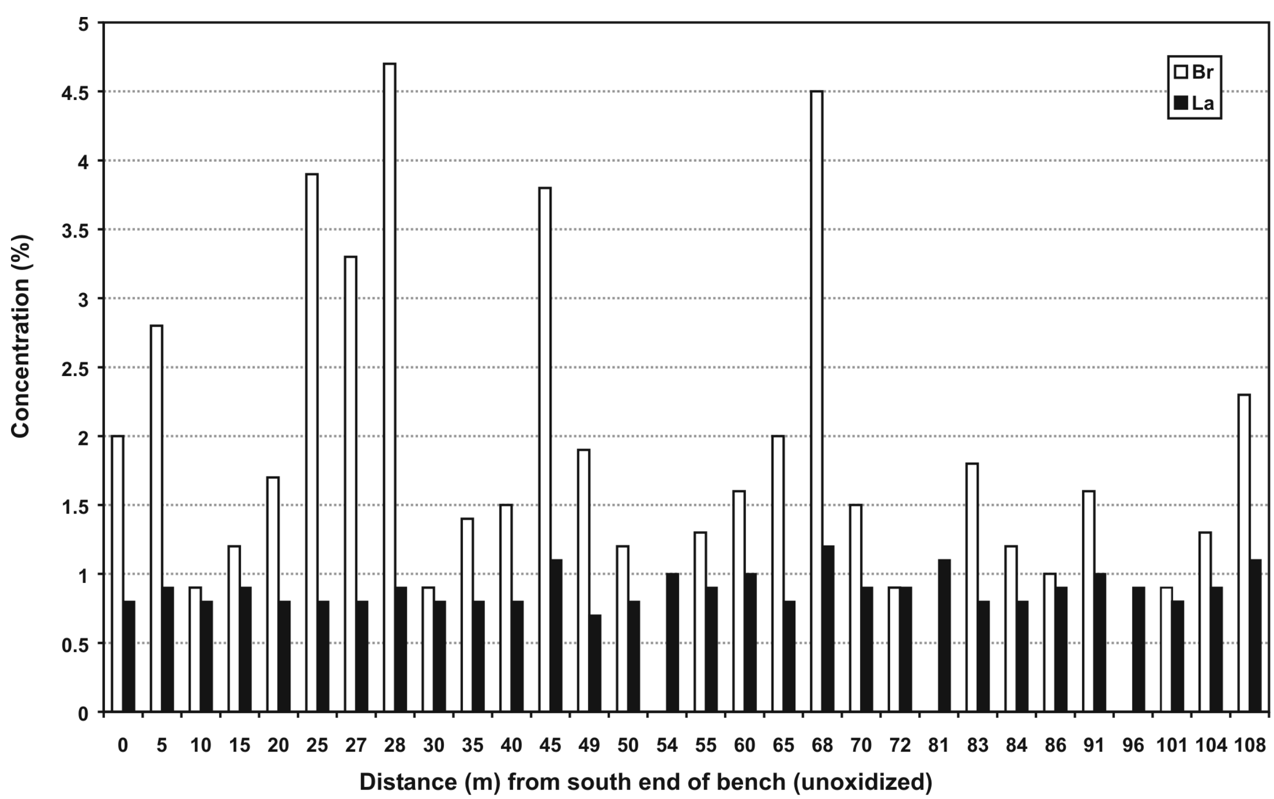

Figure 32: Variation in Br and La concentrations in rock-chip samples on the southeast profile across the oxide cap, North Mafeking Quarry.

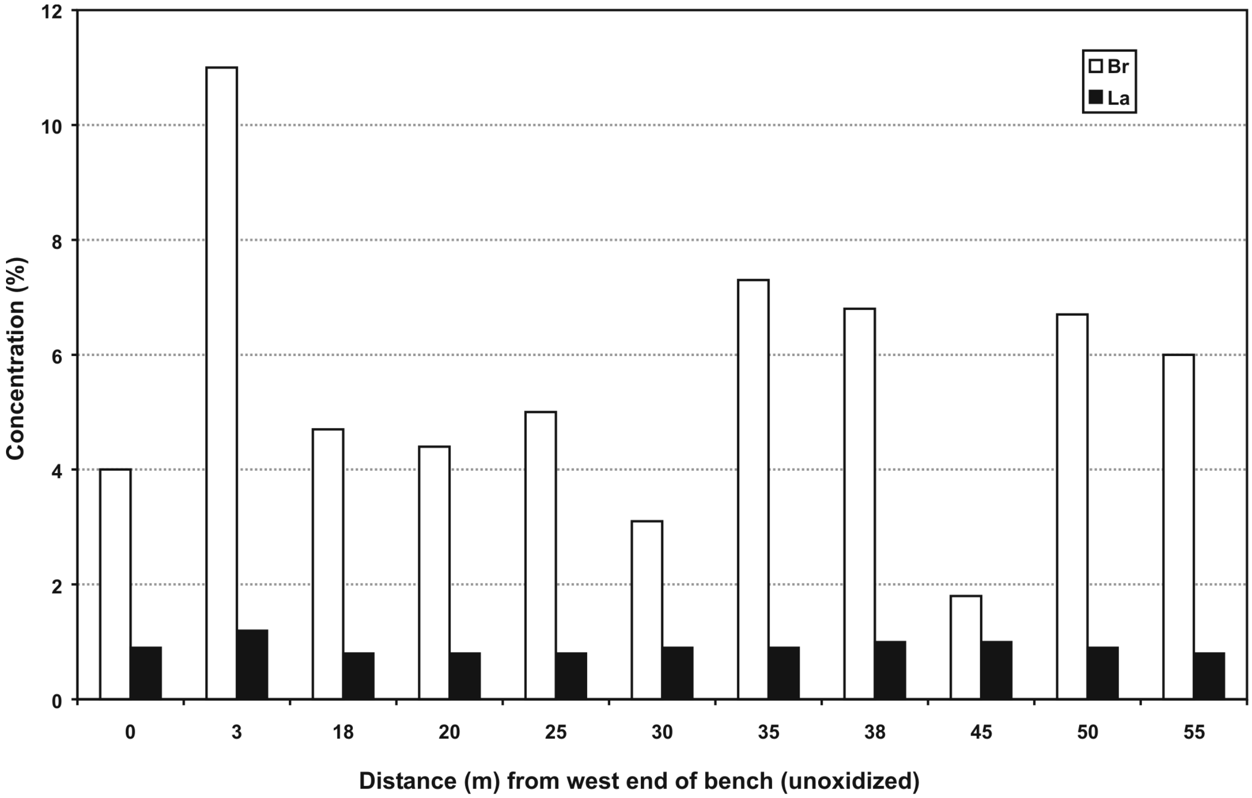

Figure 33: Variation in Br and La concentrations in rock-chip samples on the northwest profile across the oxide cap, North Mafeking Quarry.

Enzyme Leach^{SM} soil-geochemical surveys

Compositionally diverse overburden of variable thickness, such as till, its derivatives (sand, silt and clay) and peat, represent serious impediments to the search for buried/subcropping or blind mineralization. The analysis of various size fractions (<2 µm, <63 µm) of till and, to some degree, boulder tracing in glaciated terrain have been successful in delineating gold- and base metal–enriched dispersion fans (Fedikow and Ziehlke, 1996). The explorationist, however, must still search 'up-ice' or within the areal influence of the dispersion trains for the source of the anomalies. In some instances, the till dispersion fans can attain considerable areal dimensions (cf. Kaszycki, 1989).

Recent development of geochemical techniques based on sequential, phase-specific and partial digestions, coupled with routine sub–parts-per-billion geochemical analyses, have provided an opportunity to 'see through' transported and other types of overburden. Anomalies defined in this manner generally occur directly over, or in the immediate vicinity of, the mineralized source. Since the Enzyme Leach^{SM} approach to mineral exploration represents a commercially available technique that has direct application to the search for buried and/or blind mineralization, it formed the basis for the soil-geochemical surveys conducted around the North Mafeking Quarry.

Quaternary geology of the survey area

Surficial deposits in the Mafeking and Enzyme Leach^{SM} survey areas are characterized by glacial and glaciolacustrine sediments of indeterminate thickness. Glacial deposits predominate and comprise up to 10 m of highly calcareous till derived from the underlying Paleozoic carbonate sequences. Carbonate outcrops or outcrop mantled with less than 1 m of carbonate-rich till are not uncommon in the vicinity of the Mafeking quarries. In addition, glaciolacustrine beach deposits of sand and gravel, up to 2 m thick, are present. Occasional 1 m veneers of sand are recognized locally.

Enzyme Leach^{SM} theory

The Enzyme Leach^{SM} process is a phase-specific leach that preferentially attacks amorphous Mn-oxide coatings on mineral grains, thereby liberating trace metals that are trapped in this material. Amorphous Mn oxide represents an efficient chemical sieve or trap for cations, anions and polar molecules because of its surface area and the random distribution of charges on this surface. The trace elements that are trapped or complexed on the amorphous Mn oxides are interpreted to represent the chemical signatures of buried, oxidizing mineralization at depth, rather than signatures originating from a transported overburden source, such as till.

It should be noted, however, that the geochemical signature within soil may be strongly affected by the weathering of till and the subsequent downward movement of metals that results (Clark et al., 1993). This could produce a 'transported' till geochemical signature in addition to site-specific mineralization-related geochemical signatures, resulting in a composite signature that is more difficult to interpret. Although the parent sediment composition (till or residual soil) should theoretically not contribute to the Enzyme Leach^{SM} geochemical signature, the relationship is currently not well understood.

Most of the amorphous Mn oxide is developed in the B-horizon. Studies in both arid and humid geological and climatic environments have established that mineral particles within this soil horizon are coated with this authigenic material. The A-horizon of the soil may not reflect geochemical anomalies identified in the B-horizon, since the A-horizon is fairly rapidly leached of its metallic components, which are carried downward, perhaps as humic- or fulvic-acid compounds (humate/fulvate?) and trapped or sieved as they encounter the amorphous Mn-oxide coatings on mineral grains in the B-horizon. The chemical composition of the A-horizon is significantly impacted by the metal contents of vegetation contributing litter to the forest floor. This litter will reflect metals obtained by vegetation during nutrient acquisition from soil horizons tapped by root systems. Accordingly, the A-horizon geochemical signature will reflect the ability of various species to acquire and store metals until such time as they are dropped to the forest floor, decompose and move downward in the soil profile. This source of metal may therefore reflect a transported metal signature representing a clastic component within an exotic till, rather than a buried mineralization signature. The diffusion of relatively volatile metal phases or metal transport by gases, consisting of Hg-vapour, CO_2, Rn, He, N, O_2, CO_4, Ar and S compounds, away from an oxidizing mineralized zone undoubtedly proceeds as a result of a number of processes. Metal transport may be effected by the influence of an electrochemical or self-potential cell, or as components in soil gases derived from mantle degassing (cf. Gold and Soter, 1980; ‘geo gas’ of Malmqvist and Kristiansson, 1984; ‘earth gas’ of Wang et al., 1997). Metals carried by one or more of these mechanisms will enrich the amorphous Mn oxide in the B-horizon in metals.

Table 11. Comparison of geochemistry of samples from the sand- and clay-filled cavities with that of the oxidized dolomitic limestone of the Dolomitic Limestone Beds (DLB), southeast profile, North Mafeking Quarry.

Element	Sand/clay (ppb)	DLB (ppb)
Au	7.0	<2.0
	(ppm)	**(ppm)**
As	1.4	<0.5
Ba	210.0	<50.0
Br	0.9	<0.5
Co	15.0	3.0
Cr	61.0	<5.0
Cs	4.0	<1.0
Hf	7.0	<1.0
Rb	110.0	<15.0
Sb	0.6	<0.1
Sc	8.5	0.3
Th	6.8	0.2
U	10.0	0.8
La	29.0	1.1
Ce	46.0	<3.0
Nd	24.0	<5.0
Sm	4.6	0.2
Eu	1.2	<0.2
Tb	0.8	<0.5
Yb	3.6	0.2
Lu	0.65	<0.5
Cu	12.0	<0.4
Pb	7.0	<4.0
Zn	40.0	9.0
Ag	0.9	<0.4
Ni	66.0	7.0
V	75.0	4.0
Y	42.0	6.0
	(%)	**(%)**
P	1.038	0.013
Ti	0.3	0.0
Al	5.23	0.17
K	2.11	0.11

Enzyme Leach^{SM} application to the Mafeking quarries area

The purpose of using the Enzyme Leach^{SM} method for sample analysis was to determine whether meaningful geochemical indications of buried Prairie-type mineralization could be observed in B-horizon soils around the quarry area. As such, this aspect of investigations into Prairie-type mineralization represents a soil-geochemical orientation program.

Sample collection, preparation and analysis

Soil samples were collected every 25 m from hand-dug pits, with duplicate samples collected from a second pit every 15–20 sites. Previously cut grids were used during sampling and resulted in the collection of 117 samples from 114 pits along 6 east-west transects in the area of the North and South Mafeking quarries (Figure 34).

Samples consisted of approximately 2 kg of inorganic material stored in medium-sized Ziploc® freezer bags. Care was taken to exclude all organic material from the samples. Possible volatilization of metals from the water-rich, amorphous Mn-oxide coatings on individual soil particles was prevented by maintaining sample temperature at 15–20°C.

Samples were air dried on plastic disposable plates and sieved to isolate the -60 mesh size fraction in the laboratories of the Manitoba Geological Survey. This fraction was forwarded to Activation Laboratories Ltd. (Ancaster, Ontario) for Enzyme Leach^{SM} extraction.

Native Au and Hg, if present as discrete grains in the soil profile, are not digested by the Enzyme Leach^{SM}. The leachate from the soil samples was analyzed by ICP-MS for 59 elements at detection limits in the parts per billion range. It should be noted that the Enzyme Leach^{SM} extraction used in this study was the ‘standard’ grade.

Descriptions of samples sent for Enzyme Leach^{SM} analysis are presented in Appendix 5. Geochemical data and analyses for field-duplicate samples are presented in Appendix 6 (Parts 1 and 2). Descriptive statistics for elements determined by this method are presented in Table 12.

Data reproducibility

Good reproducibility is indicated for most elements above the lower limit of detection (LLD) and across the observed concentration ranges. The elements V, Co, Ni, Cu, Zn, Ga, As, Rb, Y, Zr, Mo, Cd, Sb, I, Pb and Th, and the rare earth elements (REE), are reported in concentrations generally less than 50 ppb in the six duplicate pairs collected. Good reproducibility for the analyses is apparent even at concentrations less than 10 ppb. Within the range 100–500 ppb and 500–1000 ppb, the elements Br,

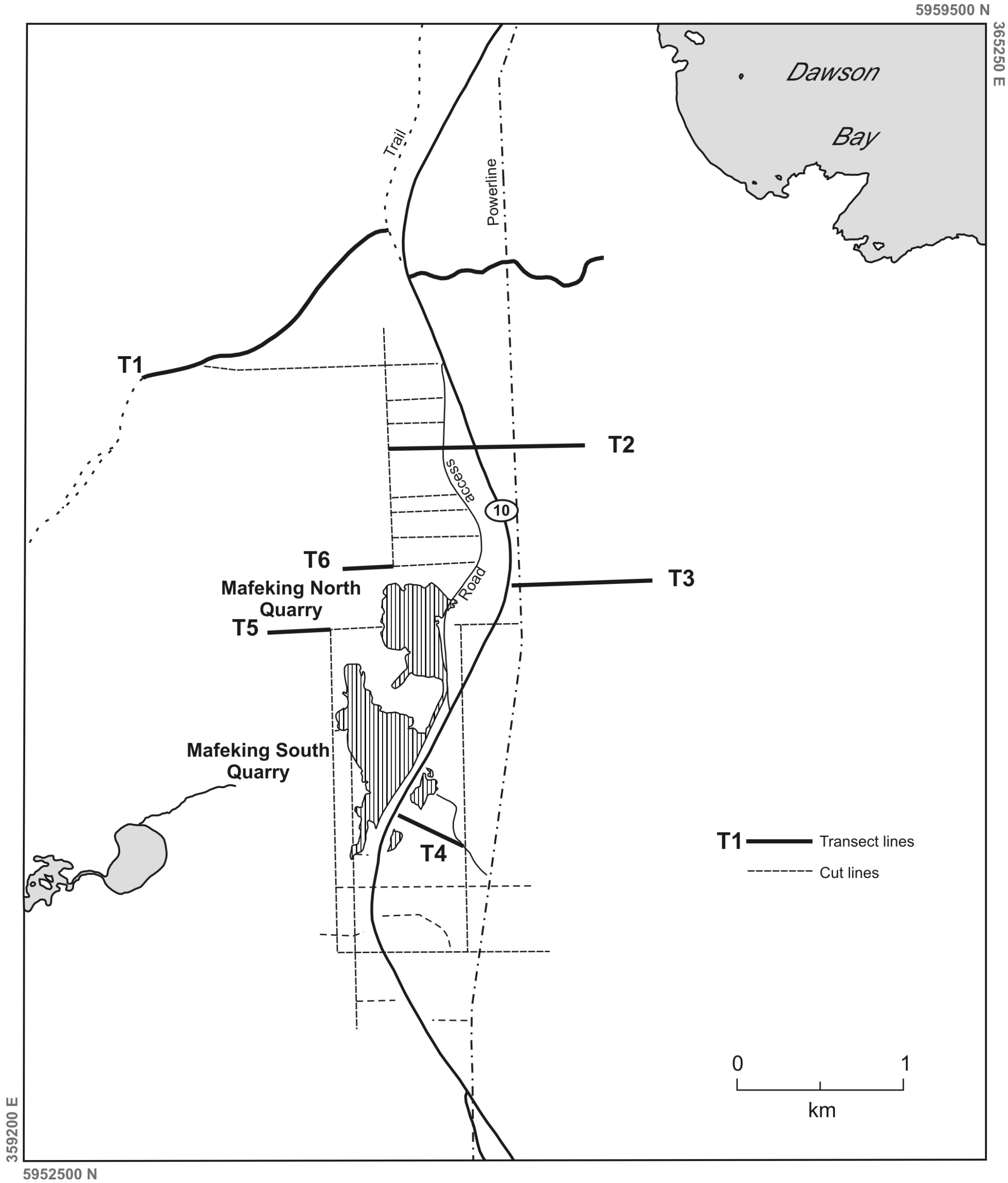

Figure 34: Locations of Enzyme Leach[SM] sampling transects 1 through 6, Mafeking quarries area.

Sr, Ba and semiquantitative Ti (SQTi) are reproducible. Semiquantitative Cl (SQCl; >1000 ppb) is erratic and semiquantitative Li (SQLi) is considered to be moderately reproducible. Reproducible analyses of duplicate pairs at concentration levels <10 ppb is significant because slight sample inhomogeneities or fluctuations in instrument stability or digestion procedure can impart a significant variance to the data. Selected elements are plotted in Figure 35 and illustrate reproducibility in the six duplicate pairs.

Enzyme Leach[SM] profiles

The elements Be, Sc, Ge, Se, Ru, Pd, In, Ag, Sn, Sb, Te, Eu, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Os, Pt, Au, Tl and Bi were consistently at or below the LLD for the Enzyme Leach[SM]–ICP-MS method, or were ineffective in defining a recognizable geochemical response along transects 1 through 6. Accordingly, they are not discussed further in this report. Beryllium and scandium were determined semiquantitatively (SQ). Enzyme Leach[SM] geochemical profiles are presented in Appendix 7.

Transect 1

Transect 1 is the longest sample profile in the study area, with 58 samples collected from 65 sites over a distance of 1600 m (Figure 34). The majority of sites that could not be sampled were from a flooded depression topped by >0.5 m of peat. Although

Table 12: Summary of descriptive statistics for Enzyme Leach[SM] results above the lower limit of detection. Statistics based on 117 samples. All analyses in parts per billion.

Element	Range	Mean	Standard deviation	Median	Coefficient of variation
SQLi[1]	5.0-68.0	11.0	12.0	5.0	1.049
SQCl[1]	1500.0-28767.0	6097.0	5510.0	5156.0	0.904
SQTi[1]	50.0-1238.0	116.0	201.0	50.0	1.723
V	17.0-808.0	72.0	82.0	60.0	1.135
Mn	42.0-3083.0	694.0	670.0	445.0	0.966
Co	1.0-21.0	6.0	3.0	5.0	0.504
Ni	10.0-94.0	37.0	17.0	32.0	0.473
Cu	2.5-153.0	22.0	18.0	19.0	0.807
Zn	5.0-76.0	20.0	14.0	16.0	0.732
Ga	0.5-10.0	1.2	1.5	0.5	1.220
As	2.5-34.0	10.0	5.0	9.0	0.523
Br	15.0-1167.0	219.0	161.0	208.0	0.734
Rb	0.5-59.0	10.0	10.0	8.0	0.974
Sr	43.0-803.0	157.0	134.0	101.0	0.851
Y	4.0-35.0	15.0	6.0	14.0	0.431
Zr	3.0-75.0	16.0	11.0	14.0	0.701
Mo	4.0-85.0	11.0	8.0	10.0	0.707
I	12.0-222.0	54.0	25.0	52.0	0.460
Ba	78.0-3480.0	367.0	485.0	231.0	1.321
La	5.0-37.0	15.0	7.0	15.0	0.459
Ce	7.0-67.0	24.0	12.0	22.0	0.475
Pr	1.0-11.0	4.0	2.0	4.0	0.435
Nd	5.0-44.0	17.0	8.0	16.0	0.448
Sm	1.0-11.0	4.0	2.0	4.0	0.431
Gd	2.0-12.0	5.0	2.0	5.0	0.427
Pb	1.0-18.0	4.0	2.0	4.0	0.497
Th	0.5-10.0	3.0	2.0	2.0	0.831

[1] SQ stands for semiquantitative

sample collection was attempted in this area, flooding of the pit and concomitant organic contamination of the material in the hole could not be avoided. The transect was established on both the west and east sides of Highway 10.

Two main areas of elevated geochemical response have been documented from transect 1. The first of these anomalies occurs at 750 m along the transect and is defined by a single sample collected from the flooded area that extends from approximately 600 to 825 m on the western portion of the transect. Although this sample was beige, lightly oxidized clay, it was collected amidst flooding in the pit; some organic/humified peat was observed adhering to the outer surface of the sample. Although the organic material was carefully removed, there is still a possibility of contamination of the sample with organic material that is relatively metal rich compared to the inorganic B-horizon. Despite these concerns, an apical response was obtained at this site for the elements SQLi, V, Cu, Zn, Ga, Rb, Zr, Nb, Cs, Re, Hf, Pb, Th, U, La, Ce and Sm. The responses for the elements are generally low contrast but somewhat greater than that from samples on either side of the flooded depression, so the single-sample anomaly appears as a spike at 750 m along the profile.

Interestingly, there is a strong possibility of a Ba 'rabbit-ear' anomaly flanking the flooded depression. The high-contrast Ba response is particularly noticeable because background concentrations are relatively low along this transect.

Another anomalous response is noted between 500 and 600 m on the western portion of transect 1. This response occupies a position on the immediate west flank of the single-sample apical response and the Ba rabbit-ear anomaly. The elements responding on this portion of the transect include SQLi, SQCl, Ni, Co, Sr, As, Y, Cd, Mo and possibly the REE, although their response is erratic.

The final interpreted response occurs at approximately the 1500–1575 m station on the eastern portion of transect 1. At this site, a multisample apical anomaly is developed for SQLi, SQTi, V, Cu, Zn, As, Y, Th, and possibly Pb and most of the REE. This response is not associated with any observed topographic lineament or depression.

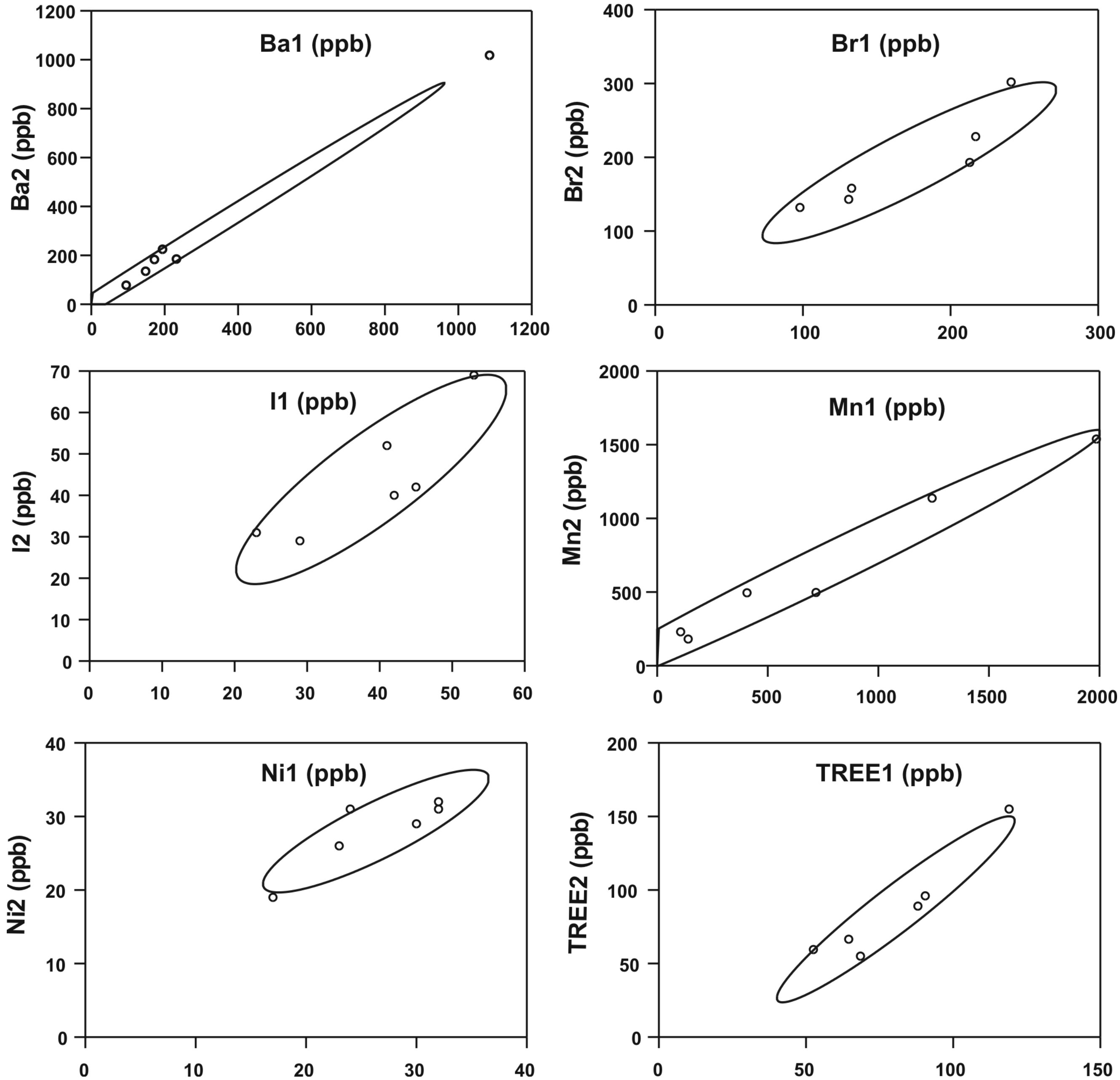

Figure 35: Analytical reproducibility of field-duplicate pairs (n=6) with 95% confidence ellipse. 'TREE' refers to total rare earth elements, as determined by Enzyme Leach[SM].

Transect 2

This transect is substantially shorter (500 m) than transect 1 and, like transect 1, was established on both the east and west sides of Highway 10 (Figure 34). Twenty-one samples were collected along this profile. Two samples at 225 and 250 m on the transect could not be collected due to wet swamp. Three sites of anomalous geochemical response have been identified on transect 2. Moderate- to low-contrast Ni, Cu, Zn and Ba responses are observed at 0–75 m, at the western extremity of the transect. The second anomalous response is obtained between 275 and 350 m on the western edge of the eastern portion of transect 2. This 75 m wide zone is characterized by SQLi, SQCl, V, Ni, SQTi and Zr responses. There are also a large number of elements that form apical responses over this portion of the transect, albeit at very low contrasts. The apical response is often only 2–5 ppb higher than adjacent samples. These low-contrast anomalies include Pb, Th, Nb, Rb, Sr, Ga, Sn and Cs.

Another multi-element response is developed over the final 50 m of the transect, between 450 and 500 m. It is characterized by high SQLi, SQCl, V, Ni, La, Ce, Pr, Nd, Sm and Gd. The shape or pattern of this response indicates that it likely extends farther to the east, past the end of the transect at 500 m.

Transect 3

This 325 m long, east-west sampling profile extends east of Highway 10 at about the northern extent of the North Mafeking

Quarry (Figure 34). Fourteen samples were collected along the line with 100% recovery. Three zones of moderate contrast geochemical response were obtained along this transect.

The first response occurs at 90 m on the profile and is characterized by the element assemblage SQLi, SQCl, Ba, Y, Mn, Co and possibly REE. The Mn response is considered to be a high-contrast signature, whereas Co, SQLi and SQCl are moderate- to low-contrast responses. The Y and REE responses approximate a rabbit-ear anomaly, although it is poorly defined.

The second response along this transect occurs at 185 m and is defined by Ni, SQLi, Sr, Ba and a trough or zone of depletion for Zn. The third response, developed between 225 and 280 m, consists of enrichments and apical signatures for V, As, Nb and I, and very low contrast Tm, Yb, Lu, Ho and Pb spikes. A well-defined Sr rabbit-ear anomaly is documented at this location.

Transect 4

This 125 m long transect was established on the east side of Highway 10, extending in a southeasterly direction from the South Mafeking Quarry (Figure 34). Six samples were collected from moderately low terrain; wet swamp prevented extending the line past 125 m.

The relatively short transect distance makes definitive identification of geochemical responses difficult; however, there is a zone of multi-element response, characterized by low to high contrasts, at 50–80 m. At this location, a rabbit-ear response was identified for SQLi, Mn, Co and I, with the trough of the response marked by apical anomalies for SQTi, Zn, Ga, Rb, Y, Zr, Nb, La, Ce, Pr, Nd, Sm, Gd, Dy, Yb and Pb. Many of these responses may not be valid because of the very low contrast between 'background' and 'anomaly'. The highest values for SQLi, V, Ni, Cu, As, Sr, Sb and Ba occur at 125 m on the transect, the last sample point.

Transect 5

Transect 5 is another short (75 m), east-trending sampling profile restricted by wet swamp on the west side of the North Mafeking Quarry. Four samples were collected, starting at the intersection between an unmarked baseline and grid line. The interpretation, based on these four samples, is tenuous owing to the restricted nature of the transect as well as the very low contrast of the geochemical responses. The highest responses for SQCl, V, Br and Rb occur within 25 m of the start of the sampling transect. Apical, single-sample responses occur for SQLi, Co, Cu, Zn, Sr, Mo, I, Sb, Re and U at the 50 m station and correspond to a rabbit-ear trough developed for Ba, Mn, As, Y, Zr, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Er and Th.

It is debatable whether these responses are real or simply representative of random geochemical background variation.

Transect 6

Transect 6 is similar to transects 4 and 5 in that it is a short (150 m) sampling profile restricted by wet swamp. It extends westward from an unmarked baseline–grid line intersection at a point just north of the North Mafeking Quarry. Most 'anomalous' responses occur at the 100 m station on the transect and are typically single-sample low-contrast signatures. The highest values for SQLi, V, Co, Ni, Cu, Zn, Br, Rb, Mo, Cd, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, W, Pb and Th occur this station. Contrasts for SQLi, V, Ni, Cu, Zn, Sr and Ba between this and adjacent samples are probably significant. The remainder of the elements are marked by very low to low contrasts, usually a few ppb, and are only described because these responses correspond spatially to the higher contrast elements.

Statistical and graphical evaluation of Enzyme Leach^{SM} geochemical response using probability plots

The evaluation of geochemical response in soils, or other sampling media, can be assessed on the basis of the change in absolute concentration or the recognition of the pattern of this change. Assessment of Enzyme Leach^{SM} geochemical response along transects 1 through 6 was based primarily on the recognition of apical and rabbit-ear responses. Where contrast between these responses was restricted to a few ppb or perhaps 10–20 ppb, the significance of the 'anomalies' was qualified.

Application of probability plots to the evaluation of Enzyme Leach^{SM} geochemical response provides a statistical and graphical method of defining geochemical outliers without data transformation. The approach is based on the comparison of the data population of interest against a data population of known distribution. The known distribution can be normal, exponential or binomial; however, if a normal distribution is selected as the basis for comparison, then non-normal outliers can be detected.

A normally distributed data population will plot along a straight line on a probability plot. The expected values for a normal distribution are plotted along the vertical axis and the observed values (e.g., ppb V) are plotted on the horizontal axis. The point of deviation from the straight line or normal distribution can be assigned as the upper limit of background variation or the threshold, and identifies the presence of a separate data population. This population is deemed to be 'anomalous'.

Table 13 gives the threshold values for elements determined using the Enzyme Leach^{SM} method from all 117 samples collected for this study. The values can then be used to reassess the Enzyme Leach^{SM} geochemical profiles along each of the 6 transects. These threshold values have been plotted, where applicable, on the profiles presented in Appendix 7.

Many of the anomalous responses described from the transect profiles are shown to be statistically/graphically invalid and should therefore be interpreted to represent random background fluctuation. This is not universal, however, as valid anomalies are present along these transects.

Transect 1 anomalous responses are present for SQTi, V, Cu, Zn, Ga, As, Rb, Zr, Mo, La, Ce, Sm, Pb and Th at 750 m, and for SQTi, V, Co, Cu, Zn, Ga, As, Y, La, Ce, Pr, Nd, Sm, Gd, Pb and Th between 1500 and 1575 m along the transect.

Transect 2 anomalies for Ni, Cu, Zn and Ba between 0 and 75 m are validated, as are those for SQTi, V, Ni, Th, Zr, Zn, Ga, As, Rb and Sr from 275–350 m. The third response along the transect, identified between 450 and 500 m, is marked by V, Ni, Br, Rb, La and Sm.

Transect 3 anomalies were observed at 90 m and 185 m, and between 225 and 280 m. Elements interpreted to represent statistically and graphically valid anomalies or outliers at 90 m include Mn, Br, Y, La and Sm; Ni and Mo are anomalous at 185 m. The third response, observed between 225 and 280 m, is characterized by values for As and I above threshold.

Transect 4 anomalies occur between 50 and 80 m, and at 125 m. Only the elements Zn and I at 50–80 m and V, Ni, As, Mo and Ba at 125 m remain as validated outliers when all data are assessed with respect to the threshold for the area.

The identification of multi-element anomalies at the 25 and 50 m stations of transect 5 is considered tenuous due to generally low-contrast responses from only four samples. Subsequent to threshold determination, V, Ni, As, Sr, Ba, Sm and Th at 25 m and V, Ni, As, Sr, Ba and Th at 50 m were determined to be valid. These two lists of indicator elements are nearly identical and it is interesting that all four samples for Ni and three of four samples for V and Ba are above the 'regional' threshold. This observation suggests that a threshold calculated on the basis of approximately 60% of the data from one area (i.e., that transected by sampling profile 1, Figure 35), may not be appropriate for application to other areas.

Transect 6 outliers were identified and validated at the 100 m station for V, Ni, Zn, Sr and Ba.

Table 13: Threshold determinations using probability plots for elements determined by Enzyme Leach^{SM} and ICP-MS analysis (n=117), Mafeking quarries area.

Element	Threshold (ppb)[1]
SQLi	68
SQCl	25200
SQTi	620
V	108
Mn	600
Co	12.5
Ni	45
Cu	36
Zn	33
Ga	4.5
As	14
Br	400
Rb	19
Sr	336
Y	25
Zr	41
Mo	17
I	78
Ba	450
La	25
Ce	48
Pr	9
Nd	36
Sm	6
Gd	9
Pb	9
Th	6

Conclusions

The combination of pattern recognition and a simple statistical/graphical technique of outlier or anomaly recognition has established the presence of low- to high-contrast multisample and multi-element geochemical anomalies along each of the six transects run in the area of the North and South Mafeking quarries. The number of chemical elements defining anomalies along the transects are invariably reduced when probability plots are constructed and compared with 'descriptive' or 'pattern recognition' anomalies. Table 14 summarizes the elements that are interpreted to represent bona-fide anomalies from each transect, shown on Figure 34.

Calculation of a regional threshold and application to all transects is demonstrated to be tenuous where a significant number of analyses (60% in this study) are collected from one area. This implies the possibility of the existence of variable backgrounds, thresholds and anomalous levels of concentration for the elements between the various subareas (i.e., the six transects).

Of note in these surveys is the failure of the standard grade of Enzyme Leach^{SM} extraction and ICP-MS analysis to report Au or Pt. These are the commodity elements of interest, to date, in Prairie-type mineralization. The elements responding to this survey are 'associated' elements that, like Au, have been identified and quantified in the hostrocks using scanning electron microscopy (SEM) and energy dispersive X-ray spectrometry (EDS), as well as neutron activation (INAA) and inductively coupled plasma–atomic emission spectrometry (ICP-AES) techniques. In this regard, the geochemical outliers depicted along the sampling transects are *indirect* indicators of solution chimneys, hosts to Prairie-type microdisseminated mineralization.

The abundance of bona fide geochemical outliers defined by samples collected adjacent to and within the low–lying, flooded area between 600 and 825 m, as well as the well-developed Ba rabbit-ear anomaly on transect 1, warrant particular attention. The low-lying area may be the surface reflection of an underlying fault with associated solution chimneys and attendant collapse features.

Brine sediment survey

Sampling technique

Collection of 203 sediment samples from 33 saline brine pools (Figure 36) over the SBZ and in the vicinity of the microdisseminated precious and base-metal mineralization described from the Mafeking quarries (Fedikow et al., 1996) was undertaken in

Table 14: Summary of pattern-recognition elements and threshold elements indicative of geochemical outliers along transects 1 to 6, Mafeking quarries area.

Transect	Location	Anomalous elements based on pattern recognition	Anomalous elements based on thresholds determined from probability plots
1	600 m:	SQLi, SQCl, Ni, Co, Sr, As, Y, Cd, Mo, REE	SQCl, Ni, Co, As, Sr, Y, Mo, LREE
	750 m:	SQLi, V, Cu, Zn, Ga, Rb, Zr, Nb, Cs, Mo, Re, Hf, Pb, Th, U, La, Ce, Sm, Ba	SQTi, V, Cu, Zn, Ga, As, Rb, Zr, Mo, La, Ce, Sm, Pb, Th, Ba
	1500-1575 m:	SQLi, SQTi, V, Cu, Zn, As, Y, Th, Pb, REE (?)	SQTi, V, Co, Cu, Zn, Ga, As, Y, La, Ce, Pr, Nd, Sm, Gd, Pb, Th
2	0-75 m:	Ni, Cu, Zn, Ba	Ni, Cu, Zn, Ba
	275-350 m:	SQLi, SQCl, SQTi, V, Ni, Zr	SQTi, V, Ni, Th, Zr, Zn, Ga, As, Rb, Sr
	450-500 m:	SQLi, SQCl, V, Ni, La, Ce, Pr, Nd, Sm, Gd	V, Ni, Br, Rb, La, Sm
3	90 m:	SQLi, SQCl, Ba, Y, Mn, Co, LREE	Mn, Br, Y, La, Sm
	185 m:	SQLi, Ni, Sr, Ba, Zn	Ni, Mo
	225-280 m:	V, As, Nb, I, Pb	As, I
4	50-80 m:	SQLi, Mn, Co, I, SQTi, Zn, Ga, Rb, Y, Zr, Nb, La, Ce, Pr, Nd, Sm, Gd, Dy, Yb, Pb	Zn, I
	125 m:	SQLi, V, Ni, Cu, As, Sr, Sb, Ba	V, Ni, As, Mg, Ba
5	25 m:	SQCl, V, Br, Rb, Ni, As, Sr, Ba, Sm, Th	
	50 m:	SQLi, Co, Cu, Zn, Sr, Mo, I, Sb, Re, Y, Ba, Mn, As, Y, Zr, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Er, Th	V, Ni, As, Sr, Ba, Sm, Th V, Ni, As, Sr, Ba, Th
6	100 m:	SQLi, V, Co, Ni, Cu, Zn, Br, Rb, Mo, Cd, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, W, Pb, Th	V, Ni, Zn, Sr, Ba

1997. Sampling was completed during a six-week period beginning in early June and ending in mid-July. During this time interval, local water levels were higher than normal, thereby submerging some brine springs and limiting sample collection (Bezys et al., 1997a). The brine-sediment survey was designed as a follow-up to brine geochemical surveys undertaken by Stephenson (1973), in which high metal concentrations (Ag, Ni, Cu, Pb, Zn, Cd) were identified in brine samples collected over the SBZ relative to brines sampled outside the SBZ (Figures 37 to 43). These elements, however, did not identify a focus for this enrichment. The brine-pool sediments were sampled to ascertain whether a zone (or zones) of enrichment could be identified within the SBZ and thereby identify localized 'hot spots' for detailed exploration. From a practical, field-oriented perspective, the brine sediments were considered to be potentially more useful than the brines for this purpose, since 1) the sediments were observed to be partially composed of black, locally Fe-rich material interpreted to represent a primary mineral precipitate that could be metal rich; and 2) the sediments could be more easily sampled than the brines, with less sampling error and higher metal concentrations that could be easily measured by routine, commercially available analytical procedures.

Black anoxic mud samples were collected, using a plastic trowel, from 5–20 cm below the sediment-water interface. Initially, a grid was established at each spring location, and samples were collected at 2 m intervals. This sampling technique was later modified because 1) at most sites, the distribution of anoxic mud is discontinuous; and 2) a greater effort was made to sample the mud proximal to discharge vents subsequent to examination of preliminary geochemical data. If mud was not present near a discharge vent, samples were taken as close to as possible. Approximately 1 kg of material was collected for each sample and sealed in Ziploc® bags for analysis.

The black, euxinic character of the sediment can be observed adjacent to and surrounding the brine discharge vents in Figures 44 and 45.

Brine springs

Gross morphology of the brine springs is generally uniform, but variations exist from one location to the next. The brine springs are generally flat lying to gently sloped, and contain small mounds associated with discharge sites. Springs are often perched on a 'pan' of barren, glacially derived, iron-stained surficial material ('algal biscuits', shown in Figure 46), frequently surrounded by the red salt-loving plant *Salicornia* sp. (McKillop et al., 1992). At some sites, domes or hummocks are present within the brine spring and appear to represent the bedrock expression of the underlying Devonian Dawson Bay Formation, where it is draped over a Winnipegosis Formation reef mound.

Three types of discharge sites were observed in the study area. 'Pools' or 'cauldrons' are discharge sites ranging from a few centimetres to greater than 1 m deep and up to 1.5 m in diameter. One spring, at site DB53, has a very large pool that can be described as a saline pond (Figure 46). The brine within the cauldrons is usually clear and overflows the rims of the pools. Brine 'boils' or gas bubbles frequently percolate from these pools. Composition of the gas bubbles includes He, CH_4, N_2, O_2, Ar and

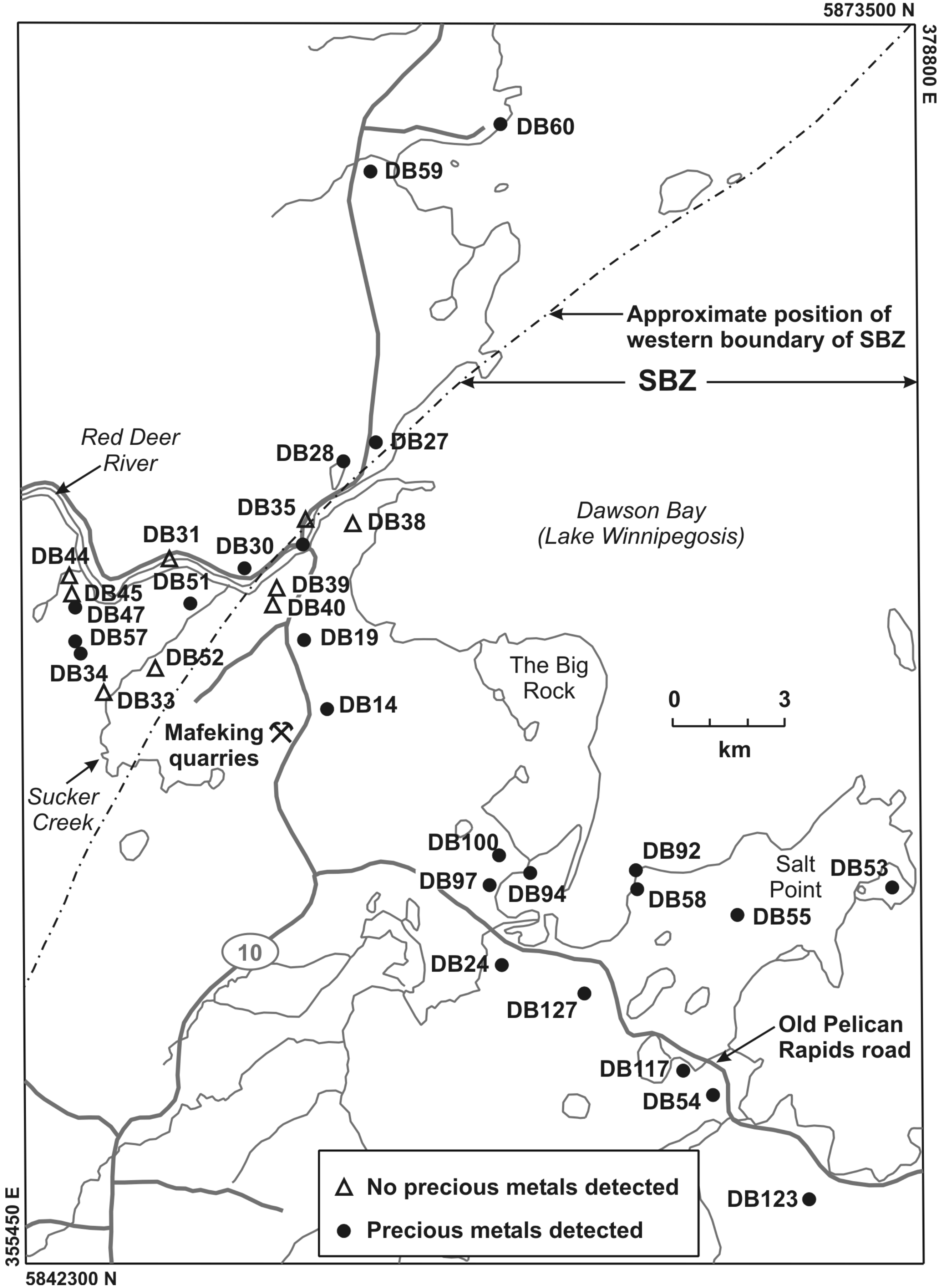

Figure 36: Location of brine springs sampled for euxinic sediments in 1997 relative to the SBZ (see Table 1 for details on site locations).

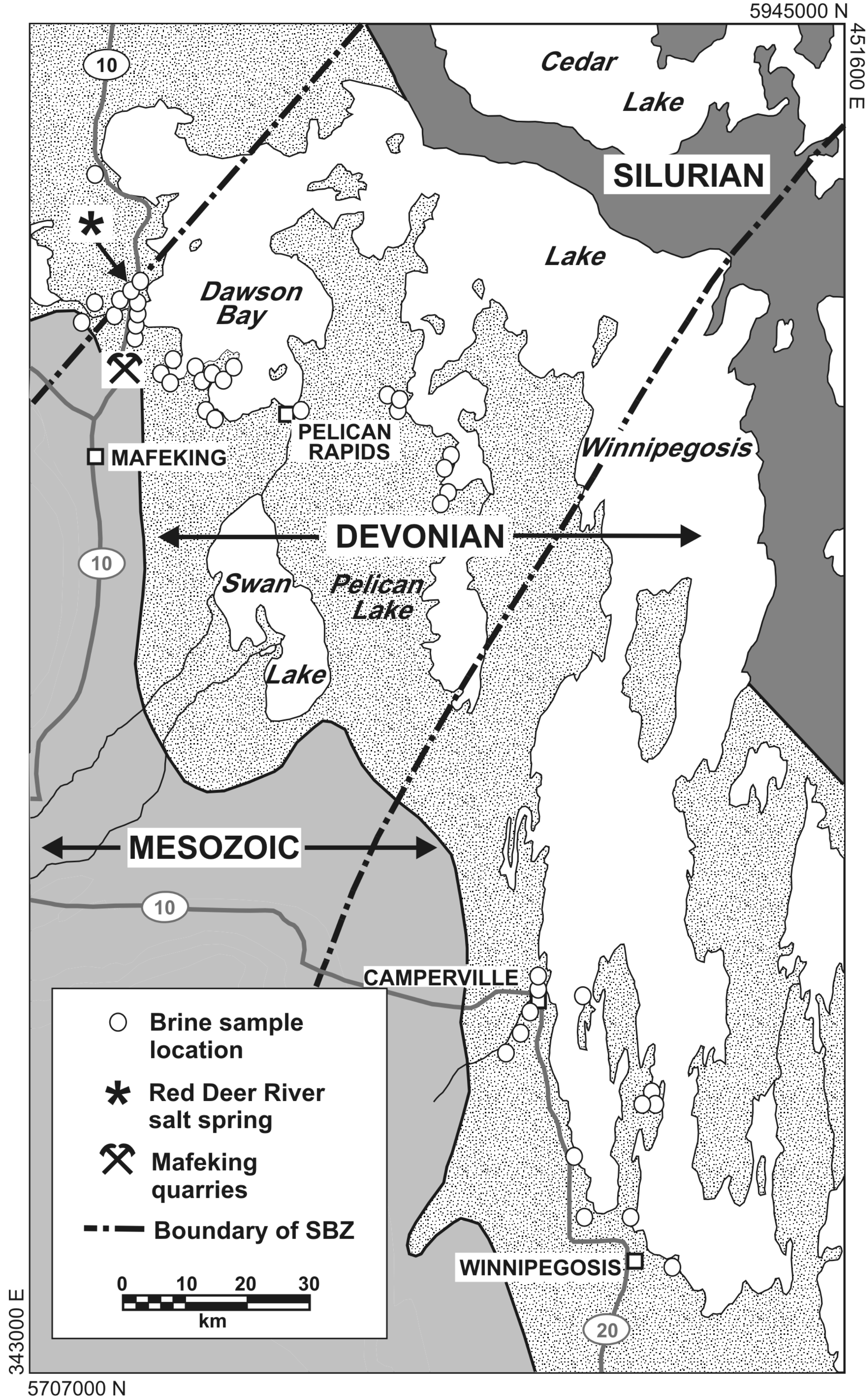

Figure 37: Location of brine springs sampled by Stephenson (1973).

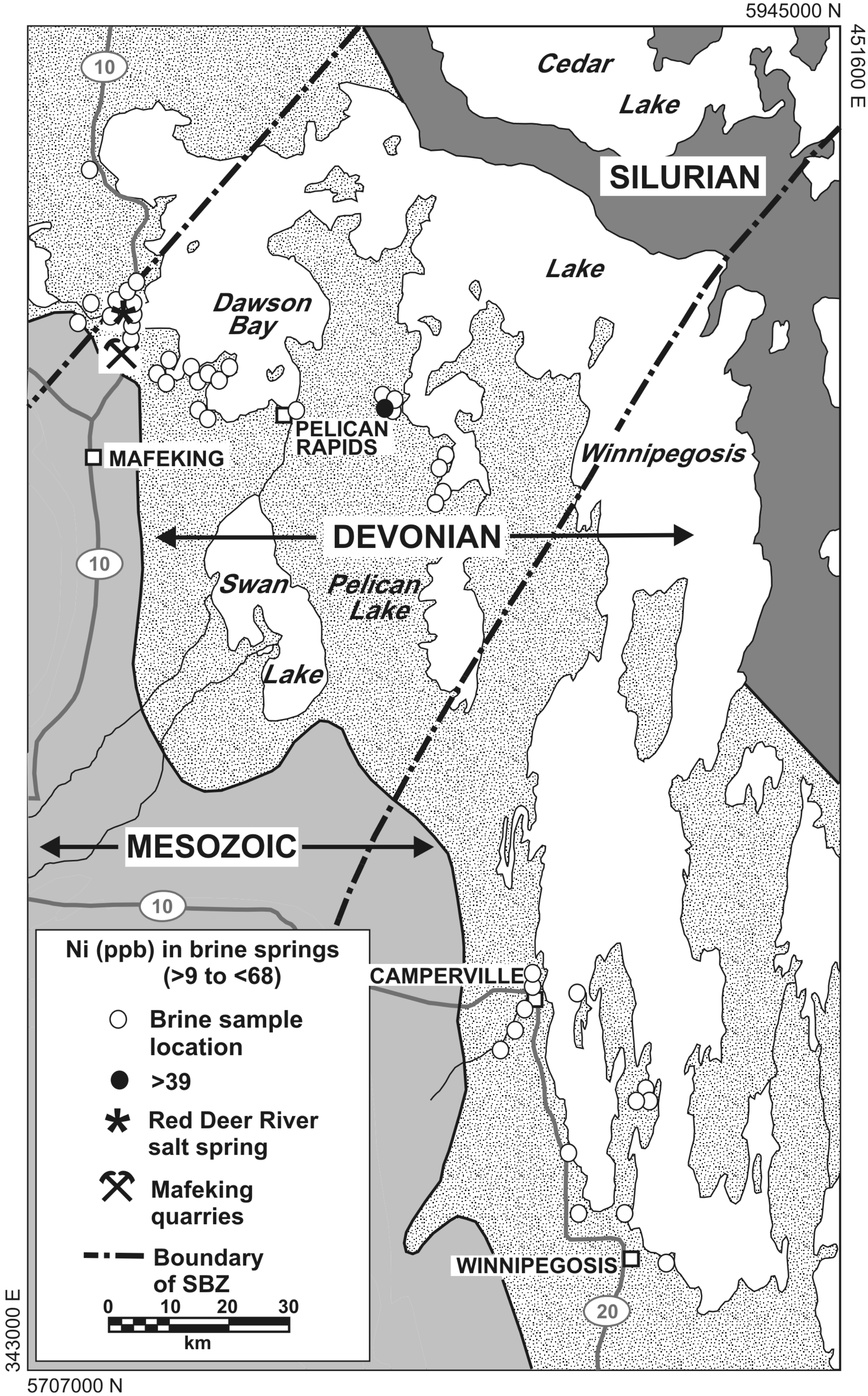

Figure 38: Concentration of Ni (ppb) in brine springs (from Stephenson, 1973).

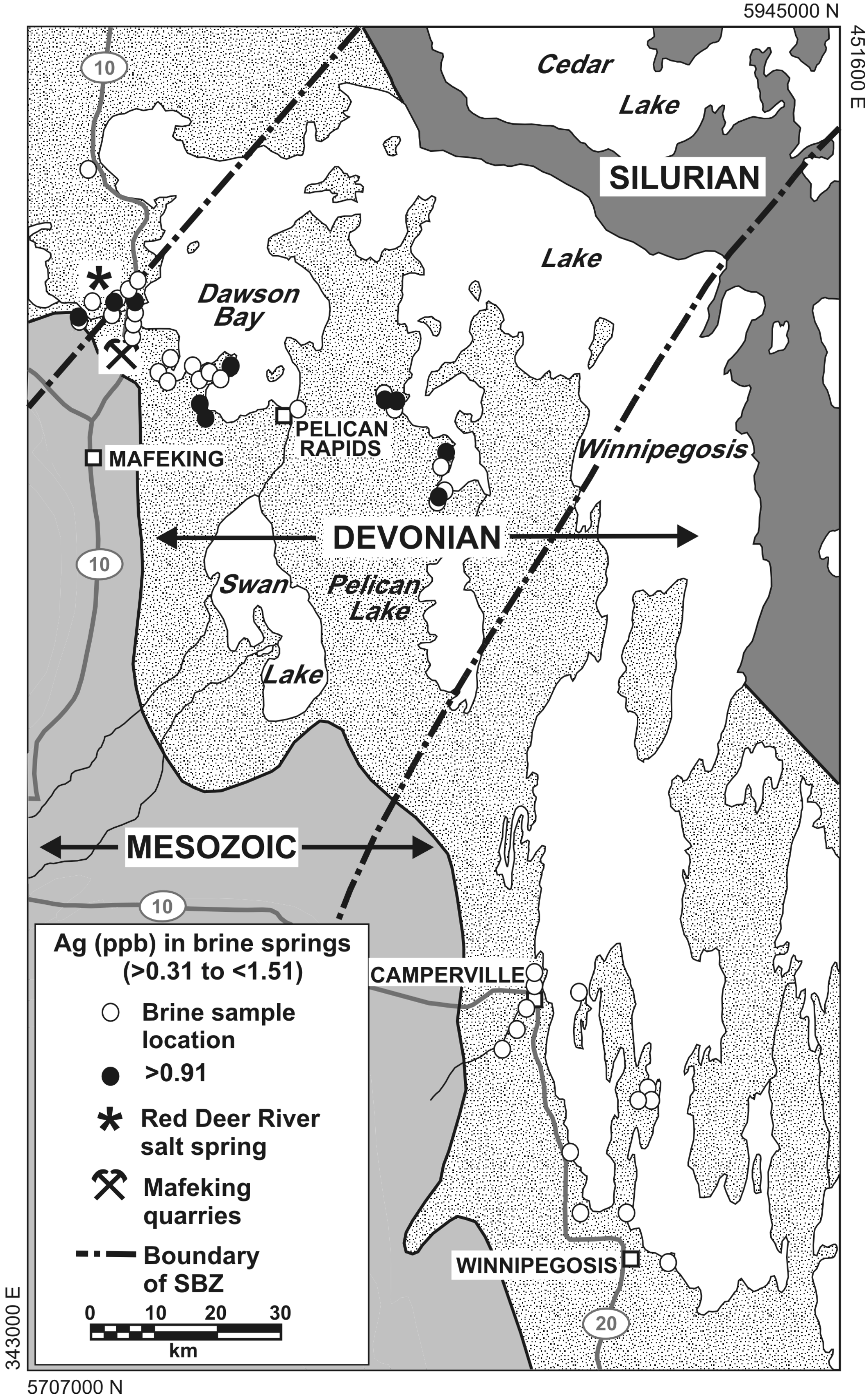

Figure 39: Concentration of Ag (ppb) in brine springs (from Stephenson, 1973).

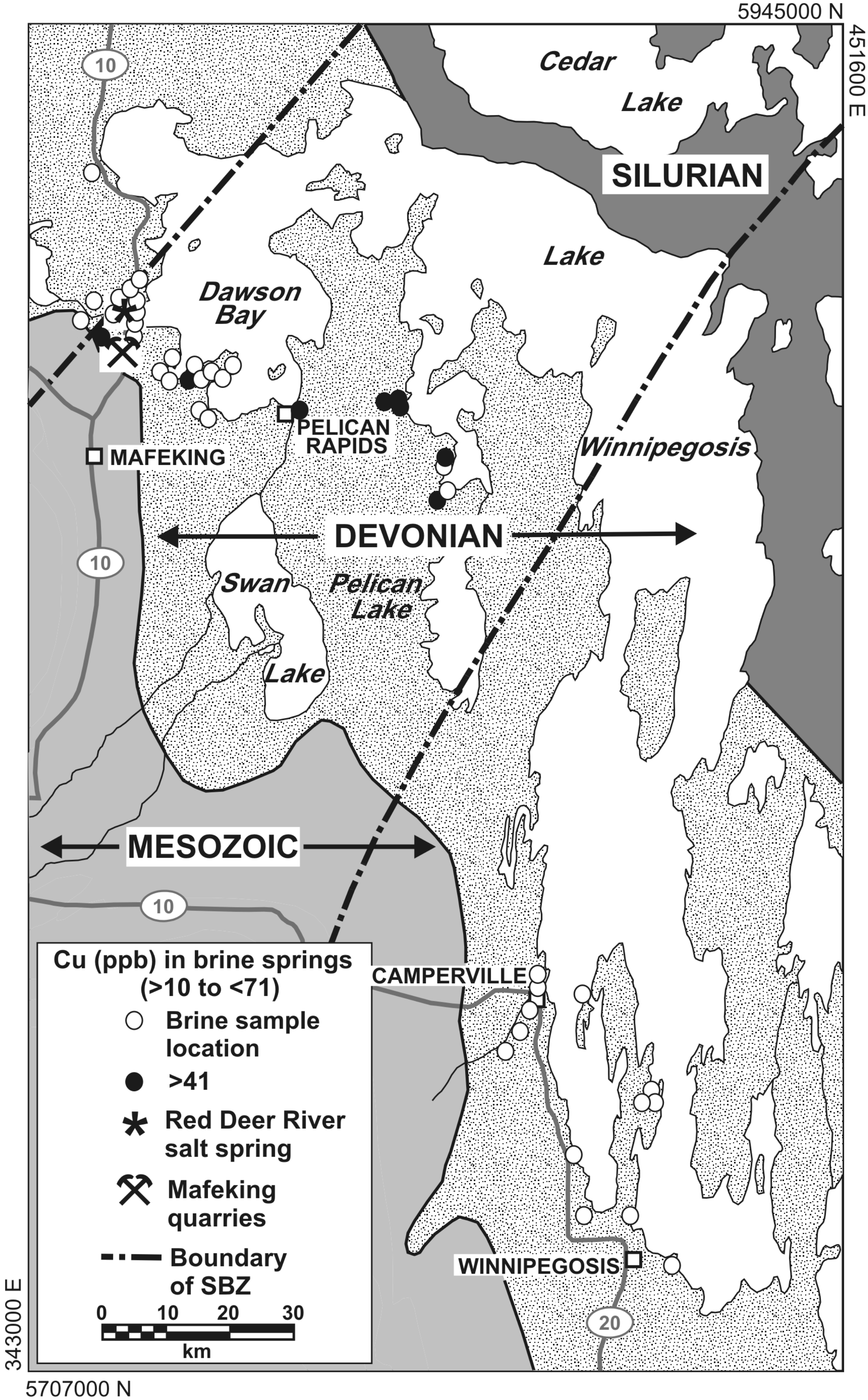

Figure 40: Concentration of Cu (ppb) in brine springs (from Stephenson, 1973).

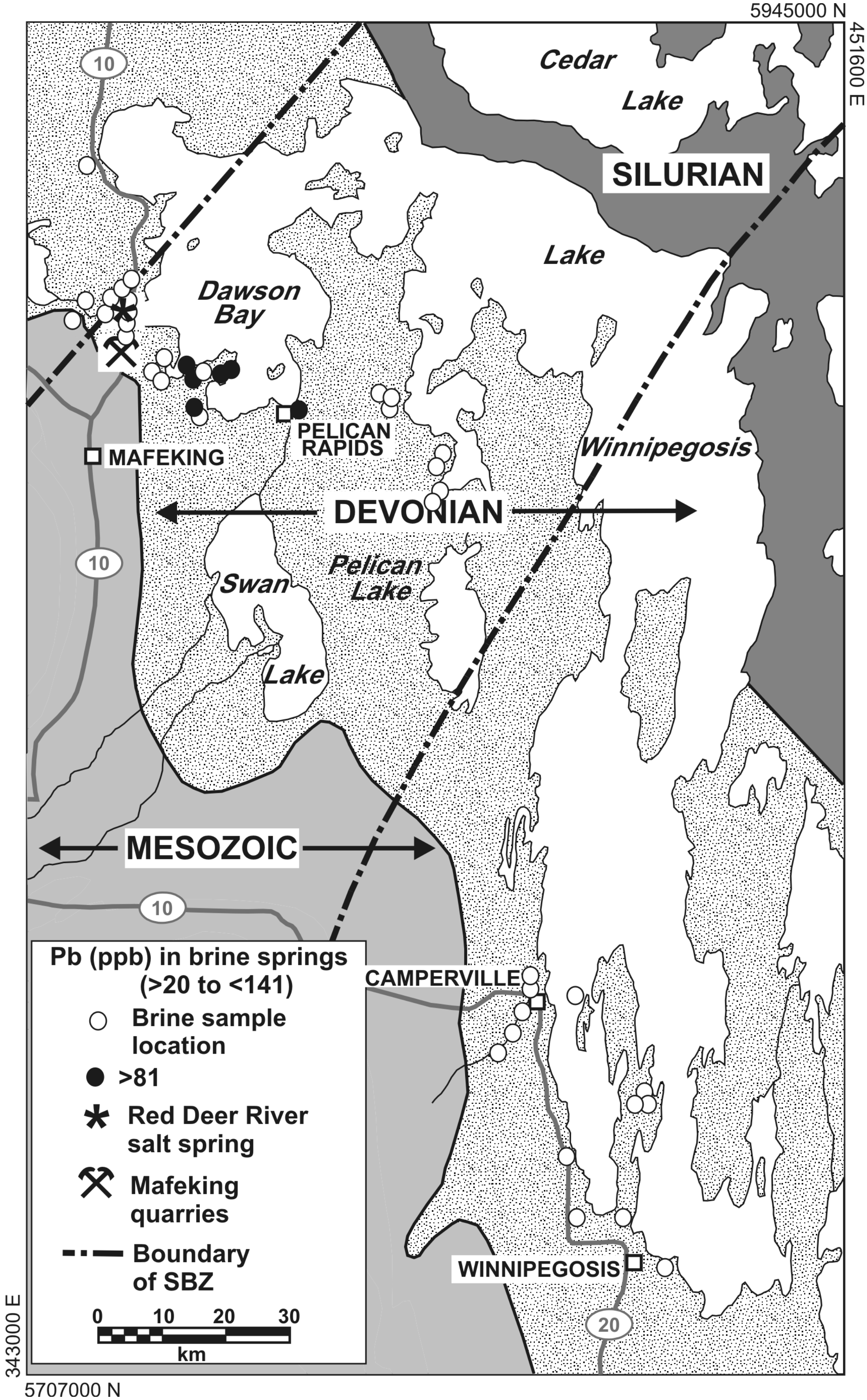

Figure 41: Concentration of Pb (ppb) in brine springs (from Stephenson, 1973).

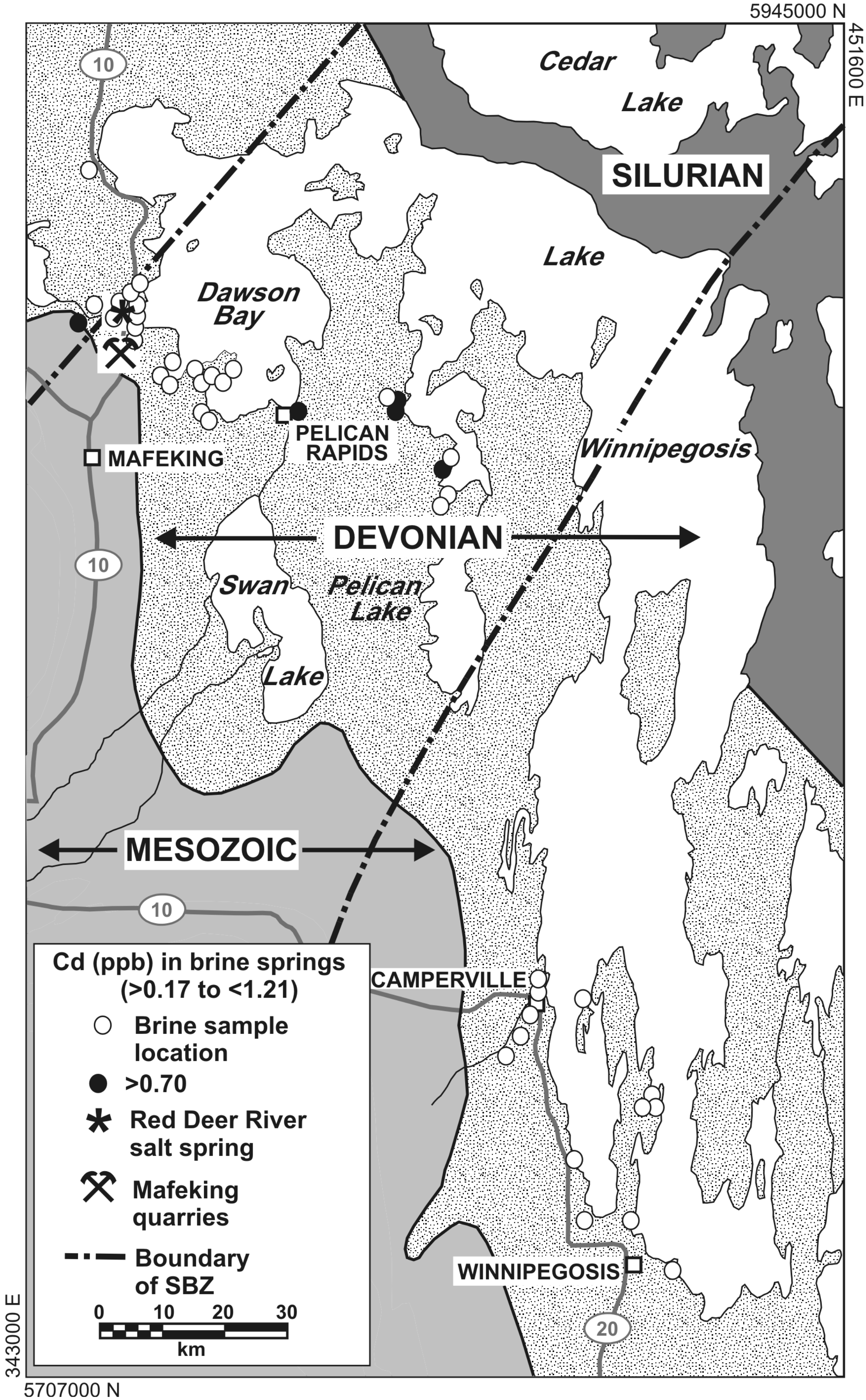

Figure 42: Concentration of Cd (ppb) in brine springs (from Stephenson, 1973).

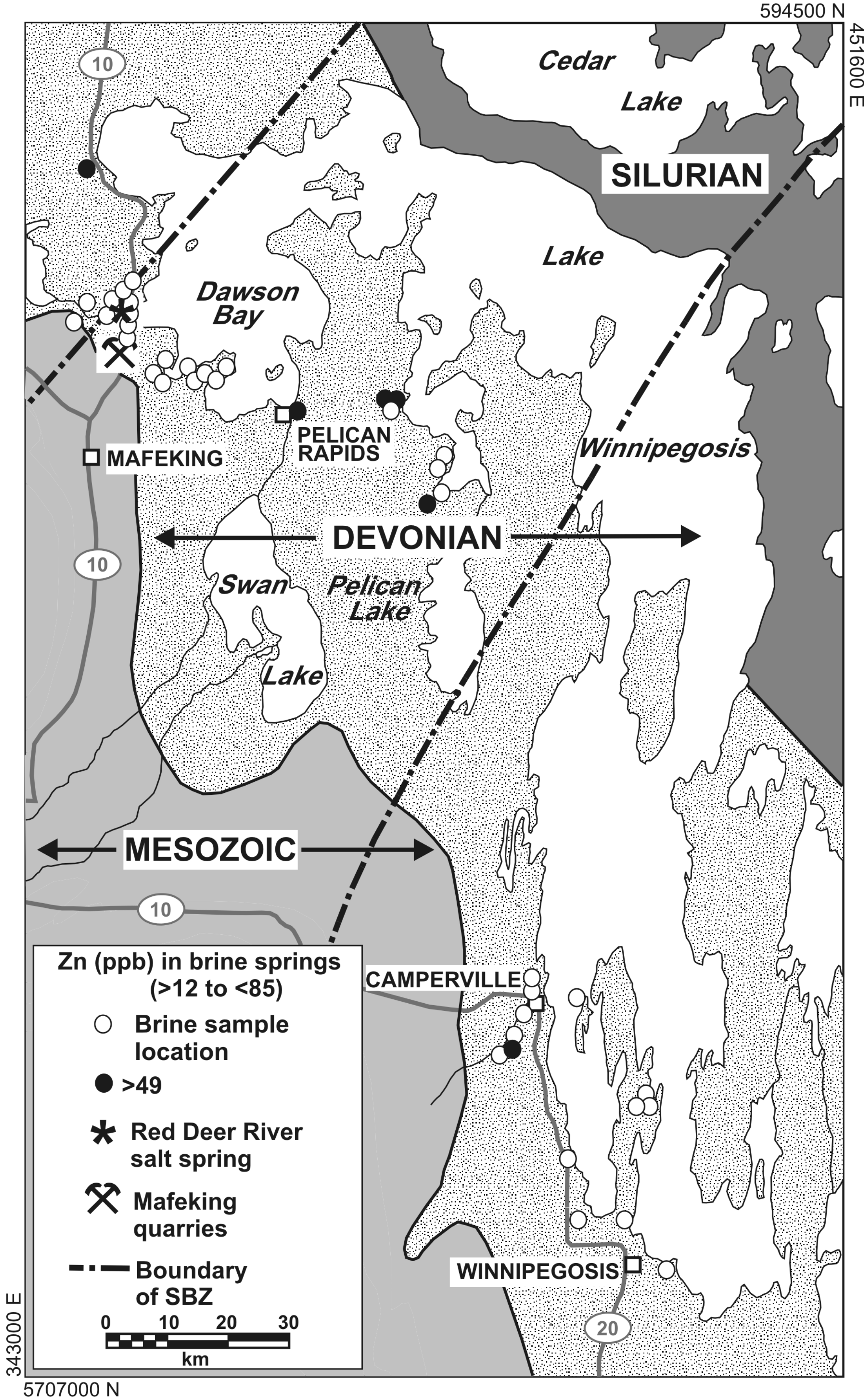

Figure 43: Concentration of Zn (ppb) in brine springs (from Stephenson, 1973).

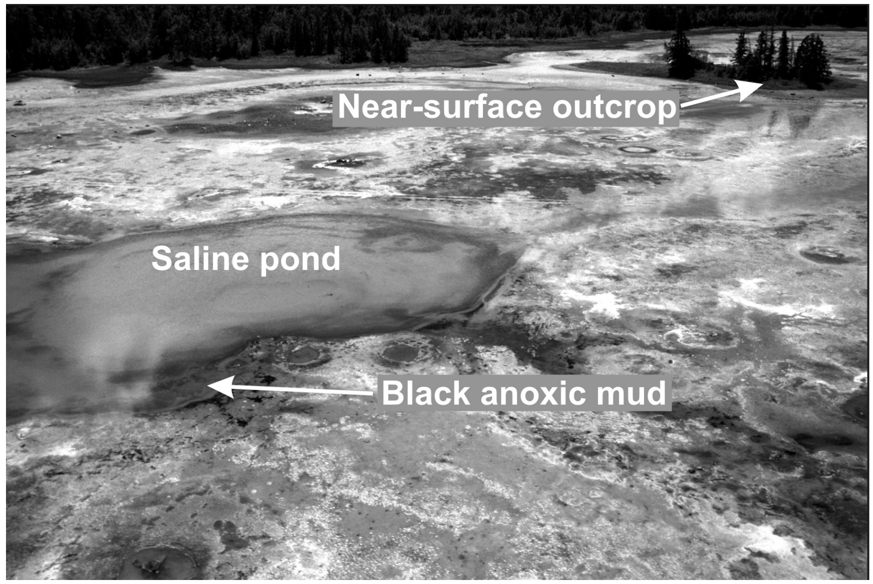

Figure 44: Photograph of large saline brine pond at Salt Point, with near-surface outcrop present where trees are growing, station 88-97-DB53 (see Table 1 for station details). Trees in background (right-hand corner) provide scale.

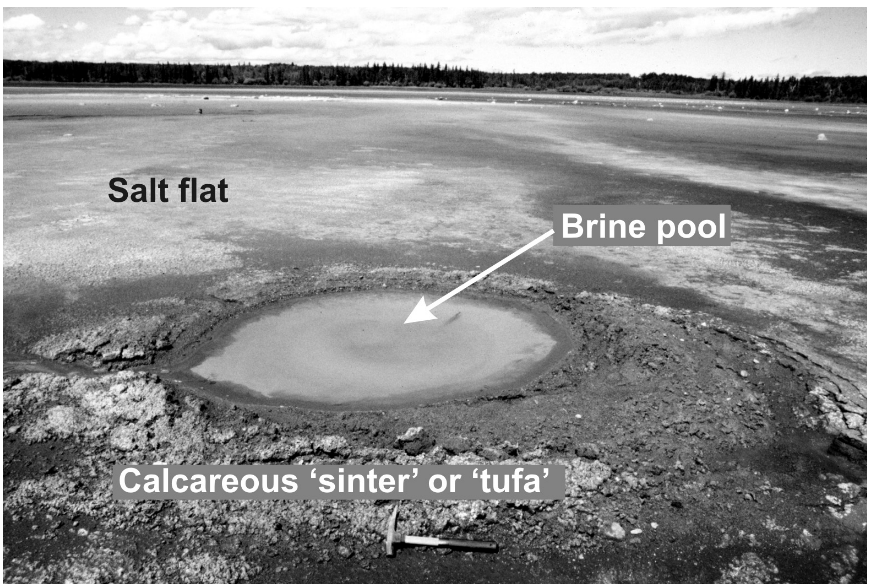

Figure 45: Photograph of Salt Point brine spring with carbonate/algal 'biscuit' gravels and associated salt flat, station 88-97-DB53 (see Table 1 for station details). Hammer provides scale.

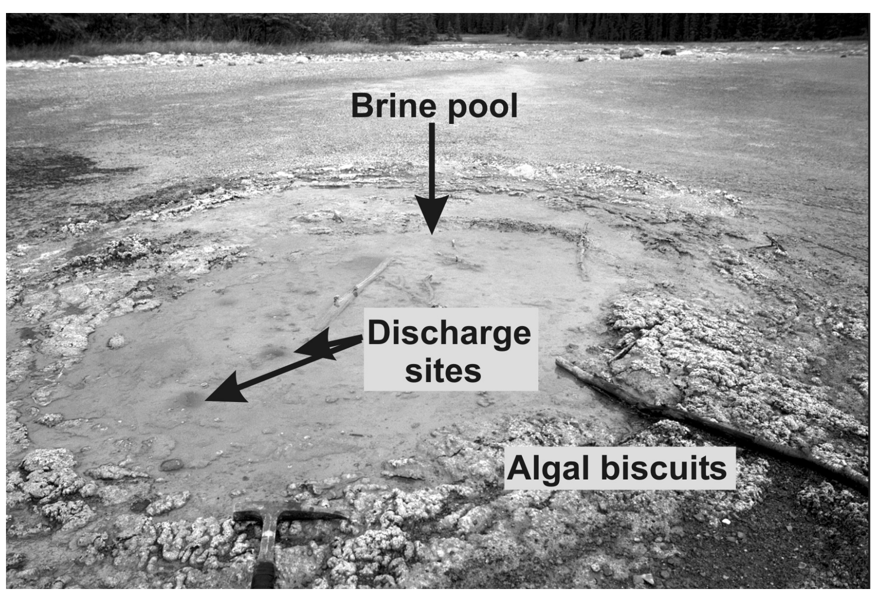

Figure 46: Photograph of saline brine pool with individual discharge vents, station 88-97-DB47, Mafeking quarries area (see Table 1 for station details); black, sulphidic sediment is proximal to the discharge sites; 'algal biscuit' gravels are also proximal to the vent.

CO_2, and dissolved gas composition includes H_2, He, CH_4, N_2, O_2, Ar, CO_2 (McKillop et al., 1992). The second type, abandoned or ephemeral discharge sites, are much smaller than pools but are identifiable even when inactive and are marked by small mud volcanoes or mud pots. The third type of discharge site (seeps) flood a large area to a depth of 1–2 cm; the actual discharge site is very small and may not be visible. The number and type of discharge sites can vary for each spring. Total dissolved solid content of water from brine springs in the Dawson Bay area varies from 29 000 to 88 946 mg/l, the latter value coming from a large spring at station #DB53 on eastern Salt Point (Table 15; Betcher, 1991).

A distinct spatial arrangement of vegetation was observed at the brine-spring sites. Burchill (1991) and Jones (1991) described eight vegetation communities ringing the saline springs in this area, whereas McKillop et al. (1992) observed five communities. Trees will not grow within 5–10 m of the discharge sites unless they are rooted on near-surface bedrock outcrop or there is a source of fresh water.

Mounds of reddish brown 'sinter' or 'tufa' occur around the springs. They are hematite- to limonite-stained, gravel-like deposits composed of calcium carbonate (Figure 45). The tufa mounds can rise up to 1 m in height surrounding the discharge sites and are spongy, porous and friable. The reddish brown tufa can dominate the surface area of the salt flat. Red to green algae are also present within the pools and, in places, algal mats may cover the salt flat. Brown to green algae growths in shapes approximating tubes or chimneys are also observed to be growing within the brine pools. At some locations these 'tubes' appear to be attached to the walls or base of the brine pool.

Many of the brine springs are littered with glacially transported boulders and erratics. The boulders are composed of locally derived carbonate and Precambrian Shield rocks, and vary in size from a few centimetres to a metre in diameter. Some of the boulders are extensively altered and corroded to form distorted 'salt hats' in the salt flats. Clusters of boulders may be present around discharge sites.

Orientation survey results

Brine pool DB27 (Figure 36) was sampled at 19 separate locations, including sediment from two identifiable vent discharge sites (Figure 47). Analysis of the samples by INAA and ICP-AES was undertaken by Activation Laboratories Ltd. (Ancaster, Ontario) and Intertek Testing Services (Vancouver, British Columbia), respectively, on this material (Appendix 8, Parts 1 and 2). No duplicates or standards were submitted for these analyses. The results, presented in Table 16, demonstrate that the two sediment samples (sites 15 and 16), collected from the immediate area of the vent, have elevated concentrations of Zn, Ni, Co, As, Sb, Mo, Br, Cu, Pb, Fe and U compared to peripheral sediment or sediment collected away from the discharge vent. Vent-proximal sediments were therefore analyzed preferentially for the remainder of the program in 1997. The metal-enriched character of the vent-proximal sediment suggests that a metal-enriched compound (arsenian pyrite?) was being precipitated at the vent and that the concentration levels of metals in this material ensured that a relatively straightforward analytical approach could be adopted for the remainder of the samples.

Regional survey results

The location of the brine-pool sediments (Figure 36) and the analytical results for samples taken during this study are plotted in Figures 48 to 58. In general, all responses are characterized by elevated concentrations close to the western boundary of the SBZ and to the Red Deer River. The exceptions are Cu and U, which are highest near Salt Point, a peninsula jutting into Dawson Bay (Lake Winnipegosis). The elevated concentration of Fe (up to 20%) suggests the presence of an Fe-rich mineral precipitate (pyrite?), possibly associated with an algal component observed at the brine pools. Within the data, there appear to be three distinct groups of metals: 1) As-Sb-Mo (precious metals or 'Prairie-type'), 2) Ni-Co-Cr (mafic-ultramafic suite), and 3) Cu-Pb-Zn (carbonate base metals of Mississippi Valley–type or 'MVT'). Uranium is also enriched along the western boundary of the SBZ, with a single moderately elevated U response associated with the Cu anomaly near Salt Point. Interestingly these three element groups mimic the scanning electron microscopic (SEM) and energy dispersive X-ray spectrometric (EDS) identification of micrometre-sized components of solution chimneys described in the Mafeking quarries (Figure 19). Fire-assay results for Au and

Table 15: Total dissolved solid values for brine springs in the Dawson Bay area (Betcher, 1991).

Station[1]	Name of site	TDS (mg/l)
DB24	South Steeprock River, southwest of church camp	29 000
DB30	North Red Deer River	51 900
DB35	North Red Deer River (north of bridge)	45 027
DB38	Near Smith Point (mouth of Red Deer River)	54 900
DB51	South Red Deer River, north Sucker Creek	53 200
DB53	East Salt Point	88 946
DB58	Northwest Salt Point	58 400

[1] see Table 1 for list of field locations

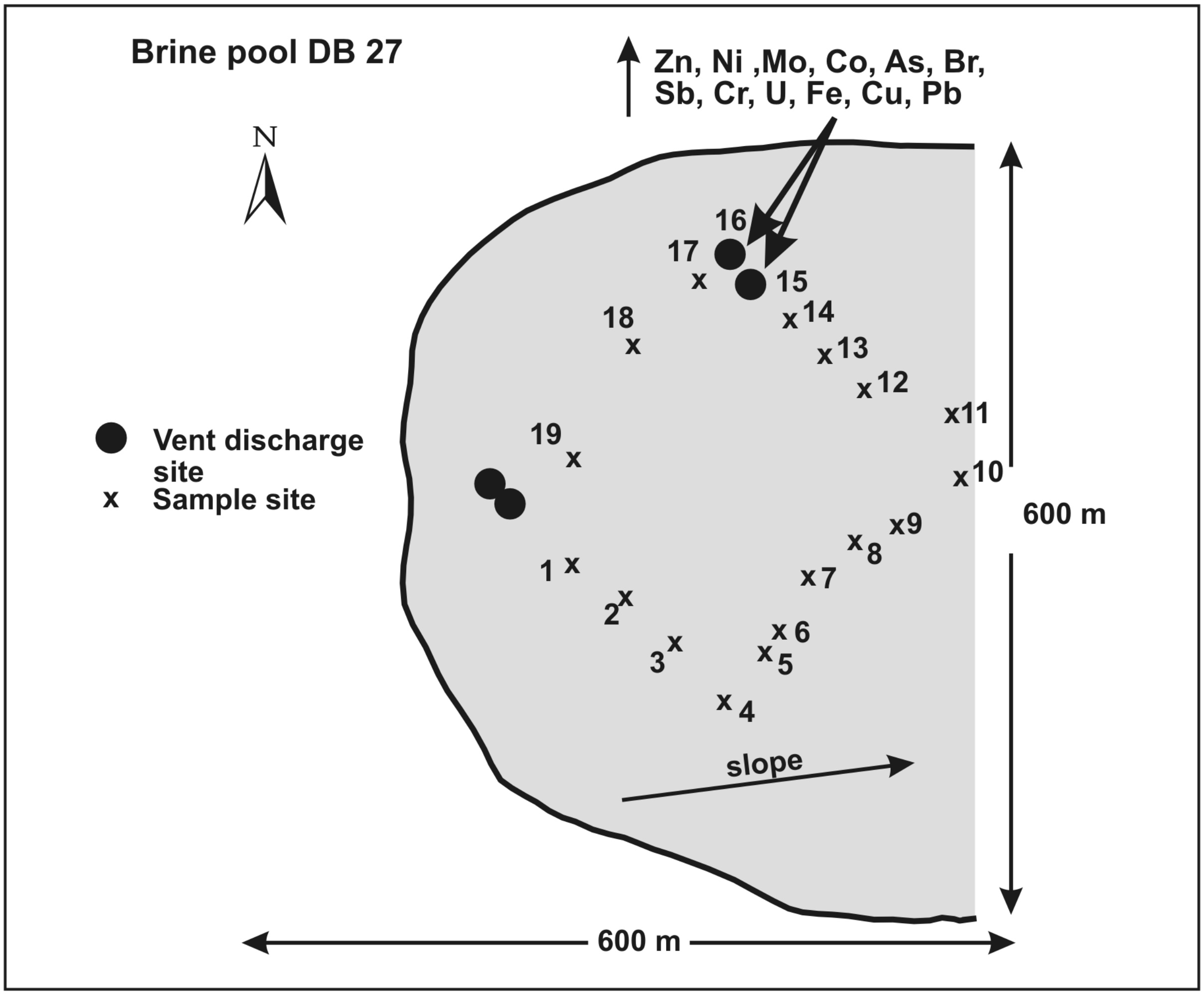

Figure 47: Sample sites for brine-pool sediment orientation survey, Mafeking quarries area (station 88-97-DB27; see Table 1 and Figure 36 for station details); sediment sample sites #15 and 16, proximal to discharge vent, indicated by arrows.

Table 16: Summary of geochemical data, brine pool DB27, Mafeking quarries area (see Figure 47 for sample locations); note difference in metal contents between sediments proximal to discharge vent (samples 15 and 16) and the 17 samples collected peripheral to the vent.

Sample location	Concentration (ppm)[1]											
	Zn	Ni	Co	Cr	As	Sb	Mo	Br	Cu	Pb	Fe	U
Vent discharge site 15	4153	762	320	68	150	0.6	22	210	23	26	7.65%	9.7
Vent discharge site 16	3200	1484	360	81	240	2.3	34	330	35	16	8.40%	21
Peripheral sediment (n=17)	38–68	10–24	6–12	11–54	3.5–7.5	0.1–0.9	<2	30–66	6–15	<5–9	1.22–2.83%	0.5–1.4

[1] except where noted

Pt in brine-spring sediments are presented in Table 17. Values for both metals are low.

Brief examination of a Spearman correlation matrix for INAA and ICP-AES analytical data from the brine-pool sediments indicates that many of the ‘enriched’ suite of elements do not significantly correlate with Fe. This suggests variable modes of occurrence for these metals. It is possible that a significant correlation exists between the algal components of the brine pools and the enriched elements.

A conceptual brine-pipe morphology is presented in Figure 59. The various features of the brine pipe are analogous to the mineralized solution chimneys exposed in the Mafeking quarries. The geochemical signatures of the vent-discharge sediments in the brine pools are mimicking the metal assemblages in the solution chimneys and in carbonate pebbles examined (using SEM and EDS) from the brine pools. Accordingly, the brine pools and their associated sediments are interpreted as modern-day equivalents of the Devonian solution chimneys developed in the Souris River Formation, and as evidence for the ongoing mechanism responsible for the formation of Prairie-type mineralization.

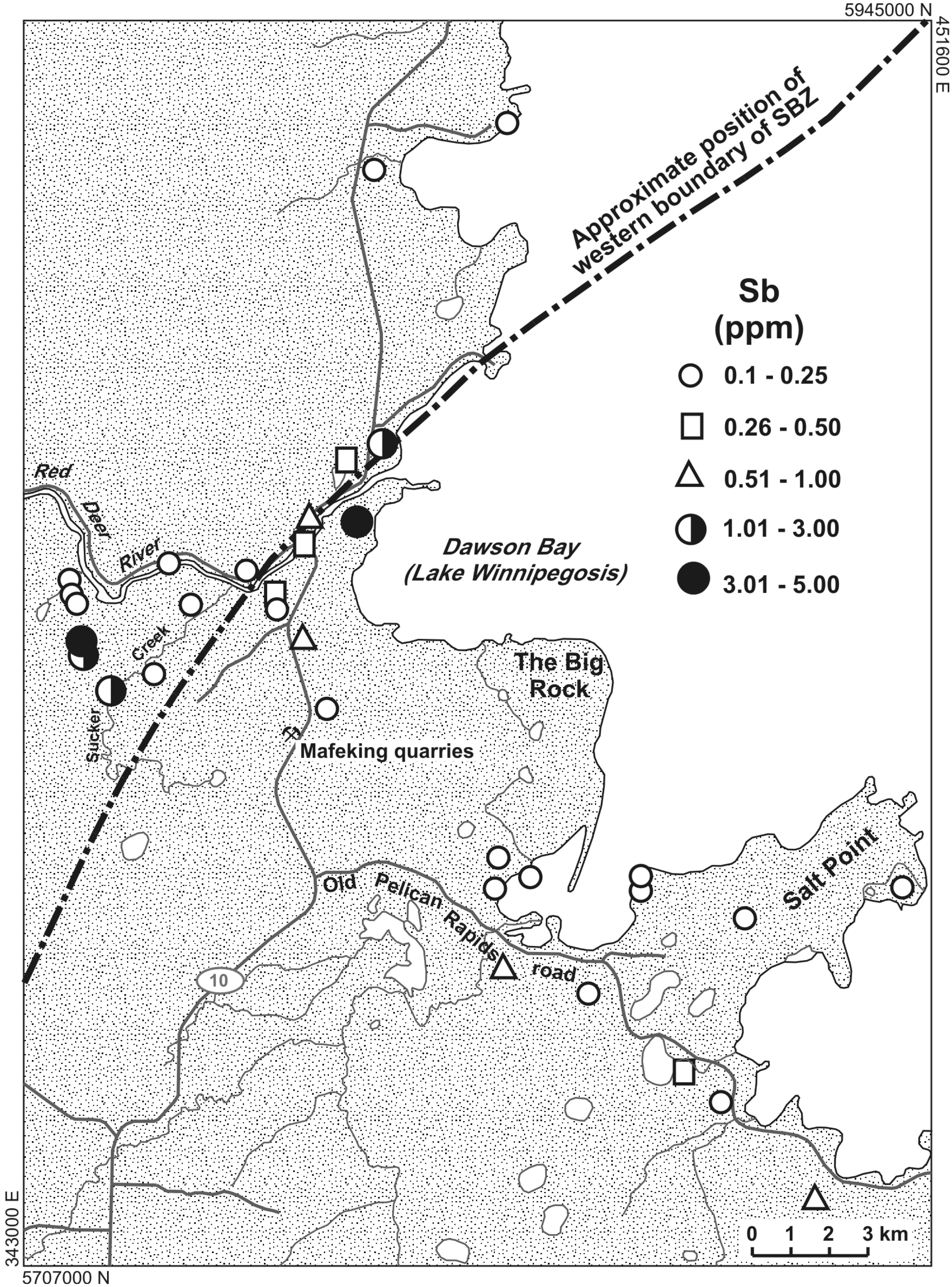

Figure 48: Concentration of Sb (by INAA) in brine-pool sediments, Mafeking quarries area.

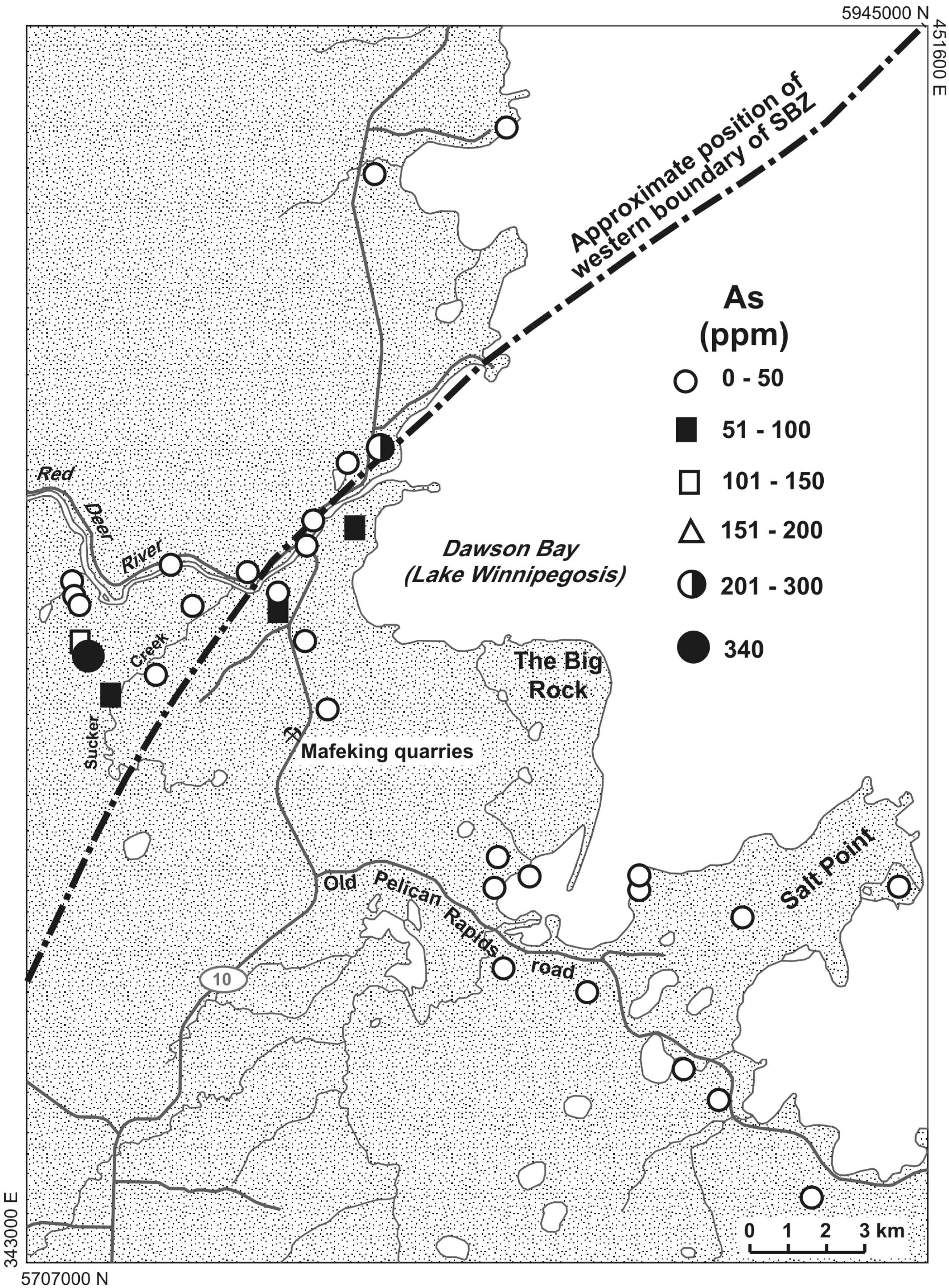

Figure 49: Concentration of As (by INAA) in brine-pool sediments, Mafeking quarries area.

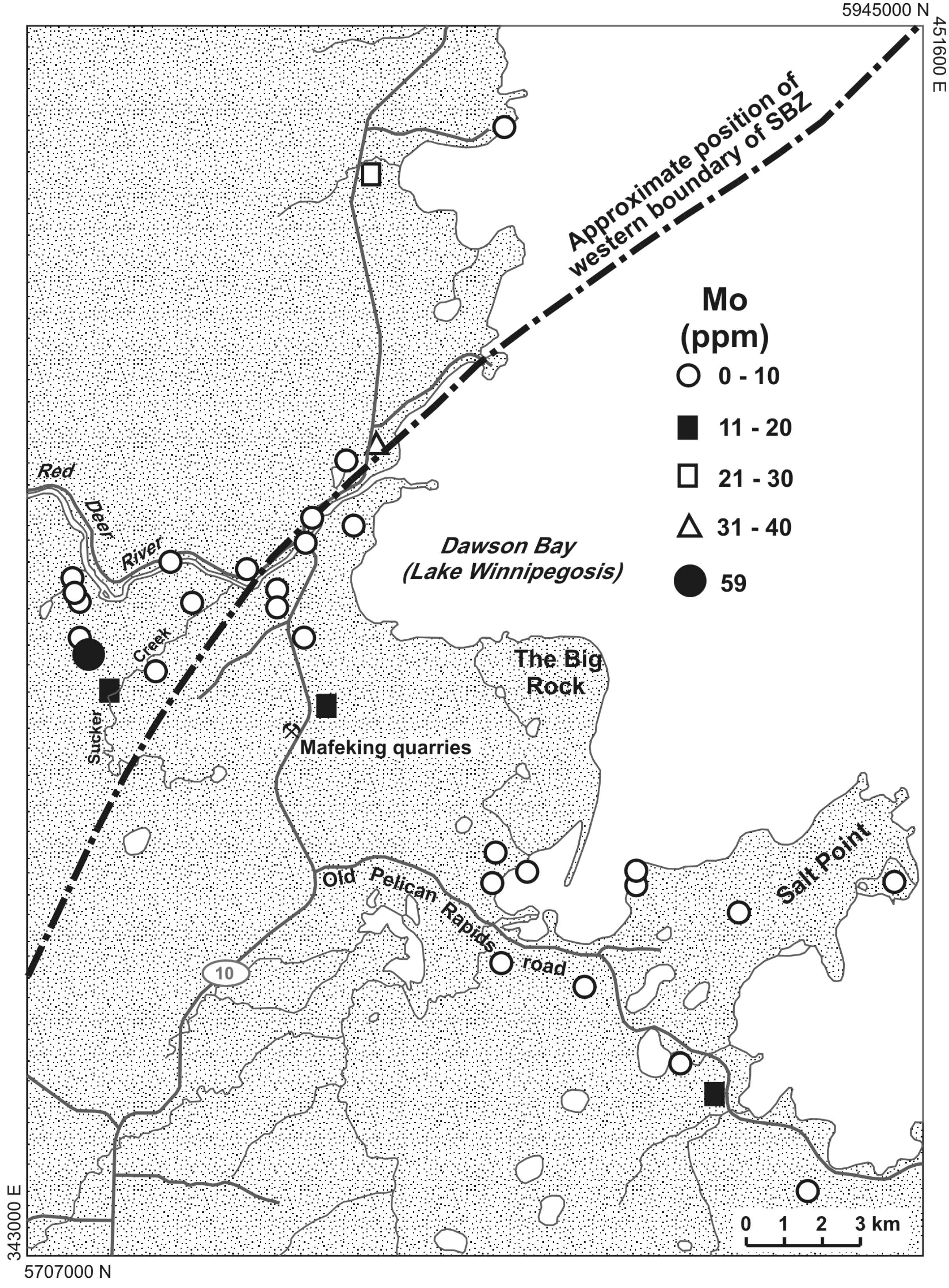

Figure 50: Concentration of Mo (by ICP-AES) in brine-pool sediments, Mafeking quarries area.

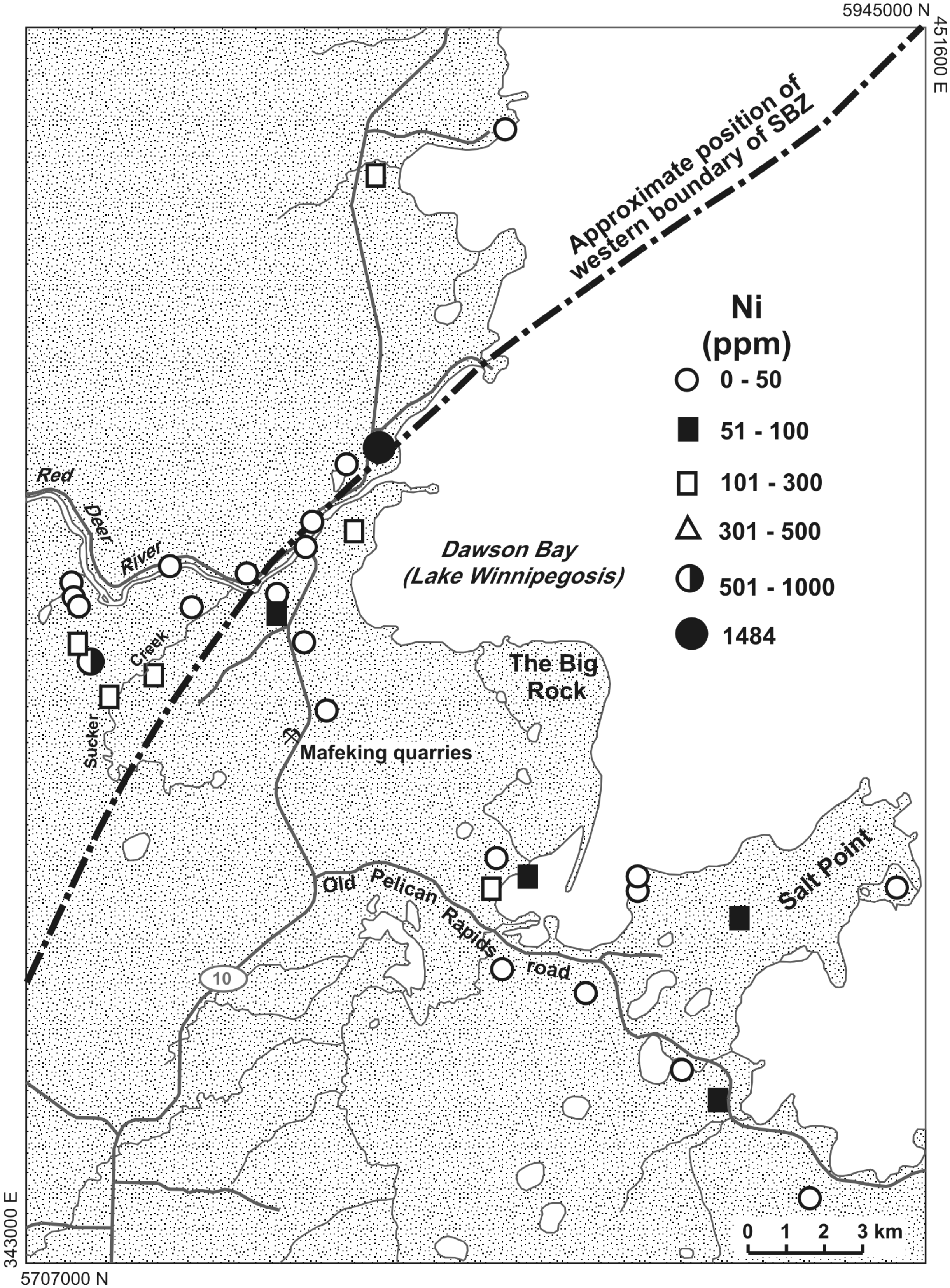

Figure 51: Concentration of Ni (by ICP-AES) in brine-pool sediments, Mafeking quarries area.

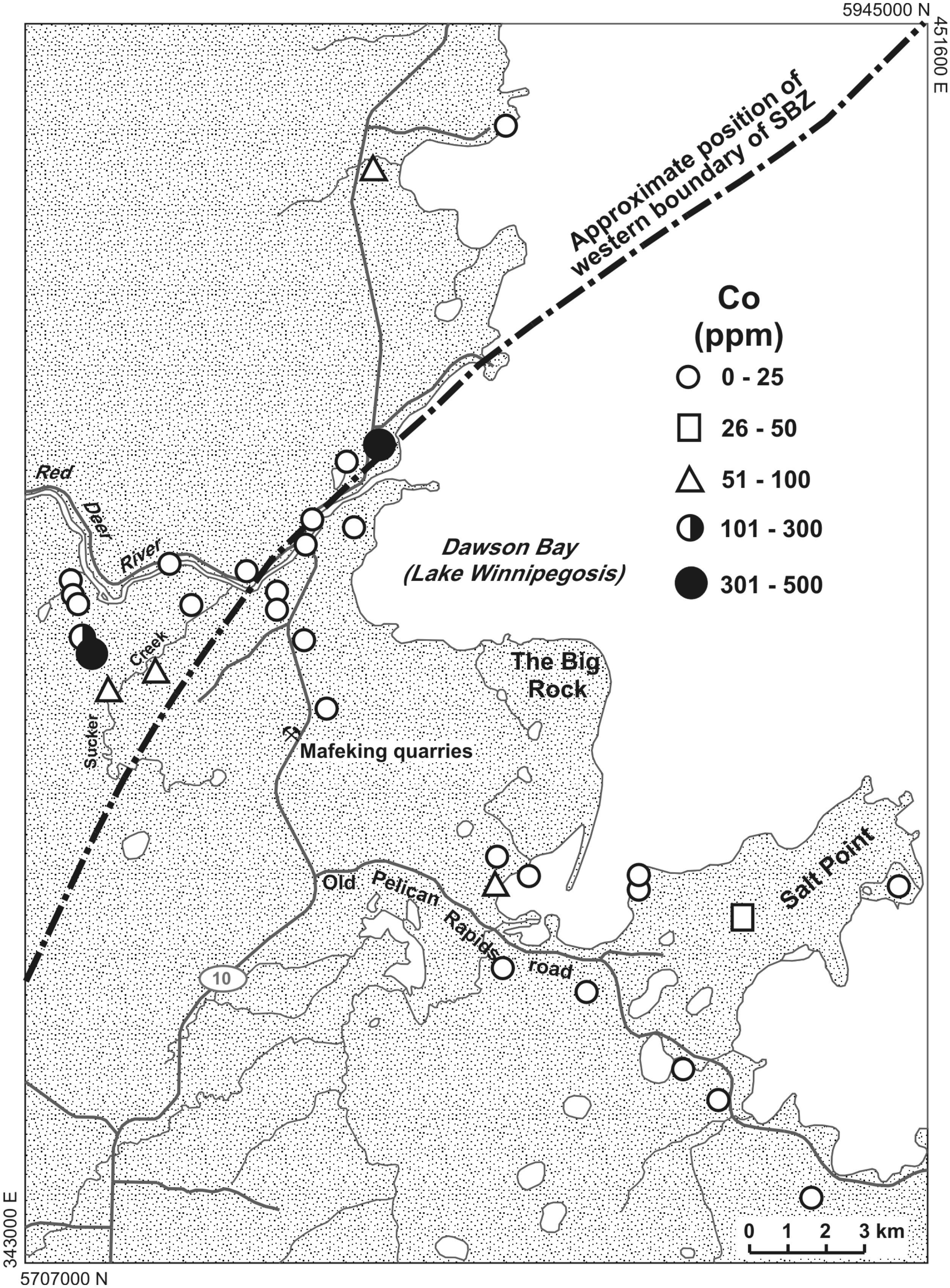

Figure 52: Concentration of Co (by INAA) in brine-pool sediments, Mafeking quarries area.

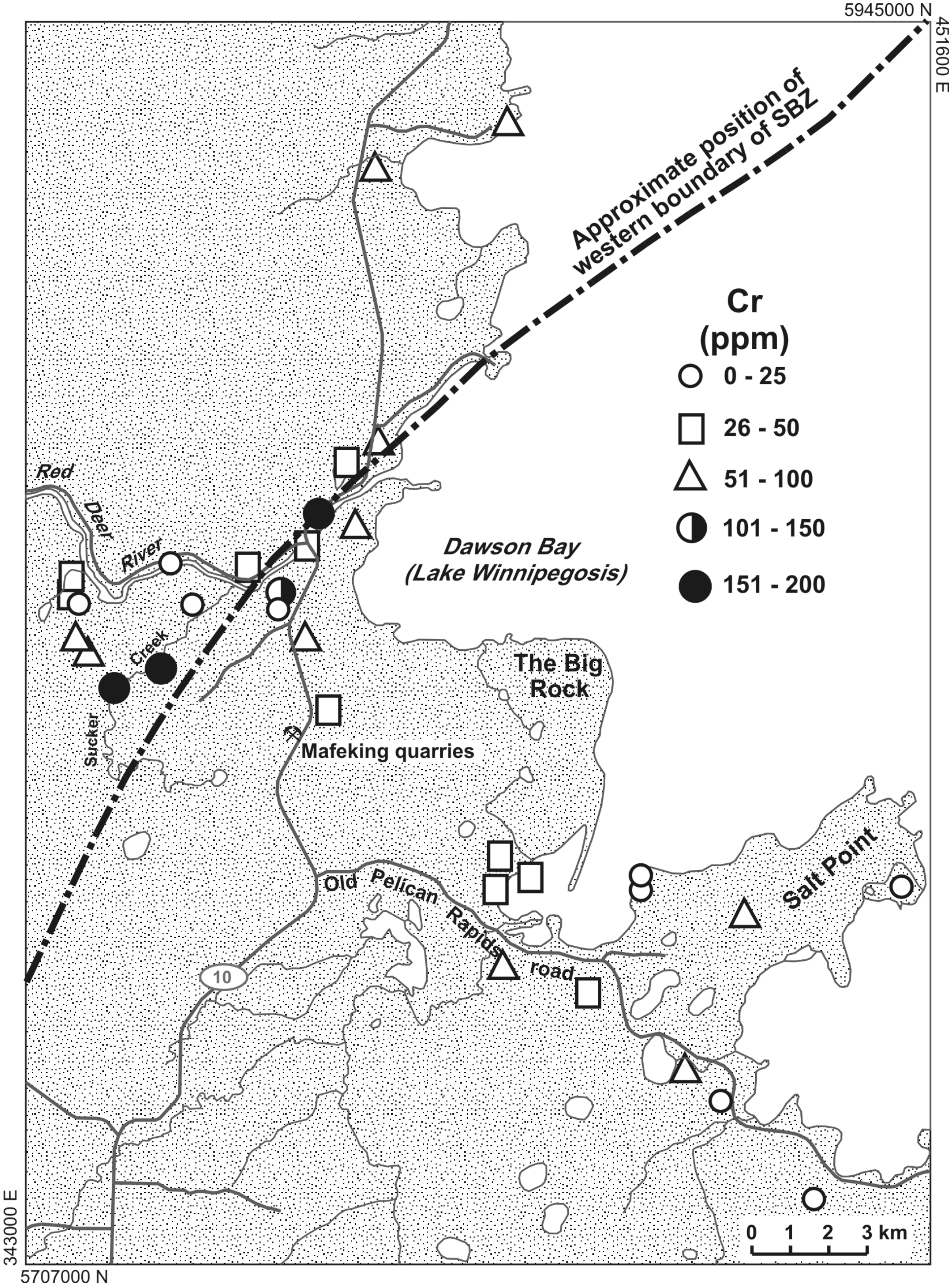

Figure 53: Concentration of Cr (by ICP-AES) in brine-pool sediments, Mafeking quarries area.

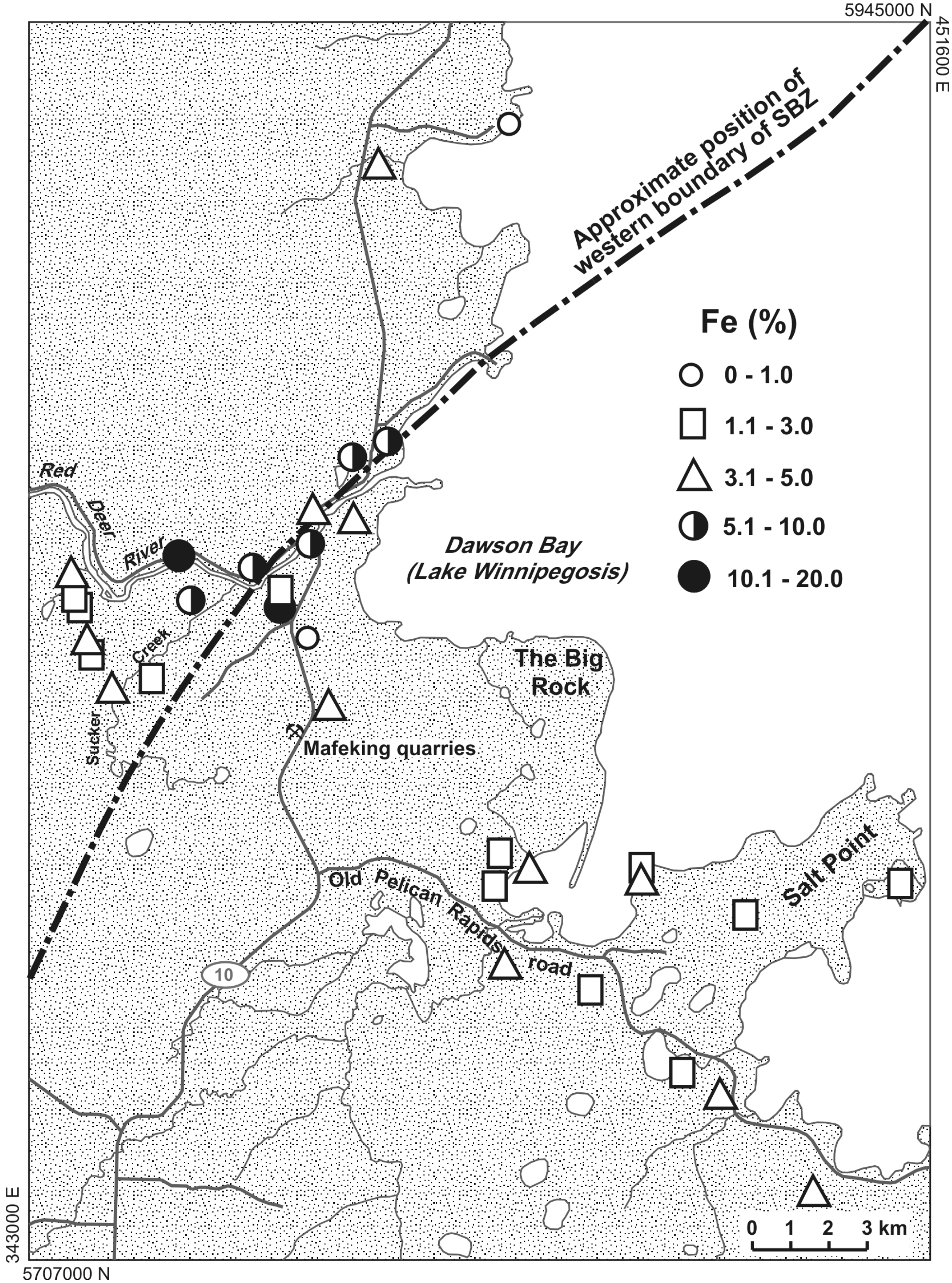

Figure 54: Concentration of Fe (by INAA) in brine-pool sediments, Mafeking quarries area.

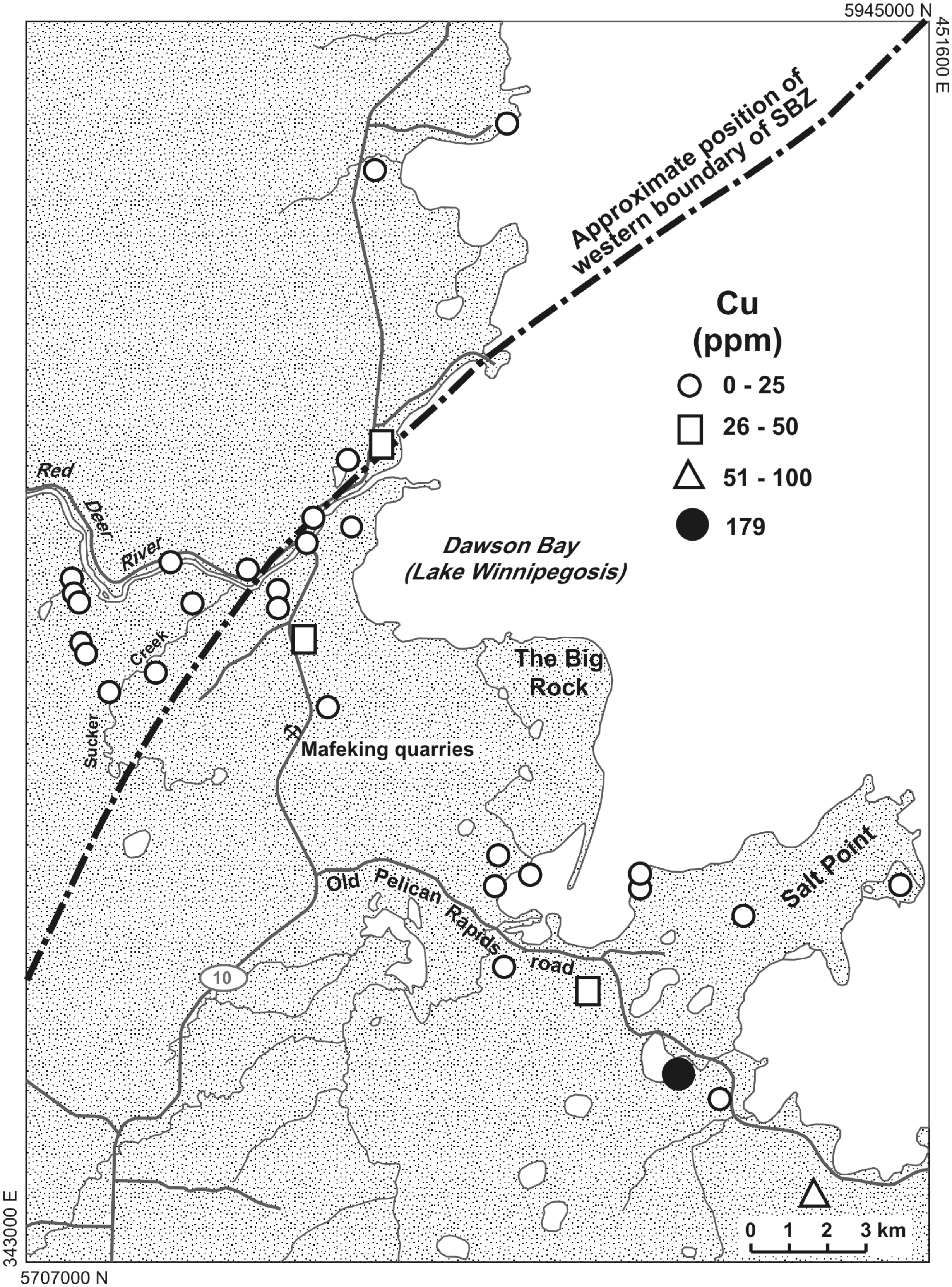

Figure 55: Concentration of Cu (by ICP-AES) in brine-pool sediments, Mafeking quarries area.

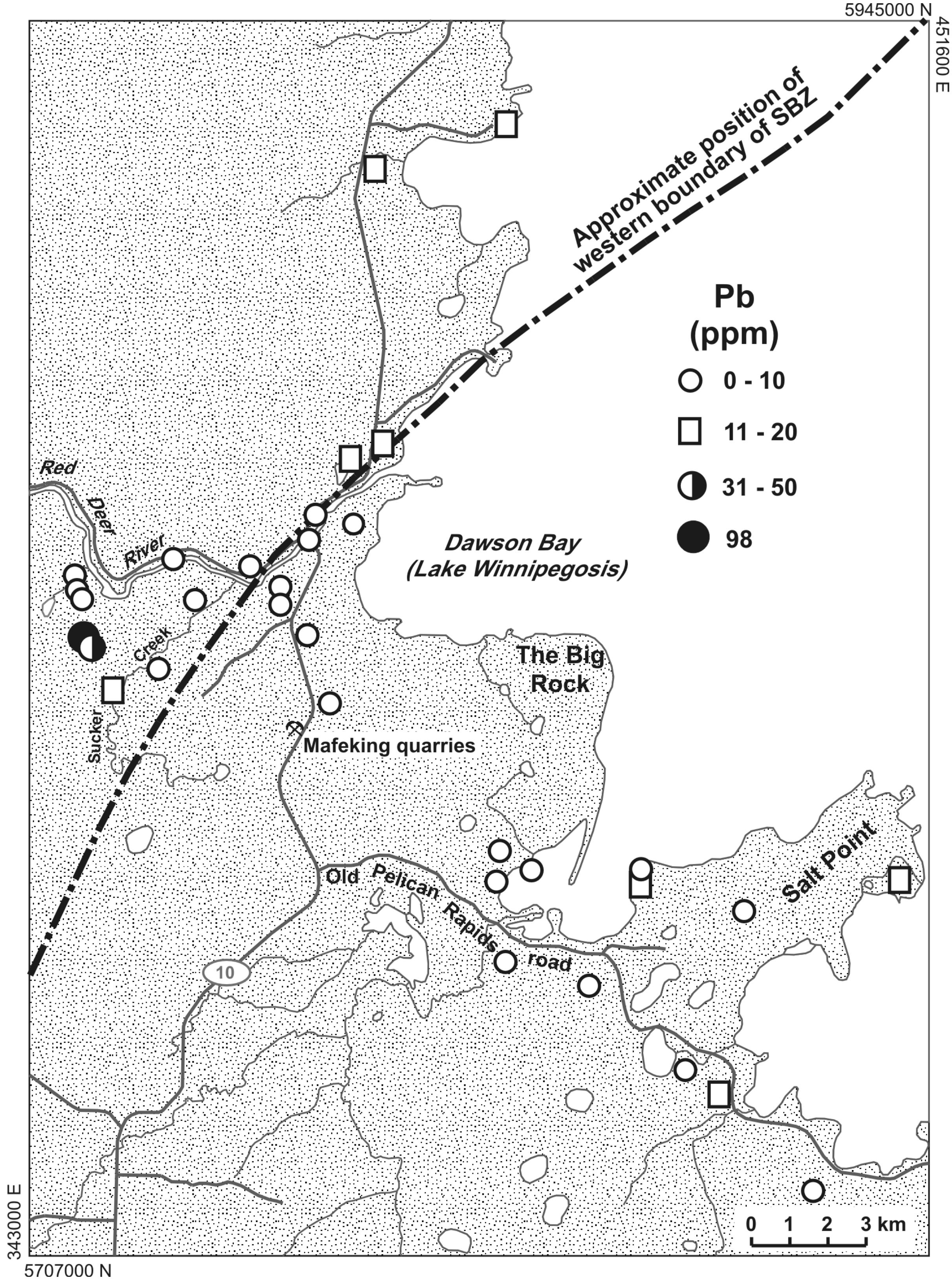

Figure 56: Concentration of Pb (by ICP-AES) in brine-pool sediments, Mafeking quarries area.

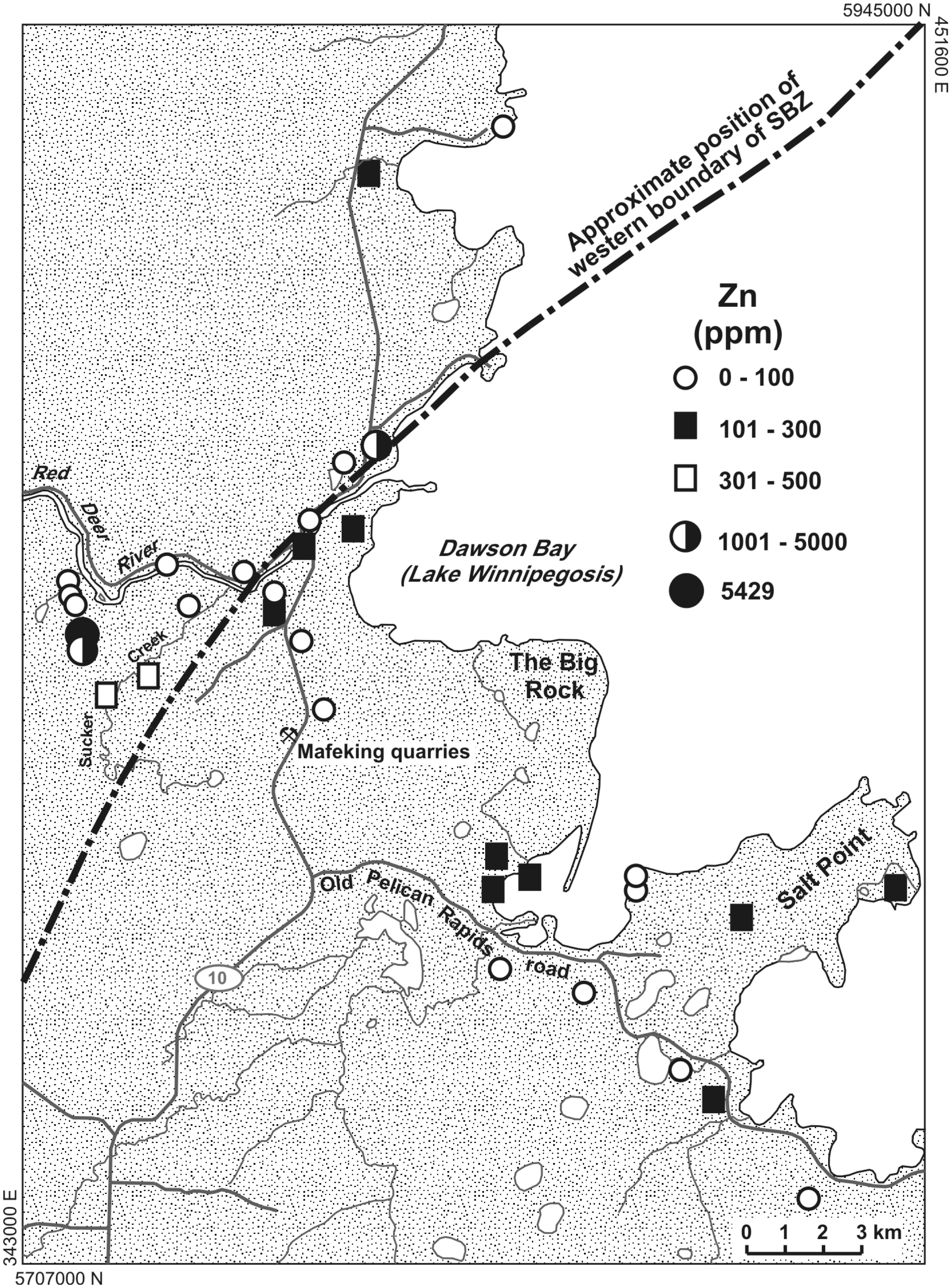

Figure 57: Concentration of Zn (by ICP-AES) in brine-pool sediments, Mafeking quarries area.

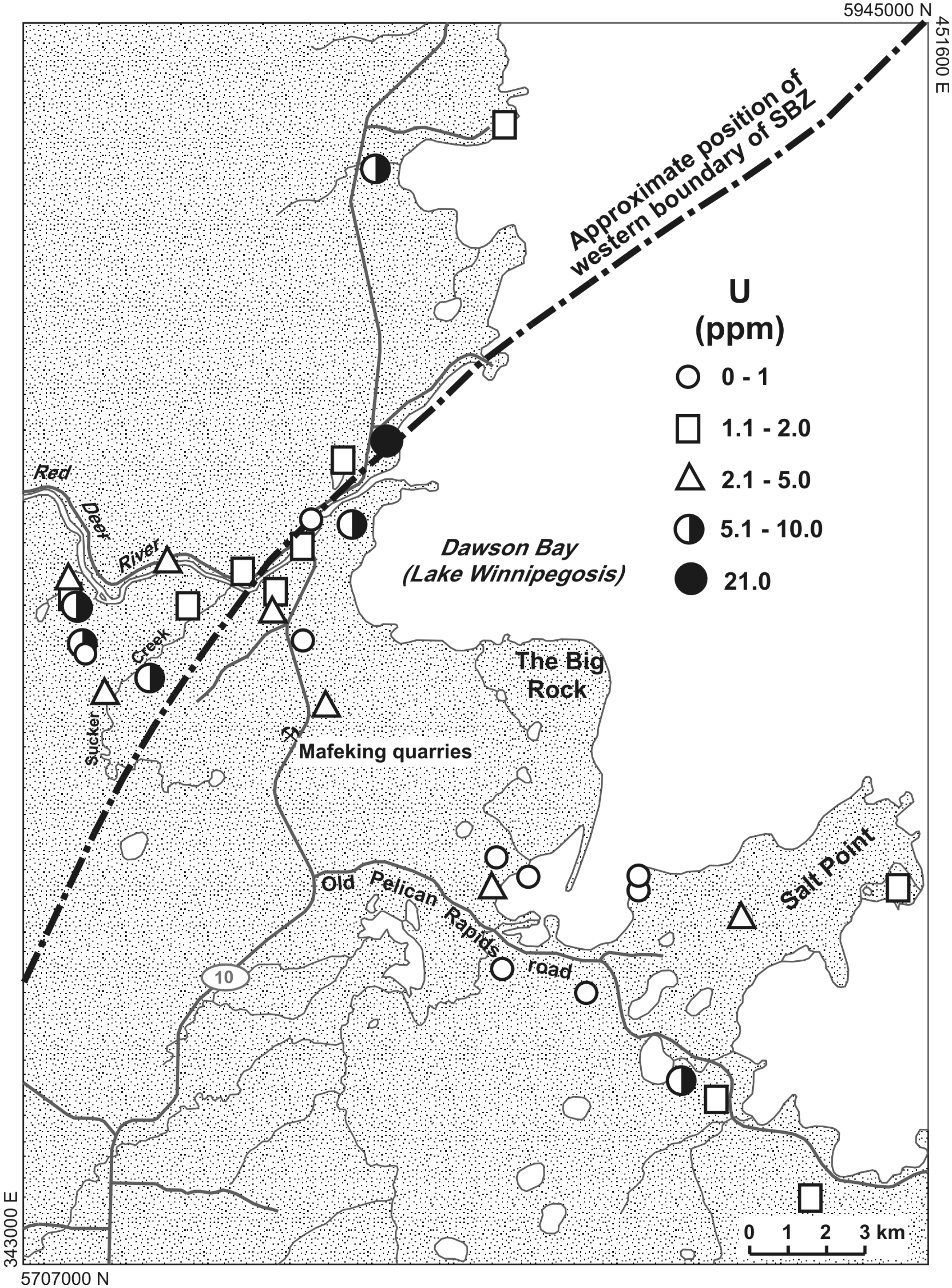

Figure 58: Concentration of U (by INAA) in brine-pool sediments, Mafeking quarries area.

Summary

The results from the brine-pool sediment geochemistry indicate that

1) metals are being precipitated close to discharge vents;
2) data corroborate the findings of Stephenson's (1973) brine geochemistry surveys, in particular that
   a) higher metal concentrations are associated with brine pools near the western edge of SBZ, and
   b) there is some suggestion of regional zonation/variation (Cu, U);
3) the brine sediments are the preferred sample medium for outlining geochemically anomalous areas because metals are present in concentrations that are easily detected using routine, commercially available analytical procedures;
4) metal 'hot spots' can be identified, thereby reducing large areas of interest to more localized sites where 'routine' exploration approaches can be concentrated; and
5) geochemical 'hot spots' are identified by high concentrations of Zn, Ni, Co, Cr, As, Sb, Mo, Cu, Pb, Fe and U.

Table 17: Concentrations of Au and Pt (by fire assay) in brine sediments from brine pool DB27, Mafeking quarries area.

Element	Au (ppb)	Pt (ppb)
Brine pool sediment (fire assay)	4–13	7–11

The precipitation of metal-rich material adjacent to saline-brine discharge vents is indicative of the ability of saline brines to transport metal until the transport mechanism is destabilized. Precipitation of metals may be the result of interaction of the fluids at a redox boundary represented by a unique rock type (sulphide-bearing black shale?) or a biological/algal 'sieve'. Regardless of the mechanism of metal precipitation, an interesting question becomes apparent: Does the metal-rich sulphide precipitate at the brine-pool vent discharge site represent all of the metal in solution, or has destabilization and precipitation of metals occurred elsewhere in the system? The vent-proximal material observed at the brine pools may represent residual sulphide and, as such, may

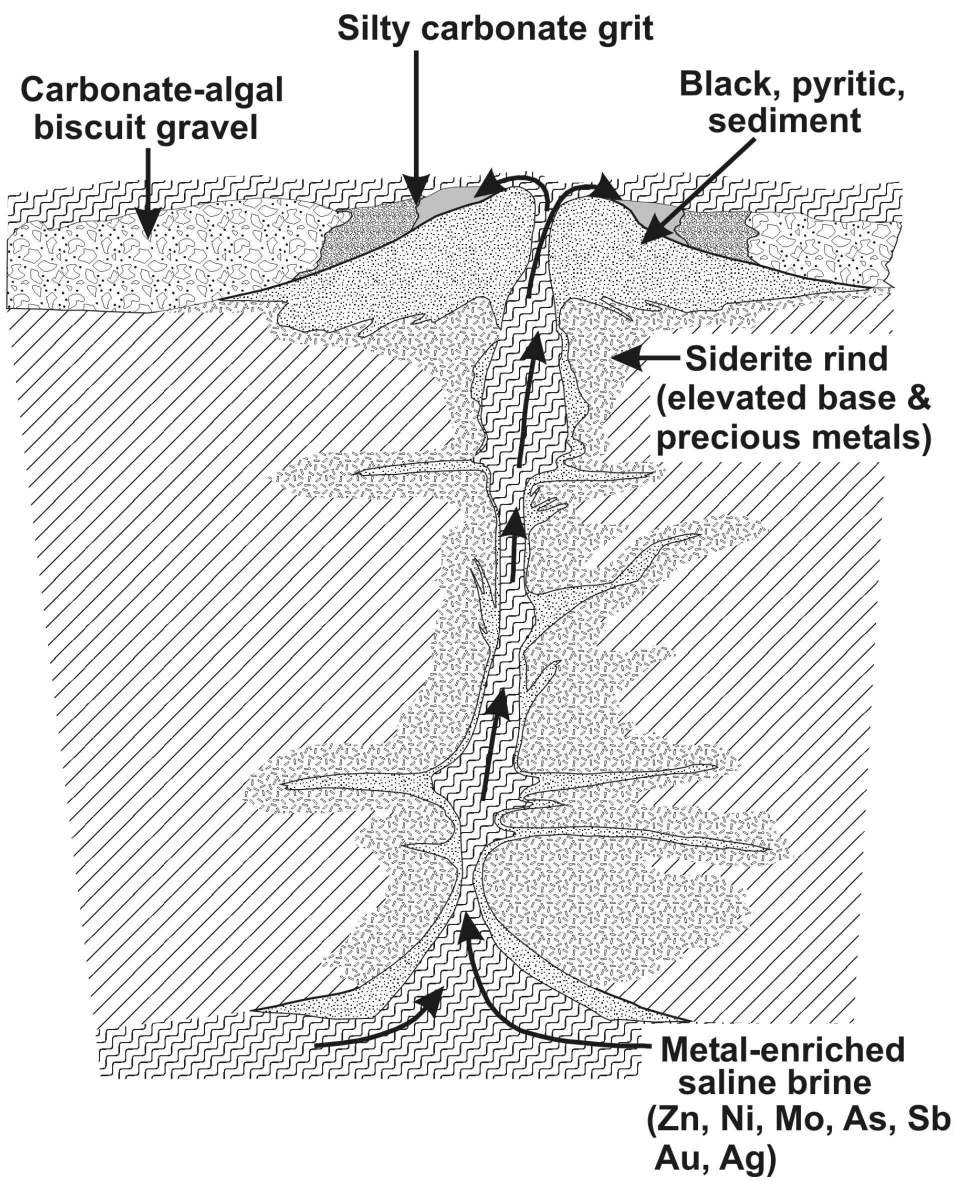

Figure 59: Conceptual brine-pipe morphology.

be a ‘leakage’ or ‘mobilized’ geochemical-mineralogical halo. The current level of understanding of the active process at the brine pools is insufficient to answer this; however, it identifies one area of investigation for future studies.

Metallogenic implications

Regionally, the zone of overlap between the SBZ beneath Paleozoic formations and the dissolution edge of the Prairie Evaporite represents a prospective area for Prairie-type microdisseminated mineralization (Figure 4). The presence of high-salinity brines or formation waters, bitumen-bearing laminite units (Winnipegosis Formation interreef facies), biogenic and pyritic carbonate, metal-rich shale, native sulphur, zones of increased permeability (such as those associated with salt-dissolution collapse breccia), and redox boundaries should be considered key elements for the localization of Prairie-type mineralization.

A demonstration of the importance of recognizing these criteria is provided in the area of the Red Deer River salt spring (station DB35, 25 km north of the town of Mafeking on Highway 10; Figure 36). This salt spring emanates from the Devonian outcrop belt with a total salinity of 52 800 mg/l and a flow rate of approximately 0.44 l/min (J. Stephenson, unpub. data, 1973). Betcher (1991) recorded a salinity of 45 027 mg/l for same spring. The stratigraphic section near the spring consists of a small section of Lower Dawson Bay Formation (an argillaceous, fossiliferous limestone) and the basal Second Red Beds. It is probable that the Second Red Beds are underlain by a Winnipegosis Formation reef, potentially the source of the spring.

The base of the Dawson Bay Formation in the Devonian stratigraphic column is marked by the Second Red Beds, whereas the base of the Souris River Formation is marked by the First Red Beds (Figure 5). In the deeper portions of the Elk Point Basin, these beds are underlain by evaporites. In the Manitoba outcrop belt, these evaporites have undergone dissolution. Appreciable brecciation, and therefore induced permeability, are apparent in both red-bed intervals. Interestingly, SEM analysis of a sample of a limonite-goethite–coated cobble (Au 96MB8a-1), collected from the site of the Red Deer River salt spring (station DB35, Figure 36) revealed a 3 µm Au-Cu-Ni-Zn grain (Figure 19b, Table 2). Aeromagnetic and VLF surveys indicate that basement faulting is present at the Red Deer River salt spring (Figure 12). Abundant marcasite and/or pyrite and halite are observed as infillings of intercrystalline pore spaces and dissolution porosity in a microcrystalline dolomite. Silver, in association with Fe, Cu and Zn, is also present, as are several grains of Cu-Zn or Cu-Zn-Ni alloys. Grains of Fe-Cr-Ni and native Sn were also observed. Two types of bitumen were recognized in the sample: a C- and S-bearing variety and a more complex bitumen with C, O, Na, Si, Al, K and Cl (Figure 19).

Many of the carbonate and Precambrian boulders and cobbles present in the salt flat area are undergoing in situ leaching. The brine springs in the Dawson Bay area and the associated rocks are an example of a modern-day, ongoing process of metal-bearing brines altering and precipitating precious and base metals within Dawson Bay Formation carbonate rocks. The overlying and underlying red beds represent a potential metal source.

A 1.6 m intersection of 2–5 g/tonne Pt and 0.2 g/tonne Au in altered (sideritized and decalcified) shale (Upper Devonian Waterways Formation), from Prairie-type mineralization near Fort McMurray (northeastern Alberta), was announced by Birch Mountain Resources Ltd. in 1997 (Birch Mountain Resources Ltd., written comm., 1997). This mineralized interval occurs within a stratigraphic formation interpreted to be time equivalent to the Souris River Formation in the Mafeking quarries, and indicates the potential for Pt–Au–base-metal mineralization in Manitoba. It also underscores the relative potential importance of black shale in the genesis of the Prairie-type deposit. The presence of black shale in the stratigraphic section hosting mineralizing, metal-enriched saline-brine pipes may be an important factor in localizing mineralization, by acting as a redox barrier and/or as an aquitard that focuses or ‘caps’ mineralizing brines and aids in the precipitation of metals.

The metal assemblage Ni-Co-Cr is present as an ‘enriched’ group of elements in 1) the solution chimney rinds; 2) black, vent-proximal sediment in the brine pools; and 3) residual clay representing highly altered, high-Ca MLB in the Mafeking quarries. This observation suggests linkage between the saline brines responsible for the formation of solution chimneys, the clay-rich alteration zones in the MLB and the associated sediments precipitating adjacent to actively discharging saline-brine vents. The development of the Ni-Co-Cr signature in these features is interpreted to reflect the acquisition of metals from basement rocks of the Thompson Nickel Belt (and any contained mineralization?) through interaction with oxidizing groundwater. Groundwater would have accessed basement rocks along fractures emanating from the basement that were produced as a result of reactivation of the SBZ, and/or by dissolution of the Prairie Evaporite and subsequent solution collapse. Evidence of faulting is indicated in Figure 12. This process and the pathway for Ni-Co-Cr acquisition are consistent with the model proposed for the north-eastern Alberta Prairie-type mineralization (Abercrombie, 1996). Accordingly, proximal brine-pool sediments contain a composite geochemical signature produced by metal-charged, oxygenated chloride brines that have interacted with Thompson Nickel Belt basement rocks and possibly Pb-Zn ‘MVT’ mineralization, as reflected in the Zn and Pb enrichments in the brine-pool sediments.

Prairie-type mineralization in Manitoba

The current interpretation of the Prairie-type model, as it applies to Manitoba, is shown in Figure 60. This schematic diagram is a compilation of figures presented earlier in this report, supplemented with additional field observations.

According to Norris et al. (1982), the Souris River Formation in the Mafeking quarries area may have been down-dropped by as much as 150 m due to the dissolution of the Devonian Prairie Evaporite. Nevertheless, the rate of subsidence was relatively slow and under sufficient confining pressure to result in minimal disruption, despite both collapse and draping. Areas of extreme

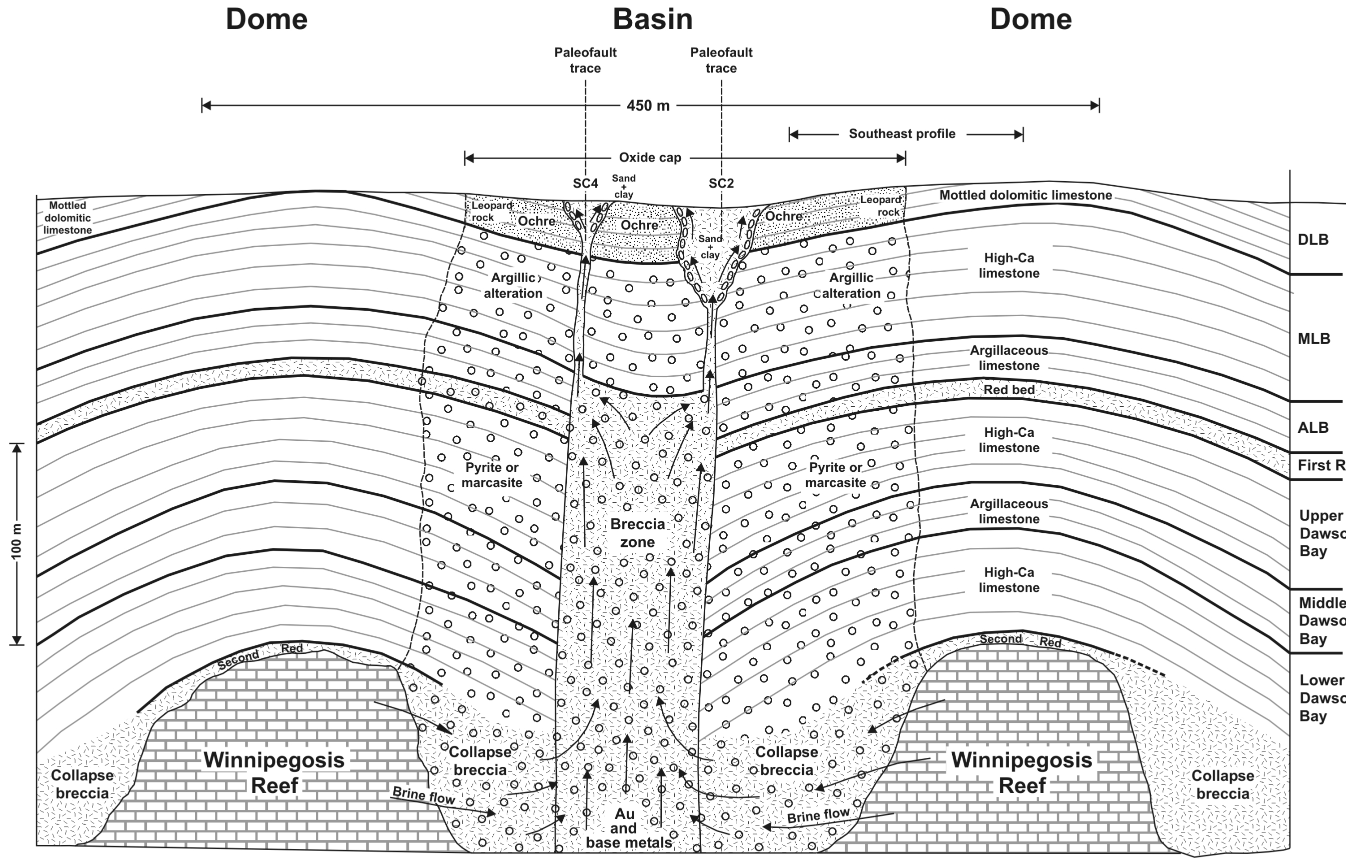

Figure 60: Vertically exaggerated structural cross-section of a reconstructed solution chimney, looking east across the North Mafeking Quarry from the west wall, prior to quarry development (see Figure 13 for location of solution chimneys SC2 and SC4).

brecciation occurred only in structurally low Winnipegosis Formation interreef or reef-flank positions. The reefs may be of the pinnacle type, rising 76–91 m above the interreef beds. Dips on the Dawson Bay Formation beds are probably 20°, as they are exposed near Salt Point; however, the dips become shallower upward into the Souris River beds, where they range from 3 to 6°. Dissolution of the Prairie Evaporite may be due to faulting, as indicated in Figure 12.

The model shown in Figure 60 is only the top of a much deeper hydrogeological system, which probably was controlled by faulting in the Precambrian basement along the SBZ (Figures 6, 12). Figure 61 depicts such a hypothetical deeper system. The western boundary of the SBZ is the Thompson Fault, which was active during deposition of overlying Phanerozoic sedimentary rocks (Figures 8, 11 (in back pocket), 12). Fluids originating within the Precambrian or from the WCSB along numerous unconformities, permeable sand horizons, porous limestone and dolomite, and karst channels were brought into the Devonian beds by these deep vertical faults. The Ni-Co-Cr enrichment in brine-pool sediments may reflect the interaction of downward-moving brines with one another, their interaction with basement rocks and their acquisition of these metals through leaching of the bedrock and contained mineralization. These metal-charged fluids would then move to the surface along fractures. This is reflected in the high metal content of brine-pool sediments along the western edge of the SBZ near the Red Deer River (Figures 36, 48 to 58). Norris et al. (1982) speculated that the source of artesian flow in the Dawson Bay area was due, in part, to the underlying Silurian Interlake Group and that the porous Winnipegosis reefs were only conduits for the deeper formation fluids. These fluids were then responsible for dissolution of the Prairie Evaporite and other evaporite beds in the Devonian section, and ultimately for the slow subsidence of the relatively flat lying beds onto the Winnipegosis reefs.

The Second Red Beds and the Lower and Middle Dawson Bay Formation are effective cap rocks (Norris et al., 1982); the Lower Member is very dense and tight, with essentially no porosity. Brine-fluid flow passed into the collapse breccia on the reef flanks and into the area above the interreef where the greatest amount of salt solution of the Prairie Evaporite had taken place (Figure 60). Some of the flow, however, also moved vertically into the breccia zone beneath the chimneys, as well as horizontally within more permeable units, and was trapped in the domes. These saline-rich fluids leached and subsequently deposited mineral components in the brecciated country rock, depending upon pressure, temperature and oxidizing conditions. The chimneys seen in the Mafeking area are the result of the combined leaching and precipitation process. The funnel-shaped chimneys, opening upward, were the sites of focused fluid flow, which removed the Ca from the carbonate and replaced it with Fe to form the siderite rinds. The blue-green clay, present as lenses or disseminations, is the residual clay component of the carbonate that was altered by the upward-moving brine. Some of this clay-rich material may have travelled as flocculated clay in the brine solutions. The silica-rich sand might be the result of the same process; however, this has not been resolved. Other possible sources of the sand may be the

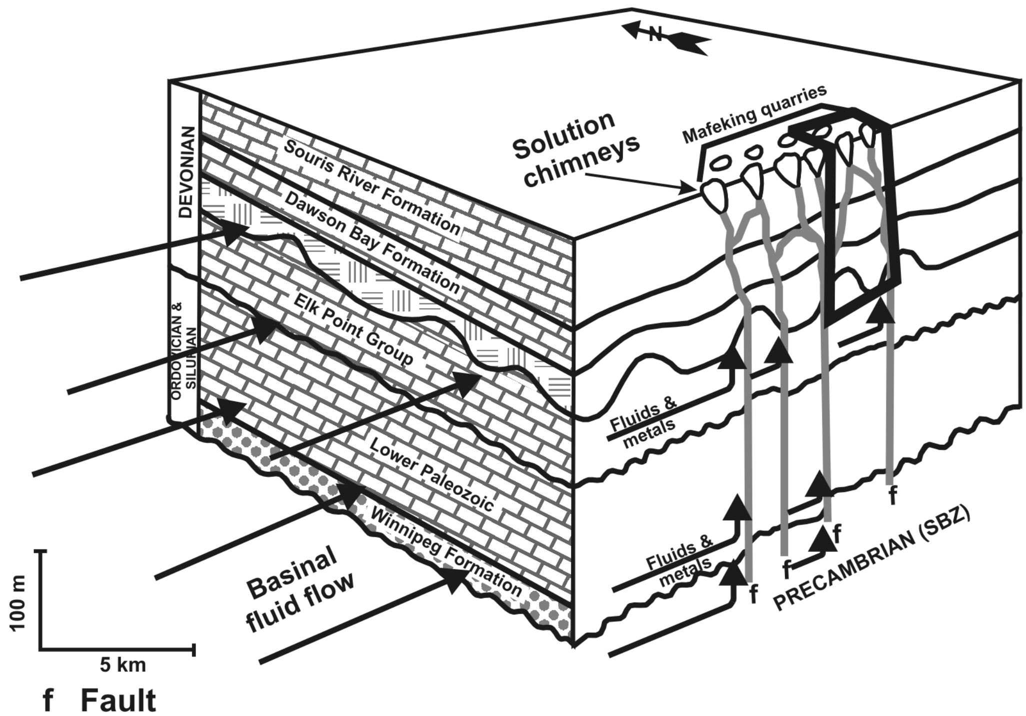

Figure 61: Hypothetical hydrogeological system beneath the Mafeking quarries area.

Winnipeg Formation, situated just above the Precambrian contact (Figures 6, 61), or possibly the Swan River Formation, as infill during Cretaceous marine transgressions and regressions. In any event, the brines were supersaturated with respect to silica, and precipitation of silica cemented the sand grains to form the siliceous sinter at the edges of the conical chimneys, adjacent to the blue-green clay and the rind. Individual carbonate grains encapsulated by silica (Ramnath, 1999) tend to support this observation.

Two related features accompanied the development of the solution chimneys. The first was the argillic alteration of the MLB beds and probably the underlying units. Pyrite/marcasite was also deposited by brines seeping into the high-Ca limestone of the MLB along horizontal bedding planes and microfractures. The second feature was the alteration of the DLB from a mottled dolomitic limestone into an ochre carbonate near the chimneys. Transitional between the two end members is an altered, mottled dolomitic limestone, termed 'leopard rock', in which dolomite replaces the limestone and is surrounded by a ferruginous matrix. According to Norris et al. (1982), the DLB are coarser grained and have a different faunal content (mainly stromatoporoids) than that of the underlying MLB. This may account for the different styles of alteration in the two units.

The relative position of the DLB in the Phanerozoic stratigraphic sequence at the time of initiation of the development of the chimneys and the accompanying alteration is unknown. One possibility is that the overlying carbonate cover was intact, with the Davidson Evaporite overlying the DLB, as it did 32 km to the west in the subsurface, as indicated by a well-developed zone of intraformational collapse breccia (Norris et al., 1982). Overlying the Davidson Evaporite was the Sagemace Member, which was drilled near Minitonas by Gulf Oil Ltd. In this case, the DLB have been altered as a sill-like body in the carbonate sequence, which may or may not have been capped by Cretaceous shale and sand. A more likely scenario, however, is that the DLB were exposed to the atmosphere during one of the many erosional intervals that have occurred since the end of Devonian time. In this case, the alteration event paralleled the processes occurring at modern brine springs that are flowing to the north and east of the Mafeking quarries, except for the chemistry and possibly the temperature of the saline fluids, which have changed with dissolution of the underlying evaporites.

Potential targets for further investigation

Upward moving brines (Figure 61) may have carried Au and base metals from the Precambrian or possibly from lower Phanerozoic units, such as the Winnipeg Formation black shale. These metals may have been deposited in structural traps, or in salt-free reefs and brecciated rock where pressure conditions were suddenly decreased with increased porosity and permeability. The Prairie-type model suggests that, with the slow collapse of Devonian beds in the Mafeking area and possibly to the southwest along the trend of the SBZ, such structural traps did exist along with collapse breccia. Five targets for further investigation as potential sites of Au and base-metal mineralization are

1) the salt-free, porous, Winnipegosis Formation reefs, or the overlying, brecciated Second Red Beds, if they had been locally fractured while being draped over the reefs;
2) the Upper Dawson Bay Formation, which is located beneath the impermeable shaly beds of the First Red Beds (Norris et al., 1982), is highly variable in porosity and ranges from a tight stromatoporoid biolithite to a relatively coarse grained

saccharoidal dolomite with excellent intergranular porosity;

3) the breccia zone developed between the paleofault traces and collapse breccia on the reef flanks and above the interreef in the Winnipegosis Formation;
4) at the Cretaceous-Devonian angular unconformity and within the overlying Swan River Formation aquifer beneath the Porcupine Hills, southwest of the Mafeking area; and
5) within the Cretaceous black shale that forms the base of the Porcupine Hills beneath the glacial cover.

Conclusions

Micropetrographic analysis of only a few samples from a selected number of sites in the Mafeking area of west-central Manitoba demonstrates the presence of 1) a diverse suite of native metals, including Au; 2) a brine or formation water 'signature', consisting of KCl, NaCl and bitumen in the samples; 3) apparent low temperatures of formation; and 4) high induced permeabilities through ground preparation by structural disruption and dissolution phenomena. Together, these phenomena are highly suggestive of a style of mineralization similar to that recognized in northeastern Alberta and termed 'Prairie type'.

Although only small amounts of Au, Ag and base metals (up to 0.5% Zn and 0.1% Ni) have been identified in samples examined to date, it appears reasonable that a mechanism involving metal delivery by oxygenated chloride-rich brines and precipitation by redox reactions has been identified in a small segment of Phanerozoic rocks. As demonstrated in the Red Deer River area, this process is currently active and is precipitating base and precious metals in a saline-spring environment.

The source of metals necessary for the development of a mineable precious-metal deposit is unknown, although possible candidates include metal-enriched black shale and mineralization in the rocks constituting the Superior Boundary Zone (SBZ). It is possible that the bulk of the metals carried by the saline brines was precipitated elsewhere and that the sulphide mounds currently forming in the Dawson Bay area represent leakage or residual metals. The role of the black shale in the formation of this mineral-deposit type might be elucidated by detailed geochemical evaluation of these units. The first phase of the black-shale geochemical program, which has been completed, used oil- and gas-well chips, as well as outcrop samples, to assess the nature of the depositional environment and geochemical characteristics of the black shale (Fedikow et al., 1997, 1998).

The Prairie-type microdisseminated base-metal and Au-Ag mineralization identified in Upper Devonian rocks from the Mafeking area represents a first step to a better understanding of this new mineral-deposit type. The recognition of precious-metal mineralization, potentially over large areas of the Phanerozoic in Manitoba, represents an exciting new target for exploration in a readily accessible area of the province.

Regional and local tectonic and stratigraphic characteristics of Phanerozoic rocks of the Western Canada Sedimentary Basin (WCSB) in western Manitoba are favourably compared to rocks constituting the WCSB in northeastern Alberta, the discovery site of Prairie-type, microdisseminated Au mineralization. In Manitoba, the definition of the SBZ beneath Phanerozoic cover provides a locus for Paleozoic tectonic features such as structural and stratigraphic anomalies associated with the dissolution front of the Prairie Evaporite, as well as a possible source of metals. Chloride-rich brines, bitumen laminite units and red-bed sequences all contribute to a depositional environment that satisfies the requirements for the formation of Prairie-type microdisseminated mineralization. An example of Prairie-type Au mineralization in Manitoba is documented in Upper Devonian Souris River Formation limestone of the Mafeking area. Modern-day examples of this style of mineralization that are still forming have been documented at many localities in the Dawson Bay area. Exploration for this deposit type should focus on the coincidence of the SBZ with paleobrine discharge solution chimneys or other flow localization structures along the dissolution front of the Prairie Evaporite. In this area, metal-enriched brines, microbial oxidation of organic material and reduction of sulphate may have localized the precipitation of precious and base metals.

Geochemical-prospecting techniques using selective (Enzyme Leach^{SM}) and partial (Mobile Metal Ion$^{®}$) leaching methods, followed by inductively couple plasma–atomic emission spectrometry, represent viable and innovative methods of exploration. Limited geophysical surveys undertaken at the Mafeking quarries, when coupled with a sound geological database, indicate the beneficial application of these techniques to exploration for Prairie-type microdisseminated mineralization.

Acknowledgments

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References

Abercrombie, H.J. 1996: Prairie-type sedimentary Au-Ag-Cu; *in* New Mineral Deposit Models of the Cordillera; British Columbia Geological Survey and Geological Survey of Canada, Short Course Notes, December 1996, p. 1–22.

Abercrombie, H.J. and Feng, R. 1994: Gold and PGE anomalies in Phanerozoic sedimentary rocks, northeastern Alberta – potential for new deposits (abstract); *in* The Calgary Mining Forum Program and Abstracts, February 10 and 11, 1994; Calgary Mineral Exploration Group Society, p. 51.

Abercrombie, H.J. and Feng, R. 1997: Geological setting and origin of microdisseminated Au-Ag-Cu minerals, Fort Mackay region, northeastern Alberta; *in* Exploring for Minerals in Alberta: Geological Survey of Canada Geoscience Contributions, Canada-Alberta Agreement on Mineral Development (1992-1995), R.W. Macqueen (ed.), Geological Survey of Canada, Bulletin 500, p. 247–277.

Ash Associates 1996: Sodium silicate study bench-scale tests with silica sands of Manitoba; Manitoba Energy and Mines, Minerals Division, Open File Report OF96-4, 29 p.

Bamburak, J.D. and Nielsen, E. 1996: Scoriaceous clinker in Swan River valley gravel pits (NTS 63C/2 and C/3); *in* Report of Activities 1996, Manitoba Energy and Mines, Geological Services, p. 134–138.

Bamburak, J.D, Bezys, R.K., Fedikow, M.A.F. and Hosain, I. 1997: Geology, geochemistry and geophysics of Prairie-type micro-disseminated mineralization in west-central Manitoba (NTS 63C); *in* Report of Activities 1997, Manitoba Energy and Mines, Geological Services, p. 112–117.

Bannatyne, B.B. 1970a: Industrial minerals; *in* Summary of Geological Field Work 1970, Manitoba Department of Mines and Natural Resources, Mines Branch, Geological Survey, Geological Paper 70-4, p. 42–43.

Bannatyne, B.B. 1970b: The clays and shales of Manitoba; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 67-1.

Bannatyne, B.B. 1971: High-calcium limestone project; *in* Summary of Geological Field Work 1971, Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Geological Paper 71-6, p. 69–70.

Bannatyne, B.B. 1975: High-calcium limestone deposits of Manitoba; Manitoba Department of Mines, Resources and Environmental Management, Publication 75-1, 103 p.

Bannatyne, B.B. 1981: Limestone resources of the Dawson Bay area; *in* Report of Field Activities 1981, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 89.

Betcher, R.N. 1991: Swan Lake area (NTS 63C); Manitoba Natural Resources, Water Resources, Groundwater Availability Map Series, 11 figures (including 5 maps at 1:250 000 scale) and 1 table.

Bezys, R.K. 1989: Stratigraphic and industrial minerals corehole program; *in* Report of Activities 1989, Manitoba Energy and Mines, Minerals Division, p. 121–126.

Bezys, R.K. 1990: Stratigraphic mapping (NTS 63G) and corehole program; *in* Report of Activities 1990, Manitoba Energy and Mines, Minerals Division, p. 140–151.

Bezys, R.K. 1991: Stratigraphic mapping (NTS 63F, 63K) and corehole program 1991; *in* Report of Activities 1991, Manitoba Energy and Mines, Minerals Division, p. 61–73.

Bezys, R.K. 1992: Stratigraphic mapping and corehole program 1992; *in* Report of Activities 1992, Manitoba Energy and Mines, Minerals Division, p. 123–131.

Bezys, R.K. 1996a: Sub-Paleozoic structure in Manitoba's northern Interlake along the Churchill Superior Boundary Zone: a detailed investigation of the Falconbridge William Lake study area; Manitoba Energy and Mines, Geological Services, Open File OF94-3, 32 p.

Bezys, R.K. 1996b: Stratigraphic mapping (NTS 63G) and corehole drilling program 1996; *in* Report of Activities 1996, Manitoba Energy and Mines, Geological Services, p. 96–102.

Bezys, R.K. and McCabe, H.R. 1996: Lower to Middle Paleozoic stratigraphy of southwestern Manitoba; Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Winnipeg, Manitoba, May 1996, Field Trip Guidebook B4, 92 p.

Bezys, R.K., Bamburak, J.D. and Fedikow, M.A.F. 1997c: Geological setting of Prairie-type mineralization, Mafeking Quarry, west-central Manitoba, 1997 work; Manitoba Energy and Mines, Preliminary Map 1997P-2, scale 1:5 000.

Bezys, R.K., Ducharme, E.B., Bamburak, J.D. and Fedikow, M.A.F. 1997a: A geochemical study of saline brine sediments as a guide to Prairie-type micro-disseminated mineralization and other precious metals in west central Manitoba (NTS 63C); *in* Report of Activities 1997, Manitoba Energy and Mines, Geological Services, p. 118–122.

Bezys, R.K., Fedikow, M.A.F., Bamburak, J.D. and Abercrombie, H.J. 1997b: Geological setting of Prairie-type mineralization, Mafeking Quarry, west-central Manitoba, 1996 work; Manitoba Energy and Mines, Geological Services, Preliminary Map 1997P-1, scale 1:5 000.

Bezys, R.K., Fedikow, M.A.F. and Kjarsgaard, B.A. 1996: Evidence of Cretaceous (?) volcanism along the Churchill-Superior Boundary Zone, Manitoba (NTS 63G/4); *in* Report of Activities 1996, Manitoba Energy and Mines, Geological Services, p. 122–126.

Bloom, M.S., Gilbert, D.J., Gammons, C.H. and Wilde, A.R. 1992: Reaction path model for hydrothermal Au-PGE mineralization at Coronation Hill and similar deposits of the South Alligator Mineral Field, Australia; *in* Proceedings–International Symposium on Water-Rock Interaction, v. 7, p. 1569–1573.

Burchill, C. 1991: Vegetation-environment relationships of an inland boreal salt pan; M.Sc. thesis, University of Manitoba, Winnipeg, Manitoba, 103 p.

Cameron, E.L. 1949: Salt, potash and phosphate in Manitoba; Manitoba Mines Branch, Bulletin 48-9, p. 1–13.

Clark, J.R., Meier, A.L. and Riddle, G. 1993: Enzyme leaching of surficial geochemical samples for detecting hydromorphic trace-element anomalies associated with precious-metal mineralized bedrock buried beneath glacial overburden in northern Minnesota; Transactions of the Institute of Mining and Metallogeny, Section B, p. B19–B29.

Cole, L.H. 1914: Saline springs of Manitoba; Canada Mines Branch, Report 285, p. 50–53.

Cole, L.H. 1915: Report on the salt deposits of Canada and the salt industry (with reference to Manitoba); Canada Mines Branch, Report 325, p. 1–2, 49–81.

Dietrich, J.R., Magnusson, D.H., Lyatsky, H.V. and Hajnal, Z. 1997: Basement-sedimentary cover relationships along the Churchill-Superior Boundary Zone, southwestern Manitoba (abstract); Manitoba Mining and Minerals Convention '97, Manitoba Energy and Mines, Minerals Division, p. 33.

Dyck, W. 1969: Radon determination apparatus for geochemical prospecting for uranium; Geological Survey of Canada, Paper 68-21, 30 p.

Eugster, H.P. 1989: Geochemical environment of sediment-hosted Cu-Pb-Zn deposits; Geological Association of Canada, Special Paper 36, p. 111–126.

Evans, D.S. 1976: EO-4 Dawson Bay (63C/13, 14, 15); *in* Summary of Field Activities 1976, Manitoba Department of Mines, Resources and Environmental Management, Geological Survey, p. 56–57.

Fedikow, M.A.F. and Ziehlke, D.V. 1996: Enzyme leach–based soil-geochemical exploration for gold in deep overburden terranes, Assean Lake area, northeastern Manitoba; Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Program with Abstracts, v. 21, p. A28.

Fedikow, M.A.F., Bamburak, J.D. and Weitzel, J. 1995: Geochemistry of Ordovician Winnipeg Formation black shale, sandstone and their metal-rich encrustations, Black Island, Lake Winnipeg (NTS 62P/1); *in* Report of Activities 1995, Manitoba Energy and Mines, Geological Services, p. 128–135.

Fedikow, M.A.F., Bezys, R.K., Bamburak, J.D. and Abercrombie, H.J. 1996: Prairie-type micro-disseminated Au mineralization – a new deposit type in Manitoba's Phanerozoic rocks (NTS 63C/14); *in* Report of Activities 1996, Manitoba Energy and Mines, Geological Services, p. 108–121.

Fedikow, M.A.F., Bezys, R.K., Bamburak, J.D., Conley, G.G. and Garrett, R.G. 1998: Geochemical database for Phanerozoic black shales in Manitoba; Manitoba Energy and Mines, Geological Services, Open File Report OF98-2, 124 p.

Fedikow, M.A.F., Bezys, R.K., Bamburak, J.D. and Garrett, R.G. 1997: Geochemical characterization of black shales in Manitoba's Phanerozoic; *in* Report of Activities 1997, Manitoba Energy and Mines, Geological Services, p. 129–130.

Feng, R. and Abercrombie, H.J. 1994: Disseminated Au-Ag-Cu mineralization in the Western Canada Sedimentary Basin, Fort MacKay, northeast Alberta: a new gold deposit type; *in* Current Research 1994-E, Geological Survey of Canada, p. 121–132.

Gale, G.H., Nielsen, E. and McCabe, H.R. 1981: Mineral deposit studies in Phanerozoic rocks of southern Manitoba; *in* Report of Field Activities 1981, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 57–62.

Gale, G.H., Nielsen, E. and McCabe, H.R. 1984: Investigations of lead-zinc potential in Paleozoic rocks of southern Manitoba; *in* Report of Field Activities 1984, Manitoba Energy and Mines, Mineral Resources, p. 159–161.

Gale, G.H. and Conley, G.G. 2000: Metal contents of selected Phanerozoic drill cores and the potential for carbonate-hosted Mississippi Valley–type deposits in Manitoba; Manitoba Industry, Trade and Mines, Manitoba Geological Survey, Open File Report OF2000-3, 126 p.

Geological Survey of Canada 1969a: Barrows, Manitoba, NTS 63C/14; Geological Survey of Canada, Geophysical Series Map 4251G, scale 1:63 360.

Geological Survey of Canada 1969b: Swan Lake, Manitoba, NTS 63C; Geological Survey of Canada, Geophysical Series Map 7724G, 1:253 440.

Gold, T. and Soter, S. 1980: The deep earth-gas hypothesis; Scientific American, v. 242, p. 130–138.

Gunter, W.R. 1989: Industrial minerals mapping, Swan River–Mafeking area (63C and 62O); *in* Report of Field Activities 1989, Manitoba Energy and Mines, Minerals Division, p. 127–131.

Jones, C.W. 1986: A preliminary assessment of selected carbonate bedrock resources for aggregate potential; *in* Report of Field Activities 1986, Manitoba Energy and Mines, Minerals Division, p. 226–228.

Jones, G. 1991: Competitive processes and spatial patterning of plant species in inland boreal saline habitats; M.Sc. thesis, University of Manitoba, Winnipeg, Manitoba, 276 p.

Kaszycki, C.A. 1989: Surficial geology of till composition, northwestern Manitoba; Geological Survey of Canada, Open File 218, 48 p.

Kent, D.M., Minto, J.W. and Sparks, D. 1992: Controls on initial growth, shape and distribution of Devonian Winnipegosis reefs, Elk Point Basin, Manitoba; *in* Report of Field Activities 1988, Manitoba Energy and Mines, Mineral Resources Division, p. 130–138.

Malmqvist, L. and Kristiansson, K. 1984: Experimental evidence for an ascending microflow of geo gas in the ground; Earth and Planetary Science Letters, v. 70, p. 407–416.

Matile, G. and Nielsen, E. 1994: Kimberlite indicator mineral follow-up project, Westlake Plain, southwestern Manitoba (NTS 62J, 62K, 62N, 62O, 63C); *in* Report of Activities 1994, Manitoba Energy and Mines, Mineral Resources Division, p. 179–181.

McCabe, H.R. 1967: Tectonic framework of Paleozoic formations in Manitoba; Canadian Institute of Mining and Metallurgy, Annual Western Meeting, Transactions, v. L20, p. 180–189.

McCabe, H.R. 1971a: Stratigraphic mapping; *in* Summary of Geological Field Work 1971, Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Geological Paper 71-6, p. 56–58.

McCabe, H.R. 1971b: Subsurface stratigraphic studies; *in* Summary of Geological Field Work 1971, Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Geological Paper 71-6, p. 59–60.

McCabe, H.R. 1972: Stratigraphic corehole programme; *in* Summary of Geological Field Work 1972, Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Geological Paper 72-3, p. 59–63.

McCabe, H.R. 1977: Stratigraphic corehole programme: *in* Report of Field Activities 1977, Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, p. 93–97.

McCabe, H.R. 1978: Stratigraphic corehole and mapping programme; *in* Report of Field Activities 1978, Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, p. 64–67.

McCabe, H.R. 1981: Stratigraphic mapping and corehole programme; *in* Report of Field Activities 1981, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 83–88.

McCabe, H.R. 1984: Stratigraphic mapping and stratigraphic and industrial minerals corehole program; *in* Report of Field Activities 1984, Manitoba Energy and Mines, Mineral Resources, p. 136–143.

McCabe, H.R. 1985: Stratigraphic mapping and stratigraphic and industrial minerals corehole program; *in* Report of Field Activities 1985, Manitoba Energy and Mines, Geological Services/Mines Branch, p. 216–225.

McCabe, H.R. 1986: Stratigraphic mapping and stratigraphic and industrial minerals corehole program; *in* Report of Field Activities 1986, Manitoba Energy and Mines, Minerals Division, p. 191–198.

McCabe, H.R. 1987: Stratigraphic mapping and stratigraphic and industrial minerals corehole program; *in* Report of Field Activities 1987, Manitoba Energy and Mines, Minerals Division, p. 151–161.

McCabe, H.R. 1988: Stratigraphic mapping and corehole program; *in* Report of Field Activities 1988, Manitoba Energy and Mines, Minerals Division, p. 130–138.

McCabe, H.R. and Bannatyne, B.B. 1970: Mines Branch corehole programme for stratigraphy and industrial minerals; *in* Summary of Geological Field Work 1970, Manitoba Department of Mines and Natural Resources, Mines Branch, Geological Survey, Geological Paper 70-4, p. 40–41.

McCabe, H.R. and Bannatyne, B.B. 1971: Stratigraphic and industrial minerals corehole programme; *in* Summary of Geological Field Work 1971, Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Geological Paper 71-6, p. 61–63.

McCracken, A.D. 1996: Report on two lower Upper Devonian (Frasnian) conodont samples (contribution no. 614) from outcrop, western Manitoba, submitted by R.K. Bezys (Manitoba Energy and Mines) in 1996 (NTS 63C/14); Geological Survey of Canada, Paleontological Report #007-ADM-1996, 2 p.

McCracken, A.D. 1999: Report on Late Ordovician and early Devonian (Frasnian) conodont samples (contribution no. 1561) from drillhole and quarry outcrop, respectively (formations unknown), western Manitoba, submitted by R.K. Bezys (Manitoba Energy and Mines) in 1998 (NTS 63C/14, 63G/12 and 63G/14); Geological Survey of Canada, Paleontological Report #4-ADM-1999, 4 p.

McKillop, W.B., Patterson, R.T., Delorme, L.D. and Nogrady, T. 1992: The origin, physico-chemistry and biotics of sodium chloride dominated saline waters on the western shore of Lake Winnipegosis, Manitoba; Canadian Field Naturalists, v. 106, no. 4, p. 454–473.

NcNeil, D.H. 1996: Micropaleontological report on four outcrop and core samples from Cretaceous (?)/Devonian (?) sediments in western Manitoba, submitted by R.K. Bezys (Manitoba Energy and Mines) in 1996 (NTS 63C and 63G); Geological Survey of Canada, Paleontological Report #7-DHM-1996, 2 p.

McNeil, D.H. and Caldwell, W.G.E. 1981: Cretaceous rocks and their foraminifera in the Manitoba Escarpment; Geological Association of Canada, Special Paper 21, 439 p.

McRitchie, W.D. 1989: Lead-zinc potential in Paleozoic rocks; northern Interlake region, spring and creek waters and sediments; *in* Report of Activities 1989, Manitoba Energy and Mines, Minerals Division, p. 95–102.

McRitchie, W.D. 1994: Spring water and marl geochemical investigations, Grand Rapids uplands (NTS 63G); *in* Report of Activities 1994, Manitoba Energy and Mines, Geological Services, p. 148–162.

McRitchie, W.D. 1995: Spring water and marl geochemical investigations, Grand Rapids region, 1995 status report (NTS 63G); *in* Report of Activities 1995, Manitoba Energy and Mines, Geological Services, p. 109–119.

McRitchie, W.D. 1996: Groundwater geochemistry and structural investigations of Paleozoic carbonates in Manitoba's Interlake region; *in* Report of Activities 1996, Manitoba Energy and Mines, Geological Services, p. 143–152.

McRitchie, W.D. and Kaszycki, C.A. 1997: Tufa mounds, upwellings and gravity springs in the central and northern Interlake region, Manitoba (parts of NTS areas 62O, 62P, 63B and 63G); *in* Report of Activities 1997, Manitoba Energy and Mines, Geological Services, p. 133–146.

Nielsen, E. 1982: Mineral deposit studies in Phanerozoic rocks in southern Manitoba; *in* Report of Field Activities 1982, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 65–68.

Nielsen, E. and Gale, G.H. 1983: Mineral deposit studies of Phanerozoic rocks in southern Manitoba; *in* Report of Field Activities 1983, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 115–121.

Nielsen, E. and Gale, G.H. 1985: Lead-zinc potential in Paleozoic rocks of southern Manitoba; *in* Report of Field Activities 1985, Manitoba Energy and Mines, Geological Services/Mines Branch, p. 235–236.

Nielsen, E. and Gale, G.H. 1989: Quaternary stratigraphy and overburden geochemistry in the Phanerozoic terrane of southern Manitoba; Manitoba Energy and Mines, Minerals Division, Geological Paper GP87-1, 78 p.

Nielsen, E. and Matile, G. 1978: Quaternary geology of the Swan River area; *in* Report of Field Activities 1978, Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, p. 120–123.

Norris, A.W., Uyeno, T.T. and McCabe, H.R. 1982: Devonian rocks of the Lake Winnipegosis–Lake Manitoba outcrop belt, Manitoba; Manitoba Energy and Mines, Minerals Resources Division, Publication 771, 280 p.

Olson, R.A., Richardson, R.J.H. and Eccles, D.R. 1994: Regional metallogenetic evolution of Alberta; Alberta Research Council, Open File Report 1994-8, 280 p.

Ramnath, S.M. 1999: Prairie-type mineralization: a mineralogical and geochemical study of solution chimneys in the Mafeking Quarry, Manitoba, Canada; B.Sc. thesis, University of Manitoba, Winnipeg, Manitoba, 49 p.

Rejebian, V.A., Harris, A.G., and Huebner, J.S. 1987: Conodont color and external alteration: an index to regional metamorphism, contact metamorphism and hydrothermal alteration; Geological Society of America Bulletin, v. 99, p. 471–479.

Rhodes, D., Lantos, E.A., Lantos, J.A., Webb, R.J. and Owens, D.C. 1984: Pine Point orebodies and their relationship to the stratigraphy, structure, dolomitization, and karstification of the Middle Devonian barrier complex; Economic Geology, v. 79, p. 991–1055.

Schmidtke, B.E. and Fedikow, M.A.F. 1996: Mineralogy of metal-rich encrustations on Ordovician Winnipeg Formation black shales and sandstones, Black Island, Lake Winnipeg; *in* Report of Activities 1996, Manitoba Energy and Mines, Geological Services, p. 139–142.

Schmidtke, B.E. and Bamburak, J.D. 1993: Industrial minerals investigations in southern Manitoba (NTS 52E, 52L, 62G, 62I, 62P, 63C); *in* Report of Activities 1993, Manitoba Energy and Mines, Geological Services, p. 141–145.

Stephenson, J.F. 1973: Geochemical studies; *in* Summary of Geological Field Work 1973; Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Geological Paper 73-2, p. 7–8.

Sverjensky, D.A. 1987: The role of migrating oil-field brines in the formation of sediment-hosted Cu deposits; Economic Geology, v. 82, p. 1130–1141.

Tyrrell, J.B. 1892: Report of north-western Manitoba with portions of the adjacent districts of Assiniboia and Saskatchewan; Geological Survey of Canada, Annual Report, Part E, 235 p.

Wadien, R. 1984: The geochemistry and hydrogeology of saline spring waters of the Winnipegosis area, southwestern Manitoba; B.Sc. thesis, University of Manitoba, Winnipeg, Manitoba, 63 p.

Wang, X., Cheng, Z., Lu, Y., Xu, L. and Xie, X. 1997: Nanoscale metals in the earthgas and mobile forms of metals in overburden in wide-spaced regional exploration for giant deposits in overburden terrains; Journal of Geochemical Exploration, v. 58, p. 63–72.

Watson, D.M. 1982: Silica in Manitoba; *in* Report of Field Activities 1982, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 84–86.

Watson, D.M. 1985: Industrial minerals of the Swan Lake area (NTS 63C); *in* Report of Field Activities 1985, Manitoba Energy and Mines, Geological Services/Mines Branch, p. 226–228.

Watson, D.M. and Kohuska, C. 1984: Industrial mineral investigations, 1984; *in* Report of Field Activities 1984, Manitoba Energy and Mines, Mineral Resources, p. 156–158.

Appendices

Appendix 1: Summary of stratigraphic corehole data from the Dawson Bay area, 1997

Hole no.	Location and elevation (m)	SYSTEM/Formation/ (Member)	Interval (m)	Summary lithology
M-4-97	7-32-44-25W	OVERBURDEN	0.0-1.7	Rubbly limestone
Dawson Bay	5855308N	DEVONIAN/Souris River/(Point	1.7-3.0	Dolomitic Limestone Beds: rusty brown; limestone to
N. Mafeking	361965E	Wilkins)		dolomitic limestone; mudstone; some intense red
Quarry	279 m			colouration
SC-1			3.0-9.3	Micritic Limestone Beds: mottled limestone; mudstone to
50° angle				wackestone; fossiliferous
M-5-97	8-33-44-25W	OVERBURDEN	0.0-3.8	Boulder till; possible silica sinter pebble at the base
Dawson Bay	5855302N	DEVONIAN/Souris River (Point	3.8-6.9	Micritic Limestone Beds: tan limestone; wackestone;
N. Mafeking	363929E	Wilkins)		fossiliferous
Quarry	274 m		6.9-8.2	Sand clay infill; brown sand; some green grey clay; silica
SC-1				sinter pebble at the base
			8.2-22.3	Micritic Limestone Beds: as above; very broken
M-6-97	7-32-44-25W	DEVONIAN/Souris River (Point	0.0-0.6	Dolomitic Limestone Beds: yellow orange to tan;
North Dawson	5855302N	Wilkins)		limestone; wackestone
Bay	561872E		0.6-25.5	Micritic Limestone Beds: light tan to brown; mottled
N. Mafeking	279 m			limestone; fossiliferous
Quarry			25.5-34.3	Argillaceous Limestone Beds: light brown tan;
				limestone; mudstone; scattered light green clay
		(First Red Beds)	34.3-44.7	Red brown to green limestone; mudstone
		Dawson Bay/(Upper)	44.7-51.6	Limestone: wackestone; light tan to dark brown;
				abundant green grey clay along fractures and bedding
				planes
		Dawson Bay (Middle)	51.6-69.4	Limestone: mudstone; dark grey to light olive green
		Dawson Bay (Lower)	69.4-76.2	Limestone: wackestone; light tan; fossiliferous
		(Second Red Beds)	76.2-81.4	Limestone: grey to dark red argillaceous mudstone
M-7-97	12-33-44-25W	OVERBURDEN	0.0-0.4	Glacial till
Dawson Bay	5855935N	DEVONIAN/Souris River/(Point	0.4-0.5	Rind (?): dark brown dolomitic limestone to limestone;
Borrow Pit	362619E	Wilkins)		sideritic
East of Mafeking	276 m	SOLUTION CHIMNEY (?)	0.5-8.3	Micritic Limestone Beds: limestone; fossiliferous;
Quarry				mudstone to wackestone; scattered grey clay
M-8-97	12-33-44-25W	DEVONIAN/Souris River/(Point	0.0-0.2	Dolomitic Limestone Beds: limestone; light brown to
Dawson Bay	5855935N	Wilkins)		brown
Borrow Pit	362619E		0.2-0.3	Rind: sideritic limestone; dark brown
E. of Mafeking	276 m			
Quarry			0.3-2.0	Micritic Limestone Beds: light brown tan limestone;
55° angle				mudstone
			2.0-2.2	Pebble infill: carbonate and Precambrian fragments
			2.2-3.5	Micritic Limestone Beds: (as above)

Appendix 1: Summary of stratigraphic corehole data from the Dawson Bay area, 1997

Hole no.	Location and elevation (m)	SYSTEM/Formation/ (Member)	Interval (m)	Summary lithology
M-9-97 Dawson Bay Tower Outcrop	2-8-45-25W 5858490N 361895E 274 m	DEVONIAN/Souris River/(Point Wilkins)	0.0-17.0	Micritic Limestone Beds: light tan limestone; fossiliferous; mudstone
			17.0-26.0	Argillaceous Limestone Beds: tan to brown limestone; mudstone; abundant red colouration, fossiliferous
		(First Red Beds)	26.0-40.0	Interbedded green and red mudstone; calcareous and non-calcareous
		Dawson Bay (Upper)	40.0-43.2	Limestone with some dolomite; wackestone; scattered sulphide bonding at top
		Dawson Bay (Middle)	43.2-59.9	Grey to red calcareous shale/mudstone; fossiliferous
		Dawson Bay (Lower)	59.9-67.8	Limestone: light green to grey to red; mudstone at the base with wackestone/packstone at the top; fossiliferous
		(Second Red Beds)	67.8-72.3	Dark red to grey argillaceous dolomite; mudstone
M-10-97 Dawson Bay East Steeprock Bridge Pelican Rapids Road	15-12-44-25W 5849594N 368079E 263 m	DEVONIAN/Dawson Bay (Lower)	0.0-4.7	Limestone: fossiliferous, mudstone
			4.7-6.2	Transitional Beds: olive grey mudstone
		(Second Red Beds)	6.2-15.5	Grey mudstone; dolomitic
			15.5-17.6	Transitional Beds: blue green calcareous dolomite
		Winnipegosis/(Lower)	17.6-28.8	Light brown tan packstone; porous; reefal
M-11-97 Dawson Bay Highway 10 outcrop Borrow Pit	10-5-45-25W 5857289N 362112E 282 m	DEVONIAN/Dawson Bay (Upper)	0.0-7.3	Limestone; wackestone; light brown tan; pyrite blebs throughout; sulphide banding at top
		Dawson Bay/(Middle)	7.3-26.7	Limestone: dark grey; mudstone; fossiliferous
		Dawson Bay (Lower)	26.7-30.9	Limestone: light tan brown; mudstone; scattered sulphides
			30.9-34.8	Transitional Beds: dolomite; mudstone; brecciated
		(Second Red Beds)	34.8-40.1	Dolomite: dark red brown mudstone
M-12-97	4-21-44-25W	DEVONIAN/Souris River/(Point	0.0-1.8	Dolomitic Limestone Beds: oxide cap; dark orange brown
Dawson Bay	5851850N	Wilkins)		Micritic Limestone Beds: limestone; wackestone; very
Pelican Rapids	362550E		1.8-24.1	broken core
Rd. & Hwy. 10	283.5 m			Argillaceous Limestone Beds: limestone; mudstone; light
			24.1-31.5	green with some red
				Limestone: dolomitic; oxidized and reduced intervals
		(First Red Beds)	31.5-42.0	Transitional Beds: limestone and dolomitic limestone,
			42.0-48.3	green grey argillaceous beds
				Limestone: wackestone; light brown tan
		Dawson Bay/(Upper)	48.3-56.2	Limestone: olive green to light tan; mudstone;
		Dawson Bay/(Middle)	56.2-67.2	fossiliferous
				Limestone: mudstone and wackestone; light tan to brown;
		Dawson Bay (Lower)	67.2-74.5	some green argillaceous partings

Appendix 1: Summary of stratigraphic corehole data from the Dawson Bay area, 1997

Hole no.	Location and elevation (m)	SYSTEM/Formation/ (Member)	Interval (m)	Summary lithology
		(Second Red Beds)	74.5-78.3	Dark red dolomitic mudstone
M-13-97 Dawson Bay West of Swan Lake	2-30-41-24W 5823840N 370600E 269 m	OVERBURDEN	0.0-20.7	Glacial till and Lake Agassiz clay(?)
		DEVONIAN/Souris River/(Point Wilkins)	20.7-20.9	Micritic Limestone Beds: calcareous dolomite; mudstone; light tan to orange - looks like rind; dark brown to olive green mudstone; dark brown to olive green mudstone/clay with muscovite flakes(?)
			20.9-21.0	Siliceous sinter boulder (white)
		INFILL or SOLUTION CHIMNEY (?)	21.0-23.6	Till-like material with clay (?)
		CRETACEOUS or JURASSIC?	23.6-26.7	Clay: blue green/green grey to olive green; not sure if part of solution chimney or channel infill material
M-14-97 Dawson Bay North Mafeking Quarry	7-32-44-25W 585575N 361825E 278 m	DEVONIAN/Souris River/(Point Wilkins)	0.0-5.0	Micritic Limestone Beds: light brown tan; wackestone; poor core recovery; 5 cm of silica sinter at base
		SOLUTION CHIMNEY (?)	5.0-5.5	Blue green to green grey clay with “micro sinters”

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe
Units	PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%
Detection Limit	2	5	0.5	50	0.5	1	1	5	1	0.01
Solution Chimney (SC)										
SC1										
SINTER	-2	-5	1.4	95	-0.5	-1	-1	41	-1	0.19
RIND	4	-5	2.3	130	-0.5	2	140	20	1	36.8
WALL ROCK	-2	-5	1	-50	2.1	37	2	9	-1	0.48
SC2										
SINTER	-2	-5	18	170	-0.5	-1	1	36	-1	0.37
RIND	-2	-5	2.4	110	1.1	4	17	16	-1	32.2
WALL ROCK (mineralized)	3	-5	1.9	-50	2.5	41	2	7	-1	1.31
SC3										
SINTER	-2	-5	9.6	300	-0.5	-1	1	20	-1	0.28
RIND	-2	-5	2.8	160	-0.5	3	19	18	-1	32.9
WALL ROCK (mineralized)	-2	-5	1.6	560	1.4	38	2	10	-1	0.85
SC4										
SINTER	3	-5	2.6	200	-0.5	-1	1	27	-1	0.21
RIND	3	-5	11	100	-0.5	4	270	18	-1	38.4
SC7A										
SINTER	-2	-5	1.8	130	-0.5	-1	2	31	-1	0.26
RIND	7	-5	2.5	110	-0.5	6	43	14	1	27.2
SC7B										
SINTER	-2	-5	1.2	110	-0.5	-1	1	49	-1	0.19
RIND	15	-5	1.7	89	-0.5	9	49	12	-1	26.5
WALL ROCK (mineralized)	4	-5	3.2	60	2	38	2	9	-1	0.61

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe
Units	**PPB**	**PPM**	**PPM**	**PPM**	**PPM**	**%**	**PPM**	**PPM**	**PPM**	**%**
Detection Limit	**2**	**5**	**0.5**	**50**	**0.5**	**1**	**1**	**5**	**1**	**0.01**
Solution Chimney (SC)										
SC8										
SINTER	-2	-5	1.3	100	-0.5	-1	2	26	-1	0.18
RIND	10	-5	2	95	-0.5	10	10	13	-1	27.7
WALL ROCK (mineralized)	-2	-5	1.3	-50	2.1	38	2	-5	-1	1.14
SC9										
SINTER	-2	-5	2.9	150	-0.5	-1	1	26	-1	0.19
RIND	-2	-5	16	-50	-0.5	5	110	11	-1	28.1
SC10										
SINTER	-2	-5	1.5	110	-0.5	-1	2	20	-1	0.26
RIND	5	-5	3.2	110	-0.5	13	87	11	-1	25.5
SC11										
SINTER (mineralized)	3	-5	1.7	130	-0.5	-1	12	17	-1	0.68
SINTER	4	-5	1.2	90	-0.5	-1	7	17	-1	0.57
RIND	28	-5	2.8	170	-0.5	5	190	16	-1	31.1
WALL ROCK	4	-5	4.3	74	1.5	37	4	8	-1	1.41
SC12										
SINTER	2	-5	1.6	220	-0.5	-1	1	20	-1	0.18
RIND	-2	-5	3.7	110	-0.5	2	72	13	-1	40.7
SC13										
SINTER	-2	-5	3.7	140	-0.5	-1	2	29	-1	0.13
RIND	10	-5	3.3	-50	-0.5	8	8	16	-1	28.6
SC14										
SINTER	-2	-5	1.2	140	-0.5	-1	1	12	-1	0.14
WALL ROCK	4	-5	18	-50	3	39	3	10	-1	2.71
SC15										

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe
Units	PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%
Detection Limit	2	5	0.5	50	0.5	1	1	5	1	0.01
Solution Chimney (SC)										
SINTER	-2	-5	4.1	84	-0.5	-1	2	39	-1	0.2
RIND	-2	-5	2.6	96	-0.5	6	33	15	1	29.6
SC17										
SINTER	-2	-5	4.3	140	-0.5	-1	2	23	-1	0.3
RIND	25	-5	6	100	-0.5	3	37	15	-1	34.5
WALL ROCK (mineralized)	-2	-5	1.5	-50	3.1	43	1	8	-1	0.71
"Mineralized" refers to the presence of 1 to 3 mm marcasite/pyrite grains.										
A negative number indicates the content is less than the lower limit of detection.										

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Hf	Hg	Ir	Mo	Na	Ni	Rb	Sb	Sc	Se
Units	PPM	PPM	PPB	PPM	%	PPM	PPM	PPM	PPM	PPM
Detection Limit	1	1	5	1	0.01	20	15	0.1	0.1	3
Solution Chimney (SC)										
SC1										
SINTER	-1	-1	-5	2	0.03	-20	-15	0.6	0.4	-3
RIND	-1	-1	-5	-1	0.03	88	-15	-0.1	6.7	-3
WALL ROCK	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.7	-3
SC2										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.8	0.6	-3
RIND	-1	-1	-5	-1	0.02	-20	27	0.1	3.9	-3
WALL ROCK (mineralized)	-1	-1	-5	2	0.03	-20	-15	-0.1	0.6	-3
SC3										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.8	0.4	-3
RIND	-1	-1	-5	-1	0.03	-20	24	0.2	4.4	-3
WALL ROCK (mineralized)	-1	-1	-5	-1	0.03	-20	-15	0.2	2.9	-3
SC4										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.3	0.4	-3
RIND	-1	-1	-5	-1	0.03	-20	-15	-0.1	3.4	-3
SC7A										
SINTER	-1	-1	-5	2	0.04	-20	-15	0.5	0.4	-3
RIND	-1	-1	-5	-1	0.02	-20	-15	0.1	4.7	-3
SC7B										
SINTER	-1	-1	-5	2	0.03	-20	-15	0.3	0.4	-3
RIND	-1	-1	-5	-1	0.03	-20	-15	0.2	4.6	-3
WALL ROCK (mineralized)	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.6	-3

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Hf	Hg	Ir	Mo	Na	Ni	Rb	Sb	Sc	Se
Units	PPM	PPM	PPB	PPM	%	PPM	PPM	PPM	PPM	PPM
Detection Limit	1	1	5	1	0.01	20	15	0.1	0.1	3
Solution Chimney (SC)										
SC8										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.2	0.3	-3
RIND	-1	-1	-5	-1	0.02	-20	-15	0.1	3.5	-3
WALL ROCK (mineralized)	-1	-1	-5	-1	0.02	-20	-15	-0.1	1.2	-3
SC9										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.4	0.4	-3
RIND	-1	-1	-5	-1	0.01	71	17	0.3	2.9	-3
SC10										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.3	0.6	-3
RIND	-1	-1	-5	-1	0.02	60	-15	0.2	7.6	-3
SC11										
SINTER (mineralized)	-1	-1	-5	-1	0.03	-20	-15	1.5	0.7	-3
SINTER	-1	-1	-5	1	0.02	-20	-15	0.7	0.6	-3
RIND	-1	-1	-5	-1	0.04	89	-15	-0.1	4.9	-3
WALL ROCK	-1	-1	-5	-1	0.09	-20	-15	-0.1	8.2	-3
SC12										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.3	0.4	-3
RIND	-1	-1	-5	-1	0.14	-21	-15	-0.1	5.3	-3
SC13										
SINTER	-1	-1	-5	-1	0.02	-20	-15	0.4	0.3	-3
RIND	-1	-1	-5	-1	0.18	-20	21	-0.1	3.8	-3
SC14										
SINTER	-1	-1	-5	-1	0.03	-20	-15	1.6	0.4	-3
WALL ROCK	-1	-1	-5	-1	0.18	-20	-15	0.2	0.4	-3
SC15										

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Hf	Hg	Ir	Mo	Na	Ni	Rb	Sb	Sc	Se
Units	PPM	PPM	PPB	PPM	%	PPM	PPM	PPM	PPM	PPM
Detection Limit	1	1	5	1	0.01	20	15	0.1	0.1	3
Solution Chimney (SC)										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.3	0.3	-3
RIND	-1	-1	-5	-1	0.09	75	-15	-0.1	3.9	-3
SC17										
SINTER	-1	-1	-5	-1	0.03	-20	-15	0.7	0.5	-3
RIND	-1	-1	-5	-1	0.08	-20	32	0.3	4.3	-3
WALL ROCK (mineralized)	-1	-1	-5	-1	0.07	-20	-15	-0.1	0.5	-3
"Mineralized" refers to the presence of 1 to 3 mm marcasite/pyrite grains.										
A negative number indicates the content is less than the lower limit of detection.										

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Sn	Sr	Ta	Th	U	W	Zn	La	Ce	Nd
Units	%	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
Detection Limit	0.01	0.05	0.5	0.2	0.5	1	50	0.5	3	5
Solution Chimney (SC)										
SC1										
SINTER	-0.01	-0.05	-0.5	-0.2	3.3	1	-50	0.7	-3	-5
RIND	-0.01	-0.05	-0.5	1.3	2.5	-1	577	4.5	12	-5
WALL ROCK	-0.01	-0.05	-0.5	0.4	0.8	-1	-50	1.3	-3	-5
SC2										
SINTER	-0.01	-0.05	-0.5	0.2	3.5	2	-50	1	-3	-5
RIND	-0.01	-0.05	-0.5	0.6	1.5	-1	186	2.1	4	-5
WALL ROCK (mineralized)	-0.01	-0.05	-0.5	0.3	-0.5	1	-50	1	-3	-5
SC3										
SINTER	-0.01	-0.05	-0.5	-0.2	3.4	2	-50	0.9	-3	-5
RIND	-0.01	-0.05	-0.5	0.8	1	-1	174	4.2	9	-5
WALL ROCK (mineralized)	-0.01	-0.05	-0.5	0.7	0.6	-1	-50	3	5	-5
SC4										
SINTER	-0.01	-0.05	-0.5	-0.2	2.7	2	65	-0.5	-3	-5
RIND	-0.01	-0.05	-0.5	0.8	1.9	-1	296	3.4	6	-5
SC7A										
SINTER	-0.01	-0.05	-0.5	-0.2	3.6	-1	-50	0.6	-3	-5
RIND	-0.01	-0.05	-0.5	0.6	1.5	-1	480	4.5	16	-5
SC7B										
SINTER	-0.01	-0.05	-0.5	-0.2	2.9	1	-50	-0.5	-3	-5
RIND	-0.01	-0.05	-0.5	0.6	2.1	-1	588	4.8	14	6
WALL ROCK (mineralized)	-0.01	-0.05	-0.5	-0.2	0.8	1	-50	1.2	-3	-5

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Sn	Sr	Ta	Th	U	W	Zn	La	Ce	Nd
Units	%	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
Detection Limit	0.01	0.05	0.5	0.2	0.5	1	50	0.5	3	5
Solution Chimney (SC)										
SC8										
SINTER	-0.01	-0.05	-0.5	-0.2	2.4	1	-50	-0.5	-3	-5
RIND	-0.01	-0.05	-0.5	0.5	1.1	-1	67	5	14	-5
WALL ROCK (mineralized)	-0.01	-0.05	-0.5	0.2	1	-1	-50	1.7	5	-5
SC9										
SINTER	-0.01	-0.05	-0.5	-0.2	2.4	1	-50	0.6	-3	-5
RIND	-0.01	-0.05	-0.5	-0.2	-0.5	-1	640	1.7	-3	-5
SC10										
SINTER	-0.01	-0.05	-0.5	0.3	3.8	1	-50	1.1	-3	-5
RIND	-0.01	-0.05	-0.5	0.4	1	-1	472	4.1	17	7
SC11										
SINTER (mineralized)	-0.01	-0.05	-0.5	0.2	2.7	-1	-50	0.5	-3	-5
SINTER	-0.01	-0.05	-0.5	0.4	2.5	-1	-50	0.7	3	-5
RIND	-0.01	-0.05	-0.5	0.9	1.8	-1	193	4.9	14	-5
WALL ROCK	-0.01	-0.05	-0.5	-0.2	1.6	-1	-50	1.5	4	-5
SC12										
SINTER	-0.01	-0.05	-0.5	-0.2	2.5	1	-50	0.6	-3	-5
RIND	-0.01	-0.05	-0.5	0.5	1.9	-1	158	2.2	4	-5
SC13										
SINTER	-0.01	-0.05	-0.5	-0.2	3.6	1	-50	-0.5	-3	-5
RIND	-0.01	-0.05	-0.5	0.5	2.4	-1	99	5.5	9	-5
SC14										
SINTER	-0.01	-0.05	-0.5	0.2	4	1	-50	1	-3	-5
WALL ROCK	-0.01	-0.05	-0.5	0.3	0.6	-1	-50	1.2	-3	-5
SC15										

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Sn	Sr	Ta	Th	U	W	Zn	La	Ce	Nd
Units	%	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
Detection Limit	0.01	0.05	0.5	0.2	0.5	1	50	0.5	3	5
Solution Chimney (SC)										
SINTER	-0.01	-0.05	-0.5	-0.2	2.9	-1	-50	-0.5	-3	-5
RIND	-0.01	-0.05	-0.5	-0.2	1.5	-1	184	2.3	6	-5
SC17										
SINTER	-0.01	-0.05	-0.5	0.2	2.7	1	-50	1	-3	-5
RIND	-0.01	-0.05	-0.5	0.6	5.3	-1	80	5.3	14	5
WALL ROCK (mineralized)	-0.01	-0.05	-0.5	-0.2	0.6	-1	-50	1.1	-3	-5
"Mineralized" refers to the presence of 1 to 3 mm marcasite/pyrite grains.										
A negative number indicates the content is less than the lower limit of detection.										

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	**Sm**	**Eu**	**Tb**	**Yb**	**Lu**
Units	**PPM**	**PPM**	**PPM**	**PPM**	**PPM**
Detection Limit	**0.1**	**0.2**	**0.5**	**0.2**	**0.05**
Solution Chimney (SC)					
SC1					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	1.2	0.4	-0.5	1	0.16
WALL ROCK	0.1	-0.2	-0.5	-0.2	-0.05
SC2					
SINTER	0.1	-0.2	-0.5	-0.2	-0.05
RIND	0.3	-0.2	-0.5	0.4	0.07
WALL ROCK (mineralized)	0.2	-0.2	-0.5	-0.2	-0.05
SC3					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	0.9	0.3	-0.5	0.7	0.13
WALL ROCK (mineralized)	0.5	-0.2	-0.5	0.5	0.07
SC4					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	0.9	0.3	-0.5	0.6	0.12
SC7A					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	1.4	0.4	-0.5	1.3	0.22
SC7B					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	2.2	0.7	0.6	1.4	0.25
WALL ROCK (mineralized)	0.1	-0.2	-0.5	-0.2	-0.05

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Sm	Eu	Tb	Yb	Lu
Units	PPM	PPM	PPM	PPM	PPM
Detection Limit	0.1	0.2	0.5	0.2	0.05
Solution Chimney (SC)					
SC8					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	1.4	0.4	-0.5	1.2	0.21
WALL ROCK (mineralized)	0.4	-0.2	-0.5	0.4	0.06
SC9					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	0.3	-0.2	-0.5	0.4	0.08
SC10					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	2.5	0.7	0.5	1.5	0.26
SC11					
SINTER (mineralized)	0.1	-0.2	-0.5	0.3	-0.05
SINTER	0.1	-0.2	-0.5	0.2	-0.05
RIND	1.8	0.6	-0.5	1.3	0.23
WALL ROCK	0.5	-0.2	-0.5	0.7	0.11
SC12					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	0.6	-0.2	-0.5	0.6	0.13
SC13					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	1	0.4	-0.5	1.2	0.2
SC14					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
WALL ROCK	0.1	-0.2	-0.5	-0.2	-0.05
SC15					

Appendix 2 (Part 1): INAA of sinters, rind and wallrock samples, North Mafeking Quarry

Element	Sm	Eu	Tb	Yb	Lu
Units	PPM	PPM	PPM	PPM	PPM
Detection Limit	0.1	0.2	0.5	0.2	0.05
Solution Chimney (SC)					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	0.6	-0.2	-0.5	0.5	0.08
SC17					
SINTER	-0.1	-0.2	-0.5	-0.2	-0.05
RIND	1.2	0.4	-0.5	1	0.18
WALL ROCK (mineralized)	0.1	-0.2	-0.5	-0.2	-0.05
"Mineralized" refers to the presence of 1 to 3 mm marcasite/pyrite grains.					
A negative number indicates the content is less than the lower limit of detection.					

Appendix 2 (Part 2): XRF of solution chimney components, North Mafeking Quarry

Solution Chimney (SC)	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	LOI
	%	%	%	%	%	%	%	%	%	%	%
SC1											
SINTER	99.51	0.1	0.12	-0.01	0.03	0.05	0.01	0.01	-0.01	-0.01	0.37
RIND	4.65	1.59	57.88	2.36	2.08	3.38	0.03	0.43	0.08	0.23	26.02
WALLROCK	1.4	0.43	0.2	0.02	0.33	54.73	0.01	0.18	0.01	0.01	42.82
SC2											
SINTER	99.07	0.11	0.31	-0.01	0.03	0.13	0.01	0.02	-0.01	0.06	0.52
RIND	2.45	0.88	53.91	1.82	2.63	6.35	0.03	0.2	0.05	0.25	31.54
WALLROCK	1.15	0.33	1.35	0.02	0.38	54.41	0.02	0.13	-0.01	-0.01	41.05
SC3											
SINTER	99.32	0.12	0.28	-0.01	0.03	0.14	-0.01	0.02	-0.01	-0.01	0.57
RIND	2.98	1.12	55.35	2.09	2.62	5.11	0.03	0.27	0.07	0.27	29.6
WALLROCK	2.7	0.78	0.72	0.05	0.38	52.7	0.02	0.31	0.03	0.29	41.95
SC4											
SINTER	99.02	0.03	0.08	-0.01	-0.01	0.02	-0.01	-0.01	-0.01	-0.01	0.29
RIND	4.46	0.79	63.57	1.45	2.46	6.43	0.03	0.23	0.04	0.19	19.91
SC7A											
SINTER	99.81	0.08	0.19	0.02	0.02	0.02	0.02	0.01	-0.01	0.01	0.49
RIND	2.55	0.77	46.64	5.98	2.25	8.44	0.04	0.18	0.04	0.48	32.14
SC7B											
SINTER	98.9	0.07	0.1	-0.01	-0.01	-0.01	0.01	0.01	-0.01	0.02	0.31
RIND	2.41	0.72	43.09	4.16	2.09	12.86	0.04	0.15	0.04	0.28	33.26
WALLROCK	1.21	0.34	0.4	0.02	0.36	54.3	0.02	0.15	-0.01	0.02	43.15
SC8											
SINTER	100.17	0.05	0.08	-0.01	0.04	0.06	0.01	0.01	-0.01	0.01	0.31
RIND	2.93	0.81	42.59	2.17	2.18	14.49	0.04	0.21	0.04	0.23	33.07
WALLROCK	0.72	0.2	1.19	0.1	0.34	54.7	-0.01	0.09	-0.01	0.07	43.16
Solution Chimney (SC)	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**MnO**	**MgO**	**CaO**	**Na_2O**	**K_2O**	**TiO_2**	**P_2O_5**	**LOI**
	%	%	%	%	%	%	%	%	%	%	%

Appendix 2 (Part 2): XRF of solution chimney components, North Mafeking Quarry

SC9											
SINTER	99.94	0.1	0.09	-0.01	0.03	0.07	0.01	0.02	-0.01	0.01	0.33
RIND	1.01	0.48	51.26	1.54	2.73	8.09	0.02	0.03	0.03	0.16	33.57
SC10											
SINTER	99.37	0.26	0.2	-0.01	0.07	0.17	-0.01	0.01	0.01	-0.01	0.59
RIND	2.24	0.74	41.49	0.94	2.34	17.85	0.03	0.13	0.04	0.21	34.07
SC11											
MINERALIZED SINTER	98.41	0.16	1.12	0.29	0.03	0.1	0.02	0.02	-0.01	0.05	0.64
SINTER	97.05	0.23	0.65	0.19	0.04	0.09	-0.01	-0.01	-0.01	0.03	0.55
RIND	4.83	1.43	52.44	2.3	1.32	7.08	0.02	0.48	0.08	0.45	28.22
WALLROCK	0.99	0.34	1.92	0.06	0.27	53.47	-0.01	0.11	-0.01	0.03	42.65
SC12											
SINTER	99.63	0.1	0.12	-0.01	0.03	0.19	0.01	0.02	-0.01	0.02	0.4
RIND	1.67	0.69	65.53	1.54	1.49	2.76	0.02	0.14	0.03	0.35	25.41
SC13											
SINTER	99.68	0.03	0.06	-0.01	0.02	0.06	-0.01	-0.01	-0.01	-0.01	0.35
RIND	2.84	0.81	46.93	1.64	2.34	11.65	0.02	0.24	0.05	0.31	32.27
SC15											
SINTER	99.71	0.06	0.17	0.01	0.01	-0.01	-0.01	-0.01	-0.01	0.02	0.26
RIND	2.04	0.64	51.54	2.6	2	8.64	0.02	0.11	0.04	0.33	31.58
SC17											
SINTER	99.05	0.33	0.3	0.01	0.03	0.04	-0.01	0.04	0.02	-0.01	0.5
RIND	2.57	0.92	56.57	1.67	2.3	5.5	-0.01	0.28	0.05	0.77	28.66
WALLROCK	0.99	0.31	0.67	0.02	0.4	54.18	0.02	0.12	-0.01	0.01	42.6
A negative number indicates the content is less than the lower limit of detection.											

Appendix 2 (Part 2): XRF of solution chimney components, North Mafeking Quarry

Solution Chimney (SC)	TOTAL	Ba	Sr	Y	Sc	Zr	Be	V
	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SC1								
SINTER	100.23	61	70	-1	-1	6	-1	5
RIND	98.74	101	19	17	6	16	6	5
WALLROCK	100.14	12	120	2	-1	3	-1	-5
SC2								
SINTER	100.27	145	85	2	-1	2	-1	-5
RIND	100.11	61	19	8	3	17	7	-5
WALLROCK	98.85	9	104	1	-1	3	-1	-5
SC3								
SINTER	100.51	317	181	-1	-1	4	-1	-5
RIND	99.49	69	18	12	3	20	11	-5
WALLROCK	99.94	19	96	5	3	7	-1	5
SC4								
SINTER	99.45	176	285	-1	-1	-1	-1	-5
RIND	99.58	72	25	15	2	20	2	-5
SC7A								
SINTER	100.68	102	125	-1	-1	2	-1	5
RIND	99.52	60	24	20	4	10	11	-5
SC7B								
SINTER	99.44	63	58	-1	-1	4	-1	-5
RIND	99.1	53	31	21	4	10	10	-5
WALLROCK	99.98	9	103	2	-1	3	-1	-5
SC8								
SINTER	100.74	81	99	-1	-1	2	-1	-5
RIND	98.75	41	29	15	3	13	4	-5
WALLROCK	100.57	6	97	4	1	1	-1	-5
Solution Chimney (SC)	**TOTAL**	**Ba**	**Sr**	**Y**	**Sc**	**Zr**	**Be**	**V**
	%	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**

Appendix 2 (Part 2): XRF of solution chimney components, North Mafeking Quarry

SC9								
SINTER	100.61	115	149	-1	-1	-1	-1	-5
RIND	98.91	36	22	6	2	12	7	-5
SC10								
SINTER	100.7	76	26	-1	-1	5	-1	5
RIND	100.08	38	40	21	8	12	8	-5
SC11								
MINERALIZED SINTER	100.83	101	64	3	1	3	-1	6
SINTER	98.86	56	7	2	1	2	-1	-5
RIND	98.64	84	22	25	4	21	3	-5
WALLROCK	99.85	13	114	8	9	3	-1	8
SC12								
SINTER	100.5	165	126	-1	-1	2	-1	-5
RIND	99.61	74	14	11	4	15	5	-5
SC13								
SINTER	100.22	128	150	-1	-1	2	-1	-5
RIND	99.07	50	35	21	3	16	5	-5
SC15								
SINTER	100.28	94	45	-1	-1	2	-1	6
RIND	99.53	79	20	7	3	11	13	-5
SC17								
SINTER	100.34	135	132	-1	-1	3	-1	6
RIND	99.31	83	19	29	4	17	5	-5
WALLROCK	99.32	8	111	1	-1	6	-1	-5
A negative number indicates the content is less than the lower limit of detection.								

Appendix 3 (Part 1a): INAA geochemical analyses of vertical rock chip samples, solution chimney SC2

Element	Metres From Top	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe
Units	Of Section	PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%
Detection Limit		2	5	0.5	50	0.5	1	1	5	1	0.01
88-SC2SEV-1	0	3	-5	3.4	-50	0.8	38	2	7	-1	0.19
88-SC2SEV-2	1	4	-5	-0.5	-50	1.6	39	1	7	-1	0.17
88-SC2SEV-3	2	3	-5	-0.5	-50	1.9	38	1	8	-1	0.38
88-SC2SEV-4A	3	-2	-5	-0.5	-50	2.3	39	1	8	-1	0.19
88-SC2SEV-4B	3.1	-2	-5	3	-50	2.1	38	3	10	-1	0.66
88-SC2SEV-5	4	-2	-5	0.9	-50	2.6	37	1	6	-1	0.19
88-SC2SEV-6	5	-2	-5	1.3	-50	3.1	40	1	6	-1	0.17
Element	Metres From Top	Hf	Hg	Ir	Mo	Na	Ni	Rb	Sb	Sc	Se
Units	Of Section	PPM	PPM	PPB	PPM	%	PPM	PPM	PPM	PPM	PPM
Detection Limit		1	1	5	1	0.01	20	15	0.1	0.1	3
88-SC2SEV-1	0	-1	-1	-5	-1	0.12	-20	-15	-0.1	2.1	-3
88-SC2SEV-2	1	-1	-1	-5	-1	0.14	-20	-15	-0.1	0.9	-3
88-SC2SEV-3	2	-1	-1	-5	2	0.12	-20	-15	-0.1	0.5	-3
88-SC2SEV-4A	3	-1	-1	-5	-1	0.16	-20	-15	-0.1	0.7	-3
88-SC2SEV-4B	3.1	-1	-1	-5	-1	0.14	-20	-15	-0.1	0.7	-3
88-SC2SEV-5	4	-1	-1	-5	-1	0.16	-20	-15	-0.1	0.3	-3
88-SC2SEV-6	5	-1	-1	-5	-1	0.14	-20	-15	-0.1	0.3	-3
Element	Metres From Top	Sn	Sr	Ta	Th	U	W	Zn	La	Ce	Nd
Units	Of Section	%	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
Detection Limit		0.01	0.05	0.5	0.2	0.5	1	50	0.5	3	5
88-SC2SEV-1	0	-0.01	-0.05	-0.5	0.4	0.6	-1	-50	2.9	6	-5
88-SC2SEV-2	1	-0.01	-0.05	-0.5	0.4	0.6	-1	-50	1.9	3	-5
88-SC2SEV-3	2	-0.01	-0.05	-0.5	0.5	-0.5	-1	-50	1.6	1.5	-5
88-SC2SEV-4A	3	-0.01	-0.05	-0.5	0.6	0.5	-1	-50	1.9	1.5	-5
88-SC2SEV-4B	3.1	-0.01	-0.05	-0.5	0.4	-0.5	2	-50	1.8	3	-5
88-SC2SEV-5	4	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.2	1.5	-5
88-SC2SEV-6	5	-0.01	-0.05	-0.5	0.3	0.6	-1	-50	1.2	1.5	-5
Element	Metres From Top	Sm	Eu	Tb	Yb	Lu					
Units	Of Section	PPM	PPM	PPM	PPM	PPM					

Appendix 3 (Part 1a): INAA geochemical analyses of vertical rock chip samples, solution chimney SC2

Detection Limit		0.1	0.2	0.5	0.2	0.05					
88-SC2SEV-1	0	0.6	-0.2	-0.5	0.3	-0.05					
88-SC2SEV-2	1	0.3	-0.2	-0.5	0.2	-0.05					
88-SC2SEV-3	2	0.2	-0.2	-0.5	-0.2	-0.05					
88-SC2SEV-4A	3	0.3	-0.2	-0.5	-0.2	-0.05					
88-SC2SEV-4B	3.1	0.2	-0.2	-0.5	-0.2	-0.05					
88-SC2SEV-5	4	0.2	-0.2	-0.5	-0.2	-0.05					
88-SC2SEV-6	5	0.1	-0.2	-0.5	-0.2	-0.05					

Appendix 3 (Part 1b): INAA geochemical analyses of horizontal rock chip samples, solution chimney SC2

Element	Metres	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe
Units		PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%
Detection Limit		2	5	0.5	50	0.5	1	1	5	1	0.01
88-SC2SEL-5	5	-2	-5	-0.5	-50	2.6	39	-1	6	-1	0.48
88-SC2SEL-10	10	-2	-5	3.4	-50	1.9	39	1	7	-1	0.19
88-SC2SEL-15	15	-2	-5	1.8	-50	2.1	41	-1	8	-1	0.21
88-SC2SEL-20	20	-2	-5	-0.5	-50	2.6	51	1	10	-1	0.54
88-SC2SEL-25	25	-2	-5	-0.5	-50	3.2	39	-1	8	-1	0.25
88-SC2SEL-50	50	-2	-5	-0.5	-50	3.4	38	-1	6	-1	0.19
88-SC2SEL-75	75	-2	-5	-0.5	-50	3.6	40	-1	6	-1	0.19
88-SC2SEL-100	100	-2	-5	-0.5	-50	3.5	42	-1	7	-1	0.25
88-SC2SEL-125	125	-2	-5	-0.5	72	3	39	-1	5	-1	0.18
Element	Metres	Hf	Hg	Ir	Mo	Na	Ni	Rb	Sb	Sc	Se
Units		PPM	PPM	PPB	PPM	%	PPM	PPM	PPM	PPM	PPM
Detection Limit		1	1	5	1	0.01	20	15	0.1	0.1	3
88-SC2SEL-5	5	-1	-1	-5	-1	0.12	-20	-15	-0.1	0.3	-3
88-SC2SEL-10	10	-1	-1	-5	-1	0.08	-20	-15	-0.1	0.4	-3
88-SC2SEL-15	15	-1	-1	-5	-1	0.18	-20	-15	-0.1	0.4	-3
88-SC2SEL-20	20	-1	-1	-5	-1	0.22	-20	-15	-0.1	0.5	-3
88-SC2SEL-25	25	-1	-1	-5	-1	0.17	-20	-15	-0.1	0.4	-3
88-SC2SEL-50	50	-1	-1	-5	-1	0.16	-20	-15	-0.1	0.4	-3
88-SC2SEL-75	75	-1	-1	-5	2	0.18	-20	-15	-0.1	0.4	-3
88-SC2SEL-100	100	-1	-1	-5	-1	0.15	-20	-15	-0.1	0.5	-3
88-SC2SEL-125	125	-1	-1	-5	-1	0.13	-20	-15	-0.1	0.5	-3

Appendix 3 (Part 1b): INAA geochemical analyses of horizontal rock chip samples, solution chimney SC2

Element	**Metres**	**Sn**	**Sr**	**Ta**	**Th**	**U**	**W**	**Zn**	**La**	**Ce**	**Nd**
Units		**%**	**%**	**PPM**	**PPM**	**PPM**	**PPM**	**PPM**	**PPM**	**PPM**	**PPM**
Detection Limit		**0.01**	**0.05**	**0.5**	**0.2**	**0.5**	**1**	**50**	**0.5**	**3**	**5**
88-SC2SEL-5	5	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.3	-3	-5
88-SC2SEL-10	10	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.2	-3	-5
88-SC2SEL-15	15	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.6	-3	-5
88-SC2SEL-20	20	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.7	-3	-5
88-SC2SEL-25	25	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	1.6	-3	-5
88-SC2SEL-50	50	-0.01	-0.05	-0.5	0.3	0.5	-1	-50	1.4	-3	-5
88-SC2SEL-75	75	-0.01	-0.05	-0.5	0.3	0.5	-1	-50	1.5	-3	-5
88-SC2SEL-100	100	-0.01	-0.05	-0.5	0.3	0.7	-1	-50	1.5	-3	-5
88-SC2SEL-125	125	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.5	-3	-5
Element	**Metres**	**Sm**	**Eu**	**Tb**	**Yb**	**Lu**					
Units		**PPM**	**PPM**	**PPM**	**PPM**	**PPM**					
Detection Limit		**0.1**	**0.2**	**0.5**	**0.2**	**0.05**					
88-SC2SEL-5	5	0.1	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-10	10	0.1	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-15	15	0.1	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-20	20	0.2	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-25	25	0.2	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-50	50	0.2	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-75	75	0.1	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-100	100	0.1	-0.2	-0.5	-0.2	-0.05					
88-SC2SEL-125	125	0.2	-0.2	-0.5	-0.2	-0.05					

Appendix 3 (Part 2): XRF geochemical analyses of vertical and horizontal rock chip samples, solution chimney SC2, North Mafeking Quarry

	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	LOI	TOTAL
Vertical Profile	%	%	%	%	%	%	%	%	%	%	%	%
88-96-SC2SEV-1	2.05	0.54	0.22	0.07	0.34	53.83	-0.01	0.22	0.02	0.02	42.57	99.88
88-96-SC2SEV-2	1.69	0.48	0.15	0.02	0.34	54.01	-0.01	0.21	0.02	-0.01	42.88	99.81
88-96-SC2SEV-3	1.61	0.45	0.53	0.02	0.36	53.79	-0.01	0.18	0.02	-0.01	42.25	99.21
88-96-SC2SEV-4A	2.01	0.59	0.19	0.02	0.41	53.75	-0.01	0.24	0.02	-0.01	42.48	99.7
88-96-SC2SEV-4B	2.23	0.57	1.27	0.02	0.42	52.72	-0.01	0.24	0.02	-0.01	41.07	98.55
88-96-SC2SEV-5	0.88	0.27	0.21	0.02	0.36	54.38	-0.01	0.12	-0.01	-0.01	43.09	99.33
88-96-SC2SEV-6	0.9	0.27	0.26	0.02	0.39	54.23	-0.01	0.12	-0.01	-0.01	43.12	99.31
Horizontal Profile												
88-96-SC2SEL-5	0.96	0.29	0.66	0.03	2.38	52.1	-0.01	0.13	-0.01	-0.01	43.55	100.09
88-96-SC2SEL-10	0.92	0.28	0.21	0.01	0.63	54.76	-0.01	0.11	-0.01	0.02	43.28	100.24
88-SC2SEL-15	0.94	0.28	0.42	0.03	0.37	55.22	-0.01	0.12	-0.01	-0.01	43.25	100.64
88-SC2SEL-20	0.99	0.3	0.45	0.03	3.38	51.79	0.01	0.13	-0.01	0.02	43.71	100.82
88-SC2SEL-25	1.21	0.32	0.27	0.01	2.97	51.33	-0.01	0.13	-0.01	-0.01	43.62	99.87
88-SC2SEL-50	0.96	0.3	0.21	-0.01	1.21	54.37	-0.01	0.12	-0.01	-0.01	43.42	100.58
88-SC2SEL-75	1.19	0.32	0.24	-0.01	0.81	53.99	-0.01	0.13	-0.01	-0.01	43.23	99.93
88-SC2SEL-100	1.33	0.42	0.27	-0.01	0.97	53.66	-0.01	0.17	0.01	-0.01	43.17	100.01
88-SC2SEL-125	1.2	0.37	0.12	0.01	0.39	54.33	-0.01	0.16	0.01	-0.01	43.1	99.68
		Ba	**Sr**	**Y**	**Sc**	**Zr**	**Be**	**V**				
Vertical Profile		ppm	ppm	ppm	ppm	ppm	ppm	ppm				
88-96-SC2SEV-1		13	65	5	3	5	-1	5				
88-96-SC2SEV-2		13	89	3	-1	5	-1	-5				
88-96-SC2SEV-3		11	97	2	-1	4	-1	-5				
88-96-SC2SEV-4A		15	113	2	-1	4	-1	-5				
88-96-SC2SEV-4B		14	118	2	-1	6	-1	-5				
88-96-SC2SEV-5		8	117	-1	-1	2	-1	-5				
88-96-SC2SEV-6		8	120	-1	-1	3	-1	-5				

Appendix 3 (Part 2): XRF geochemical analyses of vertical and horizontal rock chip samples, solution chimney SC2, North Mafeking Quarry

		Ba	Sr	Y	Sc	Zr	Be	V				
Horizontal Profile		ppm	ppm	ppm	ppm	ppm	ppm	ppm				
88-96-SC2SEL-5		8	134	-1	-1	2	-1	-5				
88-96-SC2SEL-10		13	122	1	-1	4	-1	-5				
88-SC2SEL-15		10	131	-1	-1	3	-1	-5				
88-SC2SEL-20		9	131	1	-1	3	-1	-5				
88-SC2SEL-25		10	142	-1	-1	3	-1	-5				
88-SC2SEL-50		8	150	-1	-1	4	-1	-5				
88-SC2SEL-75		11	151	1	-1	3	-1	-5				
88-SC2SEL-100		11	152	-1	-1	4	-1	-5				
88-SC2SEL-125		10	125	1	-1	3	-1	-5				

Appendix 4 (Part 1): INAA results for the oxide cap (Dolomitic Limestone Beds), North Mafeking Quarry

	Southeast Profile	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe	Hf	Hg	Ir	Mo	Na	Ni	Rb	Sb	Sc
"Units"	Distance in m from S	PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%	PPM	PPM	PPB	PPM	%	PPM	PPM	PPM	PPM
"Detection Limit"	end of profile	2	5	0.5	50	0.5	1	1	5	1	0.01	1	1	5	1	0.01	20	15	0.1	0.1
southeast profile																				
"99-97-DB-4-1-1A "	0	-2	-5	-0.5	-50	2	33	-1	-5	-1	0.38	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-4-1-1AX "	Duplicate	-2	-5	-0.5	-50	2.3	34	-1	-5	-1	0.34	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-4-1-2A "	5	-2	-5	-0.5	-50	2.8	34	-1	-5	-1	0.41	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.4
"99-97-DB-4-1-3B "	10	-2	-5	-0.5	-50	0.9	34	-1	-5	-1	0.73	-1	-1	-5	-1	0.02	-20	-15	-0.1	0.3
"99-97-DB-4-1-4B "	15	-2	-5	-0.5	-50	1.2	37	-1	-5	-1	0.51	-1	-1	-5	1	0.02	-20	-15	-0.1	0.3
"99-97-DB-4-1-5B "	20	-2	-5	-0.5	-50	1.7	35	-1	-5	-1	0.45	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-4-1-5BX "	Duplicate	-2	-5	-0.5	-50	1.5	33	-1	-5	-1	0.44	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-4-1-6A "	25	-2	-5	-0.5	-50	3.9	25	1	-5	-1	1.39	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.3
"99-97-DB-4-1-7A "	27	-2	-5	-0.5	-50	3.3	26	1	-5	-1	1.73	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.3
"99-97-DB-4-1-8A "	28	-2	-5	-0.5	-50	4.7	27	2	-5	-1	2.35	-1	-1	-5	-1	0.05	-20	-15	-0.1	0.4
"99-97-DB-4-1-9B "	30	-2	-5	-0.5	-50	0.9	40	1	-5	-1	0.8	-1	-1	-5	-1	0.01	-20	-15	-0.1	0.3
"99-97-DB-4-1-10B "	35	-2	-5	-0.5	-50	1.4	38	1	-5	-1	1.31	-1	-1	-5	-1	0.01	-20	-15	-0.1	0.3
"99-97-DB-4-1-11B "	40	2	-5	-0.5	-50	1.5	32	2	-5	-1	1.48	-1	-1	-5	1	0.06	-20	-15	-0.1	0.3
"99-97-DB-4-1-12B "	45	-2	-5	-0.5	-50	3.8	24	4	-5	-1	2.91	-1	-1	-5	-1	0.08	-20	-15	-0.1	0.4
"99-97-DB-4-1-13B "	49	-2	-5	0.5	-50	1.9	25	2	-5	-1	2.53	-1	-1	-5	-1	0.08	-20	-15	-0.1	0.3
"99-97-DB-4-1-13C "	49	7	-5	8.8	210	0.9	17	15	61	4	1.93	7	-1	-5	-1	0.06	-20	110	0.6	8.5
"99-97-DB-4-1-14B "	50	-2	-5	-0.5	-50	1.2	36	2	-5	-1	1.29	-1	-1	-5	-1	0.02	-20	-15	-0.1	0.3
"99-97-DB-4-1-15B "	54	-2	-5	1.9	-50	-0.5	42	-1	-5	-1	0.13	-1	-1	-5	-1	-0.01	-20	-15	-0.1	0.6
"99-97-DB-4-1-15C "	54	-2	-5	1.4	55	-0.5	-1	1	8	-1	0.18	5	-1	-5	-1	-0.01	-20	-15	0.1	1
"99-97-DB-4-1-16A "	55	-2	-5	8.2	-50	1.3	38	7	-5	-1	1.85	-1	-1	-5	2	0.02	-20	-15	0.4	0.8
"99-97-DB-4-1-17C "	60	-2	-5	1.6	-50	1.6	29	3	-5	-1	2.05	-1	-1	-5	-1	0.06	-20	-15	-0.1	0.3
"99-97-DB-4-1-17CX	Duplicate	-2	-5	-0.5	-50	1.5	29	2	-5	-1	1.79	-1	-1	-5	-1	0.06	-20	-15	-0.1	0.2
"99-97-DB-4-1-18C "	65	-2	-5	-0.5	-50	2	31	2	-5	-1	1.65	-1	-1	-5	-1	0.05	-20	-15	-0.1	0.3
"99-97-DB-4-1-19B "	68	-2	-5	-0.5	-50	4.5	28	2	-5	-1	1.95	-1	-1	-5	-1	0.06	-20	-15	-0.1	0.5
"99-97-DB-4-1-19C "	68	-2	-5	0.7	-50	1.6	34	2	-5	-1	1.57	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.2
"99-97-DB-4-1-20C "	70	-2	-5	-0.5	-50	1.5	28	2	-5	-1	2.68	-1	-1	-5	-1	0.05	-20	-15	-0.1	0.3
"99-97-DB-4-1-21C "	72	-2	-5	3	-50	0.9	31	3	-5	-1	2.96	-1	-1	-5	-1	0.05	-20	-15	-0.1	0.3
"99-97-DB-4-2 "	Float	-2	-5	-0.5	-50	1.4	35	-1	-5	-1	0.54	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.4
"99-97-DB-4-2X "	Duplicate	-2	-5	-0.5	-50	1.2	34	-1	-5	-1	0.42	-1	-1	-5	-1	0.02	-20	-15	-0.1	0.3
"99-97-DB-5-1-1C "	81	-2	-5	5	-50	-0.5	34	3	-5	-1	4.15	-1	-1	-5	-1	0.02	-20	-15	-0.1	0.6
"99-97-DB-5-1-2A "	83	-2	-5	0.5	-50	1.9	33	2	-5	-1	1.67	-1	-1	-5	1	0.04	-20	-15	-0.1	0.4
"99-97-DB-5-1-2C "	83	-2	-5	-0.5	-50	1.8	26	2	-5	-1	2.05	-1	-1	-5	-1	0.06	-20	-15	-0.1	0.2
"99-97-DB-5-1-3C "	84	-2	-5	-0.5	-50	1.2	24	3	-5	-1	2.93	-1	-1	-5	-1	0.07	-20	-15	-0.1	0.2
"99-97-DB-5-1-4C "	86	-2	-5	-0.5	-50	1	28	3	-5	-1	3.59	-1	-1	-5	2	0.06	-20	-15	-0.1	0.3
"99-97-DB-5-1-5C "	91	-2	-5	0.7	-50	1.6	30	3	-5	-1	3.16	-1	-1	-5	-1	0.06	-20	-15	-0.1	0.4
"99-97-DB-5-1-6C "	96	-2	-5	-0.5	58	-0.5	34	2	-5	-1	2.13	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.4
"99-97-DB-5-1-6D "	96	-2	-5	1.5	150	-0.5	-1	-1	11	-1	0.19	5	-1	-5	-1	-0.01	-20	-15	-0.1	1.2
"99-97-DB-5-1-7C "	101	-2	-5	-0.5	-50	0.9	35	2	-5	-1	1.9	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-5-1-8C "	104	-2	-5	-0.5	-50	1.3	33	3	-5	-1	2.74	-1	-1	-5	1	0.05	-20	-15	-0.1	0.3
"99-97-DB-5-1-9B "	108	-2	-5	0.6	-50	2.3	33	2	-5	-1	2.3	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.5
	Northwest Profile	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe	Hf	Hg	Ir	Mo	Na	Ni	Rb	Sb	Sc
"Units"	Distance in m from W	PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%	PPM	PPM	PPB	PPM	%	PPM	PPM	PPM	PPM
"Detection Limit"	end of Profile	2	5	0.5	50	0.5	1	1	5	1	0.01	1	1	5	1	0.01	20	15	0.1	0.1
northwest profile																				
"99-97-DB-11-2-1B "	0	-2	-5	-0.5	-50	4	34	-1	-5	-1	0.34	-1	-1	-5	-1	0.02	-20	-15	-0.1	0.3
"99-97-DB-11-2-1BX	Duplicate	-2	-5	-0.5	-50	4.2	35	-1	-5	-1	0.36	-1	-1	-5	-1	0.02	-20	-15	-0.1	0.3
"99-97-DB-11-2-2B "	3	-2	-5	-0.5	-50	11	33	-1	-5	-1	0.23	-1	-1	-5	1	0.03	-20	-15	-0.1	0.5
"99-97-DB-11-2-3B "	18	-2	-5	0.8	-50	4.7	33	-1	-5	-1	0.26	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-11-2-4B "	20	-2	-5	0.6	-50	4.4	33	-1	-5	-1	0.25	-1	-1	-5	-1	0.02	-20	-15	-0.1	0.3
"99-97-DB-11-2-5B "	25	-2	-5	-0.5	-50	5	31	-1	-5	-1	0.34	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-11-2-6B "	30	-2	-5	-0.5	-50	3.1	34	-1	-5	-1	0.4	-1	-1	-5	1	0.03	-20	-15	-0.1	0.3
"99-97-DB-11-2-6BX	Duplicate	-2	-5	-0.5	-50	2.9	31	-1	-5	-1	0.45	-1	-1	-5	-1	0.03	-20	-15	-0.1	0.3
"99-97-DB-11-2-7B "	35	-2	-5	-0.5	-50	7.3	27	1	-5	-1	0.73	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.3
"99-97-DB-11-2-8B "	38	-2	-5	-0.5	-50	6.8	26	1	-5	-1	0.52	-1	-1	-5	2	0.05	-20	-15	-0.1	0.3
"99-97-DB-11-2-9B "	45	-2	-5	-0.5	-50	1.8	29	2	-5	-1	1.91	-1	-1	-5	1	0.04	-20	-15	-0.1	0.3
"99-97-DB-11-2-9BX	Duplicate	-2	-5	-0.5	-50	2.4	28	2	5	-1	1.83	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.4
"99-97-DB-11-2-10B	50	-2	-5	-0.5	-50	6.7	27	2	-5	-1	0.83	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.3
"99-97-DB-11-2-11B	55	-2	-5	-0.5	-50	6	29	2	-5	-1	1.28	-1	-1	-5	-1	0.04	-20	-15	-0.1	0.3

Appendix 4 (Part 1): INAA results for the oxide cap (Dolomitic Limestone Beds), North Mafeking Quarry

	Southeast Profile	Se	Sn	Sr	Ta	Th	U	W	Zn	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Mass
"Units"	Distance in m from S	PPM	%	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	g
"Detection Limit"	end of profile	3	0.01	0.05	0.5	0.2	0.5	1	50	0.5	3	5	0.1	0.2	0.5	0.2	0.05	0
southeast profile																		
"99-97-DB-4-1-1A "	0	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	27.47
"99-97-DB-4-1-1AX "	Duplicate	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	30.2
"99-97-DB-4-1-2A "	5	-3	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	0.9	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	28.95
"99-97-DB-4-1-3B "	10	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	28.46
"99-97-DB-4-1-4B "	15	-3	-0.01	-0.05	-0.5	-0.2	0.6	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	28.57
"99-97-DB-4-1-5B "	20	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	31.46
"99-97-DB-4-1-5BX "	Duplicate	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	29.3
"99-97-DB-4-1-6A "	25	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	34.12
"99-97-DB-4-1-7A "	27	-3	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	32.14
"99-97-DB-4-1-8A "	28	-3	-0.01	-0.05	-0.5	0.4	0.5	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	32.83
"99-97-DB-4-1-9B "	30	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	27.75
"99-97-DB-4-1-10B "	35	-3	-0.01	-0.05	-0.5	-0.2	0.5	-1	-50	0.8	-3	-5	-0.1	-0.2	-0.5	-0.2	-0.05	29.84
"99-97-DB-4-1-11B "	40	-3	-0.01	-0.05	-0.5	-0.2	1	-1	-50	0.8	-3	-5	-0.1	-0.2	-0.5	-0.2	-0.05	30.65
"99-97-DB-4-1-12B "	45	-3	-0.01	-0.05	-0.5	0.3	0.8	-1	-50	1.1	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	34.83
"99-97-DB-4-1-13B "	49	-3	-0.01	-0.05	-0.5	-0.2	1.2	-1	-50	0.7	-3	-5	-0.1	-0.2	-0.5	-0.2	-0.05	32
"99-97-DB-4-1-13C "	49	-3	-0.01	-0.05	-0.5	6.8	10	-1	50	28	46	24	4.6	1.2	0.8	3.8	0.65	27.72
"99-97-DB-4-1-14B "	50	-3	-0.01	-0.05	-0.5	0.2	0.7	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	27.94
"99-97-DB-4-1-15B "	54	-3	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	27.13
"99-97-DB-4-1-15C "	54	-3	-0.01	-0.05	-0.5	2.6	0.9	-1	-50	16	26	10	1.9	0.5	-0.5	0.6	0.12	44.39
"99-97-DB-4-1-16A "	55	-3	-0.01	-0.05	-0.5	-0.2	1.1	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	26.43
"99-97-DB-4-1-17C "	60	-3	-0.01	-0.05	-0.5	-0.2	0.8	-1	-50	1	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	31.62
"99-97-DB-4-1-17CX	Duplicate	-3	-0.01	-0.05	-0.5	-0.2	0.8	-1	-50	0.8	-3	-5	-0.1	-0.2	-0.5	-0.2	-0.05	31.37
"99-97-DB-4-1-18C "	65	-3	-0.01	-0.05	-0.5	-0.2	0.6	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	28.84
"99-97-DB-4-1-19B "	68	-3	-0.01	-0.05	-0.5	0.3	0.6	-1	-50	1.2	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	28.31
"99-97-DB-4-1-19C "	68	-3	-0.01	-0.05	-0.5	-0.2	0.9	-1	-50	0.8	-3	-5	-0.1	-0.2	-0.5	-0.2	-0.05	26.96
"99-97-DB-4-1-20C "	70	-3	-0.01	-0.05	-0.5	0.3	0.9	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	28.32
"99-97-DB-4-1-21C "	72	-3	-0.01	-0.05	-0.5	0.2	1.2	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	26.94
"99-97-DB-4-2 "	Float	-3	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	26.42
"99-97-DB-4-2X "	Duplicate	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	30.76
"99-97-DB-5-1-1C "	81	-3	-0.01	-0.05	-0.5	0.3	0.8	-1	-50	1.1	-3	-5	0.2	-0.2	-0.5	0.2	-0.05	28.8
"99-97-DB-5-1-2A "	83	-3	-0.01	-0.05	-0.5	0.2	0.5	-1	-50	1	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	27.55
"99-97-DB-5-1-2C "	83	-3	-0.01	-0.05	-0.5	-0.2	0.6	-1	-50	0.8	-3	-5	-0.1	-0.2	-0.5	-0.2	-0.05	35.53
"99-97-DB-5-1-3C "	84	-3	-0.01	-0.05	-0.5	0.2	0.7	-1	-50	0.8	-3	-5	-0.1	-0.2	-0.5	-0.2	-0.05	36.6
"99-97-DB-5-1-4C "	86	-3	-0.01	-0.05	-0.5	0.2	0.8	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	34.48
"99-97-DB-5-1-5C "	91	-3	-0.01	-0.05	-0.5	0.2	1	-1	-50	1	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	30.36
"99-97-DB-5-1-6C "	96	-3	-0.01	-0.05	-0.5	-0.2	0.8	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	27.45
"99-97-DB-5-1-6D "	96	-3	-0.01	-0.05	-0.5	3.6	0.8	-1	-50	29	47	20	3.6	0.9	0.6	0.6	0.12	44.05
"99-97-DB-5-1-7C "	101	-3	-0.01	-0.05	-0.5	-0.2	0.7	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	28.32
"99-97-DB-5-1-8C "	104	-3	-0.01	-0.05	-0.5	0.3	0.7	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	29.02
"99-97-DB-5-1-9B "	108	-3	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.1	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	27.14

	Northwest Profile	Se	Sn	Sr	Ta	Th	U	W	Zn	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Mass
"Units"	Distance in m from W	PPM	%	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	g
"Detection Limit"	end of Profile	3	0.01	0.05	0.5	0.2	0.5	1	50	0.5	3	5	0.1	0.2	0.5	0.2	0.05	0
northwest profile																		
"99-97-DB-11-2-1B "	0	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	30.49
"99-97-DB-11-2-1BX	Duplicate	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	33.36
"99-97-DB-11-2-2B "	3	-3	-0.01	-0.05	-0.5	0.3	-0.5	-1	-50	1.2	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	31.07
"99-97-DB-11-2-3B "	18	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	32.54
"99-97-DB-11-2-4B "	20	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	36.9
"99-97-DB-11-2-5B "	25	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	31.91
"99-97-DB-11-2-6B "	30	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.9	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	26.89
"99-97-DB-11-2-6BX	Duplicate	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.9	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	28.83
"99-97-DB-11-2-7B "	35	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	0.9	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	32.16
"99-97-DB-11-2-8B "	38	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	1	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	37.12
"99-97-DB-11-2-9B "	45	-3	-0.01	-0.05	-0.5	0.4	-0.5	-1	-50	1	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	26.72
"99-97-DB-11-2-9BX	Duplicate	-3	-0.01	-0.05	-0.5	0.2	-0.5	-1	-50	1	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	29.17
"99-97-DB-11-2-10B	50	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.9	-3	-5	0.2	-0.2	-0.5	-0.2	-0.05	36.16
"99-97-DB-11-2-11B	55	-3	-0.01	-0.05	-0.5	-0.2	-0.5	-1	-50	0.8	-3	-5	0.1	-0.2	-0.5	-0.2	-0.05	28.16

Appendix 4 (Part 2): ICP-AES analytical results for the oxide cap (Dolomitic Limestone Beds), North Mafeking Quarry

	Southeast Profile	Mo	Cu	Pb	Zn	Ag	Ni	Mn	Sr	Cd	Bi	V	Ca	P	Mg	Ti	Al	K	Y	Be
"Units"	Distance in m from S	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%	%	%	%	%	%	PPM	PPM
"Detection Limit"	end of Profile	2	1	4	1	0.4	1	1	1	0.5	5	2	0.01	0	0.01	0.01	0.01	0.01	2	2
southeast profile																				
"99-97-DB-4-1-1A "	0	-2	3	-5	6	0.5	3	123	140	-0.5	-5	3	34.92	0.007	4.69	0.01	0.16	0.09	5	-2
"99-97-DB-4-1-1AX "	Duplicate	-2	2	-5	8	0.5	3	123	141	-0.5	-5	3	34.37	0.008	4.63	0.01	0.14	0.09	5	-2
"99-97-DB-4-1-2A "	5	-2	3	16	7	-0.4	4	128	134	-0.5	-5	3	32.88	0.008	5.69	0.01	0.17	0.11	5	-2
"99-97-DB-4-1-3B "	10	-2	3	6	9	0.5	2	265	84	-0.5	-5	3	37.44	0.007	3.26	0.01	0.17	0.12	5	-2
"99-97-DB-4-1-4B "	15	-2	2	-5	9	-0.4	2	203	109	-0.5	-5	2	37.44	0.007	2.93	0.01	0.13	0.09	5	-2
"99-97-DB-4-1-5B "	20	-2	3	6	9	-0.4	2	162	109	-0.5	-5	3	34.88	0.007	4.29	0.01	0.15	0.11	5	-2
"99-97-DB-4-1-5BX "	Duplicate	-2	2	-5	10	-0.4	2	162	114	-0.5	-5	2	36.5	0.007	4.44	0.01	0.15	0.11	5	-2
"99-97-DB-4-1-6A "	25	-2	2	-5	25	0.4	4	287	134	-0.5	-5	2	26.59	0.009	9.08	0.01	0.16	0.11	4	-2
"99-97-DB-4-1-7A "	27	-2	2	-5	10	0.4	5	398	113	-0.5	-5	3	26.18	0.007	8.58	0.01	0.16	0.1	4	-2
"99-97-DB-4-1-8A "	28	-2	3	8	12	-0.4	4	531	120	-0.5	-5	3	27.06	0.008	8.02	0.01	0.19	0.12	4	-2
"99-97-DB-4-1-9B "	30	-2	2	-5	7	-0.4	3	287	86	-0.5	-5	2	41.29	0.005	1.37	0.01	0.13	0.09	5	-2
"99-97-DB-4-1-10B "	35	-2	2	-5	9	-0.4	3	368	108	-0.5	-5	2	40.08	0.007	2.2	0.01	0.12	0.08	5	-2
"99-97-DB-4-1-11B "	40	-2	5	5	19	-0.4	4	716	88	-0.5	-5	5	32.86	0.009	5.68	0.01	0.11	0.07	5	-2
"99-97-DB-4-1-12B "	45	-2	4	5	10	0.4	6	705	115	-0.5	-5	5	24.71	0.014	8.62	0.01	0.19	0.1	4	-2
"99-97-DB-4-1-13B "	49	-2	4	5	11	-0.4	5	725	103	-0.5	-5	4	26.96	0.011	8.02	0.01	0.12	0.07	4	-2
"99-97-DB-4-1-13C "	49	-2	12	7	40	0.9	66	275	51	-0.5	-5	75	18.7	1.038	1.11	0.28	5.23	2.11	42	2
"99-97-DB-4-1-14B "	50	-2	2	5	10	0.4	5	505	81	-0.5	-5	3	39.04	0.006	2.23	0.01	0.13	0.09	6	-2
"99-97-DB-4-1-15B "	54	-2	2	-5	11	0.4	2	195	13	-0.5	-5	3	45	0.016	0.25	0.01	0.17	0.11	6	-2
"99-97-DB-4-1-15C "	54	-2	3	5	8	-0.4	3	20	48	-0.5	-5	11	0.22	0.016	0.06	0.11	0.82	0.09	4	-2
"99-97-DB-4-1-16A "	55	-2	5	5	12	0.5	25	593	89	-0.5	-5	6	40.91	0.008	1.51	0.01	0.12	0.07	6	-2
"99-97-DB-4-1-17C "	60	-2	3	6	13	-0.4	6	739	82	-0.5	-5	4	28.93	0.011	6.98	0.01	0.15	0.08	4	-2
"99-97-DB-4-1-17CX "	Duplicate	-2	2	-5	11	0.5	5	727	86	-0.5	-5	4	29.75	0.01	7.32	0.01	0.13	0.09	4	-2
"99-97-DB-4-1-18C "	65	-2	4	-5	10	-0.4	5	816	84	-0.5	-5	4	31.73	0.011	5.73	0.01	0.13	0.08	5	-2
"99-97-DB-4-1-19B "	68	-2	4	15	12	-0.4	4	547	117	-0.5	-5	5	27.16	0.009	7.84	0.01	0.24	0.16	4	-2
"99-97-DB-4-1-19C "	68	-2	5	9	15	-0.4	4	680	84	-0.5	-5	4	34.63	0.01	4.69	0.01	0.1	0.06	5	-2
"99-97-DB-4-1-20C "	70	-2	2	5	16	-0.4	5	783	82	-0.5	-5	5	29.48	0.012	6.18	0.01	0.14	0.09	5	-2
"99-97-DB-4-1-21C "	72	-2	2	7	14	-0.4	6	753	70	-0.5	-5	4	30.95	0.011	5.06	0.01	0.13	0.09	5	-2
"99-97-DB-4-2 "	Float	-2	2	-5	10	-0.4	3	193	111	-0.5	-5	3	34.64	0.007	4.72	0.01	0.17	0.13	5	-2
"99-97-DB-4-2X "	Duplicate	-2	2	-5	7	-0.4	2	176	121	-0.5	-5	2	37.56	0.006	3.58	0.01	0.14	0.09	5	-2
"99-97-DB-5-1-1C "	81	-2	4	-5	9	-0.4	7	1001	46	-0.5	-5	4	35.82	0.013	2.71	0.01	0.17	0.11	6	-2
"99-97-DB-5-1-2A "	83	-2	2	7	8	-0.4	4	436	85	-0.5	-5	4	35.62	0.007	3.97	0.01	0.2	0.12	5	-2
"99-97-DB-5-1-2C "	83	-2	4	-5	9	-0.4	4	472	88	-0.5	-5	3	26.88	0.011	7.99	0.01	0.13	0.09	4	-2
"99-97-DB-5-1-3C "	84	-2	2	-5	12	-0.4	7	587	84	-0.5	-5	4	26.09	0.01	8.87	0.01	0.14	0.09	4	-2
"99-97-DB-5-1-4C "	86	-2	2	7	13	-0.4	7	817	74	-0.5	-5	4	28.67	0.013	6.89	0.01	0.15	0.09	4	-2
"99-97-DB-5-1-5C "	91	-2	2	-5	8	-0.4	4	810	81	-0.5	-5	4	30.62	0.012	6.74	0.01	0.14	0.1	5	-2
"99-97-DB-5-1-6C "	96	-2	2	-5	10	0.4	4	663	61	-0.5	-5	5	36.07	0.009	5.09	0.01	0.11	0.05	5	-2
"99-97-DB-5-1-6D "	96	-2	2	10	4	-0.4	3	15	90	-0.5	-5	11	0.2	0.024	0.04	0.1	1.13	0.07	6	-2
"99-97-DB-5-1-7C "	101	-2	2	-5	11	-0.4	3	649	77	-0.5	-5	3	37.9	0.008	4.63	0.01	0.1	0.06	5	-2
"99-97-DB-5-1-8C "	104	-2	2	-5	10	0.4	4	717	79	-0.5	-5	3	32.14	0.009	6.04	0.01	0.14	0.1	5	-2
"99-97-DB-5-1-9B "	108	-2	2	-5	9	-0.4	3	660	84	-0.5	-5	3	36.08	0.007	4.45	0.01	0.21	0.14	5	-2
	Northwest Profile	Mo	Cu	Pb	Zn	Ag	Ni	Mn	Sr	Cd	Bi	V	Ca	P	Mg	Ti	Al	K	Y	Be
"Units"	Distance in m from W	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%	%	%	%	%	%	PPM	PPM
"Detection Limit"	end of Profile	2	1	4	1	0.4	1	1	1	0.5	5	2	0.01	0	0.01	0.01	0.01	0.01	2	2
northeast profile																				
"99-97-DB-11-2-1B "	0	4	7	-5	57	0.4	5	108	156	-0.5	-5	4	36.73	0.009	5.58	0.01	0.15	0.1	5	-2
"99-97-DB-11-2-1BX "	Duplicate	-2	2	-5	3	0.5	2	100	158	-0.5	-5	2	36.73	0.008	5.34	0.01	0.14	0.09	5	-2
"99-97-DB-11-2-2B "	3	-2	2	-5	2	-0.4	2	70	182	-0.5	-5	3	32.89	0.007	7.04	0.01	0.23	0.16	5	-2
"99-97-DB-11-2-3B "	18	-2	2	-5	3	-0.4	2	88	164	-0.5	-5	2	35.78	0.007	5.83	0.01	0.12	0.08	5	-2
"99-97-DB-11-2-4B "	20	-2	2	-5	3	-0.4	2	83	170	-0.5	-5	2	36.26	0.007	5.18	0.01	0.12	0.08	5	-2
"99-97-DB-11-2-5B "	25	-2	2	-5	2	-0.4	2	103	140	-0.5	-5	2	31.25	0.007	7.62	0.01	0.13	0.09	4	-2
"99-97-DB-11-2-6B "	30	-2	2	-5	2	-0.4	2	133	126	-0.5	-5	2	33.55	0.007	5.72	0.01	0.13	0.1	5	-2
"99-97-DB-11-2-6BX "	Duplicate	-2	2	31	3	0.7	2	149	125	-0.5	-5	2	32.6	0.007	6.55	0.01	0.16	0.12	5	-2
"99-97-DB-11-2-7B "	35	-2	2	7	9	-0.4	2	318	153	-0.5	-5	3	27.36	0.008	9.3	0.01	0.16	0.11	4	-2
"99-97-DB-11-2-8B "	38	-2	2	6	6	-0.4	2	256	159	-0.5	-5	3	27.83	0.011	9.78	0.01	0.15	0.11	4	-2
"99-97-DB-11-2-9B "	45	-2	2	11	80	-0.4	6	542	95	-0.5	-5	3	28.92	0.008	7.89	0.01	0.16	0.11	5	-2
"99-97-DB-11-2-9BX "	Duplicate	-2	2	8	14	0.4	7	471	99	-0.5	-5	3	28.87	0.009	7.45	0.01	0.17	0.12	4	-2
"99-97-DB-11-2-10 "	50	-2	2	-5	8	0.7	4	281	152	-0.5	-5	3	27.1	0.008	9.37	0.01	0.16	0.11	4	-2
"99-97-DB-11-2-11 "	55	-2	2	-5	13	0.4	4	550	140	-0.5	-5	2	28.66	0.007	7.99	0.01	0.14	0.1	4	-2

Appendix 5: Descriptions of samples analyzed by Enzyme Leach^{SM}, Mafeking quarries area

Transect 1
__Sample__ BMR-1-1 (BMR-1-2): duplicate site; 0-5 cm active layer with brown, poorly decomposed humus and root mat overlying 7 cm of black, fine grained well decomposed humus; this tops a b-horizon consisting of poorly sorted oxidized, hematitic pebbly carbonate gravels with a clay-silt-sand matrix; one syenite pebble observed; sample collected 20 m south of gravel road; black spruce, jack pine, tamarack and labrador tea predominate; site is well drained; no outcrop.

Transect 1
__Sample__ BMR-2: 4 cm active layer with brown poorly decomposed humus and root mat overlying 3 cm black fine grained, sooty humus; b-horizon is an oxidized hematitic pebbly carbonate gravel with an occasional igneous pebble; matrix comprises clay, silt and sand; site is well drained; black spruce, jack pine, tamarack and labrador tea predominate; site is 20 m south of gravel road; no outcrop.

Transect 1
__Sample__ BMR-3: 3 cm active layer with brown, poorly decomposed humus and root mat overlying 1 cm of black, fine grained humus; b-horizon is an oxidized hematitic carbonate pebbly gravel with an occasional carbonate cobble; matrix is sandy with relatively minor clay; jack pine and poplar predominate; site is well drained; sample collected 20 m south of road; no outcrop.

Transect 1
__Sample__ BMR-4: 3 cm active layer with brown to black moderately decomposed humus and root mat; this overlies 1-1.5 cm of black, fine grained sooty humus; b-horizon is an oxidized hematitic pebbly carbonate gravel with a sand matrix, minor clay; site is well drained and 20 m south of road; jack pine and willow predominate; no outcrop.

Transect 1
__Sample__ BMR-5: 4 cm active layer with brown, poorly decomposed humus and root mat topping 2-3 cm of black, well decomposed humus; b-horizon is an oxidized hematitic pebbly carbonate gravel with a silt-clay matrix; site is well drained; sample collected 15 m south of gravel road; black spruce and jack pine predominate; no outcrop.

Transect 1
__Sample__ BMR-6: 5 cm active layer with brown, poorly decomposed humus and root mat topping 1 cm or less, fine grained dark brown to black well decomposed humus; b-horizon is a mixture of coarse angular carbonate gravels and oxidized chocolate brown silt and clay; site is well drained; sample collected 15 m south of the gravel road; jack pine, black spruce and birch predominate; no outcrop.

Transect 1
__Sample__ BMR-7: 3 cm active layer with brown poorly decomposed humus and root mat overlying 1-2 cm dark brown to black, fine grained, well decomposed humus; b-horizon is a dark brown, oxidized clay-silt mixture with coarse, angular carbonate pebbles; site is well drained; sample collected 20 m south of road; poplar and black spruce predominate; no outcrop.

Transect 1
__Sample__ BMR-8: 6 cm active layer with brown, poorly decomposed humus and root mat; 1-3 cm black, fine grained, “sooty”, well decomposed humus; b-horizon is a silty-loam with a few small carbonate pebbles; site is well drained; sample collected 5 m south of gravel road; black spruce and jack pine predominate; no outcrop but scattered carbonate and syenite boulders.

Transect 1
__Sample__ BMR-9: 2 cm active layer with brown, poorly decomposed humus and root mat topping 1 cm or less of black, fine grained, well decomposed humus; b-horizon is a light chocolate brown silt-clay mixture with a few angular carbonate pebbles and an occasional carbonate cobble; sample collected 10 m south of gravel road from a well-drained site; no outcrop; black spruce predominates.

Appendix 5: Descriptions of samples analyzed by Enzyme Leach[SM], Mafeking quarries area

Transect 1
<u>Sample</u> BMR-10: 10 cm active layer with brown, poorly decomposed humus and root mat topping 3-5 cm of black, fine grained, well decomposed humus; b-horizon is an oxidized, hematitic clay-rich layer with a few, bright chalky white, partially dissolved (pitted) carbonate pebbles; sample collected 10 m south of road from a well drained poplar grove; no outcrop.

Transect 1
<u>Sample</u> BMR-11: disturbed area; sample site has been scraped to remove soil and expose pebbly carbonate gravels; sample collected from oxidized hematitic gravels with clay-silt-sand matrix; an occasional igneous pebble is observed; black spruce, poplar, jack pine and tamarack predominate outside of the scraped area; no outcrop.

Transect 1
<u>Sample</u> BMR-12: 5 cm active layer with brown, poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is an oxidized, hematitic sand and fine silt; rock fragments are absent; site is 20 m south of gravel road and well drained; no outcrop; black spruce and poplar predominate.

Transect 1
<u>Sample</u> BMR-13: oxidized, hematitic sand, representing b-horizon was collected beneath 20 cm of non-humified sphagnum and 3-7 cm of black fine grained, well decomposed humus; 10 m south of gravel road; site is well drained; no outcrop; black spruce and labrador tea predominate.

Transect 1
<u>Sample</u> BMR-14: 3 cm active layer with brown, poorly decomposed humus and root mat; <1 cm of black fine grained, well decomposed humus; b-horizon is a pebbly, well rounded black sediment composed of carbonate and igneous pebbles, site is 15 m north of the gravel road and is well drained, difficult to ascertain whether sample is oxidized; no outcrop; black spruce predominates.

Transect 1
<u>Sample</u> BMR-15-1 (BMR-15-2): duplicate site; 3-4 cm active layer with brown, poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is an oxidized, hematitic sand with a few carbonate and igneous pebbles; site is well drained and 10 m south of the gravel road; not outcrop; black spruce predominates.

Transect 1
<u>Sample</u> BMR-16: 5 cm active layer with brown, poorly decomposed humus and root mat topping 1-2 cm black, fine grained well decomposed humus; b-horizon is a wet or damp hematitic find sand with fine rootlets; site is well drained, 10 m south of gravel road; no outcrop; black spruce predominates.

Transect 1
<u>Sample</u> BMR-17: 6 cm active layer with brown, poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon consists of hematitic, pebbly (carbonate) silts marked by 3-4 mm centers of more intense hematite staining scattered irregularly through the matrix; site is 10 m south of road and well drained, no outcrop; black spruce and tamarack predominate.

Transect 1
<u>Sample</u> BMR-18: 5 cm active layer with brown, poorly decomposed humus and root mat; <1 cm black fine grained, well decomposed humus topping a b-horizon that consists of hematitic pebbly sand; pebbles are 3:1 carbonate to igneous in origin/composition; site is well drained, 10 m south of the road; no outcrop; jack pine and black spruce predominate.

Transect 1
Sample BMR-19: 3 cm active layer with brown, poorly decomposed humus and root mat topping 2 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic carbonate pebbly sand collected from a well drained site 12 m south of the gravel road; no outcrop; black spruce and jack pine predominate.

Transect 1
Sample BMR-20: 7 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; humus is a hematitic carbonate pebbly sand; 80% carbonate pebbles and 20% mixed igneous intrusive pebbles; site is 20 m south of the gravel road and well drained; no outcrop; tamarack and black spruce predominate.

Transect 1
Sample BMR-21: 3 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic carbonate pebbly silt-sand; 90% carbonate pebbles and 10% mixed igneous intrusive pebbles; site is 20 m south of the gravel road and well drained; no outcrop; tamarack and black spruce predominate; sample site is situated 10 m south of a scraped/disturbed area.

Transect 1
Sample BMR-22: 1 cm active layer of brown poorly decomposed humus and root mat topping 30 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic light brown/beige clay; site is 35 m south of the gravel road and at the edge of a black spruce bog; no outcrop; black spruce, poplar and willow predominate.

Transect 1
Sample BMR-23: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light beige, clay-rich sediment with carbonate pebbles; site is 20 m north of the gravel road and well drained; no outcrop; tamarack and black spruce predominate.

Transect 1
Sample BMR-24: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown/beige clay with a few carbonate pebbles; site is 20 m north of the gravel road and well drained; south side of the road is flooded; no outcrop; tamarack, labrador tea and black spruce predominate.

Transect 1
Sample BMR-25: 2 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown/beige clay-rich sediment with carbonate pebbles; site is 5 m north of the gravel road and moderately to poorly drained with some standing pools of water; no outcrop; tamarack and black spruce predominate; note: site is disturbed and marked by beer cans and a rusty bedspring.

Transect 1
Sample BMR-26: 7 cm active layer of brown poorly decomposed humus and root mat topping 0.5 m of black, fine grained, well decomposed humus; b-horizon is a green-brown clay with an occasional carbonate pebble; site is 20 m south of the gravel road and well drained; no outcrop; tamarack and black spruce predominate; despite well drained sample site there was water in the sample pit during sample collection; water originates from the humus layer.

Transect 1
Sample BMR-27: No sample collected at this site owing to the presence of wet swamp on both the north and south sides of the road.

Transect 1
<u>Sample</u> BMR-28: No sample collected at this site owing to the presence of wet swamp on both the north and south sides of the road.

Transect 1
<u>Sample</u> BMR-29: No sample collected at this site owing to the presence of wet swamp on both the north and south sides of the road.

Transect 1
<u>Sample</u> BMR-30: No sample collected at this site owing to the presence of wet swamp on both the north and south sides of the road.

Transect 1
<u>Sample</u> BMR-31: 7 cm active layer of brown poorly decomposed humus and root mat topping 1 m of black, fine grained, well decomposed humus; b-horizon is a hematitic green-brown clay with an occasional carbonate pebble; site is 20 m north of the gravel road and well drained although water filled the pit during sample collection; no outcrop; tamarack, labrador tea and black spruce predominate.

Transect 1
<u>Sample</u> BMR-32: No sample collected at this site owing to the presence of wet swamp on both the north and south sides of the swamp. Water filled the pit before humus/peat layer was penetrated.

Transect 1
<u>Sample</u> BMR-33: No sample collected at this site owing to the presence of wet swamp on both the north and south sides of the road.

Transect 1
<u>Sample</u> BMR-34: No sample collected at this site owing to the presence of wet swamp on both the north and south sides of the road.

Transect 1
<u>Sample</u> BMR-35: 5 cm active layer of brown poorly decomposed humus and root mat topping 3 cm of black, fine grained, well decomposed humus; b-horizon is a light beige clay with occasional carbonate pebbles and cobbles; site is 30 m north of the gravel road at the east end of a flooded gravel pit; site is well drained; no outcrop; black spruce predominates. Note several rusty tin cans were observed approximately 3 m from the sample pit.

Transect 1
<u>Sample</u> BMR-36: 2 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a visibly unoxidized pebbly sandy gravel; pebbles are 60% carbonate and 40% igneous intrusive; site is 50 m south of the gravel road and 40 m west of Highway 10; site is well drained; no outcrop; poplar, jack pine and black spruce predominate. This site is the last sample site west of Highway 10 on Transect 1.

Transect 1
<u>Sample</u> BMR-37: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic carbonate pebble/cobble gravel with a poorly sorted sand-silt-minor clay matrix; site is 20 m south of the gravel road and well drained; no outcrop; birch, jack pine and black spruce predominate. This the first sample site east of Highway 10.

Transect 1
<u>Sample</u> BMR-38: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic igneous and carbonate pebble/cobble gravel with a sandy matrix; 80% carbonate pebbles and 20% mixed igneous intrusive pebbles; site is 10 m south of the gravel road and well drained; probable shallow overburden topping outcrop ridges in this area; jack pine predominates.

Transect 1
<u>Sample</u> BMR-39: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a silty-clay with abundant carbonate cobbles and pebbles; site is 5 m south of the gravel road and on the east slope of a small carbonate outcrop exposed by a backhoe; site is well drained; no outcrop; jack pine and poplar predominate. Note the presence of small piles of diesel oil cans scattered in the general area.

Transect 1
<u>Sample</u> BMR-40: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic carbonate pebbly gravel with a sand-silt matrix; site is 10 m south of the gravel road and well drained; site is 2 m north of outcrop; jack pine, alder and poplar predominate.

Transect 1
<u>Sample</u> BMR-41: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a coarse carbonate gravel with a clay-rich matrix; site is 10 m south of the gravel road and well drained; no outcrop; jack pine and black spruce predominate.

Transect 1
<u>Sample</u> BMR-42-1 (BMR-42-2): duplicate site; 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic carbonate pebbly clay-rich sediment; site is 5 m south of the gravel road and moderately to poorly drained; no outcrop; labrador tea and black spruce predominate. Note the differences between the b-horizon soil collected from site 42-1 and a duplicate site (42-2) only 1 m away. Site 42-2 is much more strongly oxidized (hematitic) with the oxidized horizon underlain by a white clay. This white clay is absent from site 42-1.

Transect 1
<u>Sample</u> BMR-43: 1 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a chocolate brown clay-silt-sand sediment topping coarse, angular carbonate gravels; site is 15 m north of the gravel road and well drained; site is 5 m south of an outcrop ridge; black spruce predominates.

Transect 1
<u>Sample</u> BMR-44: 1 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic/chocolate brown silt and fine sand sediment; site is 20 m north of the gravel road and well drained; no outcrop; jack pine and black spruce predominate.

Transect 1
<u>Sample</u> BMR-45: 1 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a reddish brown clay-silt sediment topping coarse carbonate gravels; site is 25 m north of the gravel road and well drained; no outcrop; poplar and black spruce predominate.

Transect 1
Sample BMR-46: 2 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic/medium brown clay with carbonate pebbles and cobbles; site is 40 m north of the gravel road and well drained; no outcrop; jack pine and black and white spruce predominate.

Transect 1
Sample BMR-47: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic sand-silt sediment intermixed with carbonate gravels; site is 2 m north of the gravel road and well drained; no outcrop; jack pine predominates. Note the presence of a large cleared area approximately 75 m south of the sample site.

Transect 1
Sample BMR-48: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic sand-silt sediment intermixed with carbonate gravels; site is 3 m north of the gravel road and well drained; no outcrop; jack pine predominates.

Transect 1
Sample BMR-49: 2 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a dark brown clay-rich sediment mixed with carbonate pebble gravels; site is 2 m north of the gravel road and well drained; no outcrop; jack pine and alder predominate. Note site is adjacent to the west edge of the powerline right of way.

Transect 1
Sample BMR-50-1 (BMR-50-2): duplicate site; 3 cm active layer of brown poorly decomposed humus and root mat topping 2 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic reddish brown silt topping coarse carbonate gravels; site is 7 m north of the gravel road and well drained; no outcrop; poplar, jack pine and white and black spruce predominate. Sample 50-2 is identical to 50-1.

Transect 1
Sample BMR-51: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown to reddish orange fine sand topping pebbly carbonate gravels; site is 7 m north of the gravel road and well drained; no outcrop; poplar and jack pine predominate.

Transect 1
Sample BMR-52: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown to reddish brown fine sand; site is 10 m north of the gravel road and well drained; no outcrop; poplar and white and black spruce predominate.

Transect 1
Sample BMR-53: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown to reddish-orange sand; site is 7 m north of the gravel road and well drained; no outcrop; poplar and jack pine predominate.

Transect 1
Sample BMR-54: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown to orange sand; site is 15 m north of the gravel road and well drained; no outcrop; white spruce, poplar and jack pine predominate.

Transect 1
<u>Sample</u> BMR-55: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown-red fine sand topping coarse carbonate gravels; site is 15 m north of the gravel road and well drained; no outcrop; poplar and white spruce predominate.

Transect 1
<u>Sample</u> BMR-56: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a weakly hematitic fine sand-silt sediment that forms the matrix to carbonate pebbly gravels; site is 10 m north of the gravel road and well drained; no outcrop; jack pine and black spruce predominate.

Transect 1
<u>Sample</u> BMR-57: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic red-brown clay topping carbonate pebbly gravels; site is 10 m north of the gravel road and well drained; no outcrop; poplar, jack pine and white and black spruce predominate.

Transect 1
<u>Sample</u> BMR-58: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic red-brown clay-silt mixture topping pebbly to coarse carbonate gravels; site is 15 m west of the gravel road and well drained; no outcrop; jack pine, willow, poplar and balsam predominate.

Transect 1
<u>Sample</u> BMR-59: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a limonitic/hematitic orange-yellow sand topping fine grained micritic limestone; site is 20 m west of the gravel road and well drained; no outcrop; jack pine, poplar and white and black spruce predominate.

Transect 1
<u>Sample</u> BMR-60: 4 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a brown clay-silt-sand sediment; site is 5 m west of the gravel road and well drained; no outcrop; poplar and black spruce predominate.

Transect 1
<u>Sample</u> BMR-61: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a grey, visually unoxidized clay; site is 8 m east of the gravel road and moderately to poorly drained; ponded water on gravel road; no outcrop; poplar and black spruce predominate.

Transect 1
<u>Sample</u> BMR-62: 5 cm active layer of brown poorly decomposed humus and root at topping 3 cm of black, fine grained, well decomposed humus; b-horizon is a brown clay; site is 5 m west of the gravel road and moderately to poorly drained; no outcrop; jack pine predominates.

Transect 1
<u>Sample</u> BMR-63-1 (BMR-63-2): duplicate site; 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown sand-silt mixture mixed with fine carbonate “pea” gravel; site is 20 m north of the gravel road and poorly to moderately drained; no outcrop; jack pine and black spruce predominate. Both samples are identical.

Transect 1
<u>Sample</u> BMR-64: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic dark brown sand with carbonate and igneous pebbles; site is 8 m north of the gravel road and well drained; no outcrop; poplar and white and black spruce predominate.

Transect 1
<u>Sample</u> BMR-65: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown clay; site is 7 m north of the gravel road and well drained; no outcrop; poplar predominates. Last sample on Transect 1.

Transect 2
<u>Sample</u> BMR-66: 3 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a grey to brown clay; site is on the north side of the grid line and moderately to poorly drained; water was trickling into the sample pit during sampling; no outcrop; alder, tamarack and black spruce predominate.

Transect 2
<u>Sample</u> BMR-67: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown clay; site is on south side of the grid line and well drained; no outcrop; poplar, tamarack and black spruce predominate; felsic and mafic intrusive and carbonate float was observed in the sampling area.

Transect 2
<u>Sample</u> BMR-68: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown clay and silt mixed with coarse carbonate gravels; site is on the south side of the grid line and well drained; no outcrop; poplar and black spruce predominate.

Transect 2
<u>Sample</u> BMR-69: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic clay-silt mixture with pink carbonate pebbles; site is on the south side of the grid line and well drained; no outcrop; poplar and black spruce predominate; carbonate float is present in the sample area.

Transect 2
<u>Sample</u> BMR-70: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown clay; site is on the south side of the grid line and well drained; no outcrop; jack pine, poplar and black spruce predominate.

Transect 2
<u>Sample</u> BMR-71: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic clay with coarse carbonate pebbly gravels; dissolution of the carbonate pebbles is evident; site is on the south side of the grid line and well drained; no outcrop; juniper, tamarack and black spruce predominate.

Transect 2
<u>Sample</u> BMR-72: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic-limonitic clay-silt mixture topping angular carbonate cobbles and gravels; site is well drained; no outcrop; poplar, jack pine and white and black spruce predominate.

Transect 2
<u>Sample</u> BMR-73: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic clay-silt mixture with rare carbonate pebbles; site is well drained; no outcrop; poplar and jack pine predominate.

Transect 2
<u>Sample</u> BMR-74: 6 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown-reddish clay; site is very wet at the initial sample site and was subsequently moved 30 m south; no outcrop; poplar, jack pine and black spruce predominate.

Transect 2
<u>Sample</u> BMR-75: No sample possible due to wet swamp.

Transect 2
<u>Sample</u> BMR-76:. No sample possible due to wet swamp.

Transect 2
<u>Sample</u> BMR-77: 12 cm active layer of brown poorly decomposed humus and root mat topping 7 cm of black, fine grained, well decomposed humus which in turn overlies an 8 cm transition or mixed zone of humus and b-horizon inorganic soil; b-horizon is a light brown clay; site is 6 m north of the grid line and moderately to poorly drained; no outcrop; alder and black spruce predominate.

Transect 2
<u>Sample</u> BMR-78: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a brown to reddish brown clay topping pebbly carbonate gravels; site is 10 m west of the right of way for the powerline and is well drained; no outcrop; jack pine and black spruce predominate.

Transect 2
<u>Sample</u> BMR-79: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown clay; site is 10 m east of the right of way for the powerline and well drained; no outcrop; white and black spruce predominate.

Transect 2
<u>Sample</u> BMR-80: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown silty clay intermixed with coarse angular carbonate cobbles and pebbles; site is on the north side of the grid line and well drained; no outcrop; jack pine and black spruce predominate.

Transect 2
<u>Sample</u> BMR-81: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic reddish-brown clay-silt mixed with carbonate pebbly gravel; site is 3 m north of grid line and well drained; no outcrop; poplar, jack pine and black spruce predominate.

Transect 2
<u>Sample</u> BMR-82: 3 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a brown/beige to reddish brown clay containing a rare flat and angular carbonate cobble; site is 3 m south of the grid line and well drained; no outcrop; poplar, jack pine and black spruce predominate.

Transect 2
<u>Sample</u> BMR-83: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown to reddish brown clay mixed with carbonate pebbly gravels; site is 3 m north of the grid line and well drained; no outcrop; poplar, jack pine, alder and black spruce predominate.

Transect 2
<u>Sample</u> BMR-84-1 (BMR-84-2): duplicate site; 6 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a brown to reddish brown sand topping fine pebbly carbonate gravels; site is 3 m south of the grid line and well drained; no outcrop; poplar, jack pine and black spruce predominate.

Transect 2
<u>Sample</u> BMR-85: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown clay with rare, sub-rounded carbonate clasts; site is 8 m south of the grid line and well drained; no outcrop; jack pine and black spruce predominate.

Transect 2
<u>Sample</u> BMR-86: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a beige-brown clay with a few flat to sub-angular carbonate cobbles; site is 2 m north of the grid line and well drained; no outcrop; jack pine and black spruce predominate.

Transect 3
<u>Sample</u> BMR-87: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic brown clay with rare carbonate pebbles; localized strong hematitic patches/blotches; site is on the south side of the grid line, 10 m west of the right of way of the powerline and well drained; no outcrop; poplar, jack pine and black spruce predominate.

Transect 3
<u>Sample</u> BMR-88: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a brown sand-silt with fine carbonate pebbly "pea" gravels; site is in a logged area and well drained; no outcrop; poplar predominates.

Transect 3
<u>Sample</u> BMR-89: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic and limonitic silty-clay mixture topping rounded pebbly carbonate gravels; site is in a logged area and is well drained; no outcrop; poplar, birch and black spruce predominate.

Transect 3
<u>Sample</u> BMR-90: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic clay-silt-sand mixture with pebbly carbonate gravels; site is in a logged area and is well drained; no outcrop; poplar and black spruce predominate.

Transect 3
<u>Sample</u> BMR-91: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic clay-silt mixture topping coarse carbonate gravels; site is well drained; no outcrop; poplar and black spruce predominate.

Transect 3
Sample BMR-92: 2 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a brown to reddish brown clay-silt mixture topping coarse carbonate gravels; site is 15 m south of the grid line and well drained; no outcrop; poplar and black spruce predominate; carbonate and granite boulder float is present in the area of the sample site.

Transect 3
Sample BMR-93: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a brown hematitic clay; site is moderately well drained; no outcrop; black spruce predominates.

Transect 3
Sample BMR-94: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown, locally hematitic clay; site is 40 m north of the grid line and poorly drained; water trickling into sample pit; no outcrop; jack pine and black spruce predominate.

Transect 3
Sample BMR-95: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown, weakly hematitic clay; site is 10 m north of the grid line and moderately well drained; no outcrop; labrador tea and black spruce predominate.

Transect 3
Sample BMR-96: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown clay with an occasional carbonate pebble; site is moderately well drained; no outcrop; black spruce predominates.

Transect 3
Sample BMR-97: 7 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light to dark brown clay with pebbly carbonate gravels; site is well drained; no outcrop; jack pine and black spruce predominate.

Transect 3
Sample BMR-98: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light to dark brown hematitic clay with coarse to pebbly carbonate gravels; site is well drained; no outcrop; jack pine and black spruce predominate.

Transect 3
Sample BMR-99: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a medium brown locally hematitic clay with pebbly carbonate gravels; site is well drained; no outcrop; jack pine and black spruce predominate.

Transect 3
Sample BMR-100: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a dark brown clay with occasional flat to angular carbonate cobbles and coarse carbonate gravels; site is moderately to poorly drained; no outcrop; labrador tea and black spruce predominate.

Transect 4
Sample BMR-101: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a locally hematitic light to dark brown clay with occasional carbonate cobbles and pebbly carbonate gravels; site is well drained; no outcrop; jack pine and black spruce predominate; a large cleared area occurs 50 m south of the sampling site which is 25 m north of the grid line.

Transect 4
Sample BMR-102: 5 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic reddish brown silty clay with an occasional carbonate cobble; clay overlies coarse carbonate gravels; site is 30 m north of the grid line and well drained; no outcrop; jack pine and black spruce predominate.

Transect 4
Sample BMR-103: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a strongly hematitic clay-silt mixture topping coarse carbonate gravels; site is 9 m south of the grid line and well drained; no outcrop; jack pine and black spruce predominate.

Transect 4
Sample BMR-104: 6 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic fine sand topping coarse carbonate cobbles and gravels; site is 6 m south of the grid line and well drained; no outcrop; poplar and black spruce predominate.

Transect 4
Sample BMR-105: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic clay-silt mixture topping fine carbonate pea gravels which grade into coarse angular gravels; site is 5 m south of the grid line and well drained; no outcrop; poplar, jack pine and black spruce predominate.

Transect 4
Sample BMR-106: 6 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown/beige clay; site is 2 m south of the grid line and well drained; no outcrop; black spruce predominates.

Transect 5
Sample BMR-107: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a dark brown clay with minor carbonate pebbles; site is 2 m south side of the grid line and moderately well drained; no outcrop; jack pine and black spruce predominate.

Transect 5
Sample BMR-108: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown clay with localized patches of hematitic clay; site is 2 m south of the grid line and moderately to poorly drained; no outcrop; labrador tea and black spruce predominate.

Transect 5
Sample BMR-109: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown to dark brown clay with abundant carbonate pebbles; site is 10 m south of the grid line and poorly drained; no outcrop; black spruce predominates.

Transect 5
Sample BMR-110: 4 cm active layer of brown poorly decomposed humus and root mat topping 1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown clay with hematitic patches; site is moderately well drained; no outcrop; poplar and black spruce predominate; site is 25 m from wet swamp and at the west edge of tailings pile.

Transect 6
Sample BMR-111: 6 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a dark brown to reddish brown fine sand topping coarse carbonate gravels; site is 7 m north of the grid line and well drained; no outcrop; labrador tea and black spruce predominate.

Transect 6
Sample BMR-112: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown clay with occasional angular carbonate pebbles; site is 2 m south of the grid line and well drained; no outcrop; jack pine and black spruce predominate.

Transect 6
Sample BMR-113: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic to limonitic silty clay with abundant carbonate pebbles; site is 9 m north of the grid line and moderately well drained; no outcrop; tamarack and black spruce predominate; abundant gravel at surface near sample site.

Transect 6
Sample BMR-114: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a hematitic light brown clay with rounded to sub-angular carbonate pebbles; site is 2 m north of the grid line and well drained; no outcrop; tamarack and black spruce predominate; gravel at surface close to sample site.

Transect 6
Sample BMR-115: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown clay adjacent to and topping carbonate cobbles and occasional carbonate pebbles; site is well drained; no outcrop; tamarack and black spruce predominate.

Transect 6
Sample BMR-116: 4 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light to medium brown clay with flat, sub-rounded carbonate cobbles; site is 2 m north of the grid line and well drained; no outcrop; tamarack and black spruce predominate.

Transect 6
Sample BMR-117: 5 cm active layer of brown poorly decomposed humus and root mat topping <1 cm of black, fine grained, well decomposed humus; b-horizon is a light brown clay topping coarse carbonate gravels; site is 2 m north of the grid line and well drained; no outcrop; tamarack and black spruce predominate.

Appendix 6 (Part 1): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of field-duplicate soil samples, Mafeking quarries area

Sample ID:	Transect	Metres	SQLi	SQBe	SQCl	SQSc	SQTi	V	Mn	Co	Ni	Cu
BMR-1-1A	1	0	11	-20	11885	-100	-100	34	140	3	23	21
BMR-1-1B		0	12	-20	9328	-100	-100	35	181	4	26	18
BMR-15-1	1	350	-10	-20	4445	-100	-100	33	718	6	17	13
BMR-15-2		350	-10	-20	-3000	-100	-100	29	497	6	19	10
BMR-42-1	1	1025	13	-20	-3000	-100	-100	30	1986	4	32	-5
BMR-42-2		1025	15	-20	-3000	-100	-100	33	1538	8	31	-5
BMR-50-1	1	1225	-10	-20	6830	-100	-100	33	406	6	30	16
BMR-50-2		1225	-10	-20	-3000	-100	-100	38	495	9	29	17
BMR-63-1	1	1550	-10	-20	3180	-100	-100	31	106	3	32	28
BMR-63-2		1550	-10	-20	5638	-100	-100	31	230	3	32	27
BMR-84-1	2	450	-10	-20	7540	-100	432	61	1243	7	24	20
BMR-84-2		450	15	-20	-3000	-100	581	86	1137	11	31	21

Appendix 6 (Part 1): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of field-duplicate soil samples, Mafeking quarries area

Sample ID:	Transect	Metres	Zn	Ga	Ge	As	Se	Br	Rb	Sr	Y	Zr
BMR-1-1A	1	0	28	-1	-1	8	-30	217	2	83	13	3
BMR-1-1B		0	30	1	-1	9	-30	228	2	94	14	4
BMR-15-1	1	350	29	1	-1	5	-30	98	9	53	13	5
BMR-15-2		350	28	-1	-1	6	-30	132	-1	74	20	6
BMR-42-1	1	1025	-10	-1	-1	11	-30	241	15	226	8	7
BMR-42-2		1025	-10	1	-1	9	-30	302	8	287	7	3
BMR-50-1	1	1225	21	3	-1	8	-30	213	-1	88	18	10
BMR-50-2		1225	23	3	-1	8	-30	193	2	89	13	16
BMR-63-1	1	1550	12	-1	-1	-5	-30	133	4	86	13	14
BMR-63-2		1550	12	-1	-1	-5	-30	158	6	86	11	16
BMR-84-1	2	450	35	3	-1	8	-30	131	24	79	20	30
BMR-84-2		450	38	5	-1	10	-30	143	27	72	25	43

Appendix 6 (Part 1): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of field-duplicate soil samples, Mafeking quarries area

Sample ID:	Transect	Metres	Nb	Mo	Ru	Pd	Ag	Cd	In	Sn	Sb	Te
BMR-1-1A	1	0	-1	13	-1	-1	-0.2	0.4	-0.2	-1	4	-1
BMR-1-1B		0	1	13	-1	-1	-0.2	0.5	-0.2	-1	3	-1
BMR-15-1	1	350	-1	5	-1	-1	-0.2	0.2	-0.2	-1	2	-1
BMR-15-2		350	-1	7	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-42-1	1	1025	-1	13	-1	-1	-0.2	0.5	-0.2	-1	2	-1
BMR-42-2		1025	-1	12	-1	-1	-0.2	0.7	-0.2	-1	1	-1
BMR-50-1	1	1225	2	18	-1	-1	-0.2	0.6	0.2	-1	4	-1
BMR-50-2		1225	2	15	-1	-1	-0.2	0.6	0.2	-1	4	-1
BMR-63-1	1	1550	-1	9	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-63-2		1550	-1	10	-1	-1	0.2	-0.2	-0.2	-1	2	-1
BMR-84-1	2	450	2	5	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-84-2		450	3	7	-1	-1	0.3	0.2	-0.2	-1	2	-1

Appendix 6 (Part 1): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of field-duplicate soil samples, Mafeking quarries area

Sample ID:	Transect	Metres	I	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd
BMR-1-1A	1	0	41	-1	172	11	14	5	13	4	2	5
BMR-1-1B		0	52	-1	183	12	16	5	12	4	2	4
BMR-15-1	1	350	23	-1	232	20	28	4	18	4	-1	4
BMR-15-2		350	31	-1	185	21	26	5	21	5	1	6
BMR-42-1	1	1025	45	-1	1085	9	17	3	10	3	1	3
BMR-42-2		1025	42	-1	1018	9	24	3	10	2	-1	2
BMR-50-1	1	1225	42	-1	148	14	19	6	17	5	3	5
BMR-50-2		1225	40	-1	135	13	24	6	15	5	2	6
BMR-63-1	1	1550	29	-1	95	13	21	4	14	4	-1	4
BMR-63-2		1550	29	-1	78	10	18	3	11	3	-1	3
BMR-84-1	2	450	53	-1	194	30	32	6	25	5	1	6
BMR-84-2		450	69	1	225	31	47	8	32	7	2	8

Appendix 6 (Part 1): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of field-duplicate soil samples, Mafeking quarries area

Sample ID:	Transect	Metres	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
BMR-1-1A	1	0	2	2	1	2	1	2	-1	-1	-1	1
BMR-1-1B		0	2	3	1	2	1	2	-1	-1	-1	-1
BMR-15-1	1	350	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-15-2		350	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-42-1	1	1025	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-42-2		1025	-1	2	-1	-1	-1	-1	-1	-1	-1	-1
BMR-50-1	1	1225	3	3	2	3	2	4	3	-1	-1	1
BMR-50-2		1225	2	3	1	2	1	3	2	-1	-1	1
BMR-63-1	1	1550	-1	2	-1	2	-1	1	-1	-1	-1	-1
BMR-63-2		1550	-1	2	-1	1	-1	-1	-1	-1	-1	2
BMR-84-1	2	450	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-84-2		450	-1	5	-1	3	-1	2	-1	1	-1	1

Appendix 6 (Part 1): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of field-duplicate soil samples, Mafeking quarries area

Sample ID:	Transect	Metres	Re	Os	Pt	Au	SQHg	Tl	Pb	Bi	Th	U
BMR-1-1A	1	0	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	-1
BMR-1-1B		0	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	-1
BMR-15-1	1	350	-0.1	-1	-1	-0.1	-1	-1	5	-1	3	1
BMR-15-2		350	-0.1	-1	-1	-0.1	-1	-1	4	-1	1	-1
BMR-42-1	1	1025	-0.1	-1	-1	-0.1	-1	-1	2	-1	3	-1
BMR-42-2		1025	-0.1	-1	-1	-0.1	-1	-1	5	-1	2	-1
BMR-50-1	1	1225	-0.1	-1	-1	-0.1	-1	-1	4	-1	-1	1
BMR-50-2		1225	-0.1	-1	-1	-0.1	-1	-1	7	-1	2	2
BMR-63-1	1	1550	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	-1
BMR-63-2		1550	-0.1	-1	-1	-0.1	-1	-1	2	-1	2	1
BMR-84-1	2	450	-0.1	-1	-1	-0.1	-1	-1	5	-1	6	2
BMR-84-2		450	-0.1	-1	-1	-0.1	-1	-1	9	-1	8	2

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

Sample	Transect	Metres	SQLi	SQBe	SQCl	SQSc	SQTi	V	Mn	Co	Ni	Cu
BMR-1	1	0	11	-20	11885	-100	-100	34	140	3	23	21
BMR-2	1	25	-10	-20	-3000	-100	-100	47	446	6	32	31
BMR-3	1	50	-10	-20	-3000	-100	-100	24	305	4	25	18
BMR-4	1	75	-10	-20	-3000	-100	-100	26	388	4	22	17
BMR-5	1	100	-10	-20	7875	-100	-100	37	109	3	33	16
BMR-6	1	125	-10	-20	-3000	-100	-100	22	651	4	20	9
BMR-7	1	150	15	-20	-3000	-100	199	65	903	7	27	20
BMR-8	1	175	-10	-20	-3000	-100	-100	21	616	3	17	11
BMR-9	1	200	-10	-20	5775	-100	366	73	644	8	22	18
BMR-10	1	225	16	-20	11219	-100	-100	41	412	4	26	16
BMR-11	1	250	-10	-20	8875	-100	-100	37	539	5	32	26
BMR-12	1	275	-10	-20	8440	-100	264	39	759	6	23	15
BMR-13	1	300	-10	-20	10368	-100	-100	36	251	4	22	14
BMR-14	1	325	13	-20	7688	-100	-100	22	445	2	22	8
BMR-15	1	350	-10	-20	4445	-100	-100	33	718	6	17	13
BMR-16	1	375	-10	-20	-3000	-100	-100	44	1421	8	26	7
BMR-17	1	400	20	-20	6409	-100	259	64	1592	9	38	5
BMR-18	1	425	-10	-20	6943	-100	118	31	122	2	20	14
BMR-19	1	450	-10	-20	11545	-100	-100	28	42	1	21	14
BMR-20	1	475	-10	-20	9874	-100	118	31	290	4	26	18
BMR-21	1	500	21	-20	8799	-100	418	78	421	6	23	17
BMR-22	1	525	35	-20	28768	-100	-100	106	462	9	61	20
BMR-23	1	550	21	-20	16501	-100	-100	75	240	5	44	19
BMR-24	1	575	15	-20	-3000	-100	-100	61	231	4	44	11
BMR-25	1	600	26	-20	-3000	-100	-100	114	1295	17	87	24
BMR-26	1	625	21	-20	-3000	-100	-100	80	881	6	40	16
BMR-27	1	650	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-28	1	675	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-29	1	700	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-30	1	725	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-31	1	750	66	-20	5265	-100	1238	808	2211	12	50	73
BMR-32	1	775	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-33	1	800	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-34	1	825	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sample	**Transect**	**Metres**	**SQLi**	**SQBe**	**SQCl**	**SQSc**	**SQTi**	**V**	**Mn**	**Co**	**Ni**	**Cu**
BMR-35	1	850	28	-20	13870	-100	-100	273	250	4	43	26

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-36	1	875	-10	-20	-3000	-100	171	33	154	3	22	16
BMR-37	1	900	-10	-20	-3000	-100	-100	19	156	2	17	11
BMR-38	1	925	-10	-20	-3000	-100	-100	22	321	4	22	34
BMR-39	1	950	-10	-20	4503	-100	-100	39	1603	7	19	14
BMR-40	1	975	-10	-20	6733	-100	-100	38	397	5	24	19
BMR-41	1	1000	-10	-20	-3000	-100	-100	20	61	3	46	14
BMR-42	1	1025	13	-20	-3000	-100	-100	30	1986	4	32	-5
BMR-43	1	1050	-10	-20	-3000	-100	-100	42	1165	6	27	8
BMR-44	1	1075	-10	-20	-3000	-100	-100	17	619	4	20	10
BMR-45	1	1100	-10	-20	-3000	-100	-100	28	109	3	29	14
BMR-46	1	1125	-10	-20	5299	-100	-100	94	354	5	37	20
BMR-47	1	1150	-10	-20	-3000	-100	-100	29	286	3	34	12
BMR-48	1	1175	-10	-20	-3000	-100	-100	35	570	3	37	10
BMR-49	1	1200	-10	-20	10522	-100	-100	48	341	3	28	5
BMR-50	1	1225	-10	-20	6830	-100	-100	33	406	6	30	16
BMR-51	1	1250	-10	-20	-3000	-100	-100	37	552	6	26	15
BMR-52	1	1275	-10	-20	-3000	-100	188	27	454	5	12	7
BMR-53	1	1300	-10	-20	-3000	-100	129	43	633	8	17	12
BMR-54	1	1325	-10	-20	-3000	-100	372	45	1579	8	16	12
BMR-55	1	1350	-10	-20	3550	-100	-100	60	2523	10	28	7
BMR-56	1	1375	-10	-20	6553	-100	-100	82	508	6	36	14
BMR-57	1	1400	-10	-20	5498	-100	-100	52	501	5	25	11
BMR-58	1	1425	-10	-20	3070	-100	-100	58	407	5	25	12
BMR-59	1	1450	12	-20	3198	-100	1011	93	2508	14	30	9
BMR-60	1	1475	-10	-20	-3000	-100	-100	56	235	4	47	21
BMR-61	1	1500	29	-20	4517	-100	-100	291	250	4	44	50
BMR-62	1	1525	-10	-20	3926	-100	-100	98	324	7	31	30
BMR-63	1	1550	-10	-20	5638	-100	-100	31	230	3	32	27
BMR-64	1	1575	-10	-20	4724	-100	-100	37	123	3	40	27
BMR-65	1	1600	-10	-20	11158	-100	-100	54	890	10	49	43
BMR-66	2	0	15	-20	9282	-100	-100	88	220	5	66	153
BMR-67	2	25	-10	-20	6353	-100	-100	45	224	4	46	34
BMR-68	2	50	-10	-20	6019	-100	-100	62	1860	21	44	26
Sample	**Transect**	**Metres**	**SQLi**	**SQBe**	**SQCl**	**SQSc**	**SQTi**	**V**	**Mn**	**Co**	**Ni**	**Cu**
BMR-69	2	75	-10	-20	5529	-100	161	78	2164	11	24	22
BMR-70	2	100	-10	-20	3845	-100	-100	72	252	4	40	26
BMR-71	2	125	-10	-20	12010	-100	-100	74	951	7	31	18

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-72	2	150	-10	-20	9956	-100	-100	63	2150	6	24	17
BMR-73	2	175	-10	-20	8848	-100	-100	43	3083	12	25	17
BMR-74	2	200	-10	-20	5409	-100	-100	21	672	6	10	5
BMR-75	2	225	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-76	2	250	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-77	2	275	34	-20	24485	-100	-100	157	364	4	67	33
BMR-78	2	300	-10	-20	5772	-100	116	97	1919	10	39	19
BMR-79	2	325	32	-20	12185	-100	1238	84	336	10	68	34
BMR-80	2	350	-10	-20	10668	-100	-100	75	615	6	32	34
BMR-81	2	375	-10	-20	7653	-100	362	67	1787	10	30	20
BMR-82	2	400	-10	-20	7099	-100	-100	49	995	8	39	30
BMR-83	2	425	-10	-20	10638	-100	-100	78	372	5	37	28
BMR-84	2	450	-10	-20	7540	-100	432	61	1243	7	24	20
BMR-85	2	475	42	-20	25797	-100	-100	145	639	8	37	21
BMR-86	2	500	17	-20	27262	-100	-100	127	347	8	59	31
BMR-87	3	0	-10	-20	11771	-100	-100	92	486	6	44	45
BMR-88	3	25	-10	-20	13346	-100	-100	48	113	3	35	23
BMR-89	3	50	12	-20	7647	-100	-100	32	730	4	24	10
BMR-90	3	75	-10	-20	13459	-100	-100	52	2943	8	39	12
BMR-91	3	100	-10	-20	14035	-100	-100	82	648	8	18	25
BMR-92	3	125	-10	-20	8734	-100	-100	83	217	6	43	18
BMR-93	3	150	-10	-20	7895	-100	-100	57	120	4	69	13
BMR-94	3	175	14	-20	9769	-100	-100	64	245	5	60	20
BMR-95	3	200	10	-20	5823	-100	-100	74	182	5	78	15
BMR-96	3	225	14	-20	4726	-100	-100	151	113	4	50	33
BMR-97	3	250	-10	-20	5556	-100	-100	61	314	4	44	16
BMR-98	3	275	-10	-20	-3000	-100	-100	69	63	3	43	15
BMR-99	3	300	-10	-20	4109	-100	-100	77	161	4	48	22
BMR-100	3	325	18	-20	-3000	-100	-100	96	186	4	46	26
BMR-101	4	0	-10	-20	-3000	-100	-100	40	115	3	32	28
BMR-102	4	25	-10	-20	-3000	-100	-100	69	1932	10	29	20
Sample	**Transect**	**Metres**	**SQLi**	**SQBe**	**SQCl**	**SQSc**	**SQTi**	**V**	**Mn**	**Co**	**Ni**	**Cu**
BMR-103	4	50	-10	-20	-3000	-100	283	96	1332	7	21	23
BMR-104	4	75	14	-20	4963	-100	540	101	1230	10	27	18
BMR-105	4	100	-10	-20	5156	-100	-100	69	1935	9	31	25
BMR-106	4	125	21	-20	11735	-100	-100	137	555	7	65	29
BMR-107	5	0	21	-20	5553	-100	-100	90	202	4	49	27

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-108	5	25	53	-20	3883	-100	-100	203	480	6	81	28
BMR-109	5	50	68	-20	-3000	-100	-100	109	313	7	73	34
BMR-110	5	75	17	-20	-3000	-100	-100	122	555	5	91	25
BMR-111	6	0	-10	-20	-3000	-100	176	37	503	5	23	27
BMR-112	6	25	14	-20	-3000	-100	-100	72	378	5	51	28
BMR-113	6	50	-10	-20	-3000	-100	-100	61	333	5	31	17
BMR-114	6	75	17	-20	-3000	-100	-100	101	331	7	56	25
BMR-115	6	100	39	-20	-3000	-100	-100	131	399	7	67	97
BMR-116	6	125	12	-20	-3000	-100	-100	61	330	8	94	38
BMR-117	6	150	27	-20	-3000	-100	-100	81	225	6	67	26

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

Sample	Transect	Metres	Zn	Ga	Ge	As	Se	Br	Rb	Sr	Y	Zr
BMR-1	1	0	28	-1	-1	8	-30	217	2	83	13	3
BMR-2	1	25	-10	-1	-1	16	-30	648	21	84	31	9
BMR-3	1	50	-10	-1	-1	10	-30	433	5	52	20	3
BMR-4	1	75	-10	-1	-1	12	-30	361	10	60	22	3
BMR-5	1	100	21	-1	-1	9	-30	241	14	103	14	5
BMR-6	1	125	-10	-1	-1	9	-30	92	7	77	14	8
BMR-7	1	150	26	4	-1	10	-30	-30	26	77	19	30
BMR-8	1	175	18	-1	-1	7	-30	45	4	43	7	10
BMR-9	1	200	31	4	-1	8	-30	223	8	51	24	37
BMR-10	1	225	16	-1	-1	8	-30	234	14	68	18	13
BMR-11	1	250	17	1	-1	9	-30	223	13	80	6	5
BMR-12	1	275	27	3	-1	7	-30	133	17	50	15	26
BMR-13	1	300	28	-1	-1	6	-30	319	3	48	19	6
BMR-14	1	325	17	-1	-1	6	-30	209	37	93	11	5
BMR-15	1	350	29	1	-1	5	-30	98	9	53	13	5
BMR-16	1	375	15	-1	-1	8	-30	105	3	71	19	5
BMR-17	1	400	24	2	-1	18	-30	69	25	110	16	20
BMR-18	1	425	18	1	-1	5	-30	109	10	58	9	11
BMR-19	1	450	11	-1	-1	7	-30	124	2	101	9	3
BMR-20	1	475	11	-1	-1	6	-30	105	7	94	6	9
BMR-21	1	500	31	3	-1	6	-30	81	10	78	31	33
BMR-22	1	525	15	-1	-1	18	-30	104	5	446	18	21
BMR-23	1	550	17	-1	-1	15	-30	349	4	303	19	26
BMR-24	1	575	-10	-1	-1	14	-30	70	2	310	15	26
BMR-25	1	600	23	-1	-1	25	-30	-30	15	453	18	15
BMR-26	1	625	20	-1	-1	14	-30	-30	9	172	23	19
BMR-27	1	650	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-28	1	675	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-29	1	700	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-30	1	725	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-31	1	750	59	10	-1	30	-30	-30	59	279	20	75
BMR-32	1	775	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-33	1	800	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-34	1	825	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sample	Transect	Metres	Zn	Ga	Ge	As	Se	Br	Rb	Sr	Y	Zr
BMR-35	1	850	16	-1	-1	20	-30	85	8	278	15	14

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-36	1	875	17	2	-1	-5	-30	-30	15	83	8	9
BMR-37	1	900	-10	-1	-1	7	-30	-30	10	75	4	10
BMR-38	1	925	28	-1	-1	5	-30	-30	5	82	4	7
BMR-39	1	950	17	2	-1	6	-30	86	8	61	10	16
BMR-40	1	975	18	-1	-1	7	-30	323	6	87	13	8
BMR-41	1	1000	-10	-1	-1	9	-30	108	2	307	7	6
BMR-42	1	1025	-10	-1	-1	11	-30	241	15	226	8	7
BMR-43	1	1050	-10	-1	-1	8	-30	119	4	129	11	3
BMR-44	1	1075	-10	-1	-1	13	-30	-30	10	93	5	3
BMR-45	1	1100	-10	-1	-1	7	-30	-30	2	131	7	7
BMR-46	1	1125	13	-1	-1	13	-30	204	6	163	18	14
BMR-47	1	1150	12	-1	-1	10	-30	77	8	198	14	12
BMR-48	1	1175	23	-1	-1	8	-30	89	13	224	9	12
BMR-49	1	1200	13	-1	-1	7	-30	238	2	133	6	8
BMR-50	1	1225	21	3	-1	8	-30	213	-1	88	18	10
BMR-51	1	1250	19	1	-1	11	-30	376	44	125	12	3
BMR-52	1	1275	23	2	-1	7	-30	43	37	65	6	12
BMR-53	1	1300	21	2	-1	7	-30	283	20	80	12	20
BMR-54	1	1325	29	3	-1	6	-30	123	33	49	7	14
BMR-55	1	1350	25	2	-1	7	-30	281	10	82	15	21
BMR-56	1	1375	10	-1	-1	11	-30	361	4	151	9	8
BMR-57	1	1400	16	-1	-1	8	-30	308	3	105	13	13
BMR-58	1	1425	35	1	-1	6	-30	229	6	73	17	24
BMR-59	1	1450	45	6	-1	9	-30	96	19	63	19	37
BMR-60	1	1475	12	-1	-1	11	-30	127	4	242	12	9
BMR-61	1	1500	15	-1	-1	34	-30	223	14	186	25	27
BMR-62	1	1525	14	-1	-1	13	-30	205	6	80	35	20
BMR-63	1	1550	12	-1	-1	-5	-30	158	6	86	11	16
BMR-64	1	1575	13	-1	-1	9	-30	272	17	71	13	5
BMR-65	1	1600	74	-1	-1	14	-30	221	15	67	19	9
BMR-66	2	0	76	-1	-1	12	-30	307	3	230	22	32
BMR-67	2	25	13	-1	-1	8	-30	279	4	228	10	11
BMR-68	2	50	15	-1	-1	9	-30	1167	5	97	21	12
Sample	**Transect**	**Metres**	**Zn**	**Ga**	**Ge**	**As**	**Se**	**Br**	**Rb**	**Sr**	**Y**	**Zr**
BMR-69	2	75	25	3	-1	8	-30	231	13	56	16	26
BMR-70	2	100	16	-1	-1	18	-30	250	6	115	13	14
BMR-71	2	125	14	-1	-1	6	-30	434	7	90	13	10

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-72	2	150	14	-1	-1	8	-30	395	12	63	9	7
BMR-73	2	175	11	-1	-1	11	-30	258	5	47	24	15
BMR-74	2	200	12	-1	-1	7	-30	68	12	56	9	16
BMR-75	2	225	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-76	2	250	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-77	2	275	-10	-1	-1	19	-30	398	3	692	16	29
BMR-78	2	300	22	2	-1	10	-30	175	6	135	15	19
BMR-79	2	325	49	7	-1	13	-30	208	53	176	15	48
BMR-80	2	350	16	-1	-1	9	-30	372	9	95	18	17
BMR-81	2	375	36	3	-1	8	-30	213	18	58	15	23
BMR-82	2	400	16	-1	-1	9	-30	273	10	69	19	17
BMR-83	2	425	17	1	-1	13	-30	278	6	127	13	14
BMR-84	2	450	35	3	-1	8	-30	131	24	79	20	30
BMR-85	2	475	13	-1	-1	10	-30	613	6	234	22	19
BMR-86	2	500	14	-1	-1	11	-30	632	8	225	18	38
BMR-87	3	0	15	-1	-1	16	-30	302	3	85	25	16
BMR-88	3	25	14	-1	-1	10	-30	238	20	122	9	6
BMR-89	3	50	17	-1	-1	-5	-30	116	12	128	6	7
BMR-90	3	75	13	-1	-1	7	-30	603	10	81	11	8
BMR-91	3	100	24	-1	-1	7	-30	176	1	103	32	24
BMR-92	3	125	16	-1	-1	10	-30	341	-1	157	28	21
BMR-93	3	150	13	-1	-1	8	-30	228	1	247	14	16
BMR-94	3	175	-10	-1	-1	7	-30	103	4	208	11	13
BMR-95	3	200	-10	3	-1	9	-30	156	3	271	14	13
BMR-96	3	225	14	1	-1	20	-30	161	2	186	16	21
BMR-97	3	250	13	-1	-1	9	-30	238	-1	182	9	10
BMR-98	3	275	15	-1	-1	13	-30	267	-1	166	11	13
BMR-99	3	300	-10	1	-1	11	-30	469	5	262	17	16
BMR-100	3	325	15	-1	-1	11	-30	321	7	241	13	15
BMR-101	4	0	14	1	-1	6	-30	175	8	152	11	14
BMR-102	4	25	33	1	-1	7	-30	211	5	100	16	12
Sample	**Transect**	**Metres**	**Zn**	**Ga**	**Ge**	**As**	**Se**	**Br**	**Rb**	**Sr**	**Y**	**Zr**
BMR-103	4	50	47	3	-1	6	-30	226	9	84	17	25
BMR-104	4	75	35	4	-1	8	-30	237	12	62	22	32
BMR-105	4	100	20	1	-1	8	-30	388	9	93	19	15
BMR-106	4	125	11	-1	-1	16	-30	194	5	258	17	23
BMR-107	5	0	-10	-1	-1	10	-30	286	16	244	14	11

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-108	5	25	-10	-1	-1	23	-30	197	8	757	19	39
BMR-109	5	50	11	-1	-1	12	-30	229	15	803	12	20
BMR-110	5	75	-10	-1	-1	27	-30	165	15	327	19	32
BMR-111	6	0	21	2	-1	6	-30	180	15	94	12	15
BMR-112	6	25	18	-1	-1	11	-30	103	3	185	8	8
BMR-113	6	50	19	2	-1	11	-30	102	7	135	6	14
BMR-114	6	75	67	-1	-1	13	-30	205	7	222	8	13
BMR-115	6	100	70	-1	-1	12	-30	174	6	378	8	13
BMR-116	6	125	-10	-1	-1	11	-30	141	8	278	8	18
BMR-117	6	150	-10	-1	-1	12	-30	157	15	428	9	14

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

Sample	Transect	Metres	Nb	Mo	Ru	Pd	Ag	Cd	In	Sn	Sb	Te
BMR-1	1	0	-1	13	-1	-1	-0.2	0.4	-0.2	-1	4	-1
BMR-2	1	25	-1	12	-1	-1	-0.2	1.1	-0.2	-1	2	-1
BMR-3	1	50	-1	10	-1	-1	-0.2	0.5	-0.2	-1	2	-1
BMR-4	1	75	-1	10	-1	-1	-0.2	0.7	-0.2	-1	1	-1
BMR-5	1	100	-1	14	-1	-1	-0.2	0.4	-0.2	-1	2	-1
BMR-6	1	125	-1	12	-1	-1	-0.2	0.5	-0.2	-1	4	-1
BMR-7	1	150	3	13	-1	-1	0.3	-0.2	-0.2	2	3	-1
BMR-8	1	175	-1	11	-1	-1	0.3	-0.2	-0.2	-1	2	-1
BMR-9	1	200	2	10	-1	-1	0.3	0.3	-0.2	1	2	-1
BMR-10	1	225	-1	9	-1	-1	-0.2	0.2	-0.2	-1	2	-1
BMR-11	1	250	-1	14	-1	-1	0.3	0.2	-0.2	1	2	-1
BMR-12	1	275	1	8	-1	-1	0.3	-0.2	-0.2	1	1	-1
BMR-13	1	300	-1	7	-1	-1	-0.2	0.4	-0.2	-1	2	-1
BMR-14	1	325	-1	10	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-15	1	350	-1	5	-1	-1	-0.2	0.2	-0.2	-1	2	-1
BMR-16	1	375	-1	8	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-17	1	400	2	13	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-18	1	425	-1	9	-1	-1	-0.2	0.3	-0.2	-1	1	-1
BMR-19	1	450	-1	9	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-20	1	475	-1	7	-1	-1	-0.2	-0.2	-0.2	2	2	-1
BMR-21	1	500	2	4	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-22	1	525	-1	19	-1	-1	-0.2	0.6	-0.2	-1	2	-1
BMR-23	1	550	-1	7	-1	-1	-0.2	0.3	-0.2	-1	1	-1
BMR-24	1	575	-1	7	-1	-1	-0.2	0.5	-0.2	-1	1	-1
BMR-25	1	600	-1	85	-1	-1	-0.2	1.5	-0.2	-1	3	-1
BMR-26	1	625	-1	15	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-27	1	650	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-28	1	675	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-29	1	700	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-30	1	725	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-31	1	750	7	28	-1	1	0.4	0.3	-0.2	3	4	-1
BMR-32	1	775	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-33	1	800	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-34	1	825	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sample	Transect	Metres	Nb	Mo	Ru	Pd	Ag	Cd	In	Sn	Sb	Te
BMR-35	1	850	-1	11	-1	-1	-0.2	0.3	-0.2	-1	2	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-36	1	875	-1	7	-1	-1	-0.2	-0.2	-0.2	1	1	-1
BMR-37	1	900	-1	10	-1	-1	0.3	-0.2	-0.2	-1	2	-1
BMR-38	1	925	-1	9	-1	-1	0.4	0.2	-0.2	2	2	-1
BMR-39	1	950	-1	8	-1	-1	-0.2	-0.2	-0.2	1	2	-1
BMR-40	1	975	-1	12	-1	-1	-0.2	0.3	-0.2	-1	2	-1
BMR-41	1	1000	-1	15	-1	-1	-0.2	0.3	-0.2	-1	3	-1
BMR-42	1	1025	-1	13	-1	-1	-0.2	0.5	-0.2	-1	2	-1
BMR-43	1	1050	-1	11	-1	-1	-0.2	0.4	-0.2	-1	2	-1
BMR-44	1	1075	-1	11	-1	-1	-0.2	0.8	-0.2	-1	1	-1
BMR-45	1	1100	-1	8	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-46	1	1125	-1	8	-1	-1	-0.2	0.2	-0.2	-1	1	-1
BMR-47	1	1150	-1	14	-1	-1	-0.2	0.8	-0.2	-1	3	-1
BMR-48	1	1175	-1	11	-1	-1	-0.2	1.1	-0.2	-1	2	-1
BMR-49	1	1200	-1	8	-1	-1	-0.2	0.6	-0.2	-1	1	-1
BMR-50	1	1225	2	18	-1	-1	-0.2	0.6	0.2	-1	4	-1
BMR-51	1	1250	1	21	-1	-1	-0.2	0.7	0.3	-1	4	-1
BMR-52	1	1275	2	13	-1	-1	-0.2	0.3	-0.2	-1	3	-1
BMR-53	1	1300	2	14	-1	-1	0.3	-0.2	-0.2	1	3	-1
BMR-54	1	1325	2	14	-1	-1	-0.2	0.3	-0.2	-1	3	-1
BMR-55	1	1350	2	15	-1	-1	-0.2	-0.2	-0.2	-1	3	-1
BMR-56	1	1375	-1	19	-1	-1	-0.2	0.9	-0.2	-1	3	-1
BMR-57	1	1400	-1	11	-1	-1	-0.2	0.7	-0.2	-1	2	-1
BMR-58	1	1425	1	10	-1	-1	-0.2	0.3	-0.2	-1	2	-1
BMR-59	1	1450	5	11	-1	-1	0.2	0.3	-0.2	1	3	-1
BMR-60	1	1475	-1	19	-1	-1	-0.2	0.6	-0.2	-1	2	-1
BMR-61	1	1500	-1	10	-1	-1	-0.2	0.3	-0.2	-1	2	-1
BMR-62	1	1525	-1	9	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-63	1	1550	-1	10	-1	-1	0.2	-0.2	-0.2	-1	2	-1
BMR-64	1	1575	-1	11	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-65	1	1600	-1	11	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-66	2	0	-1	11	-1	-1	-0.2	0.5	-0.2	1	2	-1
BMR-67	2	25	-1	11	-1	-1	-0.2	0.3	-0.2	-1	2	-1
BMR-68	2	50	-1	10	-1	-1	-0.2	0.4	-0.2	-1	2	-1
Sample	**Transect**	**Metres**	**Nb**	**Mo**	**Ru**	**Pd**	**Ag**	**Cd**	**In**	**Sn**	**Sb**	**Te**
BMR-69	2	75	2	10	-1	-1	0.2	0.4	-0.2	-1	2	-1
BMR-70	2	100	-1	10	-1	-1	-0.2	0.6	-0.2	-1	1	-1
BMR-71	2	125	-1	10	-1	-1	-0.2	-0.2	-0.2	-1	2	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-72	2	150	-1	12	-1	-1	-0.2	0.6	-0.2	-1	2	-1
BMR-73	2	175	-1	8	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-74	2	200	-1	4	-1	-1	-0.2	0.2	-0.2	-1	2	-1
BMR-75	2	225	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-76	2	250	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-77	2	275	-1	6	-1	-1	-0.2	0.7	-0.2	-1	2	-1
BMR-78	2	300	1	6	-1	-1	-0.2	0.5	-0.2	-1	1	-1
BMR-79	2	325	5	9	-1	-1	0.3	0.4	-0.2	2	2	-1
BMR-80	2	350	-1	7	-1	-1	-0.2	0.4	-0.2	-1	1	-1
BMR-81	2	375	2	8	-1	-1	0.3	0.4	-0.2	-1	2	-1
BMR-82	2	400	-1	7	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-83	2	425	-1	7	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-84	2	450	2	5	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-85	2	475	-1	9	-1	-1	-0.2	0.3	-0.2	-1	2	-1
BMR-86	2	500	-1	9	-1	-1	-0.2	0.6	-0.2	-1	1	-1
BMR-87	3	0	-1	9	-1	-1	-0.2	0.4	-0.2	-1	1	-1
BMR-88	3	25	-1	12	-1	-1	-0.2	-0.2	-0.2	-1	1	-1
BMR-89	3	50	-1	9	-1	-1	-0.2	0.3	-0.2	-1	1	-1
BMR-90	3	75	-1	10	-1	-1	-0.2	0.5	-0.2	-1	1	-1
BMR-91	3	100	-1	17	-1	-1	-0.2	0.4	-0.2	-1	3	-1
BMR-92	3	125	-1	10	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-93	3	150	-1	7	-1	-1	-0.2	0.3	-0.2	-1	2	-1
BMR-94	3	175	-1	5	-1	-1	-0.2	0.5	-0.2	-1	2	-1
BMR-95	3	200	2	20	-1	-1	-0.2	1.2	-0.2	-1	6	-1
BMR-96	3	225	2	12	-1	-1	-0.2	0.4	-0.2	-1	4	-1
BMR-97	3	250	1	14	-1	-1	-0.2	0.4	-0.2	-1	3	-1
BMR-98	3	275	1	11	-1	-1	-0.2	0.4	-0.2	-1	3	-1
BMR-99	3	300	-1	14	-1	-1	-0.2	0.4	-0.2	-1	3	-1
BMR-100	3	325	-1	12	-1	-1	-0.2	0.3	-0.2	-1	3	-1
BMR-101	4	0	1	9	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-102	4	25	1	10	-1	-1	-0.2	0.7	-0.2	-1	2	-1
Sample	**Transect**	**Metres**	**Nb**	**Mo**	**Ru**	**Pd**	**Ag**	**Cd**	**In**	**Sn**	**Sb**	**Te**
BMR-103	4	50	2	10	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-104	4	75	3	9	-1	-1	-0.2	-0.2	-0.2	-1	2	-1
BMR-105	4	100	1	18	-1	-1	-0.2	0.5	-0.2	-1	3	-1
BMR-106	4	125	-1	9	-1	-1	-0.2	1	-0.2	-1	3	-1
BMR-107	5	0	-1	9	-1	-1	-0.2	0.4	-0.2	-1	2	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-108	5	25	-1	8	-1	-1	-0.2	1.1	-0.2	-1	2	-1
BMR-109	5	50	-1	12	-1	-1	-0.2	0.9	-0.2	-1	4	-1
BMR-110	5	75	-1	6	-1	-1	-0.2	0.7	-0.2	-1	2	-1
BMR-111	6	0	1	6	-1	-1	-0.2	0.4	-0.2	-1	2	-1
BMR-112	6	25	-1	7	-1	-1	-0.2	0.2	-0.2	-1	3	-1
BMR-113	6	50	2	8	-1	-1	-0.2	0.2	-0.2	-1	3	-1
BMR-114	6	75	-1	8	-1	-1	-0.2	0.3	-0.2	-1	3	-1
BMR-115	6	100	-1	10	-1	-1	-0.2	1	-0.2	-1	3	-1
BMR-116	6	125	-1	6	-1	-1	-0.2	0.9	-0.2	-1	2	-1
BMR-117	6	150	-1	6	-1	-1	-0.2	0.9	-0.2	-1	2	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

Sample	Transect	Metres	I	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd
BMR-1	1	0	41	-1	172	11	14	5	13	4	2	5
BMR-2	1	25	74	-1	263	27	37	7	29	8	2	8
BMR-3	1	50	54	-1	154	16	24	5	18	5	1	6
BMR-4	1	75	51	-1	161	17	27	5	20	5	1	6
BMR-5	1	100	37	-1	147	10	15	3	12	4	1	4
BMR-6	1	125	59	-1	174	13	18	4	16	5	1	4
BMR-7	1	150	15	1	325	22	43	6	22	6	2	6
BMR-8	1	175	75	-1	130	7	13	2	7	2	-1	2
BMR-9	1	200	72	-1	186	20	26	6	24	6	2	7
BMR-10	1	225	24	-1	192	14	16	4	17	5	1	5
BMR-11	1	250	35	-1	138	6	9	2	6	2	-1	2
BMR-12	1	275	40	-1	160	16	21	4	15	3	-1	4
BMR-13	1	300	60	-1	124	17	21	5	19	4	-1	5
BMR-14	1	325	31	-1	142	10	13	3	11	2	-1	3
BMR-15	1	350	23	-1	232	20	28	4	18	4	-1	4
BMR-16	1	375	31	-1	188	23	42	6	24	6	1	7
BMR-17	1	400	23	-1	347	17	33	5	19	5	1	5
BMR-18	1	425	36	-1	146	7	11	2	8	2	-1	2
BMR-19	1	450	46	-1	141	6	9	2	7	2	-1	2
BMR-20	1	475	44	-1	170	5	8	1	5	1	-1	2
BMR-21	1	500	40	-1	204	34	51	9	35	8	2	10
BMR-22	1	525	56	-1	899	18	35	5	21	5	2	6
BMR-23	1	550	48	-1	460	15	27	4	18	6	1	5
BMR-24	1	575	61	-1	649	16	28	4	19	4	1	5
BMR-25	1	600	53	-1	1612	16	38	6	23	6	2	7
BMR-26	1	625	73	-1	463	25	45	8	33	9	2	9
BMR-27	1	650	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-28	1	675	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-29	1	700	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-30	1	725	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-31	1	750	37	3	539	36	67	9	31	7	2	8
BMR-32	1	775	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-33	1	800	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-34	1	825	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sample	Transect	Metres	I	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd
BMR-35	1	850	34	-1	367	22	38	6	22	5	1	5

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-36	1	875	12	-1	131	9	17	3	9	2	-1	3
BMR-37	1	900	63	-1	250	7	12	2	7	2	-1	2
BMR-38	1	925	56	-1	327	9	20	2	9	2	-1	2
BMR-39	1	950	37	-1	433	10	25	3	13	3	-1	3
BMR-40	1	975	64	-1	387	11	15	3	13	4	-1	3
BMR-41	1	1000	81	-1	3480	7	12	2	7	2	2	2
BMR-42-1	1	1025	45	-1	1085	9	17	3	10	3	1	3
BMR-43	1	1050	59	-1	355	10	22	3	12	4	1	4
BMR-44	1	1075	34	-1	210	5	12	1	6	2	-1	2
BMR-45	1	1100	69	-1	197	6	9	2	7	2	-1	2
BMR-46	1	1125	97	-1	231	18	23	5	19	5	1	6
BMR-47	1	1150	68	-1	207	12	18	4	14	4	-1	4
BMR-48	1	1175	66	-1	244	8	13	2	9	3	-1	3
BMR-49	1	1200	52	-1	119	5	8	1	6	2	-1	2
BMR-50-1	1	1225	42	-1	148	14	19	6	17	5	3	5
BMR-51	1	1250	39	-1	158	13	19	5	14	4	2	5
BMR-52	1	1275	19	-1	222	7	17	3	7	2	1	2
BMR-53	1	1300	43	-1	189	17	23	5	16	4	1	5
BMR-54	1	1325	27	-1	236	9	24	3	9	2	-1	3
BMR-55	1	1350	73	-1	246	17	29	5	17	5	1	5
BMR-56	1	1375	56	-1	135	9	15	3	10	3	-1	3
BMR-57	1	1400	52	-1	152	12	20	4	14	4	1	4
BMR-58	1	1425	52	-1	151	16	30	5	18	4	1	5
BMR-59	1	1450	32	1	218	29	39	7	26	6	1	7
BMR-60	1	1475	50	-1	337	11	15	3	12	3	1	4
BMR-61	1	1500	38	-1	374	31	44	9	34	8	2	9
BMR-62	1	1525	30	-1	213	37	58	11	44	11	2	12
BMR-63-2	1	1550	29	-1	78	10	18	3	11	3	-1	3
BMR-64	1	1575	39	-1	87	13	14	3	14	4	-1	4
BMR-65	1	1600	52	-1	170	20	22	5	22	5	1	6
BMR-66	2	0	70	-1	1683	22	36	6	24	6	2	7
BMR-67	2	25	70	-1	3425	9	13	2	9	2	3	3
BMR-68	2	50	222	-1	591	18	30	5	22	5	1	6
Sample	**Transect**	**Metres**	**I**	**Cs**	**Ba**	**La**	**Ce**	**Pr**	**Nd**	**Sm**	**Eu**	**Gd**
BMR-69	2	75	47	-1	321	16	30	4	17	4	1	6
BMR-70	2	100	50	-1	284	13	21	4	15	4	-1	4
BMR-71	2	125	53	-1	335	13	17	3	14	3	-1	3

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-72	2	150	56	-1	267	9	19	2	9	2	-1	3
BMR-73	2	175	111	-1	300	20	41	6	23	6	1	7
BMR-74	2	200	28	-1	447	7	33	3	10	2	-1	3
BMR-75	2	225	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-76	2	250	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-77	2	275	66	-1	720	21	40	6	23	5	2	6
BMR-78	2	300	39	-1	280	18	30	5	19	4	1	5
BMR-79	2	325	61	2	374	21	38	5	18	5	1	5
BMR-80	2	350	63	-1	202	16	22	4	17	4	1	5
BMR-81	2	375	37	-1	237	18	25	4	17	4	1	5
BMR-82	2	400	64	-1	167	17	15	5	19	4	1	5
BMR-83	2	425	54	-1	171	12	13	3	13	4	-1	4
BMR-84	2	450	53	-1	194	30	32	6	25	5	1	6
BMR-85	2	475	90	-1	211	27	43	7	27	7	1	8
BMR-86	2	500	102	-1	365	26	40	7	26	5	1	6
BMR-87	3	0	70	-1	205	23	17	6	24	6	1	7
BMR-88	3	25	45	-1	151	7	7	2	8	2	-1	2
BMR-89	3	50	17	-1	177	7	10	2	8	2	-1	2
BMR-90	3	75	71	-1	302	12	11	3	12	3	-1	3
BMR-91	3	100	51	-1	298	26	44	8	33	9	2	9
BMR-92	3	125	73	-1	242	27	25	8	32	8	2	8
BMR-93	3	150	59	-1	261	19	30	5	20	5	1	5
BMR-94	3	175	38	-1	366	15	27	4	15	4	1	4
BMR-95	3	200	48	-1	345	17	30	8	18	6	4	7
BMR-96	3	225	68	-1	314	19	28	7	21	6	3	7
BMR-97	3	250	91	-1	150	9	14	4	12	4	2	5
BMR-98	3	275	75	-1	142	12	14	4	14	4	2	4
BMR-99	3	300	94	-1	208	15	20	5	18	5	2	5
BMR-100	3	325	83	-1	254	13	19	4	15	4	1	4
BMR-101	4	0	54	-1	208	11	17	3	11	3	1	3
BMR-102	4	25	59	-1	194	16	31	5	19	5	1	5
Sample	**Transect**	**Metres**	**I**	**Cs**	**Ba**	**La**	**Ce**	**Pr**	**Nd**	**Sm**	**Eu**	**Gd**
BMR-103	4	50	79	-1	214	20	29	5	21	5	1	6
BMR-104	4	75	47	-1	262	25	39	7	27	7	2	7
BMR-105	4	100	60	-1	224	20	29	6	23	6	1	6
BMR-106	4	125	54	-1	593	19	38	6	21	5	2	6
BMR-107	5	0	57	-1	310	15	21	4	17	4	1	4

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-108	5	25	71	-1	687	23	46	7	26	7	2	7
BMR-109	5	50	86	-1	558	16	29	4	16	4	1	4
BMR-110	5	75	41	-1	476	22	47	6	24	6	2	7
BMR-111	6	0	-0.1	-1	-1	-0.1	-1	-1	3	-1	3	1
BMR-112	6	25	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	1
BMR-113	6	50	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	1
BMR-114	6	75	-0.1	-1	-1	-0.1	-1	-1	2	-1	2	1
BMR-115	6	100	-0.1	-1	-1	-0.1	-1	-1	6	-1	3	1
BMR-116	6	125	-0.1	-1	-1	-0.1	-1	-1	4	-1	4	-1
BMR-117	6	150	-0.1	-1	-1	-0.1	-1	-1	4	-1	3	2

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

Sample	Transect	Metres	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
BMR-1	1	0	2	2	1	2	1	2	-1	-1	-1	1
BMR-2	1	25	-1	5	-1	3	-1	2	-1	-1	-1	-1
BMR-3	1	50	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-4	1	75	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-5	1	100	1	2	-1	2	-1	1	-1	-1	-1	1
BMR-6	1	125	-1	3	-1	2	-1	2	-1	-1	-1	1
BMR-7	1	150	-1	3	-1	2	-1	1	-1	-1	-1	1
BMR-8	1	175	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-9	1	200	-1	4	-1	3	-1	2	-1	-1	-1	-1
BMR-10	1	225	-1	3	-1	2	-1	2	-1	-1	-1	-1
BMR-11	1	250	-1	1	-1	-1	-1	-1	-1	-1	-1	2
BMR-12	1	275	-1	3	-1	2	-1	1	-1	-1	-1	2
BMR-13	1	300	-1	3	-1	2	-1	2	-1	-1	-1	-1
BMR-14	1	325	-1	2	-1	1	-1	-1	-1	-1	-1	1
BMR-15	1	350	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-16	1	375	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-17	1	400	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-18	1	425	-1	1	-1	-1	-1	-1	-1	-1	-1	2
BMR-19	1	450	-1	1	-1	1	-1	-1	-1	-1	-1	-1
BMR-20	1	475	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-21	1	500	1	5	-1	3	-1	2	-1	-1	-1	-1
BMR-22	1	525	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-23	1	550	-1	3	-1	2	-1	2	-1	-1	-1	-1
BMR-24	1	575	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-25	1	600	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-26	1	625	-1	5	-1	3	-1	2	-1	-1	-1	-1
BMR-27	1	650	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-28	1	675	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-29	1	700	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-30	1	725	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-31	1	750	-1	4	-1	2	-1	2	-1	2	-1	2
BMR-32	1	775	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-33	1	800	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-34	1	825	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sample	Transect	Metres	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
BMR-35	1	850	-1	3	-1	2	-1	1	-1	-1	-1	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-36	1	875	-1	1	-1	-1	-1	-1	-1	-1	-1	1
BMR-37	1	900	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-38	1	925	-1	-1	-1	-1	-1	-1	-1	-1	-1	1
BMR-39	1	950	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-40	1	975	-1	2	-1	1	-1	1	-1	-1	-1	-1
BMR-41	1	1000	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-42	1	1025	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-43	1	1050	-1	2	-1	2	-1	-1	-1	-1	-1	-1
BMR-44	1	1075	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-45	1	1100	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-46	1	1125	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-47	1	1150	-1	3	-1	1	-1	1	-1	-1	-1	-1
BMR-48	1	1175	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-49	1	1200	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-50	1	1225	3	3	2	3	2	4	3	-1	-1	1
BMR-51	1	1250	2	3	1	2	1	2	2	-1	-1	2
BMR-52	1	1275	1	1	-1	-1	-1	1	-1	-1	-1	-1
BMR-53	1	1300	1	2	-1	2	-1	1	-1	-1	-1	1
BMR-54	1	1325	-1	2	-1	1	-1	1	-1	-1	-1	-1
BMR-55	1	1350	-1	3	-1	2	-1	2	-1	-1	-1	1
BMR-56	1	1375	-1	2	-1	-1	-1	1	-1	-1	-1	1
BMR-57	1	1400	-1	2	-1	2	-1	1	-1	-1	-1	-1
BMR-58	1	1425	-1	3	-1	2	-1	1	-1	-1	-1	1
BMR-59	1	1450	-1	4	-1	2	-1	2	-1	1	-1	2
BMR-60	1	1475	-1	3	-1	1	-1	1	-1	-1	-1	-1
BMR-61	1	1500	1	5	-1	3	-1	2	-1	-1	-1	-1
BMR-62	1	1525	1	7	1	4	-1	3	-1	-1	-1	-1
BMR-63	1	1550	-1	2	-1	1	-1	-1	-1	-1	-1	2
BMR-64	1	1575	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-65	1	1600	-1	3	-1	2	-1	2	-1	-1	-1	-1
BMR-66	2	0	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-67	2	25	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-68	2	50	-1	4	-1	2	-1	2	-1	-1	-1	-1
Sample	**Transect**	**Metres**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**Hf**	**Ta**	**W**
BMR-69	2	75	-1	3	-1	2	-1	1	-1	-1	-1	2
BMR-70	2	100	-1	2	-1	1	-1	1	-1	-1	-1	-1
BMR-71	2	125	-1	2	-1	1	-1	-1	-1	-1	-1	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-72	2	150	-1	2	-1	-1	-1	-1	-1	-1	-1	-1
BMR-73	2	175	-1	4	-1	3	-1	2	-1	-1	-1	-1
BMR-74	2	200	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-75	2	225	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-76	2	250	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-77	2	275	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-78	2	300	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-79	2	325	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-80	2	350	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-81	2	375	-1	3	-1	2	-1	-1	-1	-1	-1	-1
BMR-82	2	400	-1	3	-1	2	-1	2	-1	-1	-1	-1
BMR-83	2	425	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-84	2	450	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-85	2	475	-1	4	-1	2	-1	1	-1	-1	-1	-1
BMR-86	2	500	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-87	3	0	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-88	3	25	-1	1	-1	1	-1	-1	-1	-1	-1	-1
BMR-89	3	50	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-90	3	75	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-91	3	100	-1	6	1	3	-1	3	-1	-1	-1	-1
BMR-92	3	125	1	5	-1	3	-1	2	-1	-1	-1	-1
BMR-93	3	150	-1	3	-1	2	-1	-1	-1	-1	-1	-1
BMR-94	3	175	-1	2	-1	1	-1	-1	-1	-1	-1	-1
BMR-95	3	200	4	3	2	3	2	4	4	-1	-1	-1
BMR-96	3	225	3	4	1	3	1	3	2	-1	-1	-1
BMR-97	3	250	2	2	1	2	-1	2	2	-1	-1	-1
BMR-98	3	275	1	2	-1	1	-1	2	-1	-1	-1	-1
BMR-99	3	300	1	3	-1	2	-1	2	-1	-1	-1	-1
BMR-100	3	325	-1	2	-1	1	-1	1	-1	-1	-1	-1
BMR-101	4	0	-1	2	-1	1	-1	1	-1	-1	-1	-1
BMR-102	4	25	-1	3	-1	2	-1	1	-1	-1	-1	-1
Sample	**Transect**	**Metres**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**	**Hf**	**Ta**	**W**
BMR-103	4	50	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-104	4	75	-1	4	-1	2	-1	2	-1	-1	-1	1
BMR-105	4	100	-1	4	-1	2	-1	1	-1	-1	-1	1
BMR-106	4	125	-1	3	-1	2	-1	1	-1	-1	-1	-1
BMR-107	5	0	-1	3	-1	1	-1	-1	-1	-1	-1	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-108	5	25	-1	4	-1	2	-1	2	-1	-1	-1	-1
BMR-109	5	50	-1	2	-1	1	-1	1	-1	-1	-1	-1
BMR-110	5	75	-1	4	-1	2	-1	1	-1	-1	-1	-1
BMR-111	6	0	27	-1	152	13	17	4	15	3	1	4
BMR-112	6	25	46	-1	316	9	16	3	10	3	-1	3
BMR-113	6	50	28	-1	163	8	14	2	8	2	-1	2
BMR-114	6	75	83	-1	370	9	16	3	9	2	-1	3
BMR-115	6	100	46	-1	551	14	26	4	14	3	1	4
BMR-116	6	125	63	-1	817	11	21	3	11	3	1	3
BMR-117	6	150	61	-1	477	12	21	3	12	3	-1	3

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

Sample	Transect	Metres	Re	Os	Pt	Au	SQHg	Tl	Pb	Bi	Th	U
BMR-1	1	0	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	-1
BMR-2	1	25	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	1
BMR-3	1	50	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	-1
BMR-4	1	75	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	-1
BMR-5	1	100	-0.1	-1	-1	-0.1	-1	-1	6	-1	1	1
BMR-6	1	125	-0.1	-1	-1	-0.1	-1	-1	4	-1	1	1
BMR-7	1	150	-0.1	-1	-1	-0.1	-1	-1	8	-1	5	2
BMR-8	1	175	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	1
BMR-9	1	200	-0.1	-1	-1	-0.1	-1	-1	5	-1	4	2
BMR-10	1	225	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	-1
BMR-11	1	250	-0.1	-1	-1	-0.1	-1	-1	4	-1	-1	1
BMR-12	1	275	-0.1	-1	-1	-0.1	-1	-1	4	-1	4	2
BMR-13	1	300	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	-1
BMR-14	1	325	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	-1
BMR-15	1	350	-0.1	-1	-1	-0.1	-1	-1	5	-1	3	1
BMR-16	1	375	-0.1	-1	-1	-0.1	-1	-1	4	-1	1	-1
BMR-17	1	400	-0.1	-1	-1	-0.1	-1	-1	7	-1	4	1
BMR-18	1	425	-0.1	-1	-1	-0.1	-1	-1	4	-1	2	-1
BMR-19	1	450	-0.1	-1	-1	-0.1	-1	-1	2	-1	-1	-1
BMR-20	1	475	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	1
BMR-21	1	500	-0.1	-1	-1	-0.1	-1	-1	6	-1	5	1
BMR-22	1	525	-0.1	-1	-1	-0.1	-1	-1	4	-1	5	2
BMR-23	1	550	-0.1	-1	-1	-0.1	-1	-1	5	-1	4	2
BMR-24	1	575	-0.1	-1	-1	-0.1	-1	-1	3	-1	5	2
BMR-25	1	600	-0.1	-1	-1	-0.1	-1	-1	3	-1	5	3
BMR-26	1	625	-0.1	-1	-1	-0.1	-1	-1	7	-1	5	2
BMR-27	1	650	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-28	1	675	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-29	1	700	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-30	1	725	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-31	1	750	0.1	-1	-1	-0.1	-1	-1	18	-1	10	7
BMR-32	1	775	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-33	1	800	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-34	1	825	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sample	Transect	Metres	Re	Os	Pt	Au	SQHg	Tl	Pb	Bi	Th	U
BMR-35	1	850	-0.1	-1	-1	-0.1	-1	-1	6	-1	4	2

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-36	1	875	-0.1	-1	-1	-0.1	-1	-1	4	-1	2	1
BMR-37	1	900	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	1
BMR-38	1	925	-0.1	-1	-1	-0.1	-1	-1	6	-1	2	1
BMR-39	1	950	-0.1	-1	-1	-0.1	-1	-1	7	-1	2	1
BMR-40	1	975	-0.1	-1	-1	-0.1	-1	-1	4	-1	-1	-1
BMR-41	1	1000	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	2
BMR-42	1	1025	-0.1	-1	-1	-0.1	-1	-1	2	-1	3	-1
BMR-43	1	1050	-0.1	-1	-1	-0.1	-1	-1	4	-1	1	-1
BMR-44	1	1075	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	1
BMR-45	1	1100	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	-1
BMR-46	1	1125	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	-1
BMR-47	1	1150	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	1
BMR-48	1	1175	-0.1	-1	-1	-0.1	-1	-1	4	-1	2	1
BMR-49	1	1200	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	-1
BMR-50	1	1225	-0.1	-1	-1	-0.1	-1	-1	4	-1	-1	1
BMR-51	1	1250	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	2
BMR-52	1	1275	-0.1	-1	-1	-0.1	-1	-1	8	-1	4	3
BMR-53	1	1300	-0.1	-1	-1	-0.1	-1	-1	8	-1	4	2
BMR-54	1	1325	-0.1	-1	-1	-0.1	-1	-1	8	-1	3	3
BMR-55	1	1350	-0.1	-1	-1	-0.1	-1	-1	7	-1	3	2
BMR-56	1	1375	-0.1	-1	-1	-0.1	-1	-1	5	-1	-1	1
BMR-57	1	1400	-0.1	-1	-1	-0.1	-1	-1	4	-1	1	1
BMR-58	1	1425	-0.1	-1	-1	-0.1	-1	-1	4	-1	2	1
BMR-59	1	1450	-0.1	-1	-1	-0.1	-1	-1	11	-1	9	3
BMR-60	1	1475	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	1
BMR-61	1	1500	-0.1	-1	-1	-0.1	-1	-1	7	-1	5	2
BMR-62	1	1525	-0.1	-1	-1	-0.1	-1	-1	4	-1	3	1
BMR-63	1	1550	-0.1	-1	-1	-0.1	-1	-1	2	-1	2	1
BMR-64	1	1575	-0.1	-1	-1	-0.1	-1	-1	1	-1	1	-1
BMR-65	1	1600	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	1
BMR-66	2	0	-0.1	-1	-1	-0.1	-1	-1	8	-1	6	2
BMR-67	2	25	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	-1
BMR-68	2	50	-0.1	-1	-1	-0.1	-1	-1	5	-1	1	-1
Sample	**Transect**	**Metres**	**Re**	**Os**	**Pt**	**Au**	**SQHg**	**Tl**	**Pb**	**Bi**	**Th**	**U**
BMR-69	2	75	-0.1	-1	-1	-0.1	-1	-1	6	-1	3	1
BMR-70	2	100	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	-1
BMR-71	2	125	-0.1	-1	-1	-0.1	-1	-1	5	-1	1	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

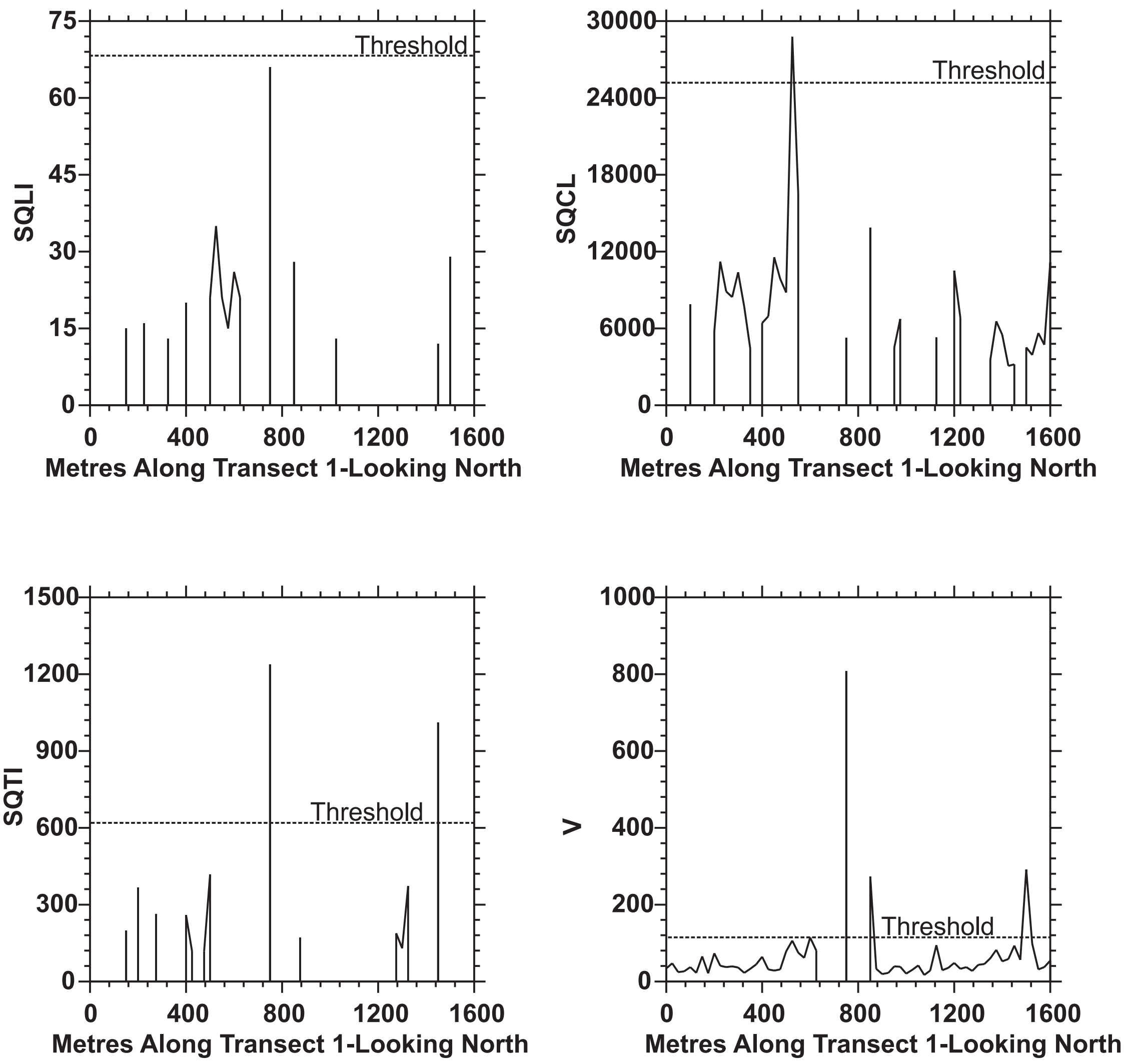
BMR-72	2	150	-0.1	-1	-1	-0.1	-1	-1	4	-1	-1	-1
BMR-73	2	175	-0.1	-1	-1	-0.1	-1	-1	4	-1	1	1
BMR-74	2	200	-0.1	-1	-1	-0.1	-1	-1	6	-1	3	1
BMR-75	2	225	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-76	2	250	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BMR-77	2	275	-0.1	-1	-1	-0.1	-1	-1	5	-1	8	2
BMR-78	2	300	-0.1	-1	-1	-0.1	-1	-1	6	-1	3	-1
BMR-79	2	325	-0.1	-1	-1	-0.1	-1	-1	8	-1	4	3
BMR-80	2	350	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	-1
BMR-81	2	375	-0.1	-1	-1	-0.1	-1	-1	5	-1	4	2
BMR-82	2	400	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	-1
BMR-83	2	425	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	-1
BMR-84	2	450	-0.1	-1	-1	-0.1	-1	-1	5	-1	6	2
BMR-85	2	475	-0.1	-1	-1	-0.1	-1	-1	4	-1	3	2
BMR-86	2	500	-0.1	-1	-1	-0.1	-1	-1	4	-1	5	2
BMR-87	3	0	-0.1	-1	-1	-0.1	-1	-1	3	-1	1	-1
BMR-88	3	25	-0.1	-1	-1	-0.1	-1	-1	2	-1	-1	-1
BMR-89	3	50	-0.1	-1	-1	-0.1	-1	-1	3	-1	-1	-1
BMR-90	3	75	-0.1	-1	-1	-0.1	-1	-1	2	-1	1	-1
BMR-91	3	100	-0.1	-1	-1	-0.1	-1	-1	5	-1	1	-1
BMR-92	3	125	-0.1	-1	-1	-0.1	-1	-1	5	-1	2	-1
BMR-93	3	150	-0.1	-1	-1	-0.1	-1	-1	4	-1	4	1
BMR-94	3	175	-0.1	-1	-1	-0.1	-1	-1	5	-1	3	-1
BMR-95	3	200	-0.1	-1	-1	-0.1	-1	-1	4	-1	4	-1
BMR-96	3	225	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	2
BMR-97	3	250	-0.1	-1	-1	-0.1	-1	-1	7	-1	-1	-1
BMR-98	3	275	-0.1	-1	-1	-0.1	-1	-1	5	-1	1	-1
BMR-99	3	300	-0.1	-1	-1	-0.1	-1	-1	5	-1	2	-1
BMR-100	3	325	-0.1	-1	-1	-0.1	-1	-1	5	-1	2	1
BMR-101	4	0	-0.1	-1	-1	-0.1	-1	-1	4	-1	2	1
BMR-102	4	25	-0.1	-1	-1	-0.1	-1	-1	5	-1	2	-1
Sample	**Transect**	**Metres**	**Re**	**Os**	**Pt**	**Au**	**SQHg**	**Tl**	**Pb**	**Bi**	**Th**	**U**
BMR-103	4	50	-0.1	-1	-1	-0.1	-1	-1	5	-1	3	1
BMR-104	4	75	-0.1	-1	-1	-0.1	-1	-1	7	-1	5	1
BMR-105	4	100	-0.1	-1	-1	-0.1	-1	-1	4	-1	2	1
BMR-106	4	125	-0.1	-1	-1	-0.1	-1	-1	4	-1	5	1
BMR-107	5	0	-0.1	-1	-1	-0.1	-1	-1	3	-1	2	-1

Appendix 6 (Part 2): Geochemical analyses (by Enzyme Leach[SM] and ICP-MS) of samples collected from transects 1 to 6, Mafeking quarries area. NS indicates no sample.

BMR-108	5	25	-0.1	-1	-1	-0.1	-1	-1	4	-1	9	2
BMR-109	5	50	0.1	-1	-1	-0.1	-1	-1	4	-1	4	3
BMR-110	5	75	-0.1	-1	-1	-0.1	-1	-1	5	-1	10	2
BMR-111	6	0	-1	2	-1	1	-1	1	-1	-1	-1	-1
BMR-112	6	25	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-113	6	50	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-114	6	75	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-115	6	100	-1	2	-1	-1	-1	-1	-1	-1	-1	2
BMR-116	6	125	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
BMR-117	6	150	-1	1	-1	-1	-1	-1	-1	-1	-1	-1

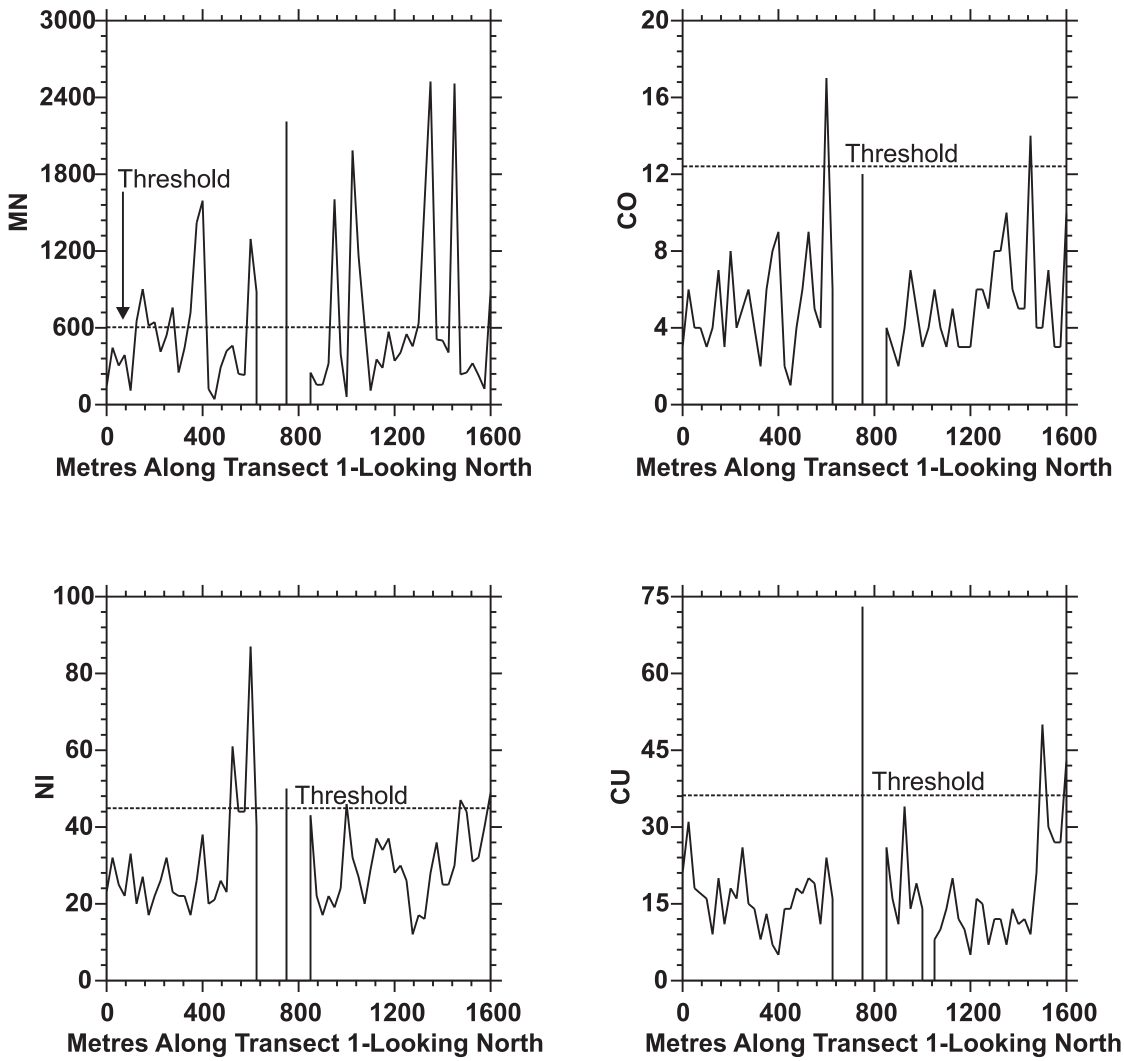
Appendix 7: Enzyme Leach^{SM} geochemical profiles

Enzyme Leach Profiles:Transect 1

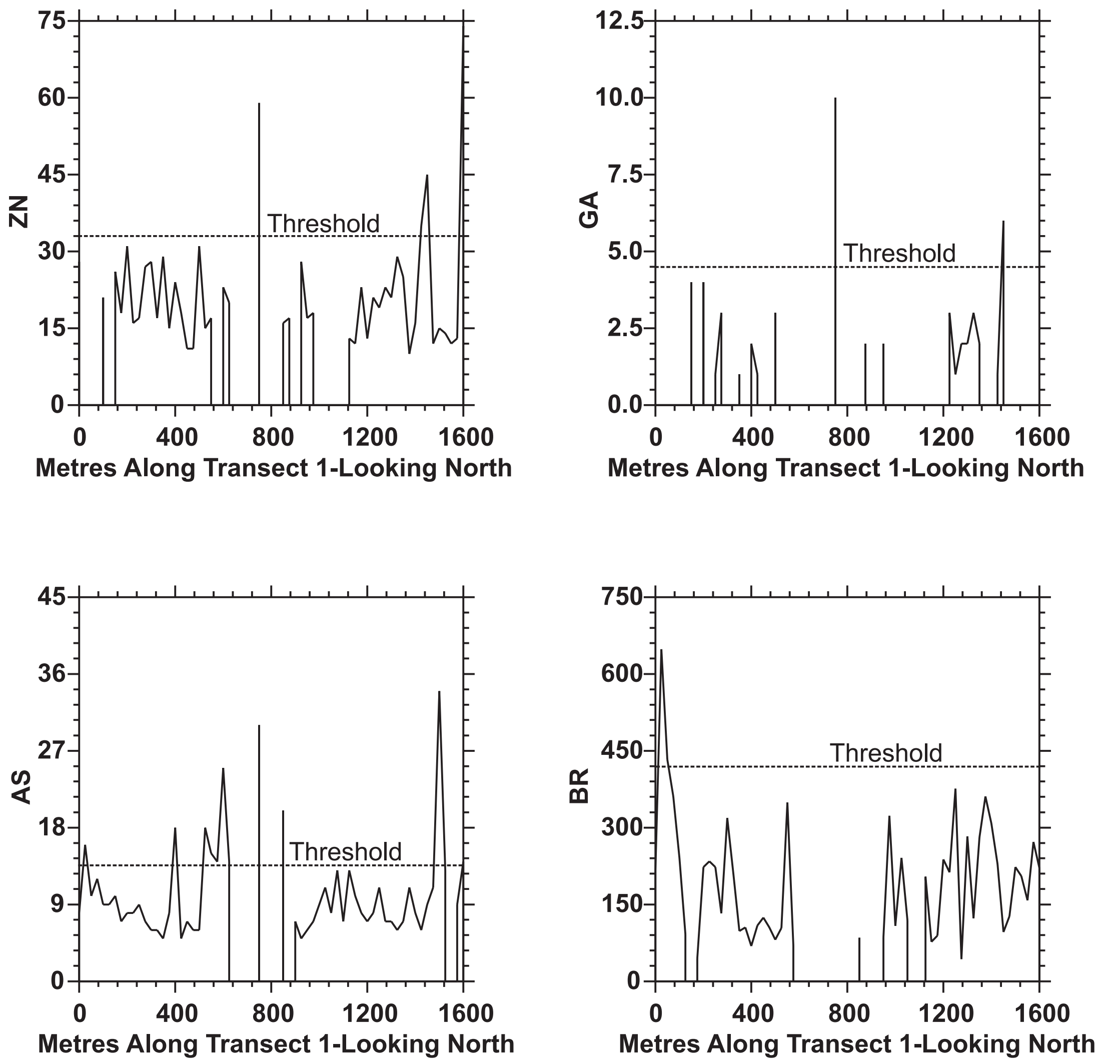


Appendix 7: Enzyme Leach[SM] geochemical profiles

Enzyme Leach Profiles:Transect 1

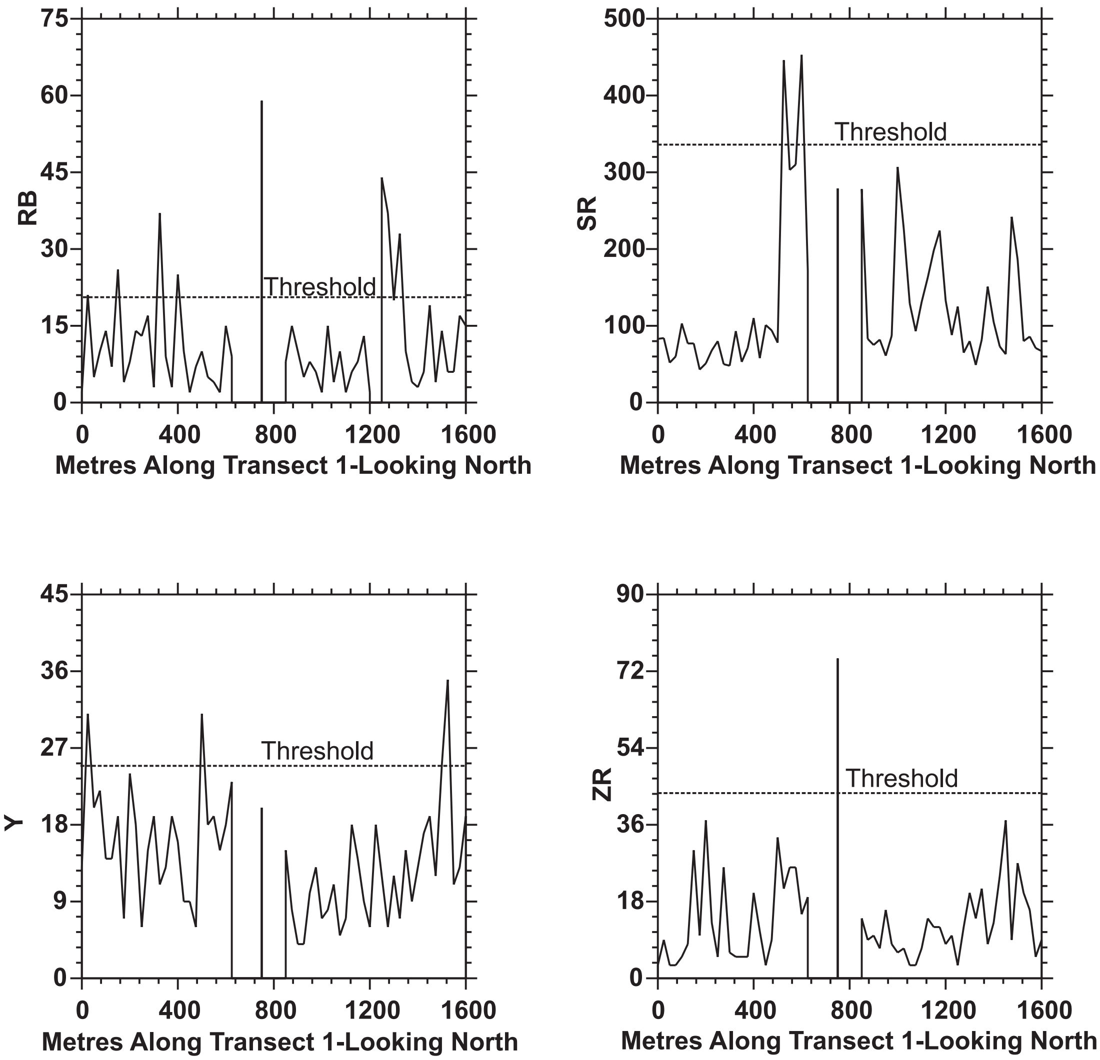


Enzyme Leach Profiles:Transect 1



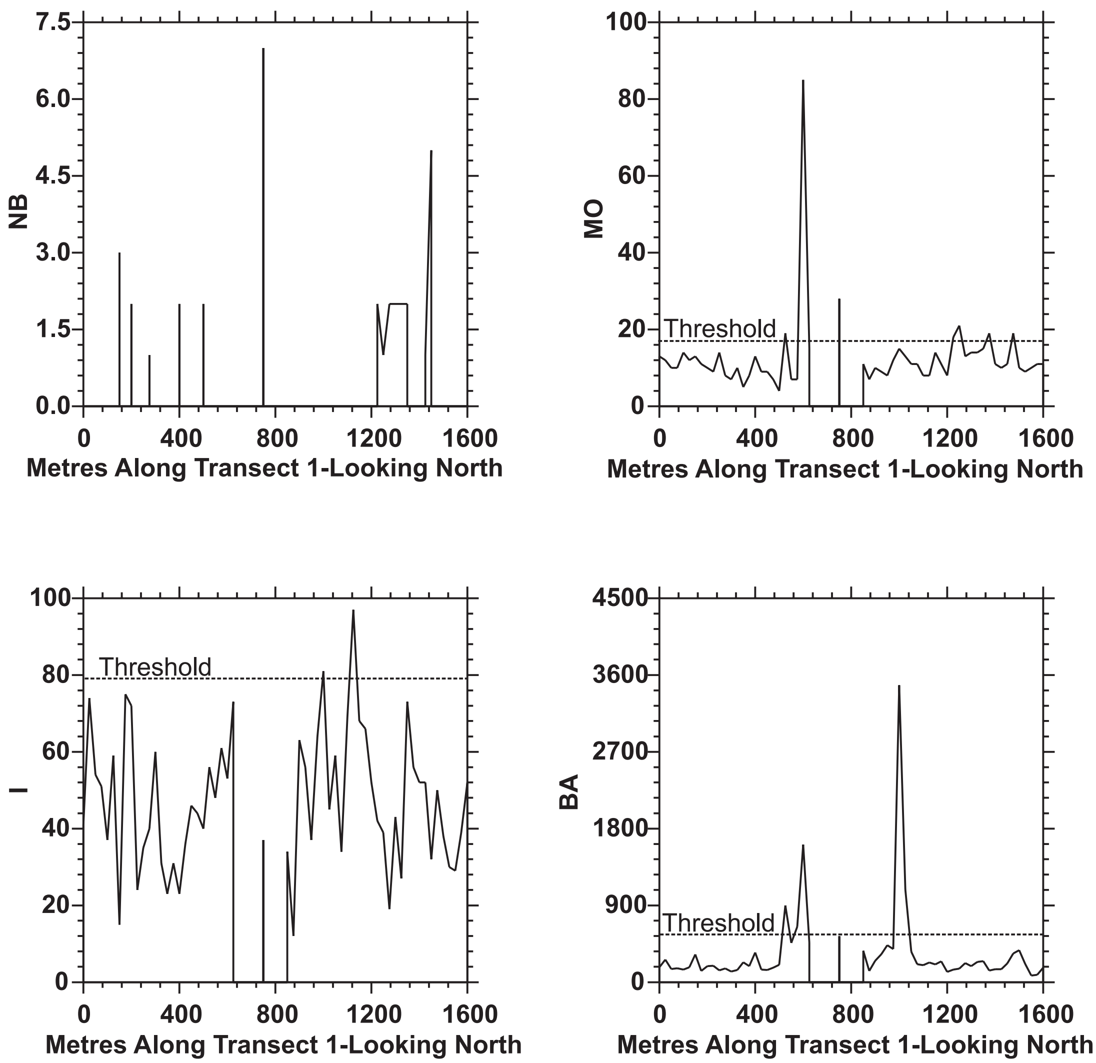
Appendix 7: Enzyme Leach[SM] geochemical profiles

Enzyme Leach Profiles:Transect 1



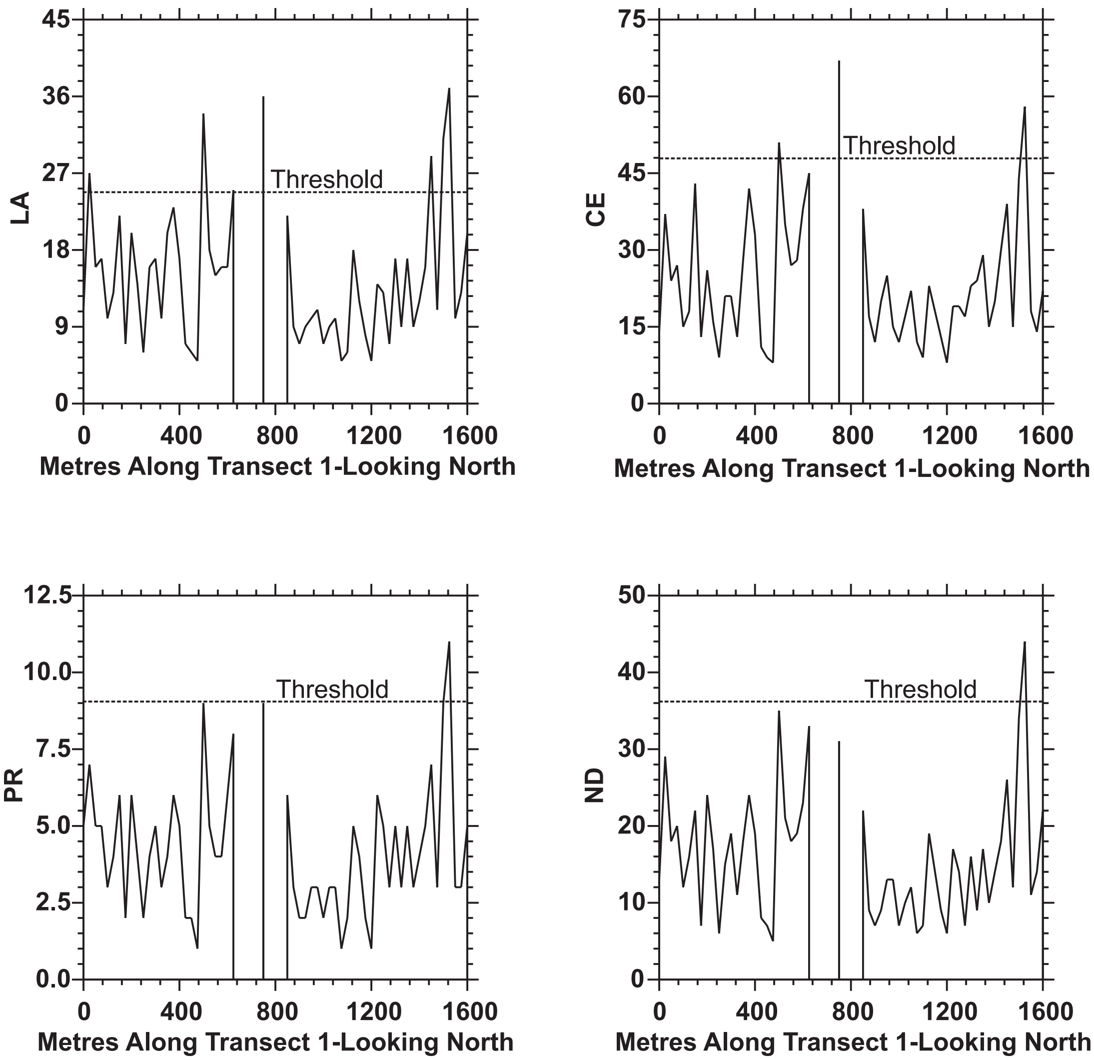
Appendix 7: Enzyme Leach[SM] geochemical profiles

Enzyme Leach Profiles:Transect 1



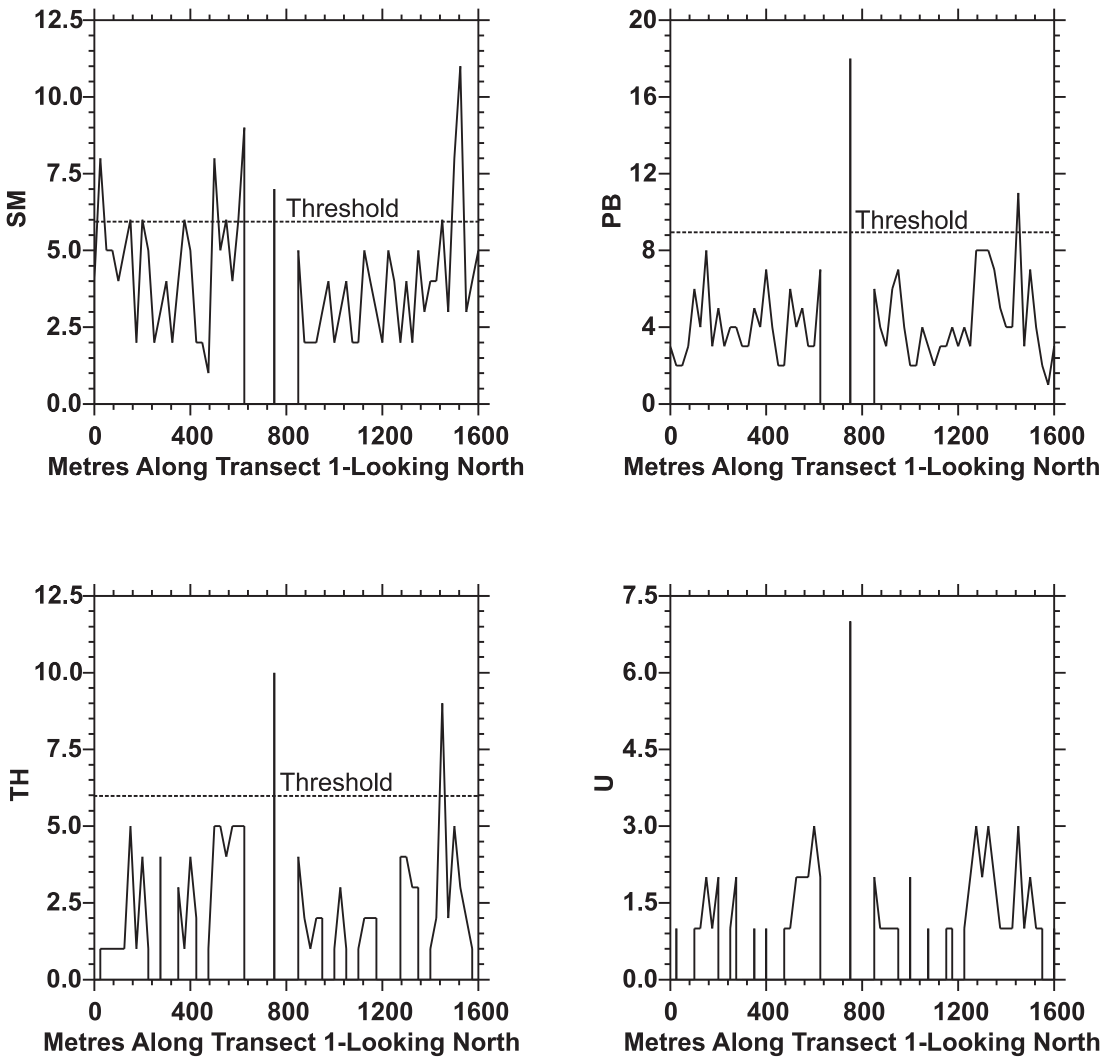
Appendix 7: Enzyme Leach[SM] geochemical profiles

Enzyme Leach Profiles:Transect 1

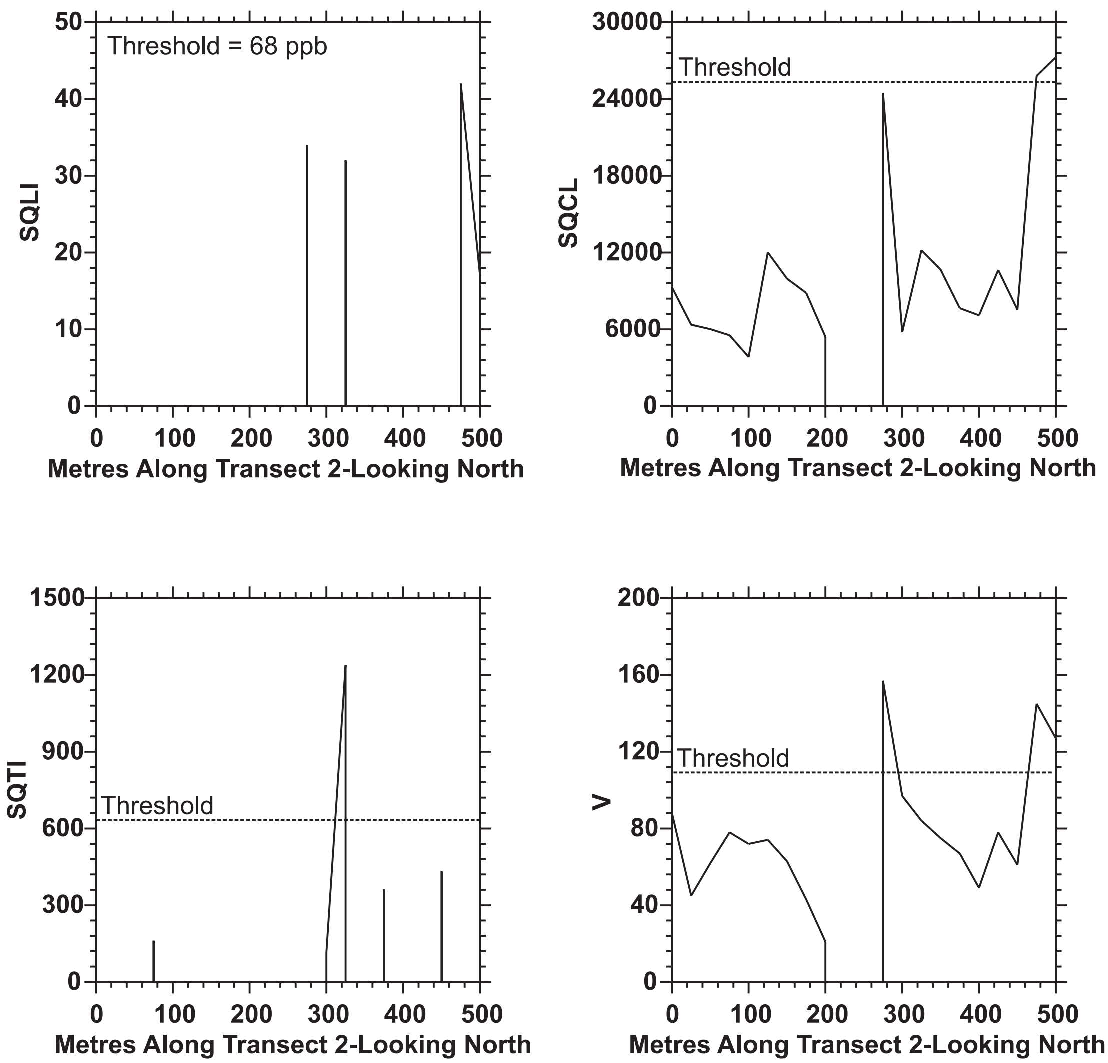


Appendix 7: Enzyme Leach^{SM} geochemical profiles

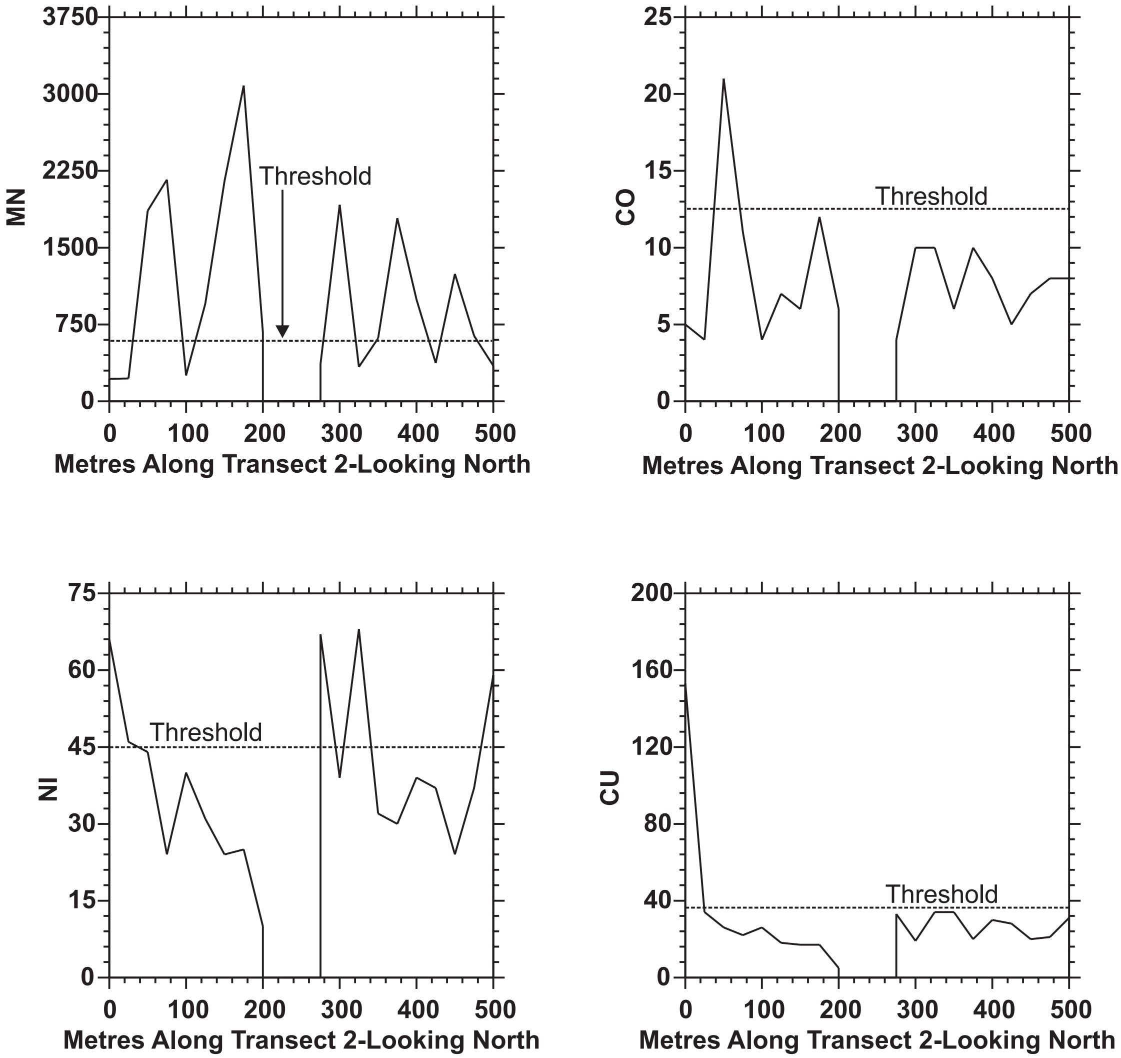
Enzyme Leach Profiles:Transect 1



Enzyme Leach Profiles:Transect 2



Enzyme Leach Profiles:Transect 2



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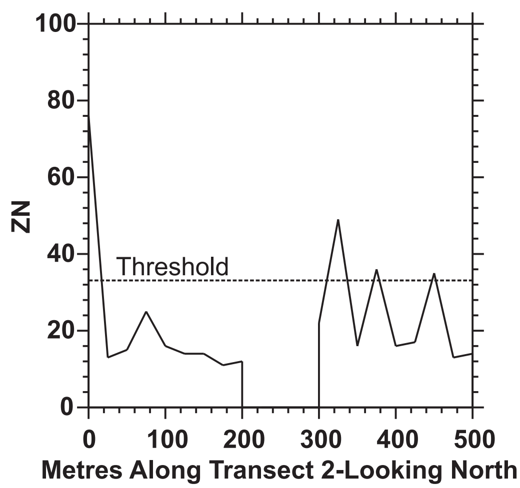
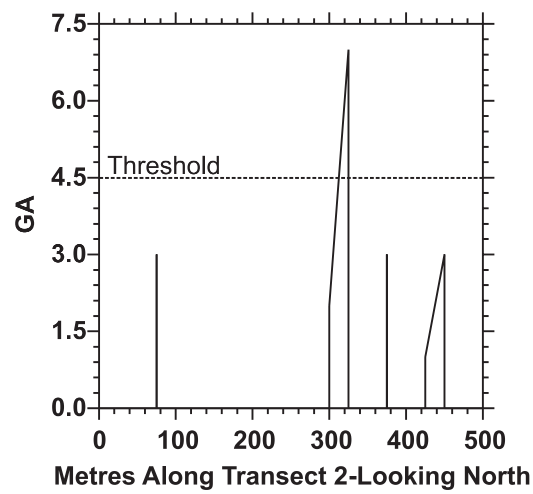
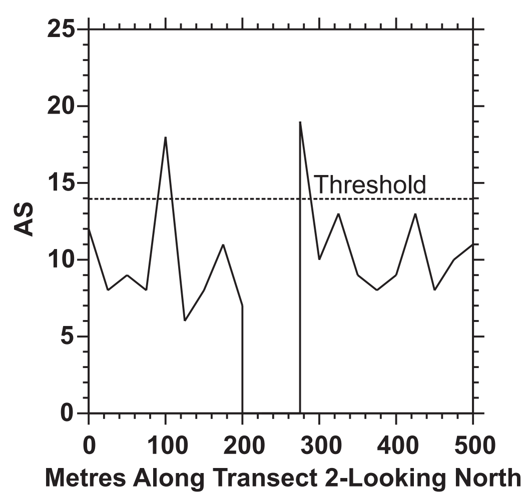
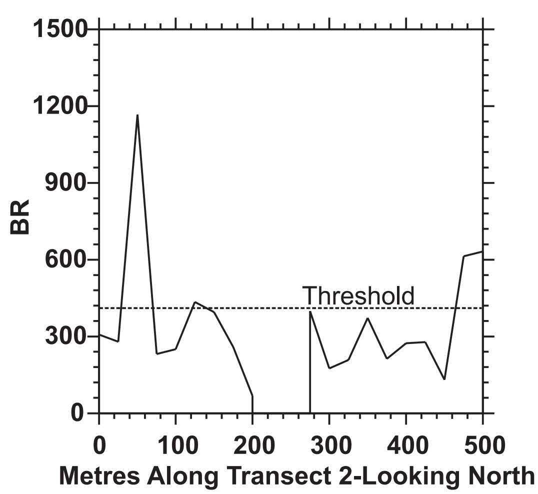
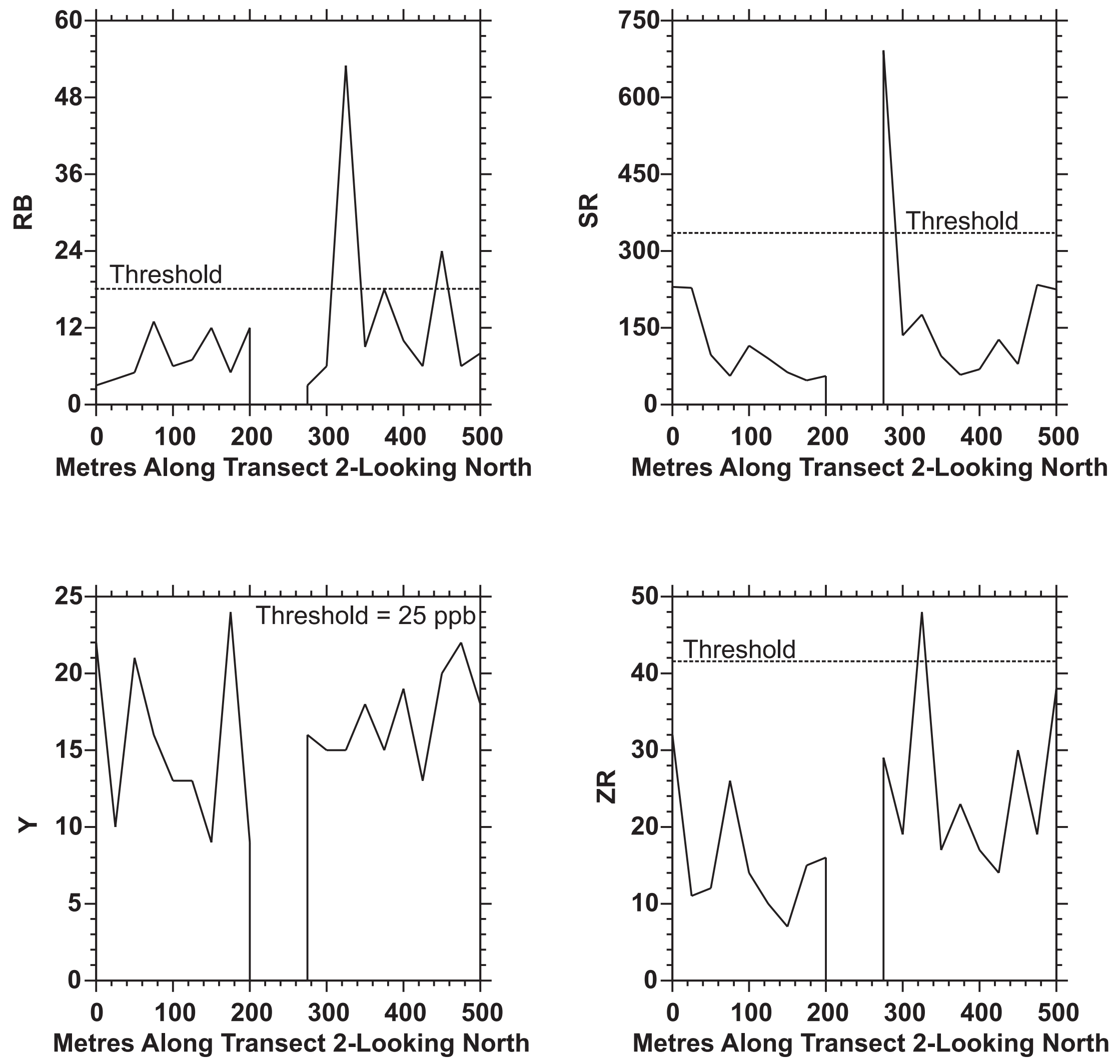








Enzyme Leach Profiles:Transect 2



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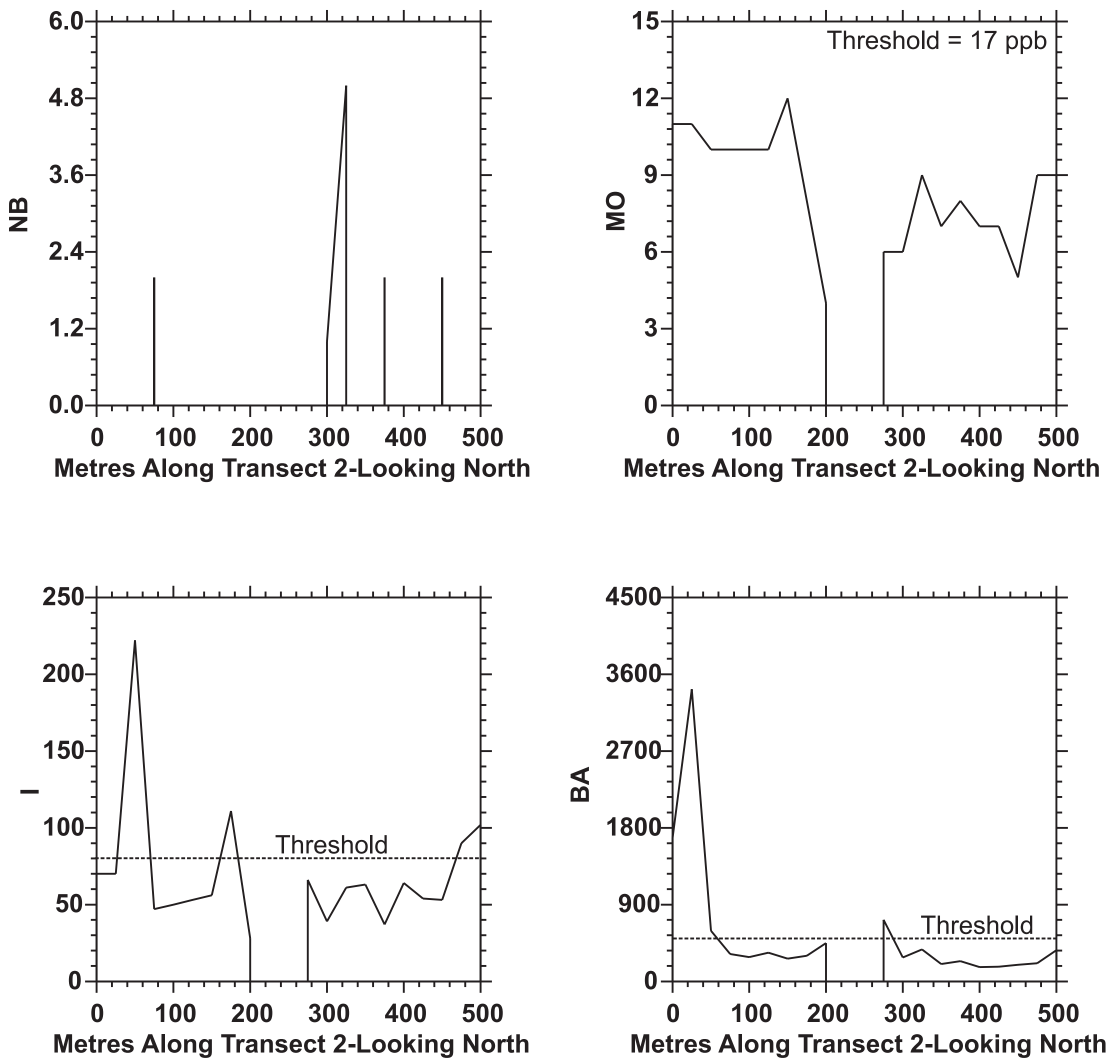
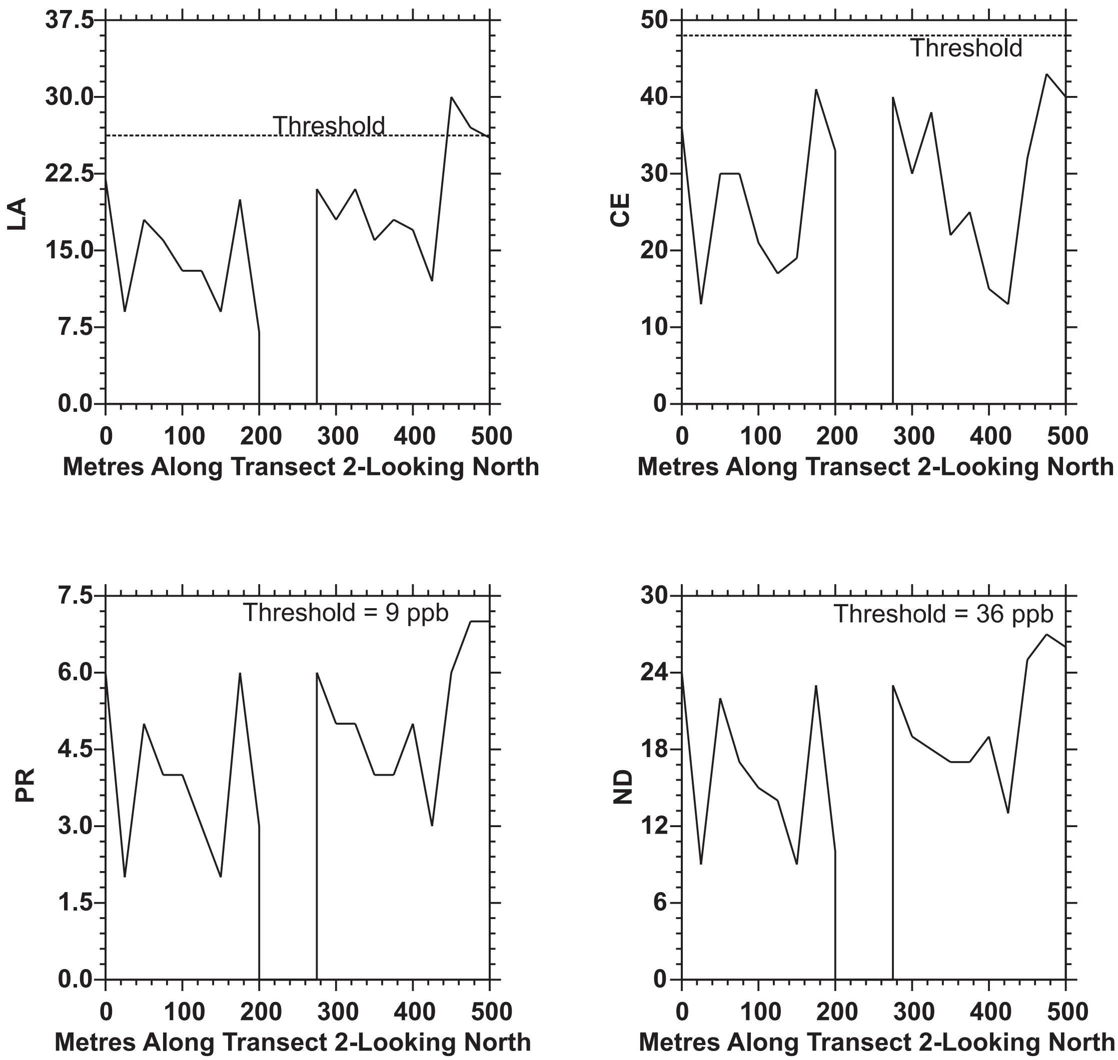
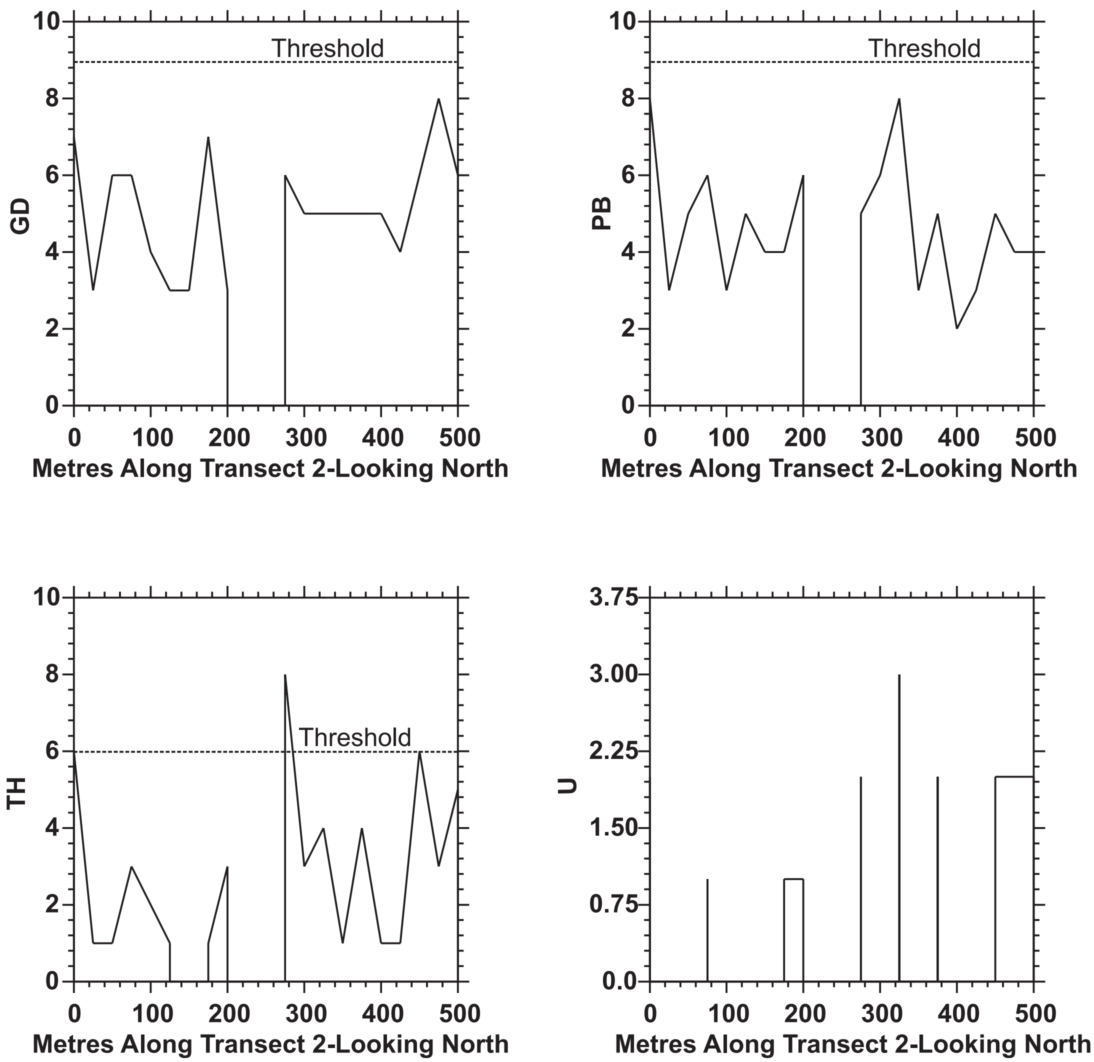


Enzyme Leach Profiles:Transect 2

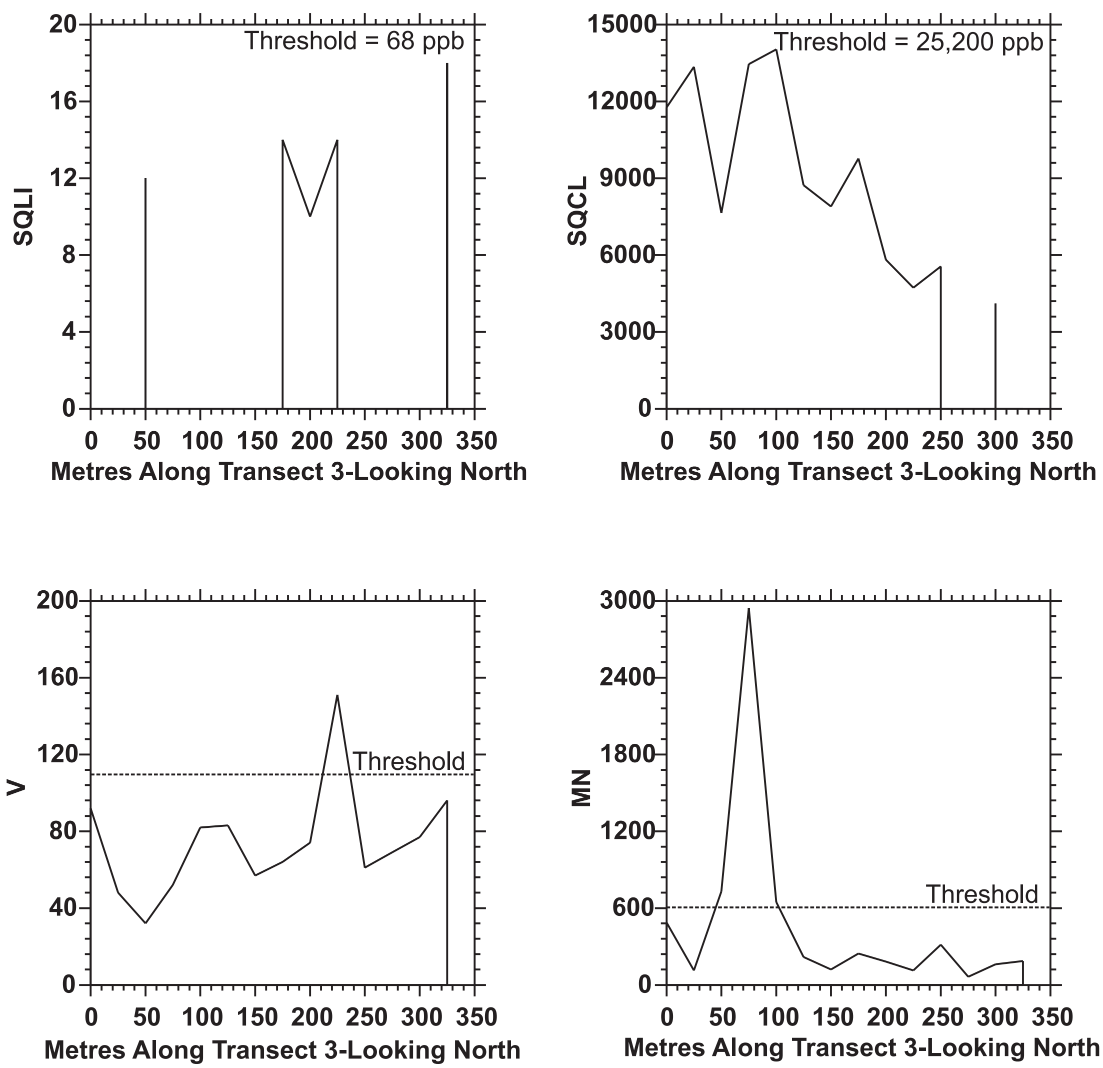


Appendix 7: Enzyme Leach℠ geochemical profiles

Enzyme Leach Profiles:Transect 2

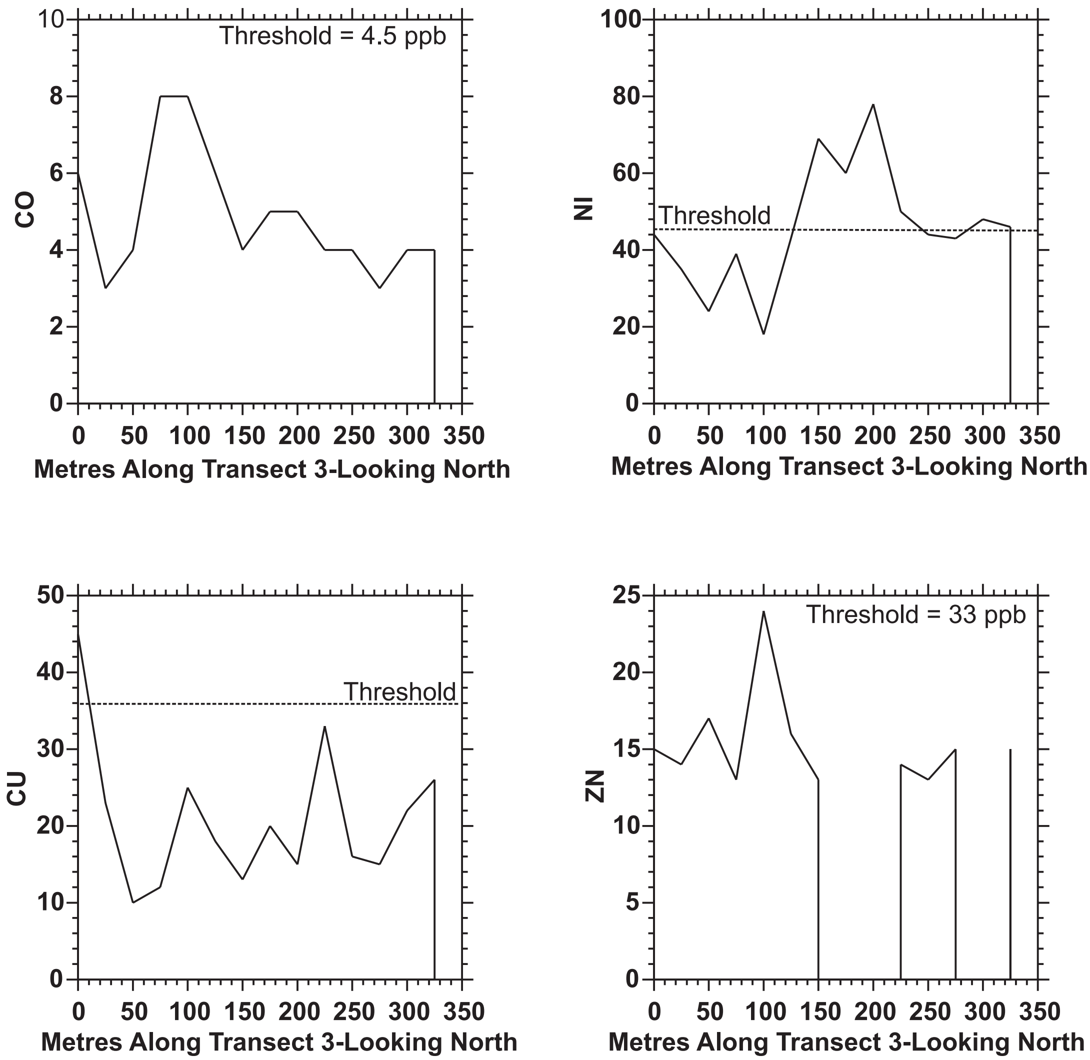


Enzyme Leach Profiles:Transect 3

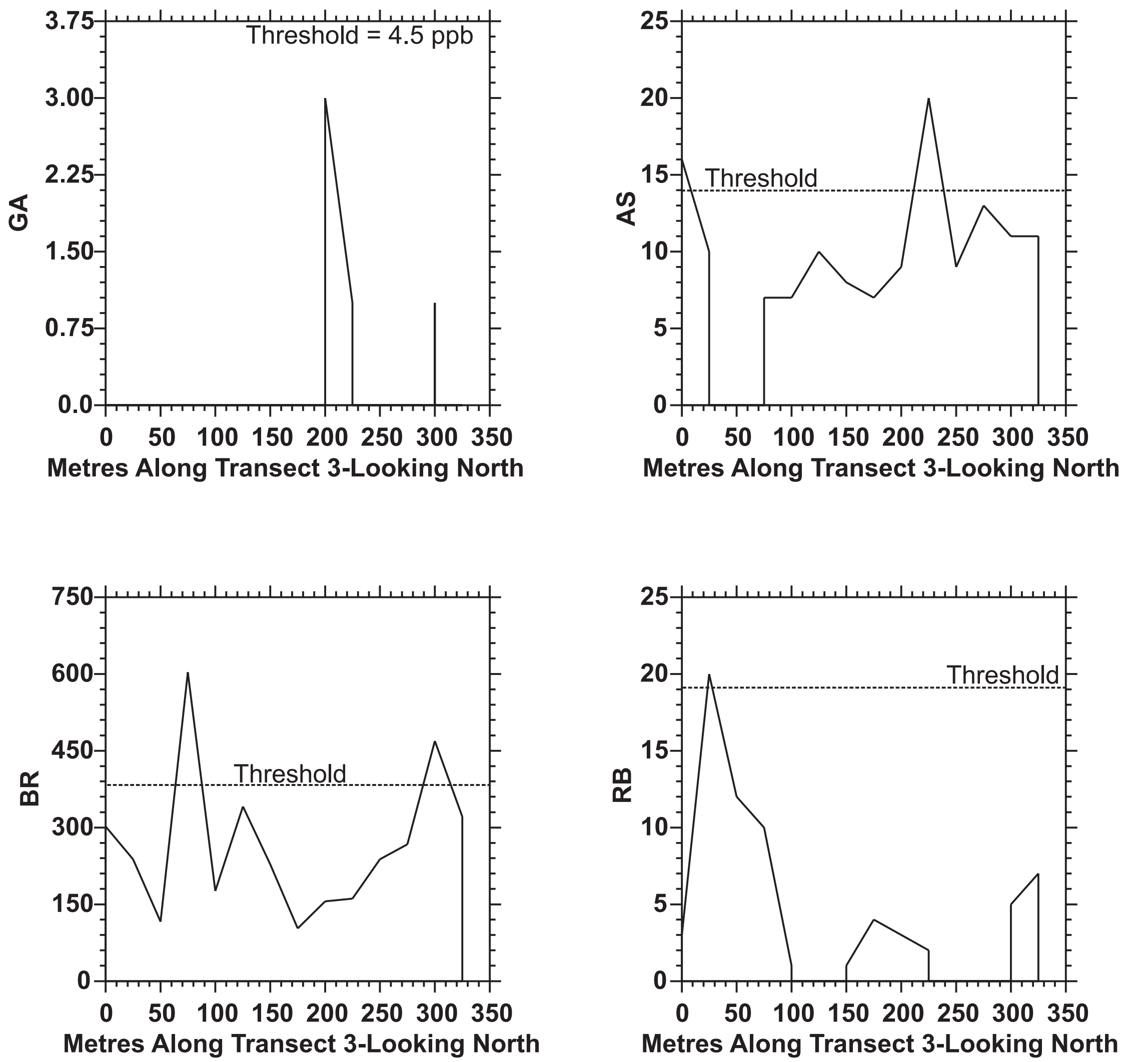


Appendix 7: Enzyme Leach[SM] geochemical profiles

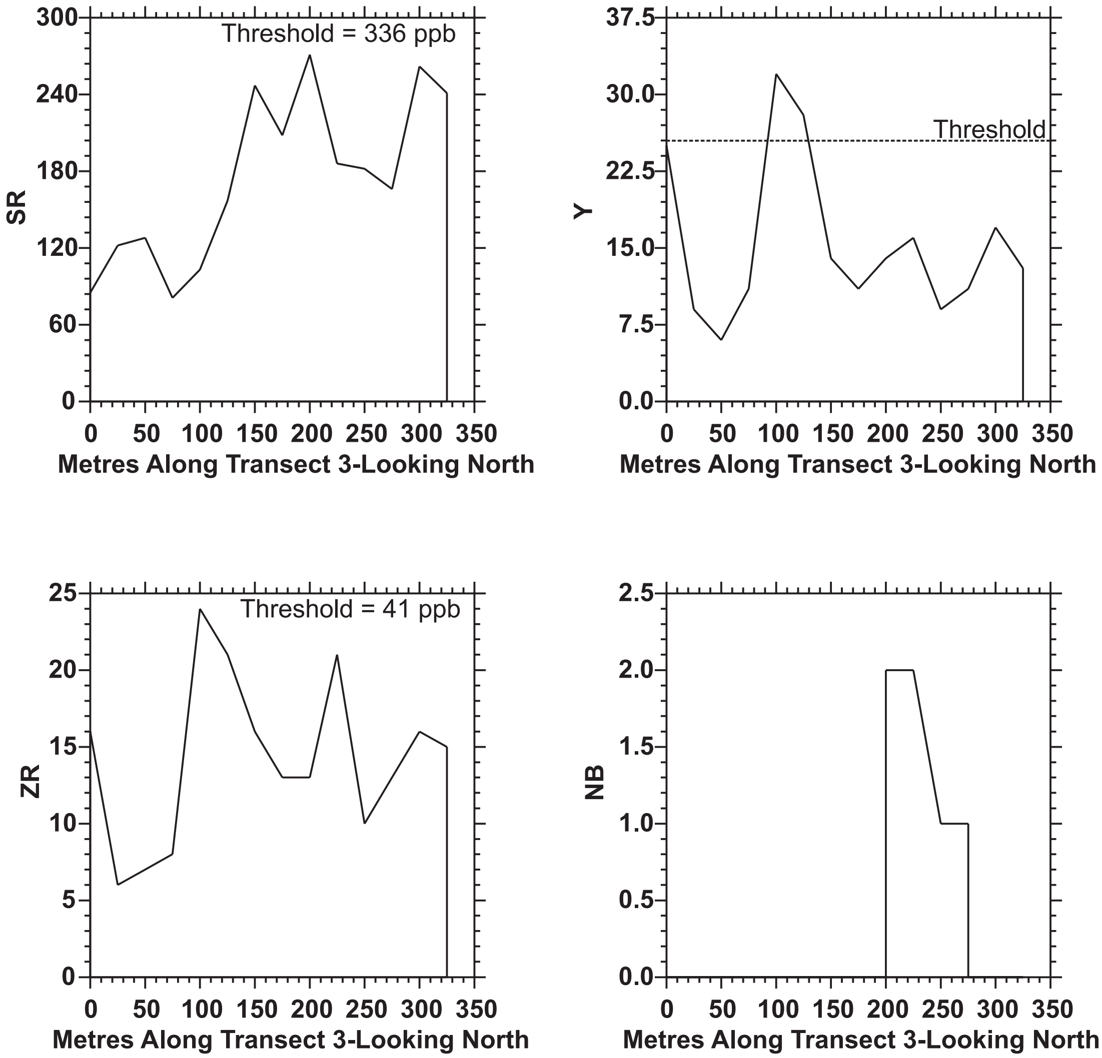
Enzyme Leach Profiles:Transect 3



Enzyme Leach Profiles:Transect 3

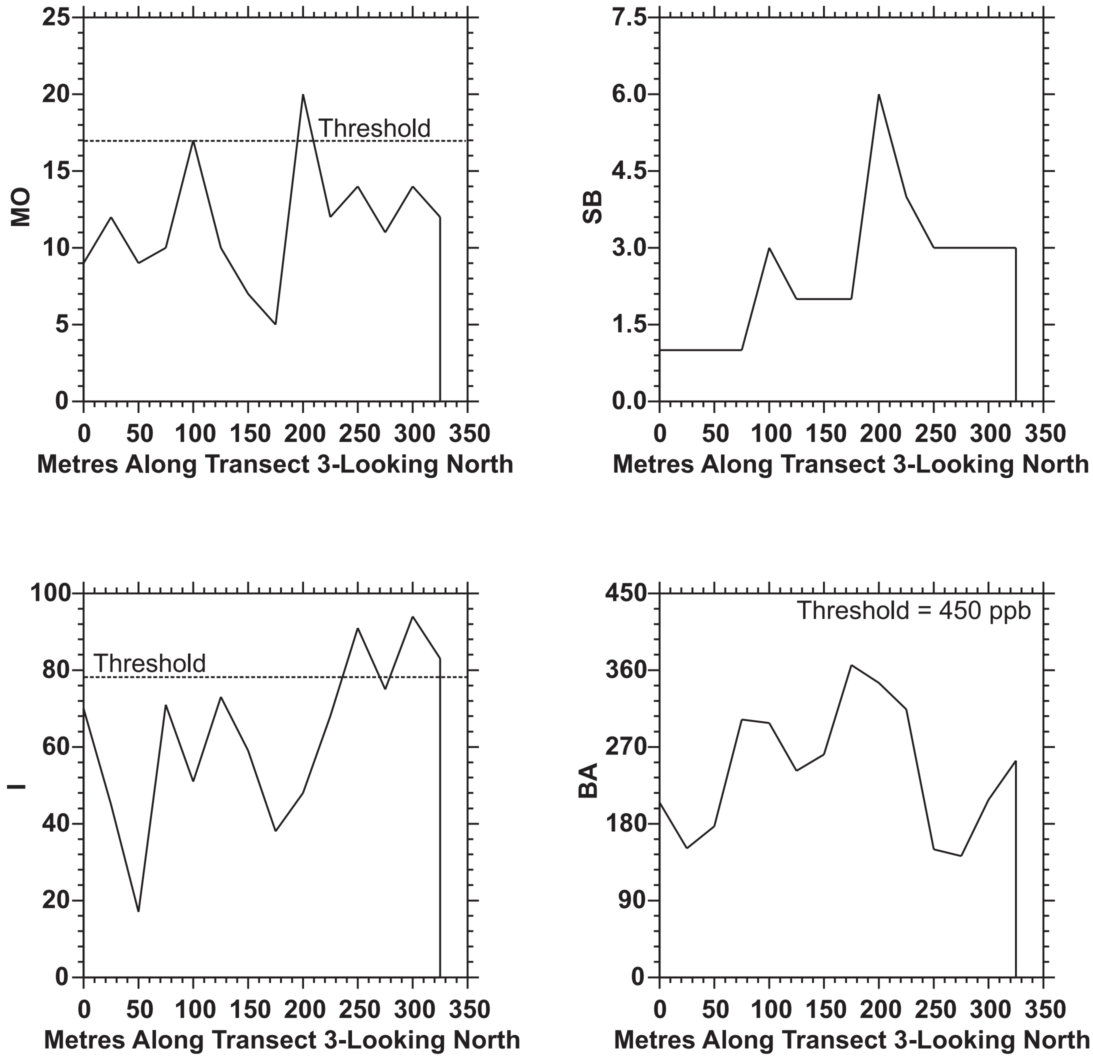


Enzyme Leach Profiles:Transect 3



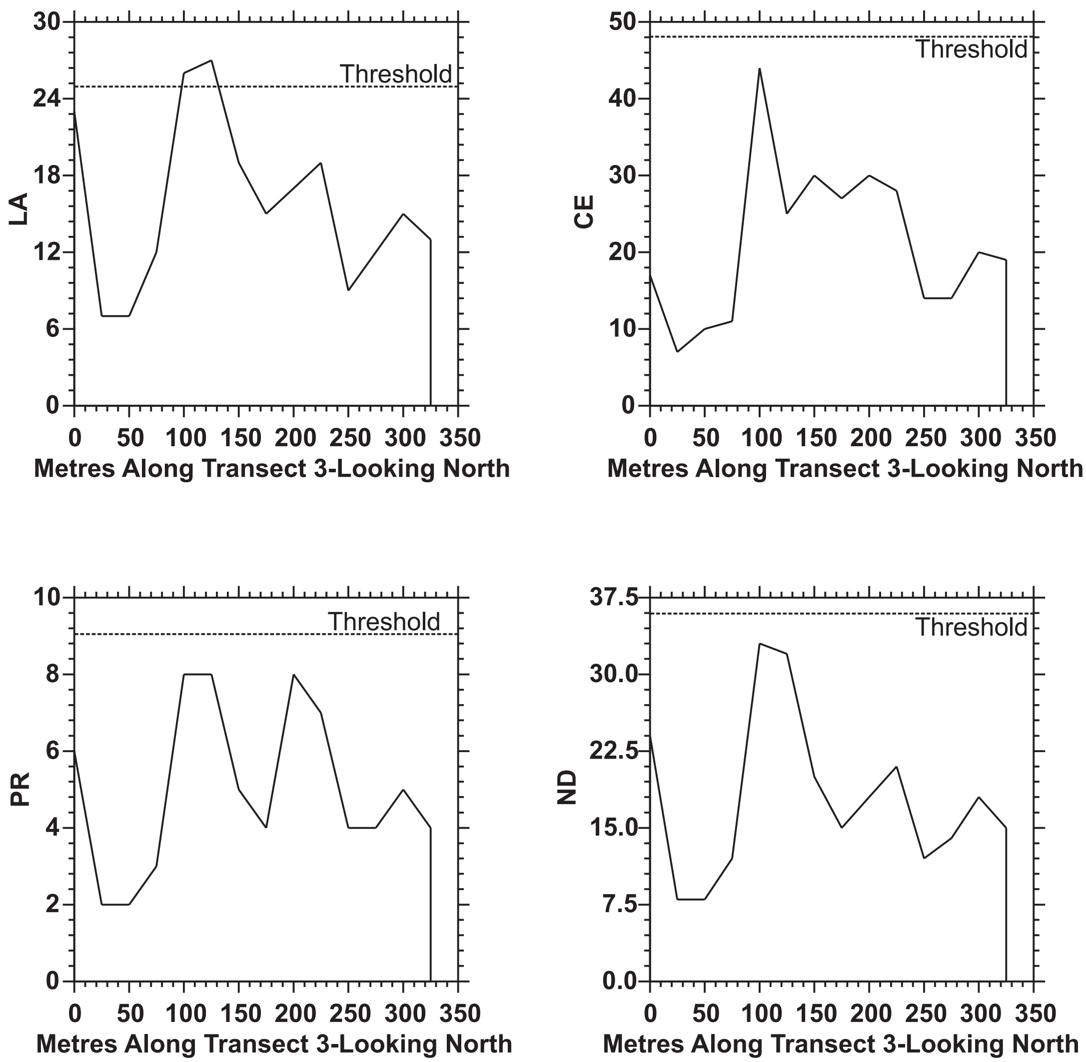
Appendix 7: Enzyme Leach^{SM} geochemical profiles

Enzyme Leach Profiles:Transect 3

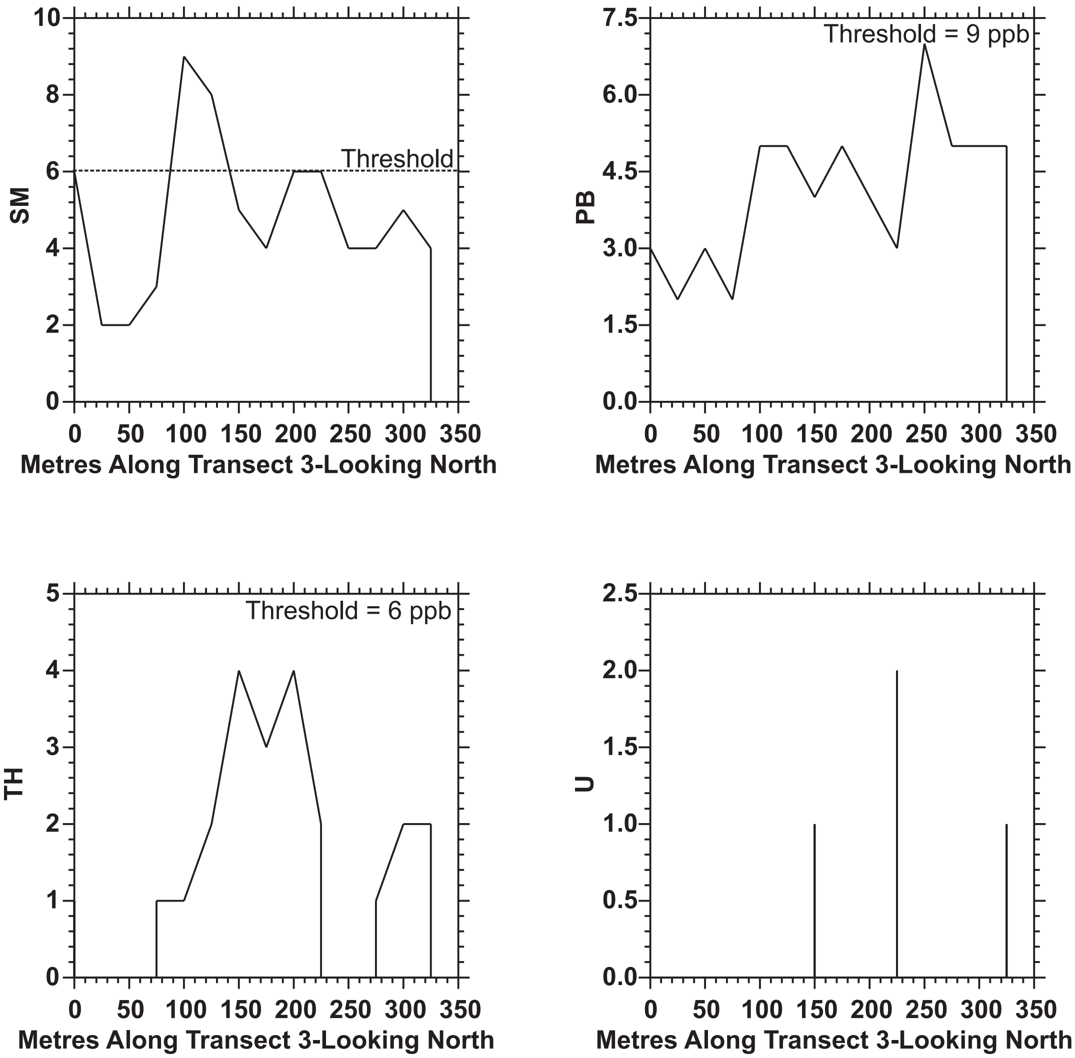


Appendix 7: Enzyme Leach[SM] geochemical profiles

Enzyme Leach Profiles:Transect 3



Enzyme Leach Profiles:Transect 3



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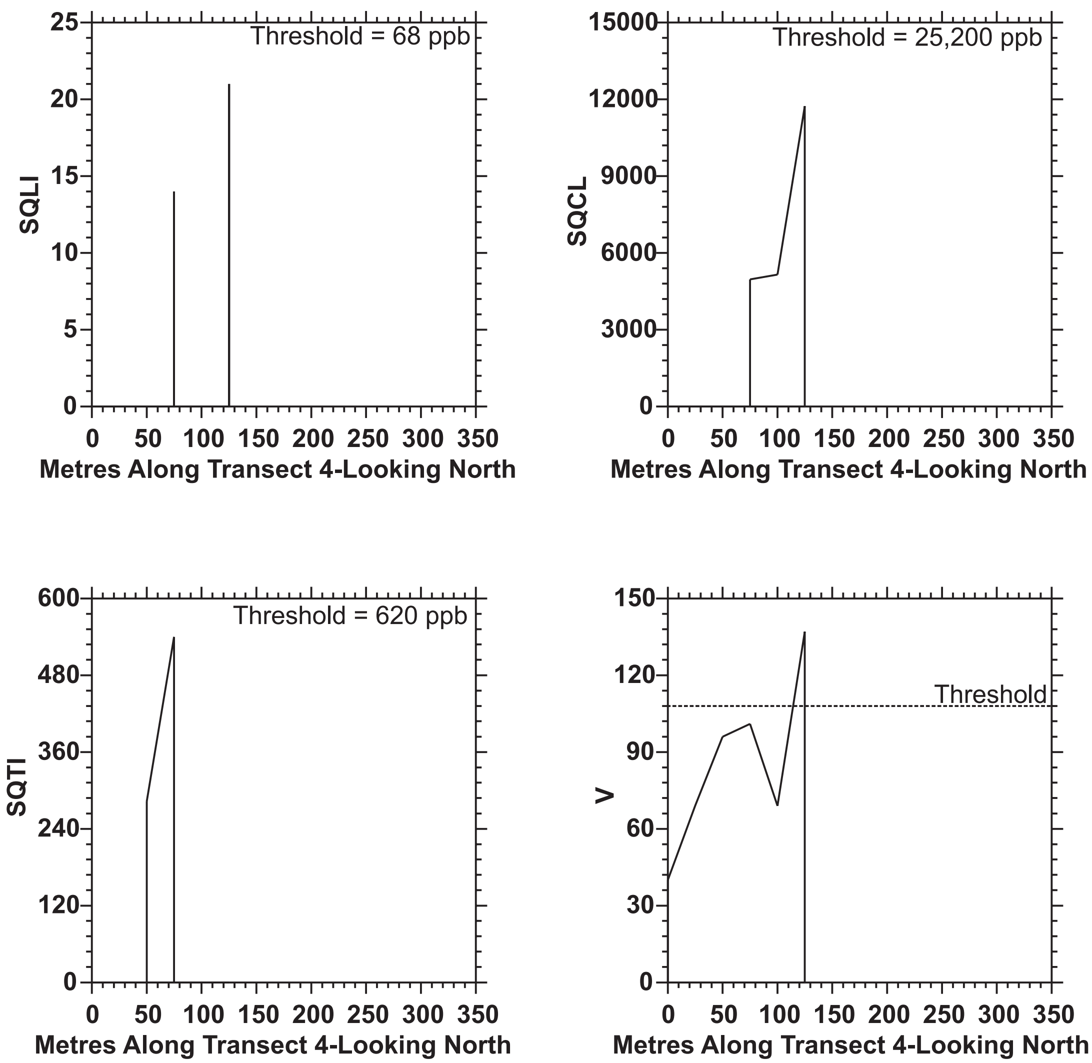
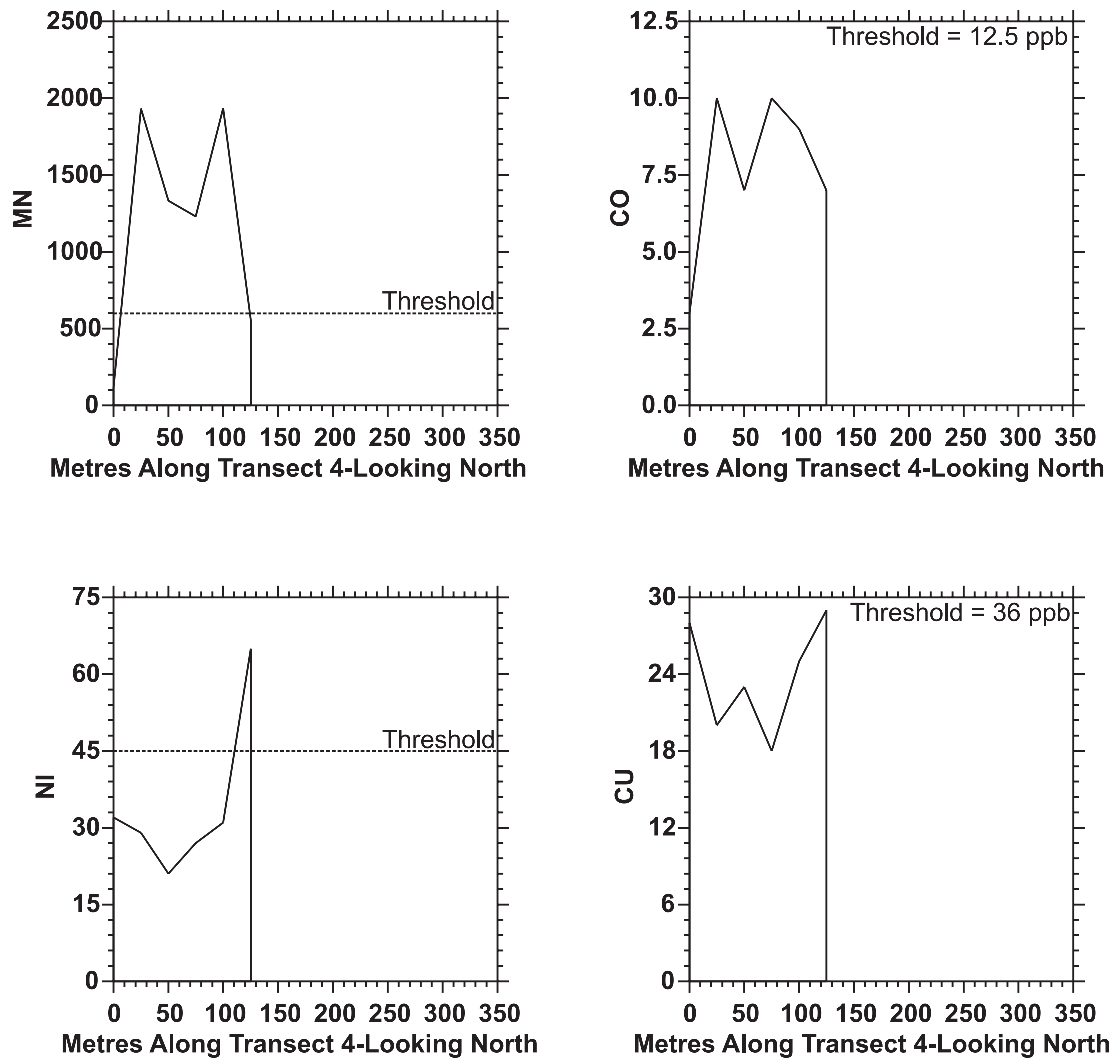


Enzyme Leach Profiles:Transect 4



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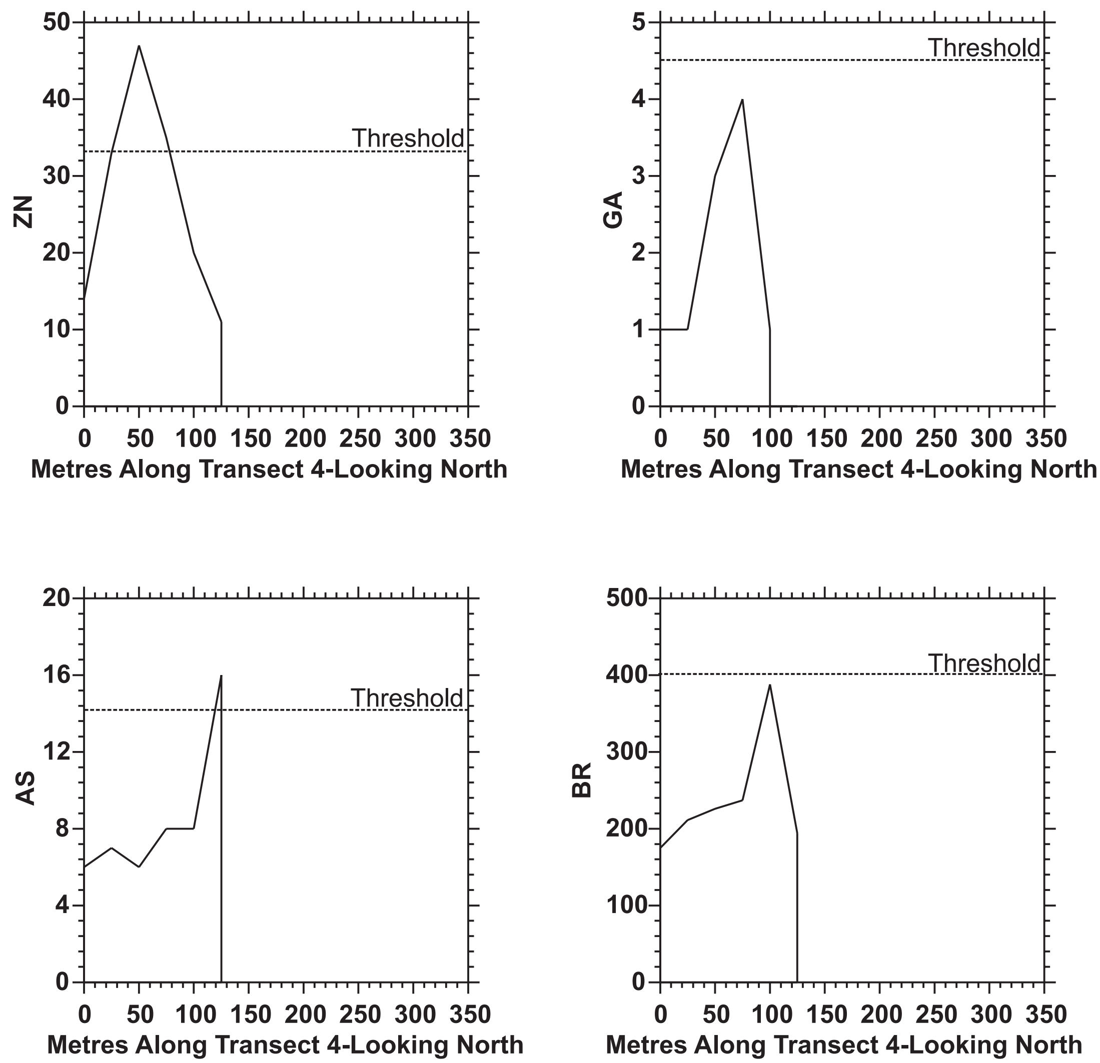

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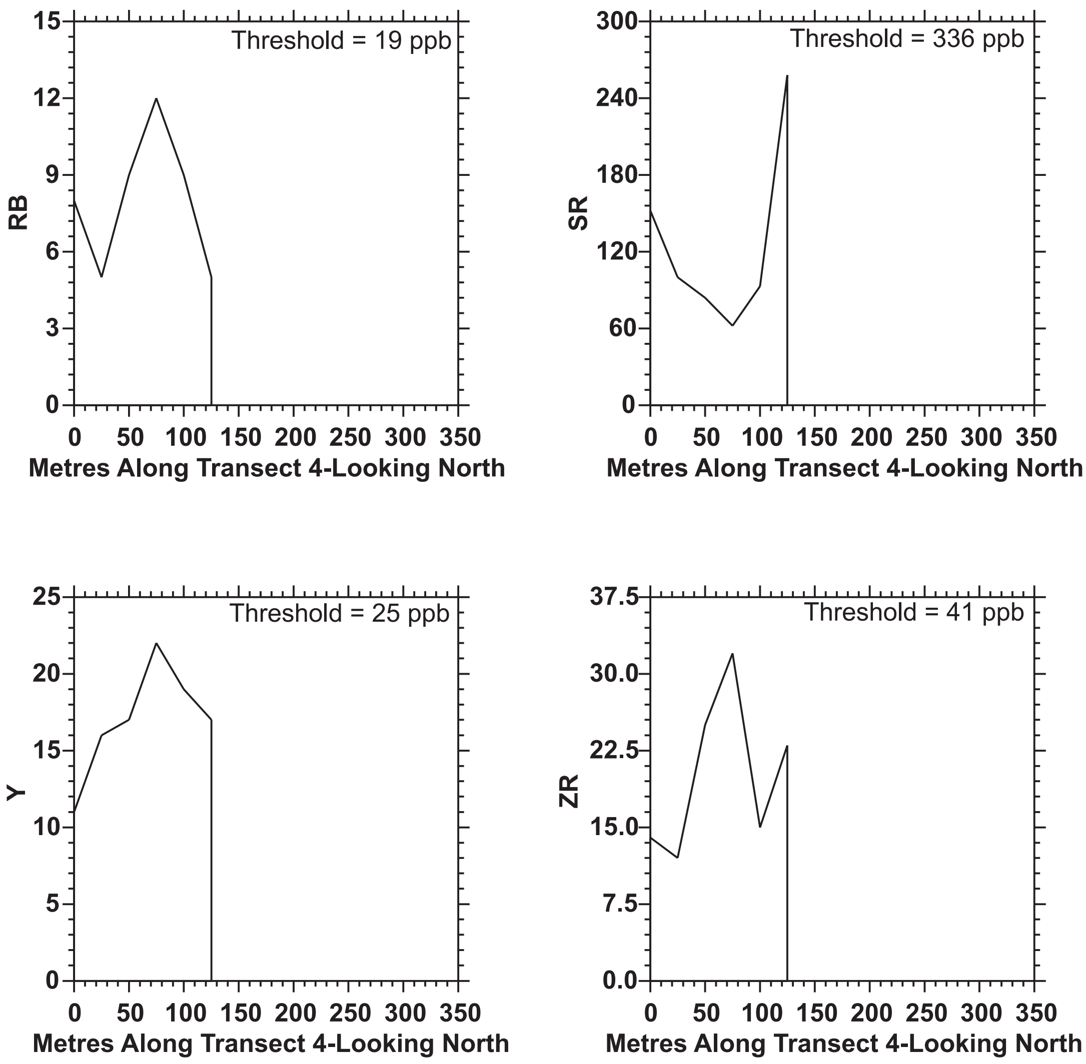

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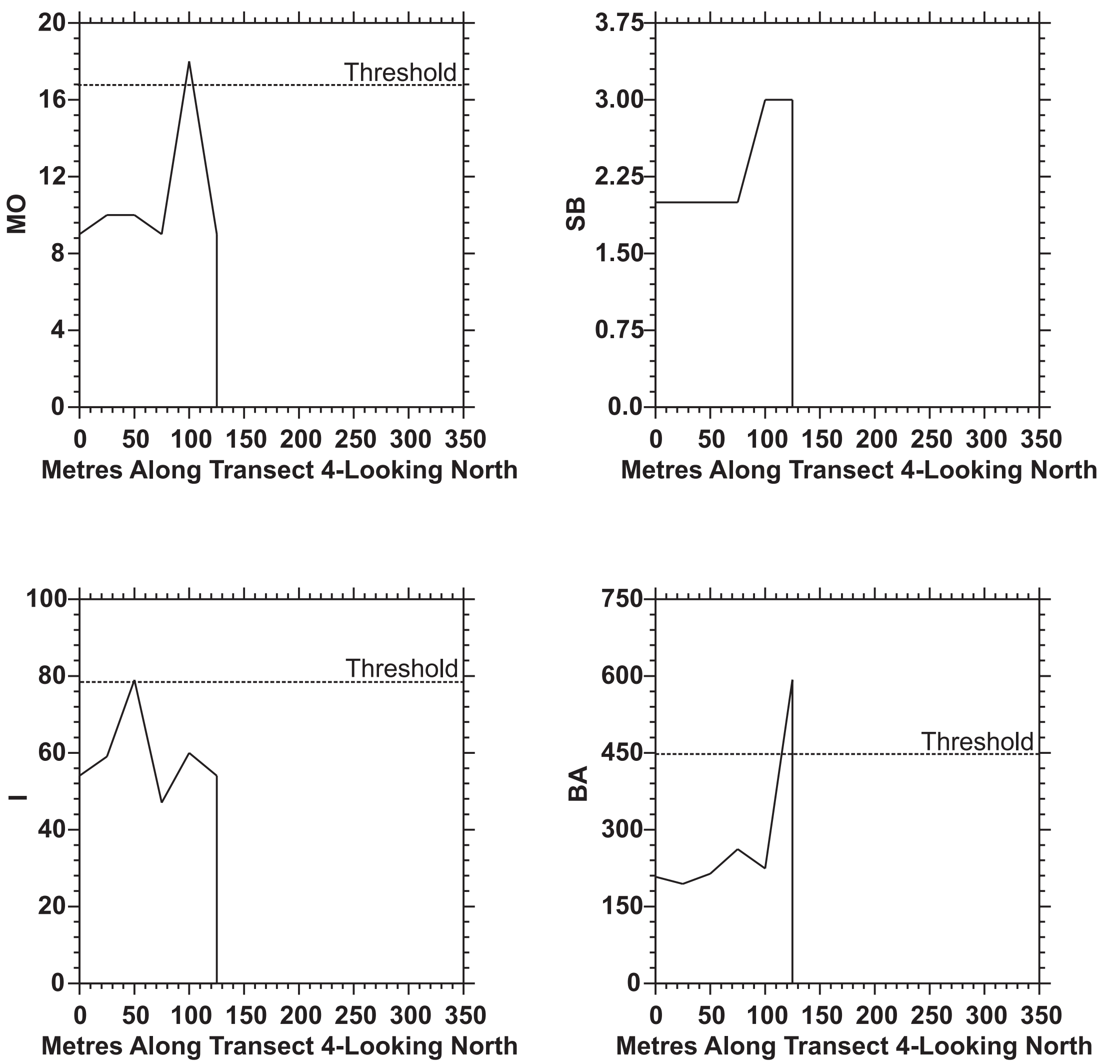

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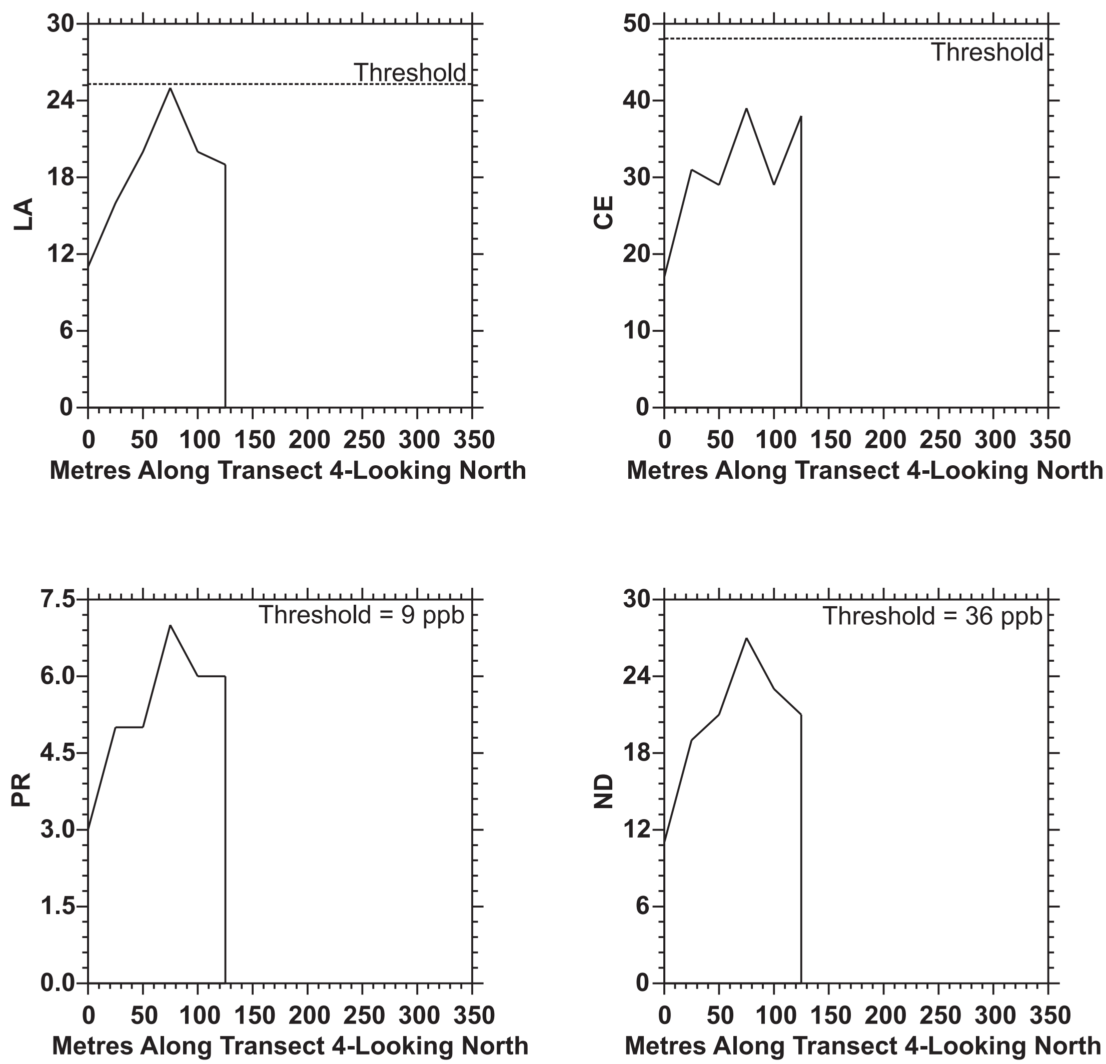

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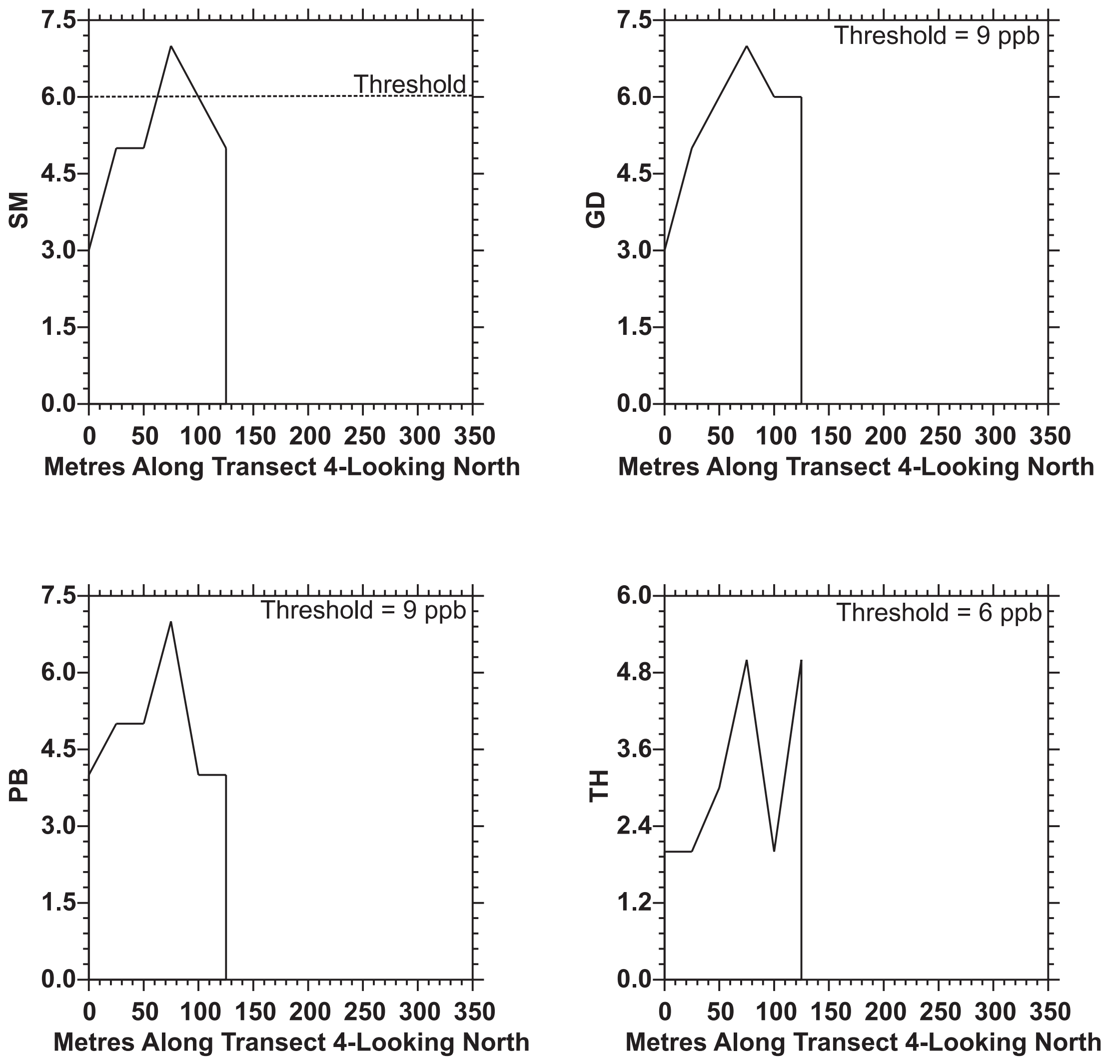

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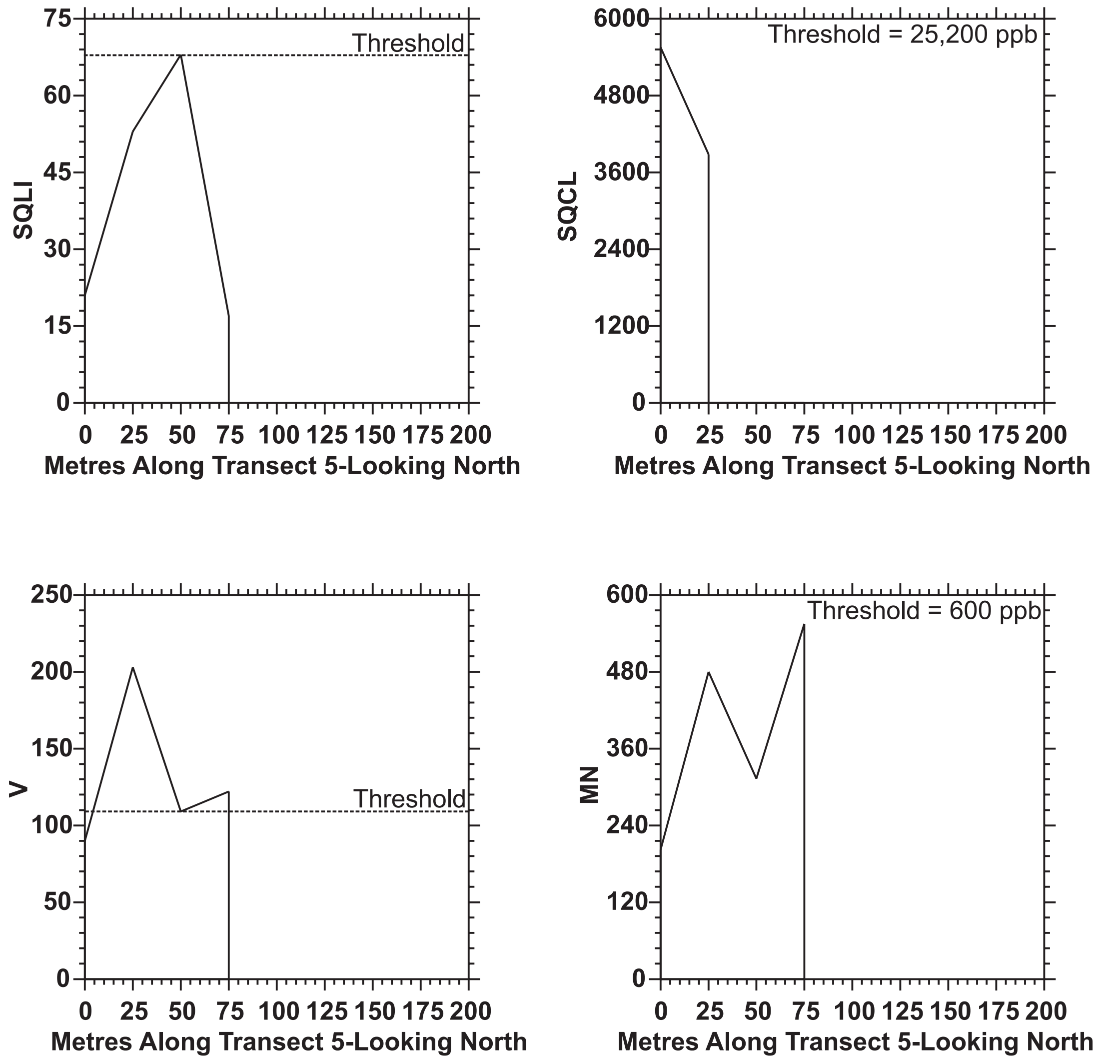

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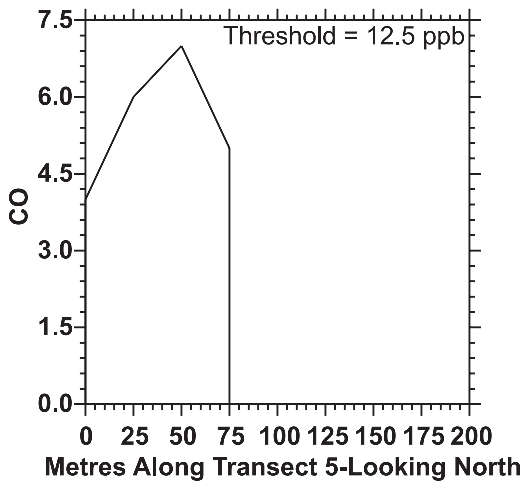

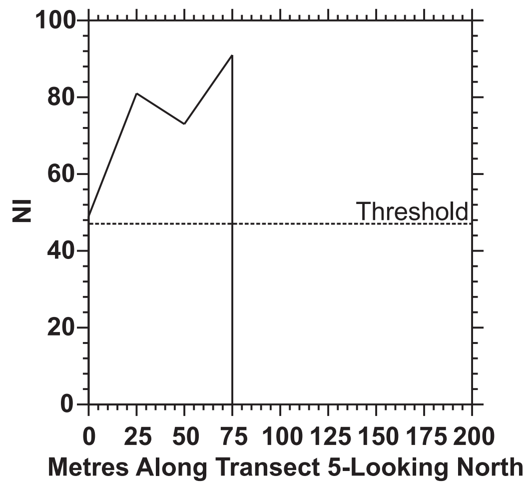

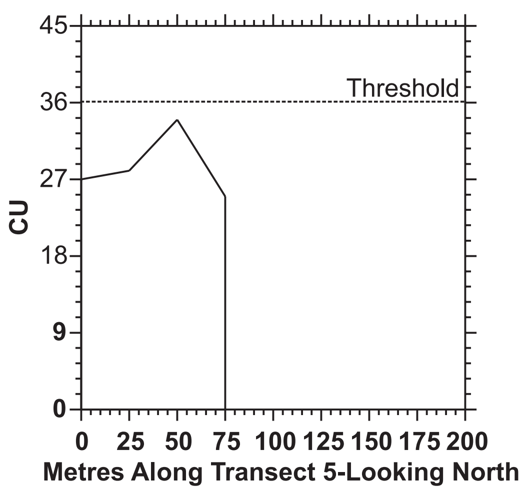

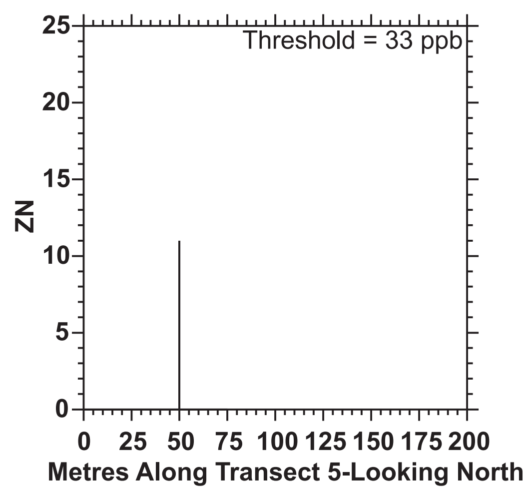

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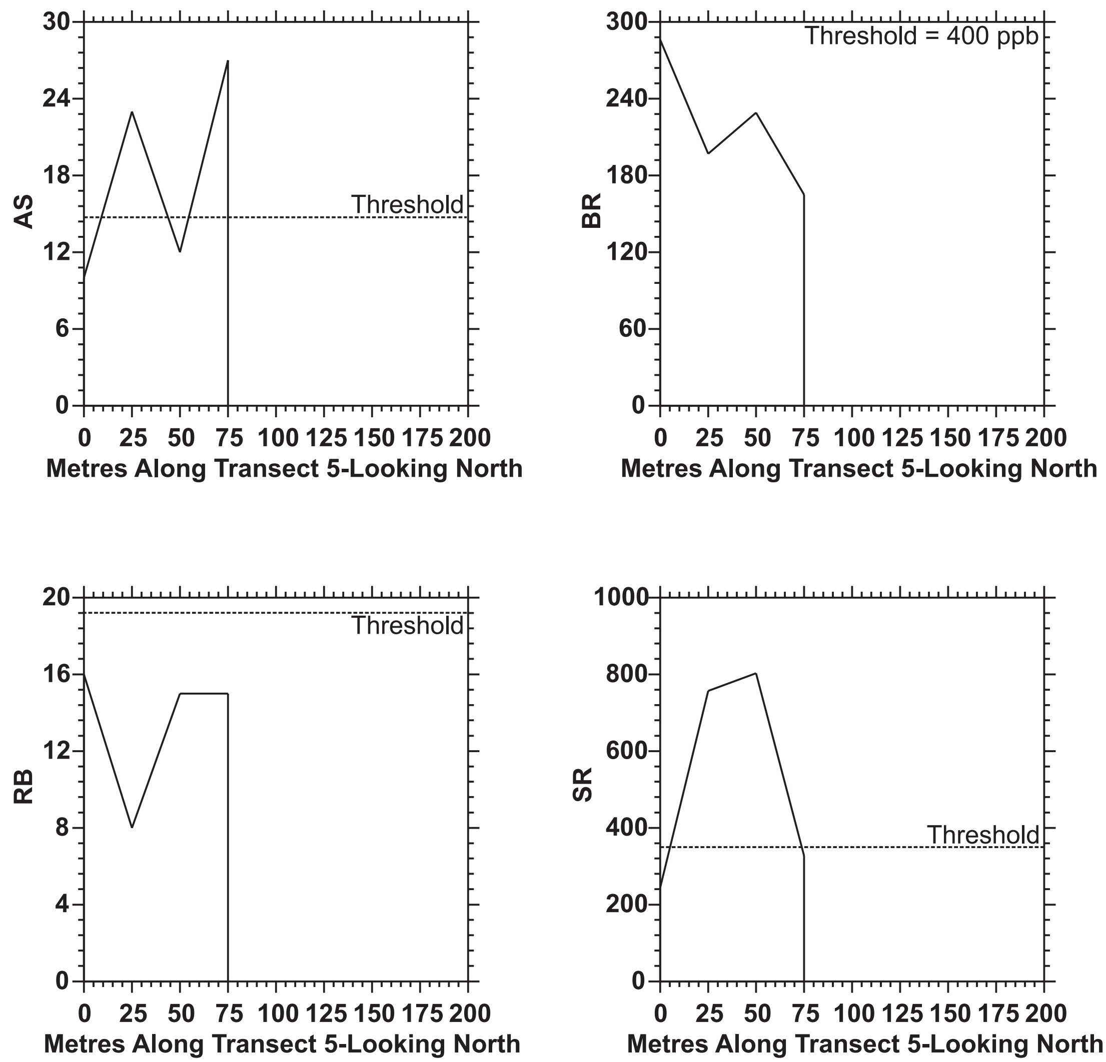

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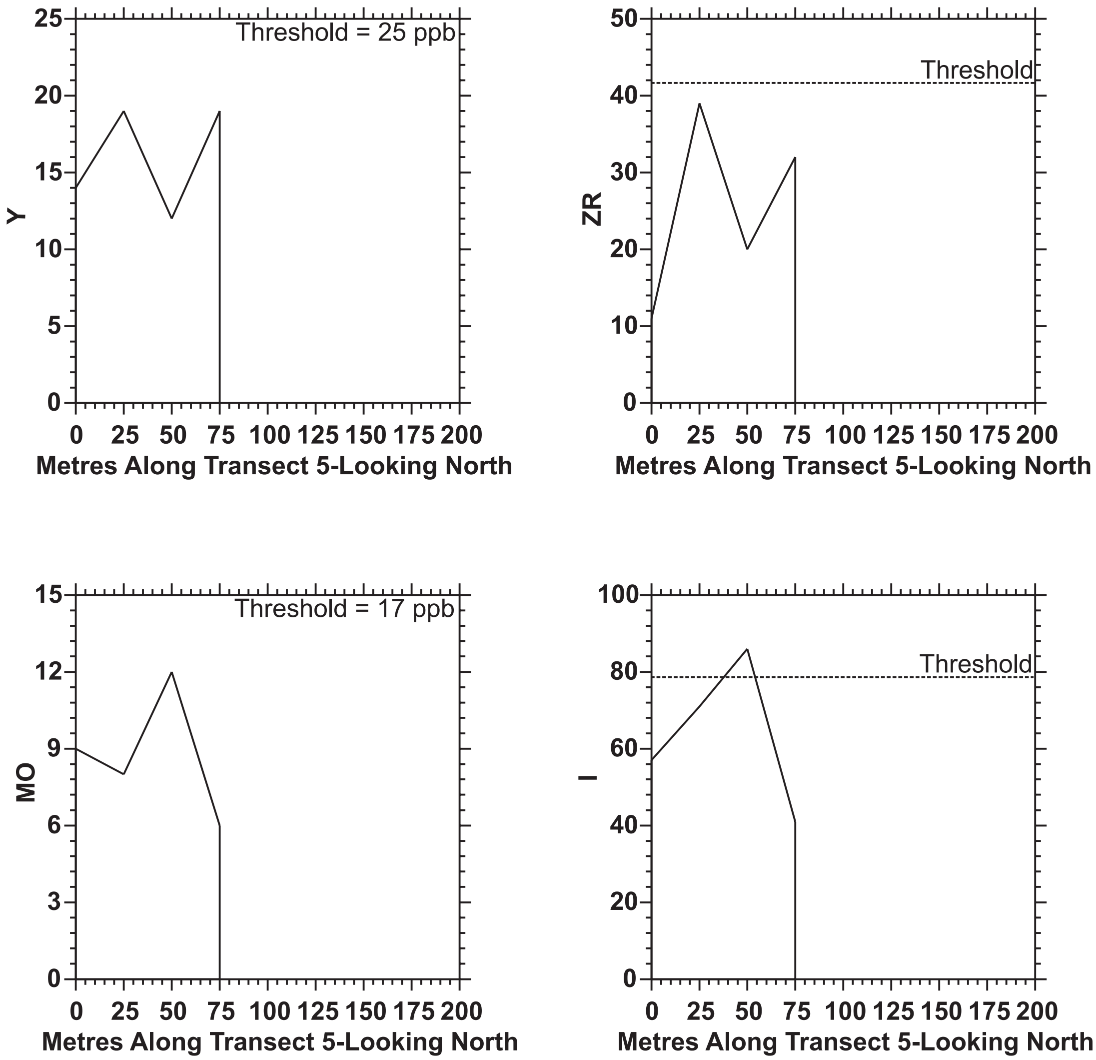

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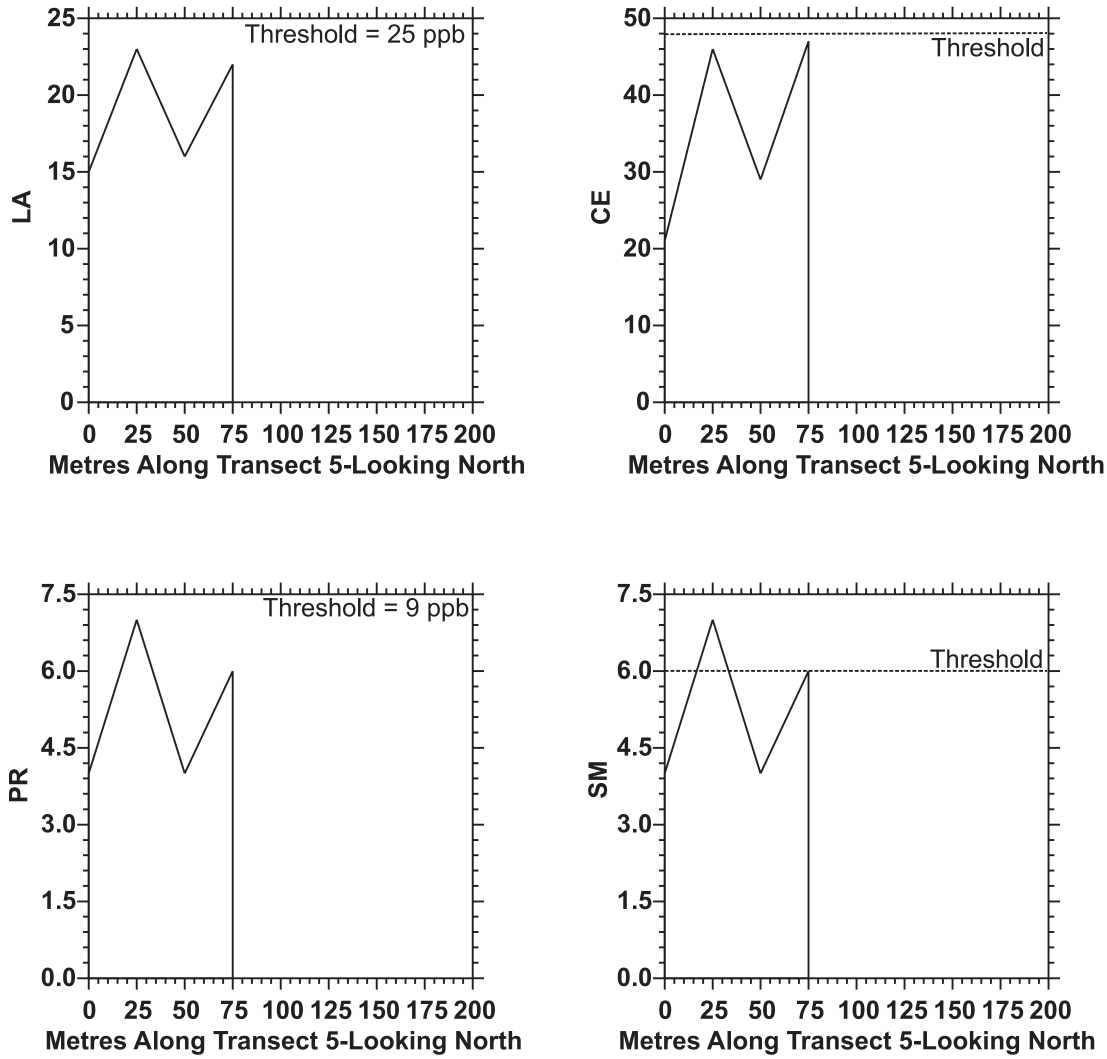

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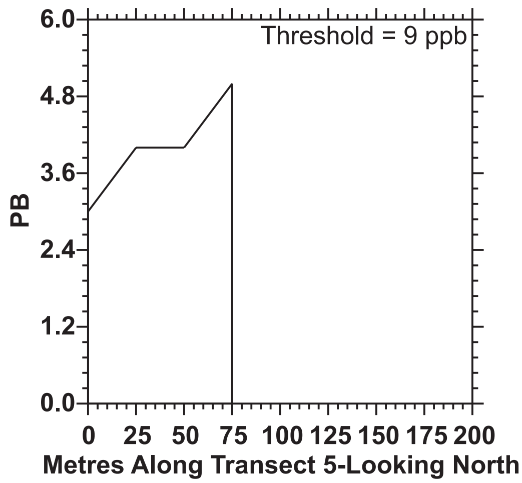
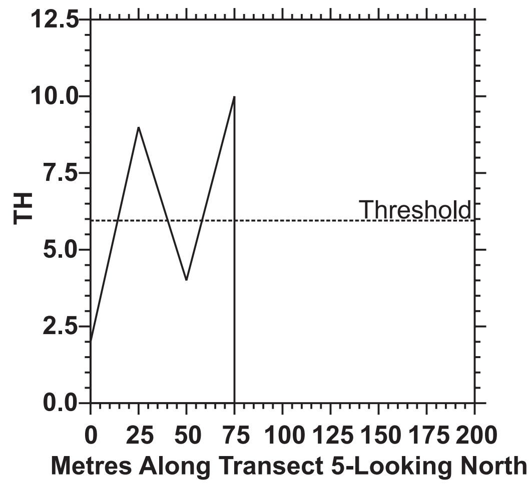
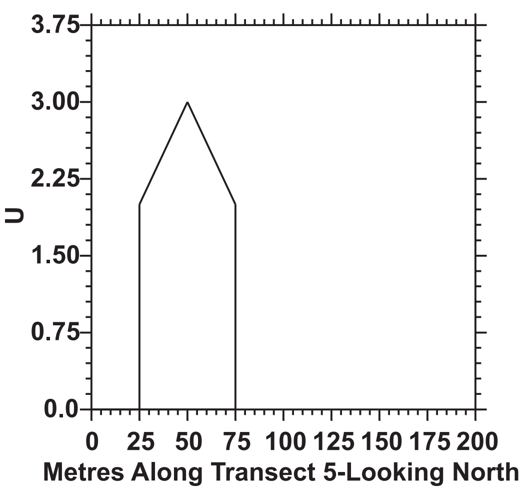
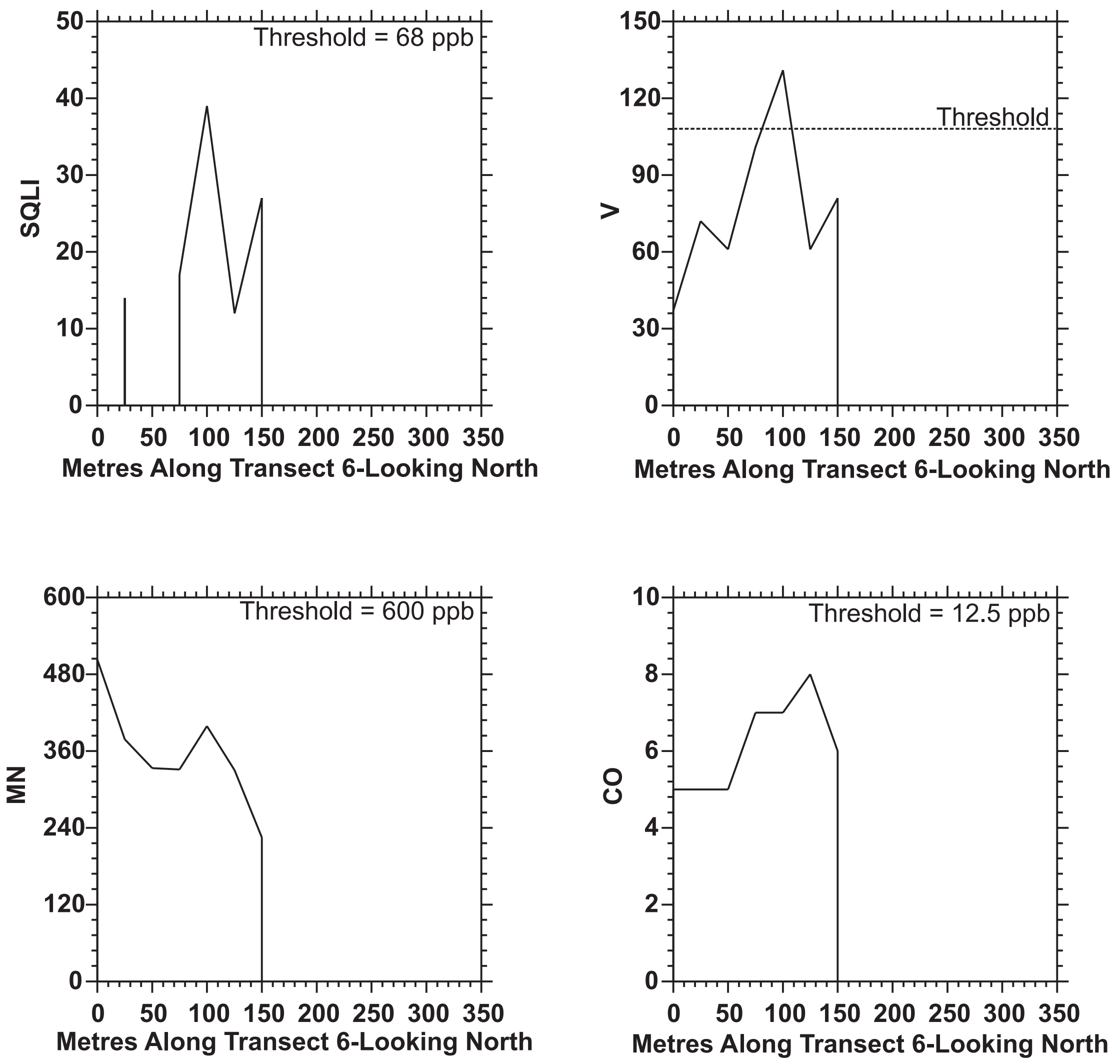


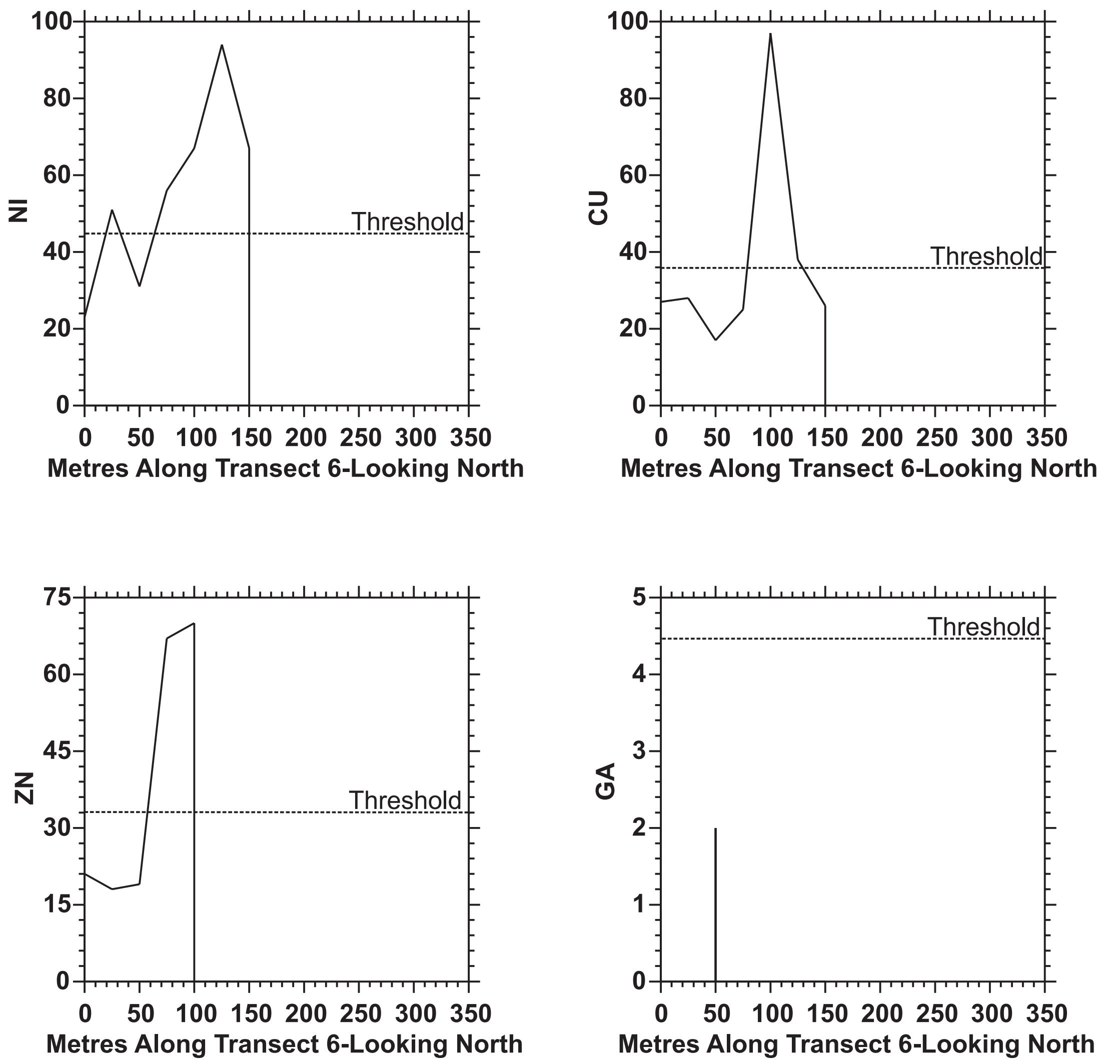




Enzyme Leach Profiles:Transect 6

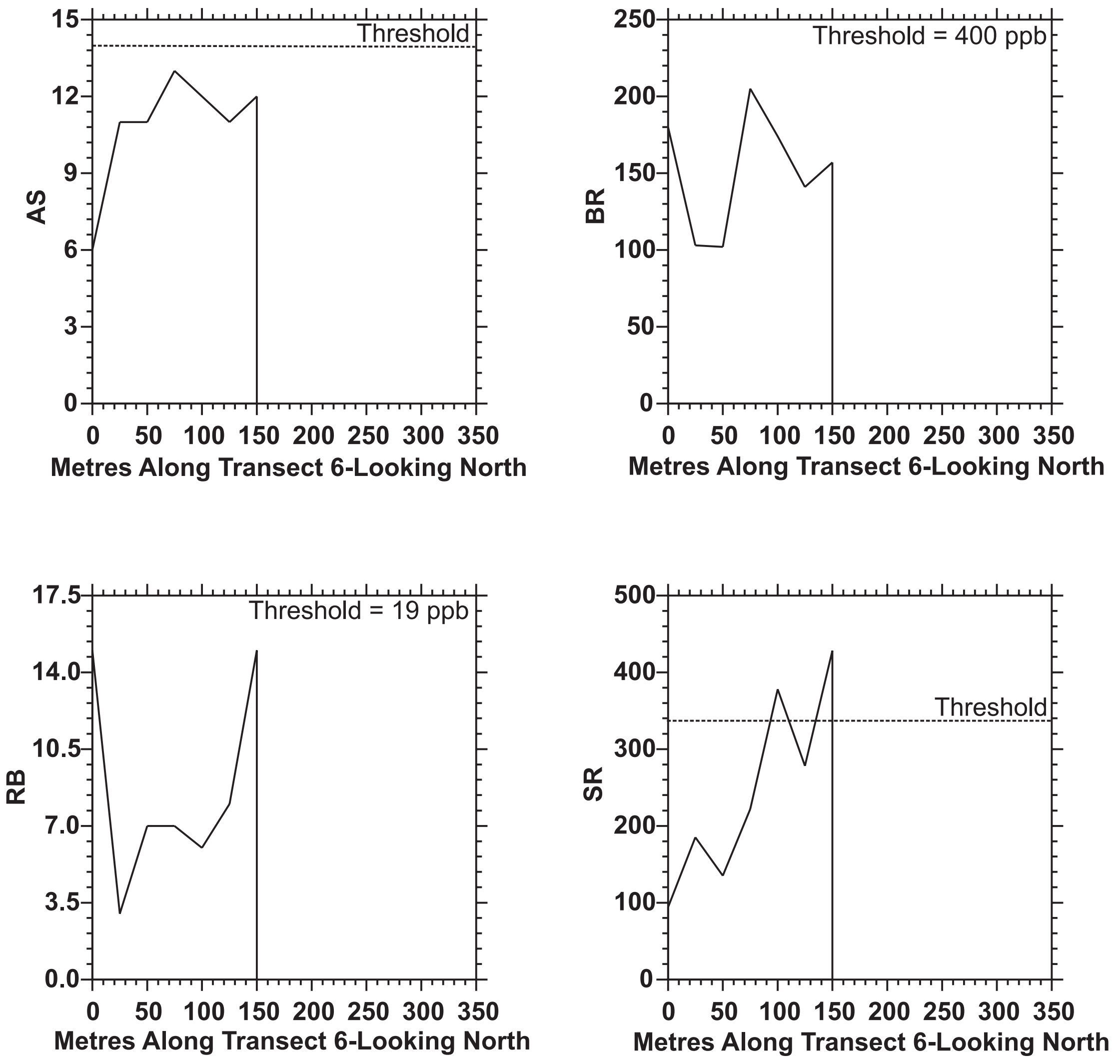


Enzyme Leach Profiles:Transect 6

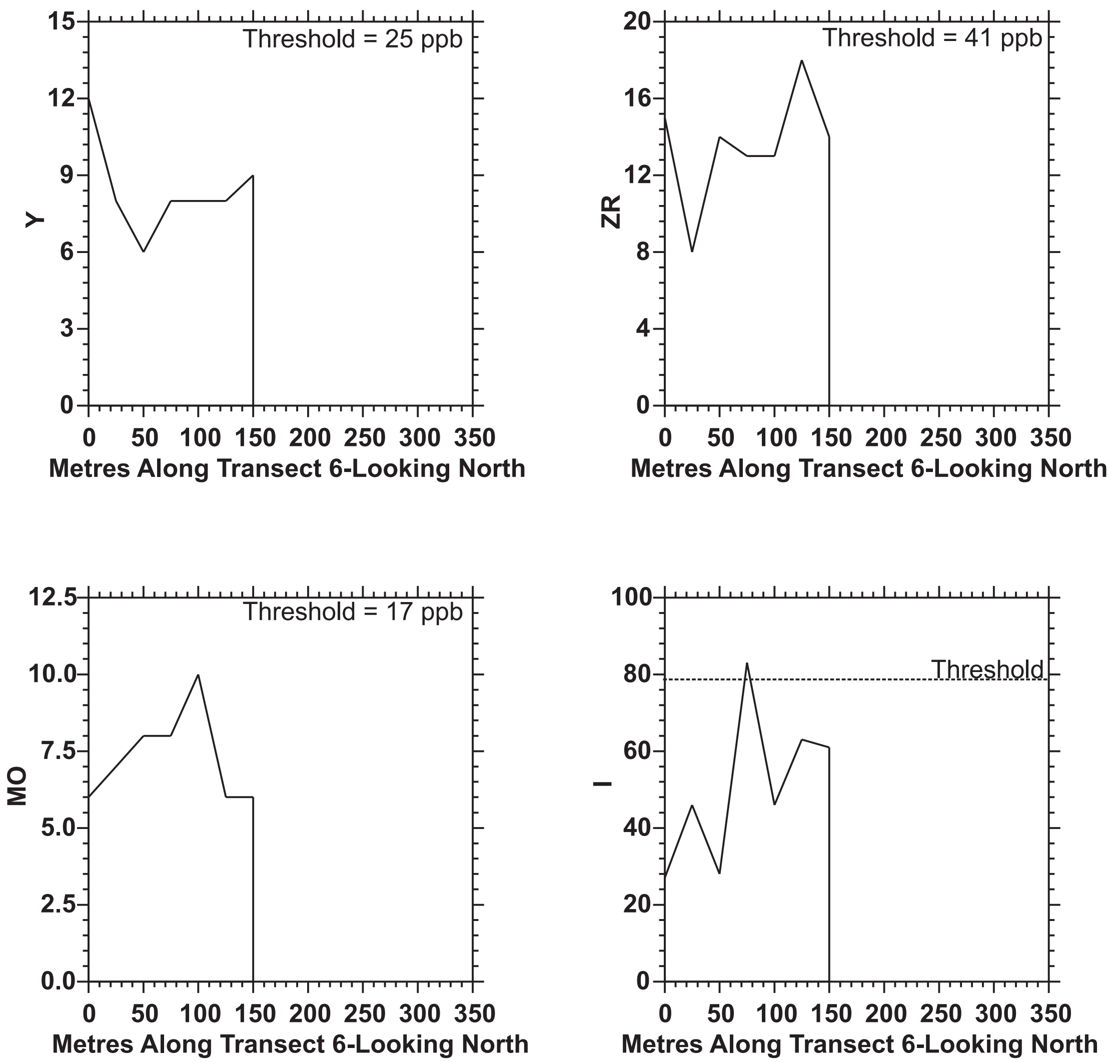


Appendix 7: Enzyme Leach[SM] geochemical profiles

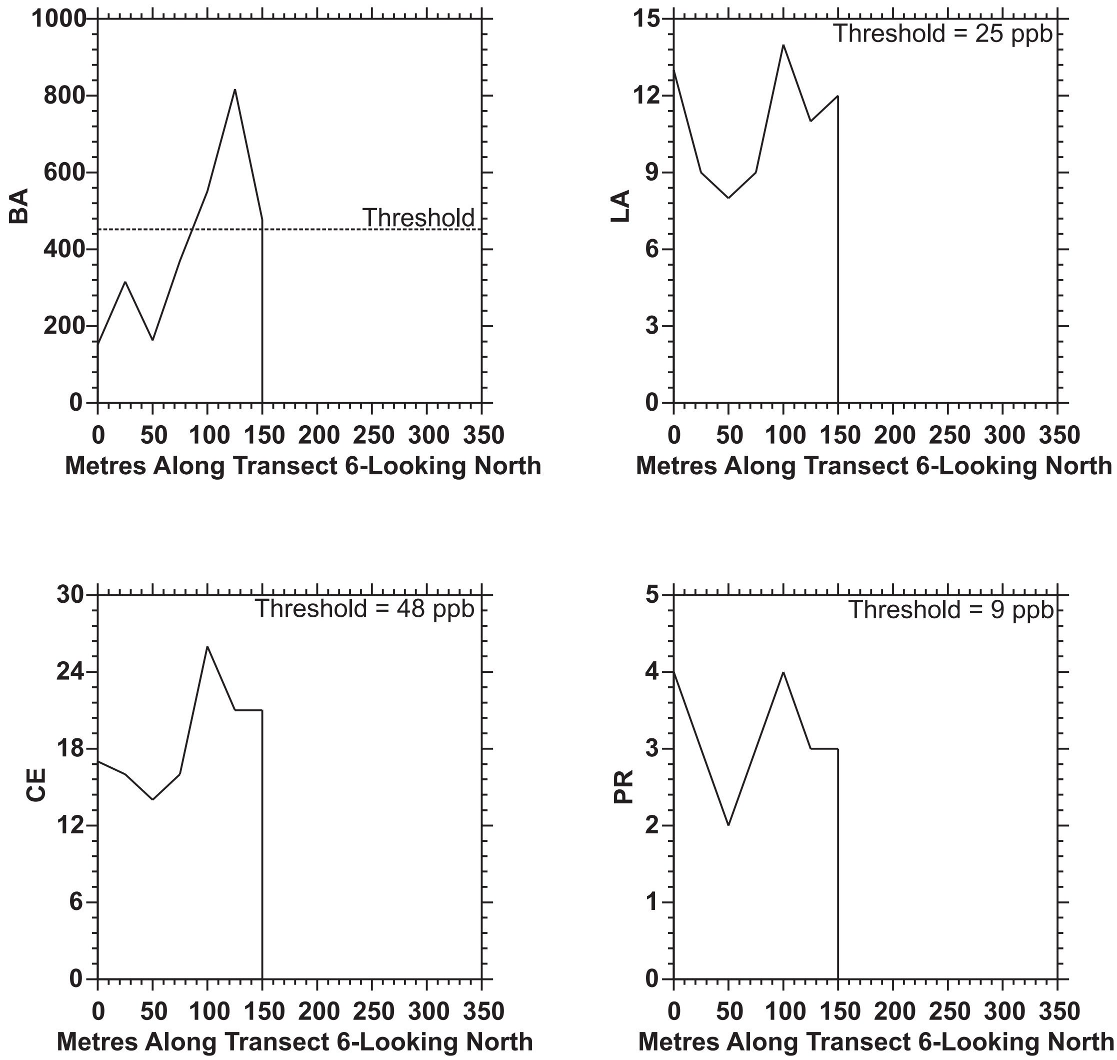
Enzyme Leach Profiles:Transect 6



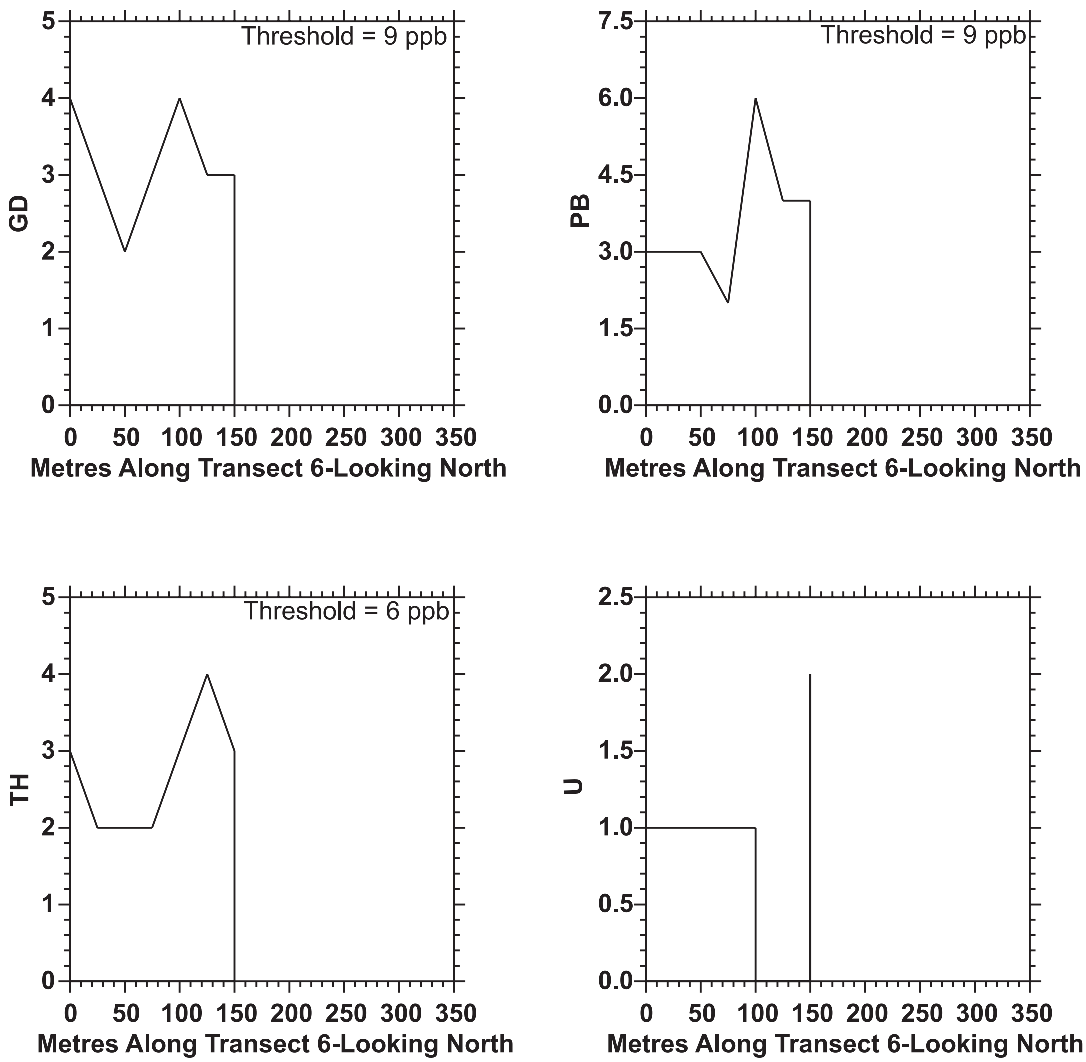
Enzyme Leach Profiles:Transect 6



Enzyme Leach Profiles:Transect 6



Enzyme Leach Profiles:Transect 6



Appendix 8 (Part 1): Geochemistry of brine-spring sediments (by INAA), Mafeking quarries area (see Appendix 4, Part 1 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)/ Assay	Pt (ppb)/ Assay	Pd (ppb)/ Assay	Mo(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Ag(ppm)	Ni(ppm)	Mn(ppm)	Sr(ppm)	Cd(ppm)	Bi(ppm)	V(ppm)	Ca(%)	P(%)	Mg(%)	Ti(%)	Al(%)	K(%)	Y(ppm)	Be(ppm)
88-97-163DB14-01	5856250N, 362775E	3	<5	<1	5	14	9	25	0.9	8	135	168	-0.5	-5	10	23.89	0.034	0.24	0.04	0.64	0.37	10	-2
88-97-163DB14-04	5856250N, 362775E	4	<5	<1	15	16	8	30	0.8	9	109	159	-0.5	-5	9	24.46	0.036	0.29	0.03	0.68	0.42	11	-2
88-97-163DB14-07	5856250N, 362775E	<1	<5	<1	3	22	7	33	0.5	12	105	145	-0.5	-5	9	25.87	0.032	0.55	0.03	0.9	0.43	11	-2
88-97-168DB19-01	5858025N, 362175E	13	7	1	-2	33	10	16	0.7	21	56	348	-0.5	-5	11	7.68	0.061	0.55	0.04	0.91	0.33	5	-2
88-97-168DB19-03	5858025N, 362175E	7	8	10	-2	197	6	25	-0.4	63	40	274	-0.5	-5	15	4.6	0.056	0.26	0.03	0.99	0.31	7	-2
88-97-168DB19-05	5858025N, 362175E	2	7	3	3	67	7	17	-0.4	42	78	345	-0.5	-5	12	7.73	0.042	0.53	0.03	1.05	0.41	6	-2
88-97-173DB24-01	5849525N, 367325E	<1	8	<1	2	11	7	54	-0.4	17	106	663	-0.5	-5	13	16.58	0.053	0.89	0.03	0.7	0.3	5	-2
88-97-173DB24-03	5849525N, 367325E	<1	<5	<1	-2	5	6	22	0.4	8	281	1352	-0.5	-5	8	33.34	0.014	1.19	0.02	0.49	0.24	6	-2
88-97-173DB24-05	5849525N, 367325E	<1	<5	<1	-2	4	6	22	-0.4	6	231	1322	-0.5	-5	6	35.93	0.013	0.94	0.02	0.43	0.19	6	-2
88-97-173DB24-07	5849525N, 367325E	2	<5	<1	-2	5	7	23	0.4	8	201	880	-0.5	-5	8	28.28	0.025	2.85	0.03	0.66	0.28	6	-2
88-97-173DB24-09	5849525N, 367325E	<1	<5	<1	-2	5	7	17	-0.4	6	480	1326	-0.5	-5	6	31.07	0.025	0.77	0.01	0.34	0.2	5	-2
88-97-173DB24-11	5849525N, 367325E	<1	<5	<1	-2	4	6	16	-0.4	6	277	1290	-0.5	-5	5	30.88	0.016	0.59	0.01	0.29	0.21	5	-2
88-97-173DB24-13	5849525N, 367325E	<1	<5	<1	-2	4	6	8	-0.4	4	578	1449	-0.5	-5	4	32.16	0.011	0.41	0.01	0.14	0.11	5	-2
88-97-173DB24-15	5849525N, 367325E	<1	<5	<1	-2	7	5	25	-0.4	11	345	1014	-0.5	-5	19	29.1	0.017	2.17	0.05	1.22	0.49	7	-2
88-97-173DB24-17	5849525N, 367325E	<1	<5	<1	-2	6	7	18	-0.4	8	405	1215	-0.5	-5	10	29.8	0.015	1.23	0.02	0.58	0.29	5	-2
88-97-173DB24-19	5849525N, 367325E	<1	<5	<1	-2	5	6	18	-0.4	5	254	1166	-0.5	-5	7	31.21	0.014	1.3	0.02	0.66	0.38	5	-2
88-97-176DB27-01	5863125N, 364125E	<1	<5	<1	-2	8	9	38	-0.4	12	334	1307	-0.5	-5	9	26.41	0.059	0.67	0.02	0.42	0.23	5	-2
88-97-176DB27-03	5863125N, 364125E	<1	<5	<1	-2	15	9	52	0.6	18	259	707	0.6	-5	43	16.76	0.046	1.56	0.09	2.05	0.68	10	-2
88-97-176DB27-05	5863125N, 364125E	<1	<5	<1	-2	7	-5	62	-0.4	20	235	1087	-0.5	-5	22	25.9	0.029	0.97	0.05	1.14	0.41	7	-2
88-97-176DB27-07	5863125N, 364125E	<1	<5	<1	-2	6	6	68	-0.4	21	172	1157	0.5	-5	18	26.92	0.026	0.7	0.04	0.86	0.29	6	-2
88-97-176DB27-09	5863125N, 364125E	<1	<5	<1	-2	11	5	65	0.6	23	258	983	0.6	-5	33	24.34	0.035	1.28	0.07	1.64	0.54	8	-2
88-97-176DB27-11	5863125N, 364125E	<1	<5	<1	-2	11	6	65	0.4	24	259	984	-0.5	-5	32	24.29	0.036	1.27	0.06	1.62	0.54	8	-2
88-97-176DB27-14	5863125N, 364125E	<1	<5	<1	-2	7	8	49	-0.4	10	388	1360	-0.5	-5	13	28.82	0.03	0.68	0.03	0.68	0.26	6	-2
88-97-176DB27-15	5863125N, 364125E	<1	7	<1	22	23	26	4153	-0.4	762	52	190	12.1	-5	21	1.88	0.069	0.42	0.04	0.99	0.46	4	2
88-97-176DB27-16	5863125N, 364125E	<1	<5	<1	34	35	16	3200	-0.4	1484	62	206	11.4	-5	12	3.4	0.074	0.99	0.02	0.65	0.36	4	5
88-97-176DB27-17	5863125N, 364125E	3	6	<1	5	22	11	292	-0.4	80	259	247	1.7	-5	48	6.82	0.053	1.41	0.09	2.5	0.8	12	2
88-97-176DB27-19	5863125N, 364125E	<1	<5	<1	-2	9	7	55	-0.4	12	366	1421	0.5	-5	11	29.64	0.03	0.88	0.03	0.68	0.27	6	-2
88-97-177DB28-01	5862650N, 363250E	<1	<5	<1	2	7	7	46	-0.4	14	239	1067	-0.5	-5	6	20.77	0.05	0.39	0.01	0.36	0.21	4	-2
88-97-177DB28-03	5862650N, 363250E	<1	<5	<1	5	14	12	32	-0.4	9	62	189	-0.5	-5	11	1.68	0.062	0.32	0.02	0.51	0.35	2	-2
88-97-177DB28-05	5862650N, 363250E	<1	<5	<1	-2	10	15	29	-0.4	5	112	276	-0.5	-5	11	3.25	0.049	0.34	0.03	0.66	0.34	2	-2
88-97-177DB28-07	5862650N, 363250E	<1	<5	<1	24	18	7	22	-0.4	15	438	127	-0.5	-5	21	2.02	0.022	0.73	0.05	1.43	0.52	5	-2
88-97-177DB28-08	5862650N, 363250E	<1	11	<1	-2	8	5	23	-0.4	4	31	188	-0.5	-5	6	1.58	0.106	0.29	0.02	0.41	0.26	2	-2
88-97-177DB28-09	5862650N, 363250E	<1	<5	<1	10	11	6	24	-0.4	11	264	642	-0.5	-5	18	14.5	0.029	1.52	0.05	1.63	0.66	6	-2
88-97-177DB28-10	5862650N, 363250E	<1	<5	<1	-2	6	-5	12	-0.4	3	224	1171	-0.5	-5	2	24.91	0.017	0.57	0.01	0.2	0.14	4	-2

Appendix 8 (Part 1): Geochemistry of brine-spring sediments (by INAA), Mafeking quarries area (see Appendix 4, Part 1 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)/	Pt (ppb)/	Pd (ppb)/	Mo(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Ag(ppm)	Ni(ppm)	Mn(ppm)	Sr(ppm)	Cd(ppm)	Bi(ppm)	V(ppm)	Ca(%)	P(%)	Mg(%)	Ti(%)	Al(%)	K(%)	Y(ppm)	Be(ppm)
		Assay	Assay	Assay																			
88-97-177DB28-12	5862650N, 363250E	<1	<5	<1	4	7	7	22	-0.4	5	359	1208	0.5	-5	9	22.91	0.028	0.53	0.02	0.65	0.26	5	-2
88-97-179DB30-01	5859550N, 360575E	<1	<5	<1	3	6	-5	46	-0.4	26	103	631	0.6	-5	6	19.9	0.022	1.4	0.02	1.13	0.4	5	-2
88-97-179DB30-02	5859550N, 360575E	<1	<5	<1	-2	5	-5	9	-0.4	4	113	1178	-0.5	-5	3	33.78	0.01	1.1	0.01	0.36	0.16	5	-2
88-97-179DB30-03	5859550N, 360575E	<1	<5	<1	-2	5	-5	13	-0.4	6	81	1144	-0.5	-5	4	27.98	0.016	0.81	0.01	0.32	0.16	5	-2
88-97-179DB30-04	5859550N, 360575E	<1	<5	<1	2	4	-5	10	-0.4	6	92	1038	-0.5	-5	2	27.7	0.016	1.95	0.01	0.19	0.18	4	-2
88-97-179DB30-05	5859550N, 360575E	<1	<5	<1	8	8	5	41	-0.4	38	105	685	-0.5	-5	7	21	0.027	2.79	0.02	0.58	0.33	5	-2
88-97-179DB30-06	5859550N, 360575E	<1	<5	<1	-2	6	-5	9	-0.4	2	81	1415	-0.5	-5	3	34.87	0.009	1.19	0.01	0.27	0.14	5	-2
88-97-179DB30-07	5859550N, 360575E	<1	<5	<1	-2	4	-5	11	-0.4	9	114	1354	-0.5	-5	8	36.16	0.009	1.13	0.02	0.38	0.13	5	-2
88-97-179DB30-08	5859550N, 360575E	<1	<5	<1	-2	3	-5	9	-0.4	2	81	1578	-0.5	-5	2	37.56	0.007	0.43	0.01	0.09	0.09	5	-2
88-97-179DB30-09	5859550N, 360575E	<1	<5	<1	-2	3	5	10	-0.4	2	81	1624	-0.5	-5	2	37.3	0.009	0.38	0.01	0.16	0.11	5	-2
88-97-179DB30-10	5859550N, 360575E	<1	<5	<1	-2	3	-5	12	-0.4	2	86	1565	-0.5	-5	3	35.76	0.011	0.51	0.01	0.21	0.14	5	-2
88-97-179DB30-11	5859550N, 360575E	<1	<5	<1	-2	5	5	22	-0.4	3	122	1343	-0.5	-5	4	31.9	0.032	0.54	0.01	0.28	0.18	5	-2
88-97-179DB30-12	5859550N, 360575E	<1	<5	<1	-2	4	6	25	-0.4	3	113	1441	-0.5	-5	4	33.91	0.028	0.51	0.01	0.27	0.15	5	-2
88-97-179DB30-13	5859550N, 360575E	<1	<5	<1	-2	4	-5	14	-0.4	2	99	1535	-0.5	-5	3	35.86	0.016	0.49	0.01	0.22	0.14	5	-2
88-97-180DB31-01	5860000N, 358725E	<1	<5	<1	-2	4	-5	18	-0.4	2	132	440	-0.5	-5	6	37.49	0.044	0.26	0.02	0.47	0.26	11	-2
88-97-180DB31-02	5860000N, 358725E	<1	<5	<1	-2	5	-5	25	-0.4	4	129	828	-0.5	-5	10	30.61	0.054	0.44	0.03	0.71	0.36	8	-2
88-97-180DB31-03	5860000N, 358725E	<1	<5	<1	3	6	6	12	-0.4	3	106	727	-0.5	-5	7	31.69	0.034	0.29	0.02	0.43	0.23	8	-2
88-97-180DB31-04	5860000N, 358725E	<1	<5	<1	10	10	-5	9	0.5	2	113	686	0.5	-5	8	25.49	0.065	0.23	0.01	0.24	0.17	7	2
88-97-180DB31-05	5860000N, 358725E	<1	<5	<1	48	23	-5	16	-0.4	3	99	180	-0.5	-5	22	1.86	0.037	0.19	0.03	0.78	0.56	8	-2
88-97-182DB33-01	5856675N, 357175E	<1	<5	<1	14	12	12	421	0.5	149	148	163	3.7	-5	27	10.06	0.041	3.85	0.09	2.18	0.74	10	-2
88-97-182DB33-02	5856675N, 357175E	<1	<5	<1	-2	5	-5	22	-0.4	12	131	1074	-0.5	-5	10	27.29	0.016	1.45	0.04	0.97	0.34	7	-2
88-97-184DB34-01	5857725N, 356425E	<1	<5	<1	3	8	10	87	-0.4	62	87	1106	0.6	-5	3	25.22	0.063	0.37	0.01	0.12	0.11	5	-2
88-97-184DB34-02	5857725N, 356425E	<1	11	<1	59	11	31	1711	-0.4	971	79	170	7	-5	11	6.71	0.021	1.08	0.02	1.1	0.37	4	-2
88-97-184DB34-03	5857725N, 356425E	<1	<5	<1	3	5	-5	46	-0.4	28	103	1290	-0.5	-5	3	31.27	0.02	0.4	0.01	0.11	0.11	5	-2
88-97-184DB34-04	5857725N, 356425E	<1	<5	<1	8	5	6	67	-0.4	54	86	1273	-0.5	-5	3	30.44	0.019	0.36	0.01	0.12	0.11	5	-2
88-97-184DB34-05	5857725N, 356425E	<1	<5	<1	2	5	5	47	-0.4	28	94	1275	-0.5	-5	4	29.82	0.021	0.32	0.01	0.09	0.1	5	-2
88-97-184DB34-06	5857725N, 356425E	<1	<5	<1	2	4	-5	28	-0.4	20	131	1318	-0.5	-5	3	35.36	0.014	0.45	0.01	0.16	0.1	5	-2
88-97-184DB34-07	5857725N, 356425E	<1	<5	<1	4	6	6	56	-0.4	36	78	1033	-0.5	-5	5	23.27	0.042	0.28	0.01	0.1	0.11	5	-2
88-97-184DB34-08	5857725N, 356425E	<1	<5	<1	3	6	5	52	0.4	29	102	1251	-0.5	-5	4	28.94	0.032	0.32	0.01	0.1	0.1	5	-2
88-97-184DB34-09	5857725N, 356425E	<1	<5	<1	3	3	5	40	-0.4	25	124	1153	-0.5	-5	3	31.93	0.021	1.23	0.01	0.31	0.17	5	-2
88-97-184DB34-10	5857725N, 356425E	<1	<5	<1	-2	3	5	41	-0.4	18	101	1322	-0.5	-5	2	31.37	0.023	0.34	0.01	0.1	0.1	5	-2
88-97-188DB35-01	5861309N, 362520E	<1	<5	<1	-2	19	-5	47	-0.4	32	471	346	-0.5	-5	87	4.36	0.046	1.21	0.27	6.32	0.86	14	-2
88-97-188DB35-02	5861309N, 362520E	<1	<5	<1	-2	6	-5	28	-0.4	20	233	1039	-0.5	-5	10	27.26	0.016	1.86	0.03	0.83	0.34	6	-2
88-97-188DB35-03	5861309N, 362520E	<1	<5	<1	-2	6	-5	31	-0.4	22	192	994	-0.5	-5	13	25.33	0.02	2.06	0.04	0.91	0.4	6	-2
88-97-188DB35-04	5861309N, 362520E	<1	<5	<1	2	5	5	25	-0.4	17	235	1276	-0.5	-5	5	30.76	0.01	1	0.01	0.36	0.18	5	-2

Appendix 8 (Part 1): Geochemistry of brine-spring sediments (by INAA), Mafeking quarries area (see Appendix 4, Part 1 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)/	Pt (ppb)/	Pd (ppb)/	Mo(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Ag(ppm)	Ni(ppm)	Mn(ppm)	Sr(ppm)	Cd(ppm)	Bi(ppm)	V(ppm)	Ca(%)	P(%)	Mg(%)	Ti(%)	Al(%)	K(%)	Y(ppm)	Be(ppm)
		Assay	Assay	Assay																			
88-97-188DB35-05	5861309N, 362520E	<1	<5	<1	-2	7	5	29	-0.4	21	223	1087	-0.5	-5	13	27.49	0.015	1.91	0.04	0.93	0.37	6	-2
88-97-188DB35-06	5861309N, 362520E	<1	<5	<1	-2	5	5	21	-0.4	20	258	1293	-0.5	-5	5	32.05	0.012	1.06	0.02	0.45	0.19	6	-2
88-97-188DB35-07	5861309N, 362520E	<1	<5	<1	3	10	7	159	-0.4	81	170	490	0.8	-5	12	10.26	0.042	1.11	0.03	1.15	0.5	5	-2
88-97-188DB35-08	5861309N, 362520E	<1	<5	<1	2	4	5	43	-0.4	30	149	1195	-0.5	-5	4	25.73	0.023	0.93	0.01	0.29	0.2	5	-2
88-97-188DB35-09	5861309N, 362520E	<1	<5	<1	3	6	5	39	-0.4	40	206	294	-0.5	-5	8	20.59	0.015	5.09	0.03	1.01	0.34	6	-2
88-97-188DB35-10	5861309N, 362520E	<1	<5	<1	11	8	5	76	-0.4	100	89	306	-0.5	-5	7	6.94	0.08	1.26	0.02	0.43	0.45	2	-2
88-97-188DB35-11	5861309N, 362520E	<1	<5	<1	2	8	5	131	-0.4	66	53	386	0.6	-5	7	6.32	0.124	0.99	0.01	0.22	0.35	4	-2
88-97-191DB36-01	5860300N, 362225E	<1	<5	<1	2	9	8	87	-0.4	60	241	824	-0.5	-5	16	26.46	0.022	1.56	0.05	1.13	0.46	7	-2
88-97-191DB36-02	5860300N, 362225E	2	<5	<1	2	6	5	161	-0.4	107	102	1198	0.7	-5	4	27.66	0.019	0.62	0.01	0.25	0.2	5	-2
88-97-191DB36-03	5860300N, 362225E	<1	<5	<1	2	10	7	204	-0.4	61	203	562	0.9	-5	17	20.63	0.033	1.94	0.05	1.11	0.5	7	2
88-97-191DB36-04	5860300N, 362225E	<1	<5	<1	-2	7	5	54	-0.4	24	149	1119	-0.5	-5	5	27.94	0.019	0.52	0.01	0.27	0.18	5	-2
88-97-191DB36-05	5860300N, 362225E	<1	<5	<1	3	7	5	233	-0.4	71	129	719	0.8	-5	13	24.98	0.021	1.07	0.03	0.82	0.42	6	-2
88-97-195DB38-01	5860575N, 363400E	<1	<5	<1	10	11	6	267	-0.4	142	45	246	1.6	-5	13	3.22	0.069	0.76	0.04	0.85	0.41	4	3
88-97-195DB38-02	5860575N, 363400E	<1	<5	<1	25	14	7	53	-0.4	106	118	200	-0.5	-5	27	1.99	0.044	0.5	0.08	2.14	0.76	7	-2
88-97-195DB38-04	5860575N, 363400E	<1	<5	<1	-2	5	5	22	-0.4	13	94	859	-0.5	-5	7	20.34	0.026	0.93	0.02	0.64	0.31	5	-2
88-97-195DB38-05	5860575N, 363400E	<1	<5	<1	9	9	6	103	-0.4	84	74	206	0.5	-5	13	4.54	0.069	1.51	0.05	1.47	0.59	5	2
88-97-195DB38-07	5860575N, 363400E	<1	<5	<1	-2	4	5	23	-0.4	22	185	1209	-0.5	-5	6	28.64	0.035	0.93	0.02	0.49	0.23	5	-2
88-97-195DB38-08	5860575N, 363400E	<1	<5	<1	7	5	5	21	0.4	24	155	1125	-0.5	-5	8	27.26	0.023	1.05	0.02	0.57	0.21	5	-2
88-97-195DB38-09	5860575N, 363400E	<1	<5	<1	3	5	5	18	-0.4	20	128	1150	-0.5	-5	10	27.85	0.021	1.02	0.02	0.55	0.22	6	-2
88-97-195DB38-12	5860575N, 363400E	<1	<5	<1	-2	5	5	17	0.4	10	142	1169	-0.5	-5	6	27.68	0.032	1.01	0.02	0.52	0.23	5	-2
88-97-197DB39-01	5859300N, 361500E	<1	<5	<1	-2	14	7	39	-0.4	20	224	144	-0.5	-5	24	15.28	0.027	5.79	0.08	1.87	0.71	8	-2
88-97-197DB39-02	5859300N, 361500E	<1	<5	<1	-2	6	10	37	0.5	21	235	732	-0.5	-5	14	21.46	0.021	2.54	0.04	1.26	0.47	6	-2
88-97-197DB39-03	5859300N, 361500E	<1	<5	<1	-2	11	7	46	0.4	17	241	149	-0.5	-5	24	15.08	0.028	5.86	0.09	1.87	0.71	8	-2
88-97-197DB39-04	5859300N, 361500E	<1	<5	<1	-2	10	16	37	-0.4	17	256	340	-0.5	-5	23	17.5	0.026	4.83	0.08	1.92	0.75	8	-2
88-97-197DB39-05	5859300N, 361500E	<1	<5	<1	-2	17	16	75	0.8	26	210	334	0.5	-5	28	16.85	0.028	4.97	0.09	2.1	0.75	8	-2
88-97-197DB39-06	5859300N, 361500E	<1	<5	<1	-2	11	10	59	0.6	21	219	429	0.5	-5	27	18.61	0.026	4.55	0.08	2	0.73	8	-2
88-97-197DB39-07	5859300N, 361500E	<1	<5	<1	-2	10	12	306	0.7	27	244	217	14.9	-5	20	19.73	0.017	6.08	0.06	1.58	0.53	8	-2
88-97-197DB39-08	5859300N, 361500E	<1	<5	<1	-2	4	5	72	0.4	14	193	1160	-0.5	-5	10	31.22	0.015	1.48	0.03	0.69	0.3	6	-2
88-97-197DB39-09	5859300N, 361500E	<1	<5	<1	-2	4	5	83	0.4	33	152	1177	-0.5	-5	7	30.67	0.018	1.39	0.02	0.39	0.22	6	-2
88-97-197DB39-10	5859300N, 361500E	<1	<5	<1	-2	4	5	52	0.6	11	137	1197	-0.5	-5	6	29.76	0.021	1.26	0.02	0.42	0.24	5	-2
88-97-197DB39-11	5859300N, 361500E	<1	<5	<1	-2	6	5	49	0.8	13	113	1175	-0.5	-5	5	27.6	0.014	0.81	0.01	0.27	0.23	5	-2
88-97-197DB39-13	5859300N, 361500E	<1	<5	<1	-2	4	5	102	-0.4	36	160	1182	-0.5	-5	5	31.24	0.016	1.33	0.02	0.42	0.2	6	-2
88-97-198DB40-01	5858750N, 361400E	<1	<5	<1	2	9	9	132	-0.4	97	121	752	0.5	-5	10	16.02	0.036	0.43	0.01	0.34	0.23	5	-2
88-97-198DB40-02	5858750N, 361400E	<1	<5	<1	2	8	6	90	0.5	102	148	737	1	-5	17	17.65	0.035	1.19	0.05	1.21	0.54	7	-2
88-97-198DB40-03	5858750N, 361400E	<1	<5	<1	3	11	7	84	-0.4	75	196	582	0.5	-5	25	14.75	0.039	2.03	0.07	1.8	0.72	8	-2

Appendix 8 (Part 1): Geochemistry of brine-spring sediments (by INAA), Mafeking quarries area (see Appendix 4, Part 1 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)/	Pt (ppb)/	Pd (ppb)/	Mo(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Ag(ppm)	Ni(ppm)	Mn(ppm)	Sr(ppm)	Cd(ppm)	Bi(ppm)	V(ppm)	Ca(%)	P(%)	Mg(%)	Ti(%)	Al(%)	K(%)	Y(ppm)	Be(ppm)
		Assay	Assay	Assay																			
88-97-203DB44-01	5859650N, 356125E	<1	<5	<1	-2	3	-5	39	-0.4	37	216	1268	-0.5	-5	3	32.76	0.011	0.65	0.01	0.26	0.16	5	-2
88-97-203DB44-02	5859650N, 356125E	<1	<5	<1	-2	4	5	62	-0.4	46	226	978	0.5	-5	6	29.45	0.012	1.25	0.01	0.38	0.21	6	-2
88-97-206DB45-01	5859150N, 356250E	<1	<5	<1	-2	4	-5	35	-0.4	16	217	969	-0.5	-5	10	34.12	0.013	1.01	0.03	0.67	0.37	7	-2
88-97-206DB45-02	5859150N, 356250E	<1	<5	<1	-2	4	-5	32	-0.4	24	246	1014	-0.5	-5	9	31.93	0.013	0.99	0.02	0.6	0.28	6	-2
88-97-211DB47-01	5858950N, 356350E	<1	<5	<1	-2	6	5	41	-0.4	20	181	805	-0.5	-5	13	27.85	0.017	2.11	0.04	1	0.39	7	-2
88-97-211DB47-02	5858950N, 356350E	<1	<5	<1	-2	4	6	57	-0.4	15	127	1341	-0.5	-5	4	31.46	0.02	0.38	0.01	0.18	0.13	6	-2
88-97-211DB47-03	5858950N, 356350E	1	<5	<1	-2	3	5	51	0.4	19	150	1391	-0.5	-5	3	38.9	0.011	0.46	0.01	0.14	0.09	5	-2
88-97-211DB47-04	5858950N, 356350E	<1	<5	1	2	3	-5	81	0.5	24	187	1152	-0.5	-5	6	36.58	0.014	0.73	0.01	0.3	0.16	6	-2
88-97-211DB47-05	5858950N, 356350E	<1	<5	<1	2	3	7	92	-0.4	32	168	1282	-0.5	-5	5	36.06	0.015	0.57	0.01	0.22	0.13	6	-2
88-97-214DB51-01	5859000N, 359275E	<1	<5	<1	8	4	13	123	-0.4	42	151	627	0.6	5	5	32.66	0.05	0.33	0.01	0.19	0.16	6	2
88-97-214DB51-02	5859000N, 359275E	<1	<5	<1	2	3	-5	28	-0.4	14	95	1252	-0.5	-5	2	34.63	0.012	0.27	0.01	0.07	0.09	5	-2
88-97-214DB51-03	5859000N, 359275E	<1	<5	<1	5	3	5	31	-0.4	32	110	1185	-0.5	-5	3	35.46	0.014	0.28	0.01	0.07	0.1	5	-2
88-97-214DB51-04	5859000N, 359275E	<1	<5	1	9	4	5	53	-0.4	58	125	938	-0.5	-5	4	31.46	0.015	0.31	0.01	0.12	0.11	5	-2
88-97-214DB51-05	5859000N, 359275E	<1	<5	<1	3	5	-5	49	-0.4	19	122	907	-0.5	-5	4	32.32	0.063	0.24	0.01	0.09	0.09	6	2
88-97-214DB51-06	5859000N, 359275E	<1	<5	1	2	3	5	43	-0.4	33	99	1310	-0.5	-5	3	34.01	0.017	0.26	0.01	0.05	0.11	5	-2
88-97-217DB52-01	5857200N, 358325E	<1	<5	<1	4	6	8	388	-0.4	153	175	354	3.7	-5	13	16.74	0.032	3.91	0.05	1.53	0.6	7	-2
88-97-219DB53-01	5851500N, 377725E	<1	<5	<1	-2	3	-5	48	-0.4	4	110	1418	-0.5	-5	3	40.3	0.014	0.36	0.01	0.13	0.1	5	-2
88-97-219DB53-02	5851500N, 377725E	<1	<5	1	-2	2	-5	29	0.4	3	95	1504	-0.5	-5	2	38.39	0.009	0.37	0.01	0.1	0.09	5	-2
88-97-219DB53-03	5851500N, 377725E	<1	<5	1	-2	3	-5	15	-0.4	3	69	1408	-0.5	-5	2	34.57	0.016	0.32	0.01	0.09	0.17	5	-2
88-97-219DB53-04	5851500N, 377725E	<1	<5	1	-2	3	5	17	-0.4	7	119	1167	-0.5	-5	3	35.34	0.013	0.61	0.01	0.2	0.13	5	-2
88-97-219DB53-05	5851500N, 377725E	<1	<5	<1	-2	3	-5	13	-0.4	3	130	1235	-0.5	-5	5	35.98	0.016	1.55	0.01	0.37	0.19	6	-2
88-97-219DB53-06	5851500N, 377725E	<1	<5	1	2	5	19	118	-0.4	31	157	527	0.9	-5	8	26.83	0.024	2.22	0.03	0.65	0.29	6	-2
88-97-219DB53-07	5851500N, 377725E	<1	<5	1	-2	2	-5	10	-0.4	3	100	1262	-0.5	-5	2	36.22	0.006	0.37	0.01	0.14	0.1	5	-2
88-97-219DB53-08	5851500N, 377725E	<1	<5	<1	-2	3	5	110	-0.4	6	170	831	-0.5	-5	5	35.02	0.024	1.39	0.01	0.28	0.14	6	-2
88-97-219DB53-09	5851500N, 377725E	<1	6	<1	-2	2	5	15	-0.4	3	92	1451	-0.5	-5	2	36.64	0.015	0.25	0.01	0.05	0.09	5	-2
88-97-219DB53-10	5851500N, 377725E	<1	<5	<1	2	3	-5	60	-0.4	16	161	717	-0.5	-5	5	34.58	0.019	0.46	0.01	0.26	0.14	6	-2
88-97-219DB53-11	5851500N, 377725E	<1	<5	1	2	3	13	210	-0.4	17	112	1161	1.4	-5	2	34.91	0.046	0.35	0.01	0.12	0.12	5	-2
88-97-219DB53-12	5851500N, 377725E	<1	<5	<1	2	3	-5	45	-0.4	7	83	1466	-0.5	-5	2	36.4	0.041	0.28	0.01	0.06	0.08	5	-2
88-97-219DB53-13	5851500N, 377725E	<1	<5	<1	4	4	27	145	-0.4	12	96	740	0.5	-5	3	26.02	0.042	0.59	0.01	0.19	0.21	5	-2
88-97-223DB54-01	5846125N, 372900E	<1	<5	1	7	6	5	37	-0.4	19	101	968	-0.5	-5	12	26.68	0.024	0.86	0.03	0.82	0.34	6	-2
88-97-223DB54-02	5846125N, 372900E	5	<5	<1	2	3	7	32	-0.4	10	152	1023	-0.5	-5	4	32.89	0.014	1.2	0.01	0.28	0.15	5	-2
88-97-223DB54-03	5846125N, 372900E	<1	<5	<1	3	3	7	33	-0.4	12	82	1384	-0.5	-5	2	34.52	0.011	0.29	0.01	0.11	0.1	5	-2
88-97-223DB54-04	5846125N, 372900E	<1	<5	1	13	4	13	129	-0.4	64	112	1038	-0.5	-5	5	29.8	0.016	0.45	0.01	0.24	0.16	5	-2
88-97-223DB54-05	5846125N, 372900E	<1	<5	1	-2	3	5	41	-0.4	7	133	1117	-0.5	-5	4	37.07	0.008	0.44	0.01	0.19	0.11	5	-2
88-97-227DB55-01	5850775N, 373625E	<1	<5	<1	-2	5	6	95	-0.4	22	173	739	1.2	-5	10	27.92	0.018	2.58	0.04	0.82	0.35	6	-2

Appendix 8 (Part 1): Geochemistry of brine-spring sediments (by INAA), Mafeking quarries area (see Appendix 4, Part 1 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)/ Assay	Pt (ppb)/ Assay	Pd (ppb)/ Assay	Mo(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Ag(ppm)	Ni(ppm)	Mn(ppm)	Sr(ppm)	Cd(ppm)	Bi(ppm)	V(ppm)	Ca(%)	P(%)	Mg(%)	Ti(%)	Al(%)	K(%)	Y(ppm)	Be(ppm)
88-97-227DB55-02	5850775N, 373625E	<1	<5	<1	2	6	8	159	-0.4	60	192	418	1.6	-5	11	22.5	0.02	3.32	0.04	0.94	0.4	6	-2
88-97-227DB55-03	5850775N, 373625E	<1	<5	1	4	4	5	18	-0.4	20	123	1185	-0.5	-5	2	32.3	0.011	0.59	0.01	0.14	0.13	5	-2
88-97-227DB55-04	5850775N, 373625E	1	<5	<1	-2	3	5	27	-0.4	15	137	1232	-0.5	-5	2	34.09	0.009	0.37	0.01	0.15	0.1	5	-2
88-97-231DB57-01	5858000N, 356375E	4	7	<1	8	3	15	233	-0.4	105	166	1127	1	-5	2	31.19	0.019	0.26	0.01	0.1	0.11	5	-2
88-97-231DB57-02	5858000N, 356375E	<1	<5	<1	5	3	7	111	-0.4	53	141	1261	-0.5	-5	2	33.35	0.012	0.27	0.01	0.11	0.09	5	-2
88-97-231DB57-03	5858000N, 356375E	1	<5	1	4	6	11	199	-0.4	111	221	535	0.9	-5	10	28.2	0.02	1.52	0.03	0.7	0.31	6	-2
88-97-231DB57-04A	5858000N, 356375E	<1	<5	1	5	7	98	5429	-0.4	260	282	278	40.7	-5	5	30.85	0.02	0.63	0.01	0.42	0.21	6	-2
88-97-231DB57-04B	5858000N, 356375E	<1	<5	1	3	3	5	62	-0.4	21	164	1090	-0.5	-5	3	33.55	0.01	0.35	0.01	0.12	0.09	5	-2
88-97-232DB58-01	5851425N, 371060E	1	<5	1	9	3	16	70	-0.4	14	150	797	-0.5	-5	2	34.1	0.024	0.3	0.01	0.09	0.11	5	-2
88-97-232DB58-02	5851425N, 371060E	<1	<5	<1	-2	3	8	32	-0.4	4	171	1357	-0.5	-5	2	34.97	0.017	0.3	0.01	0.06	0.1	5	-2
88-97-233DB59-01	5870225N, 364000E	<1	8	2	23	6	6	34	-0.4	138	135	265	-0.5	-5	11	11.26	0.016	3.28	0.04	1.58	0.48	5	-2
88-97-233DB59-02	5870225N, 364000E	<1	<5	<1	4	13	10	1305	-0.4	44	146	144	3.3	-5	30	12.05	0.042	5.52	0.09	2.23	0.82	7	2
88-97-233DB59-03	5870225N, 364000E	<1	8	1	23	9	-5	151	-0.4	138	127	169	-0.5	-5	12	11.71	0.024	5.44	0.04	0.84	0.41	4	-2
88-97-234DB60-01	5871450N, 367450E	<1	<5	1	-2	15	16	75	-0.4	17	252	615	-0.5	-5	19	17.5	0.342	2.48	0.04	1.02	0.37	6	-2
88-97-284DB92-01	5851825N, 371060E	<1	<5	1	7	6	5	138	-0.4	21	66	955	0.7	-5	4	22.62	0.054	0.8	0.01	0.19	0.23	4	-2
88-97-284DB92-02	5851825N, 371060E	<1	<5	1	-2	5	-5	24	-0.4	5	66	1028	-0.5	-5	5	22.39	0.066	0.56	0.02	0.32	0.26	4	-2
88-97-287DB94-01	5851925N, 368125E	3	<5	2	2	5	5	141	-0.4	89	105	211	1.2	-5	6	31.01	0.054	0.18	0.02	0.43	0.28	8	-2
88-97-292DB97-01	5851600N, 367100E	4	<5	1	3	4	-5	165	0.5	105	94	226	1.4	-5	7	34.51	0.062	0.18	0.03	0.45	0.31	8	-2
88-97-296DB100-01	5852400N, 367200E	1	6	1	-2	5	6	109	0.6	41	126	644	0.7	-5	12	25.46	0.059	0.34	0.04	0.99	0.55	10	-2
88-97-317DB117-01	5846750N, 372100E	7	<5	<1	-2	179	-5	41	0.5	32	188	647	-0.5	-5	10	25.15	0.025	3.19	0.03	0.83	0.33	6	-2
88-97-327DB123-01	5843350N, 372400E	7	<5	<1	-2	180	5	14	0.5	7	129	772	-0.5	-5	12	19.9	0.028	0.95	0.04	1.05	0.45	6	-2
88-97-327DB123-02	5843350N, 372400E	15	<5	<1	-2	308	14	30	0.7	5	56	190	-0.5	-5	8	2.89	0.107	0.27	0.01	0.36	0.22	2	-2
88-97-327DB123-03	5843350N, 372400E	2	<5	<1	2	84	5	40	0.7	9	144	970	-0.5	-5	10	29.06	0.02	1.07	0.02	0.51	0.29	5	-2
88-97-331DB127-01	5848840N, 369550E	1	<5	<1	-2	31	-5	12	0.4	2	231	1027	-0.5	-5	4	21.64	0.036	0.43	0.01	0.17	0.16	2	-2
88-97-331DB127-02	5848840N, 369550E	<1	<5	<1	-2	32	-5	14	0.4	6	86	1140	-0.5	-5	8	24.97	0.024	0.36	0.02	0.47	0.3	4	-2

Appendix 8 (Part 2): Geochemistry of brine-spring sediments (by ICP-AES), Mafeking quarries area (see Appendix 4, Part 2 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)	Pt (ppb)	Pd (ppb)
88-97-163DB14-01	5856250N, 362775E	3	<5	<1
88-97-163DB14-04	5856250N, 362775E	4	<5	<1
88-97-163DB14-07	5856250N, 362775E	<1	<5	<1
88-97-168DB19-01	5858025N, 362175E	13	7	1
88-97-168DB19-03	5858025N, 362175E	7	8	10
88-97-168DB19-05	5858025N, 362175E	2	7	3
88-97-173DB24-01	5849525N, 367325E	<1	8	<1
88-97-173DB24-03	5849525N, 367325E	<1	<5	<1
88-97-173DB24-05	5849525N, 367325E	<1	<5	<1
88-97-173DB24-07	5849525N, 367325E	2	<5	<1
88-97-173DB24-09	5849525N, 367325E	<1	<5	<1
88-97-173DB24-11	5849525N, 367325E	<1	<5	<1
88-97-173DB24-13	5849525N, 367325E	<1	<5	<1
88-97-173DB24-15	5849525N, 367325E	<1	<5	<1
88-97-173DB24-17	5849525N, 367325E	<1	<5	<1
88-97-173DB24-19	5849525N, 367325E	<1	<5	<1
88-97-176DB27-01	5863125N, 364125E	<1	<5	<1
88-97-176DB27-03	5863125N, 364125E	<1	<5	<1
88-97-176DB27-05	5863125N, 364125E	<1	<5	<1
88-97-176DB27-07	5863125N, 364125E	<1	<5	<1
88-97-176DB27-09	5863125N, 364125E	<1	<5	<1
88-97-176DB27-11	5863125N, 364125E	<1	<5	<1
88-97-176DB27-14	5863125N, 364125E	<1	<5	<1
88-97-176DB27-15	5863125N, 364125E	<1	7	<1
88-97-176DB27-16	5863125N, 364125E	<1	<5	<1
88-97-176DB27-17	5863125N, 364125E	3	6	<1
88-97-176DB27-19	5863125N, 364125E	<1	<5	<1
88-97-177DB28-01	5862650N, 363250E	<1	<5	<1
88-97-177DB28-03	5862650N, 363250E	<1	<5	<1
88-97-177DB28-05	5862650N, 363250E	<1	<5	<1
88-97-177DB28-07	5862650N, 363250E	<1	<5	<1
88-97-177DB28-08	5862650N, 363250E	<1	11	<1
88-97-177DB28-09	5862650N, 363250E	<1	<5	<1
88-97-177DB28-10	5862650N, 363250E	<1	<5	<1
88-97-177DB28-12	5862650N, 363250E	<1	<5	<1
88-97-179DB30-01	5859550N, 360575E	<1	<5	<1
88-97-179DB30-02	5859550N, 360575E	<1	<5	<1
88-97-179DB30-03	5859550N, 360575E	<1	<5	<1
88-97-179DB30-04	5859550N, 360575E	<1	<5	<1
88-97-179DB30-05	5859550N, 360575E	<1	<5	<1
88-97-179DB30-06	5859550N, 360575E	<1	<5	<1
88-97-179DB30-07	5859550N, 360575E	<1	<5	<1
88-97-179DB30-08	5859550N, 360575E	<1	<5	<1
88-97-179DB30-09	5859550N, 360575E	<1	<5	<1
88-97-179DB30-10	5859550N, 360575E	<1	<5	<1
88-97-179DB30-11	5859550N, 360575E	<1	<5	<1
88-97-179DB30-12	5859550N, 360575E	<1	<5	<1
88-97-179DB30-13	5859550N, 360575E	<1	<5	<1
88-97-180DB31-01	5860000N, 358725E	<1	<5	<1

Appendix 8 (Part 2): Geochemistry of brine-spring sediments (by ICP-AES), Mafeking quarries area (see Appendix 4, Part 2 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)	Pt (ppb)	Pd (ppb)
88-97-180DB31-02	5860000N, 358725E	<1	<5	<1
88-97-180DB31-03	5860000N, 358725E	<1	<5	<1
88-97-180DB31-04	5860000N, 358725E	<1	<5	<1
88-97-180DB31-05	5860000N, 358725E	<1	<5	<1
88-97-182DB33-01	5856675N, 357175E	<1	<5	<1
88-97-182DB33-02	5856675N, 357175E	<1	<5	<1
88-97-184DB34-01	5857725N, 356425E	<1	<5	<1
88-97-184DB34-02	5857725N, 356425E	<1	11	<1
88-97-184DB34-03	5857725N, 356425E	<1	<5	<1
88-97-184DB34-04	5857725N, 356425E	<1	<5	<1
88-97-184DB34-05	5857725N, 356425E	<1	<5	<1
88-97-184DB34-06	5857725N, 356425E	<1	<5	<1
88-97-184DB34-07	5857725N, 356425E	<1	<5	<1
88-97-184DB34-08	5857725N, 356425E	<1	<5	<1
88-97-184DB34-09	5857725N, 356425E	<1	<5	<1
88-97-184DB34-10	5857725N, 356425E	<1	<5	<1
88-97-188DB35-01	5861309N, 362520E	<1	<5	<1
88-97-188DB35-02	5861309N, 362520E	<1	<5	<1
88-97-188DB35-03	5861309N, 362520E	<1	<5	<1
88-97-188DB35-04	5861309N, 362520E	<1	<5	<1
88-97-188DB35-05	5861309N, 362520E	<1	<5	<1
88-97-188DB35-06	5861309N, 362520E	<1	<5	<1
88-97-188DB35-07	5861309N, 362520E	<1	<5	<1
88-97-188DB35-08	5861309N, 362520E	<1	<5	<1
88-97-188DB35-09	5861309N, 362520E	<1	<5	<1
88-97-188DB35-10	5861309N, 362520E	<1	<5	<1
88-97-188DB35-11	5861309N, 362520E	<1	<5	<1
88-97-191DB36-01	5860300N, 362225E	<1	<5	<1
88-97-191DB36-02	5860300N, 362225E	2	<5	<1
88-97-191DB36-03	5860300N, 362225E	<1	<5	<1
88-97-191DB36-04	5860300N, 362225E	<1	<5	<1
88-97-191DB36-05	5860300N, 362225E	<1	<5	<1
88-97-195DB38-01	5860575N, 363400E	<1	<5	<1
88-97-195DB38-02	5860575N, 363400E	<1	<5	<1
88-97-195DB38-04	5860575N, 363400E	<1	<5	<1
88-97-195DB38-05	5860575N, 363400E	<1	<5	<1
88-97-195DB38-07	5860575N, 363400E	<1	<5	<1
88-97-195DB38-08	5860575N, 363400E	<1	<5	<1
88-97-195DB38-09	5860575N, 363400E	<1	<5	<1
88-97-195DB38-12	5860575N, 363400E	<1	<5	<1
88-97-197DB39-01	5859300N, 361500E	<1	<5	<1
88-97-197DB39-02	5859300N, 361500E	<1	<5	<1
88-97-197DB39-03	5859300N, 361500E	<1	<5	<1
88-97-197DB39-04	5859300N, 361500E	<1	<5	<1
88-97-197DB39-05	5859300N, 361500E	<1	<5	<1
88-97-197DB39-06	5859300N, 361500E	<1	<5	<1
88-97-197DB39-07	5859300N, 361500E	<1	<5	<1
88-97-197DB39-08	5859300N, 361500E	<1	<5	<1
88-97-197DB39-09	5859300N, 361500E	<1	<5	<1
88-97-197DB39-10	5859300N, 361500E	<1	<5	<1

Appendix 8 (Part 2): Geochemistry of brine-spring sediments (by ICP-AES), Mafeking quarries area (see Appendix 4, Part 2 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)	Pt (ppb)	Pd (ppb)
88-97-197DB39-11	5859300N, 361500E	<1	<5	<1
88-97-197DB39-13	5859300N, 361500E	<1	<5	<1
88-97-198DB40-01	5858750N, 361400E	<1	<5	<1
88-97-198DB40-02	5858750N, 361400E	<1	<5	<1
88-97-198DB40-03	5858750N, 361400E	<1	<5	<1
88-97-203DB44-01	5859650N, 356125E	<1	<5	<1
88-97-203DB44-02	5859650N, 356125E	<1	<5	<1
88-97-206DB45-01	5859150N, 356250E	<1	<5	<1
88-97-206DB45-02	5859150N, 356250E	<1	<5	<1
88-97-211DB47-01	5858950N, 356350E	<1	<5	<1
88-97-211DB47-02	5858950N, 356350E	<1	<5	<1
88-97-211DB47-03	5858950N, 356350E	1	<5	<1
88-97-211DB47-04	5858950N, 356350E	<1	<5	1
88-97-211DB47-05	5858950N, 356350E	<1	<5	<1
88-97-214DB51-01	5859000N, 359275E	<1	<5	<1
88-97-214DB51-02	5859000N, 359275E	<1	<5	<1
88-97-214DB51-03	5859000N, 359275E	<1	<5	<1
88-97-214DB51-04	5859000N, 359275E	<1	<5	1
88-97-214DB51-05	5859000N, 359275E	<1	<5	<1
88-97-214DB51-06	5859000N, 359275E	<1	<5	1
88-97-217DB52-01	5857200N, 358325E	<1	<5	<1
88-97-219DB53-01	5851500N, 377725E	<1	<5	<1
88-97-219DB53-02	5851500N, 377725E	<1	<5	1
88-97-219DB53-03	5851500N, 377725E	<1	<5	1
88-97-219DB53-04	5851500N, 377725E	<1	<5	1
88-97-219DB53-05	5851500N, 377725E	<1	<5	<1
88-97-219DB53-06	5851500N, 377725E	<1	<5	1
88-97-219DB53-07	5851500N, 377725E	<1	<5	1
88-97-219DB53-08	5851500N, 377725E	<1	<5	<1
88-97-219DB53-09	5851500N, 377725E	<1	6	<1
88-97-219DB53-10	5851500N, 377725E	<1	<5	<1
88-97-219DB53-11	5851500N, 377725E	<1	<5	1
88-97-219DB53-12	5851500N, 377725E	<1	<5	<1
88-97-219DB53-13	5851500N, 377725E	<1	<5	<1
88-97-223DB54-01	5846125N, 372900E	<1	<5	1
88-97-223DB54-02	5846125N, 372900E	5	<5	<1
88-97-223DB54-03	5846125N, 372900E	<1	<5	<1
88-97-223DB54-04	5846125N, 372900E	<1	<5	1
88-97-223DB54-05	5846125N, 372900E	<1	<5	1
88-97-227DB55-01	5850775N, 373625E	<1	<5	<1
88-97-227DB55-02	5850775N, 373625E	<1	<5	<1
88-97-227DB55-03	5850775N, 373625E	<1	<5	1
88-97-227DB55-04	5850775N, 373625E	1	<5	<1
88-97-231DB57-01	5858000N, 356375E	4	7	<1
88-97-231DB57-02	5858000N, 356375E	<1	<5	<1
88-97-231DB57-03	5858000N, 356375E	1	<5	1
88-97-231DB57-04A	5858000N, 356375E	<1	<5	1
88-97-231DB57-04B	5858000N, 356375E	<1	<5	1
88-97-232DB58-01	5851425N, 371060E	1	<5	1
88-97-232DB58-02	5851425N, 371060E	<1	<5	<1

Appendix 8 (Part 2): Geochemistry of brine-spring sediments (by ICP-AES), Mafeking quarries area (see Appendix 4, Part 2 for detection limits)

SAMPLE NUMBER	LOCATION	Au (ppb)	Pt (ppb)	Pd (ppb)
88-97-233DB59-01	5870225N, 364000E	<1	8	2
88-97-233DB59-02	5870225N, 364000E	<1	<5	<1
88-97-233DB59-03	5870225N, 364000E	<1	8	1
88-97-234DB60-01	5871450N, 367450E	<1	<5	1
88-97-284DB92-01	5851825N, 371060E	<1	<5	1
88-97-284DB92-02	5851825N, 371060E	<1	<5	1
88-97-287DB94-01	5851925N, 368125E	3	<5	2
88-97-292DB97-01	5851600N, 367100E	4	<5	1
88-97-296DB100-01	5852400N, 367200E	1	6	1
88-97-317DB117-01	5846750N, 372100E	7	<5	<1
88-97-327DB123-01	5843350N, 372400E	7	<5	<1
88-97-327DB123-02	5843350N, 372400E	15	<5	<1
88-97-327DB123-03	5843350N, 372400E	2	<5	<1
88-97-331DB127-01	5848840N, 369550E	1	<5	<1
88-97-331DB127-02	5848840N, 369550E	<1	<5	<1