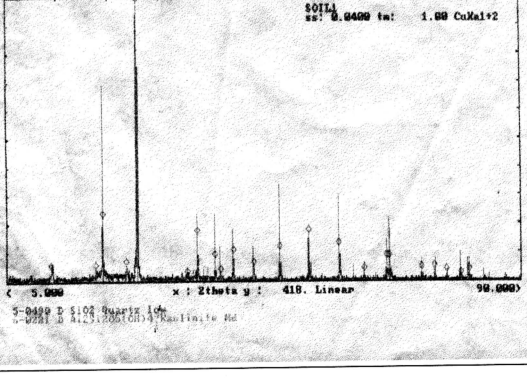
APPENDIXES

APPENDIX A

SOIL MINERALOGICAL COMPOSITION AS DETERMINED BY X-RAY DIFFRACTOMETER

Sample: SOIL1 3-Jun-1999 09:20:59
Data file: SOIL1.RAW

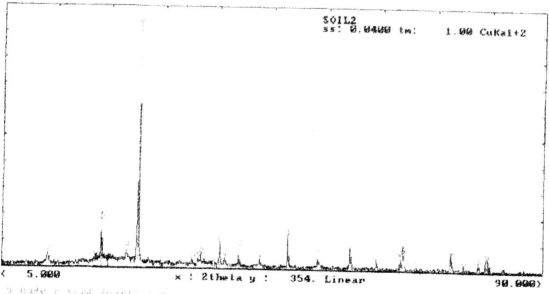
Seq	2theta	d	rel. I	Seq	2theta	d	rel. I
1	12.376	7.1475	2.30	5	26.745	3.3312	100.00
2	19.812	4.4786	2.18	3	20.966	4.2345	11.25
3	20.966	4.2345	11.25	7	36.645	2.4508	8.34
4	24.882	3.5762	2.78	13	54.974	1.6693	8.22
5	26.745	3.3312	100.00	14	60.036	1.5401	6.17
6	35.024	2.5605	1.09	12	50.256	1.8144	5.56
7	36.645	2.4508	8.34	10	42.564	2.1227	4.84
8	39.569	2.2762	4.11	8	39.569	2.2762	4.11
9	40.495	2.2263	1.33	16	67.835	1.3807	3.87
10	42.564	2.1227	4.84	17	68.280	1.3728	3.75 ?
11	45.899	1.9759	2.54	4	24.882	3.5762	2.78
12	50.256	1.8144	5.56	11	45.899	1.9759	2.54
13	54.974	1.6693	8.22	1	12.376	7.1475	2.30
14	60.036	1.5401	6.17	2	19.812	4.4786	2.18
15	64.113	1.4516	1.57	19	75.722	1.2553	1.93
16	67.835	1.3807	3.87	18	73.584	1.2864	1.81
17	68.280	1.3728	3.75 ?	15	64.113	1.4516	1.57
18	73.584	1.2864	1.81	22	81.460	1.1808	1.33
19	75.722	1.2553	1.93	20	77.724	1.2279	1.33
20	77.724	1.2279	1.33	9	40.495	2.2263	1.33
21	80.126	1.1970	0.85	6	35.024	2.5605	1.09
22	81.460	1.1808	1.33	21	80.126	1.1970	0.85



Sample: SOIL2
Data file: SOIL2.RAW

3-Jun-1999 10:57:58

Seq	2theta	d	rel. I	Seq	2theta	d	rel. I
1	12.283	7.2017	5.80	5	26.651	3.3428	100.00
2	19.945	4.4489	4.29	3	20.874	4.2530	19.14
3	20.874	4.2530	19.14	15	59.951	1.5420	14.88
4	24.882	3.5762	8.34	13	50.164	1.8175	13.19
5	26.651	3.3428	100.00	9	39.480	2.2811	11.38
6	35.157	2.5511	3.45	11	42.473	2.1270	9.60
7	35.958	2.4961	3.86	4	24.882	3.5762	8.34
8	36.574	2.4554	5.69	18	68.341	1.3717	7.75
9	39.480	2.2811	11.38	14	54.878	1.6720	7.44
10	40.361	2.2333	4.97	20	75.670	1.2560	6.76
11	42.473	2.1270	9.60	17	67.739	1.3825	5.81
12	45.832	1.9787	4.74	1	12.283	7.2017	5.80
13	50.164	1.8175	13.19	8	36.574	2.4554	5.69
14	54.878	1.6720	7.44	21	75.884	1.2530	5.24
15	59.951	1.5420	14.88	25	81.514	1.1801	5.00
16	64.015	1.4536	4.34	10	40.361	2.2333	4.97
17	67.739	1.3825	5.81	24	81.155	1.1844	4.82
18	68.341	1.3717	7.75	12	45.832	1.9787	4.74
19	70.259	1.3389	1.30	16	64.015	1.4536	4.34
20	75.670	1.2560	6.76	2	19.945	4.4489	4.29
21	75.884	1.2530	5.24	7	35.958	2.4961	3.86
22	77.662	1.2287	2.69	6	35.157	2.5511	3.45
23	80.039	1.1981	3.09	23	80.039	1.1981	3.09
24	81.155	1.1844	4.82	22	77.662	1.2287	2.69
25	81.514	1.1801	5.00	19	70.259	1.3389	1.30



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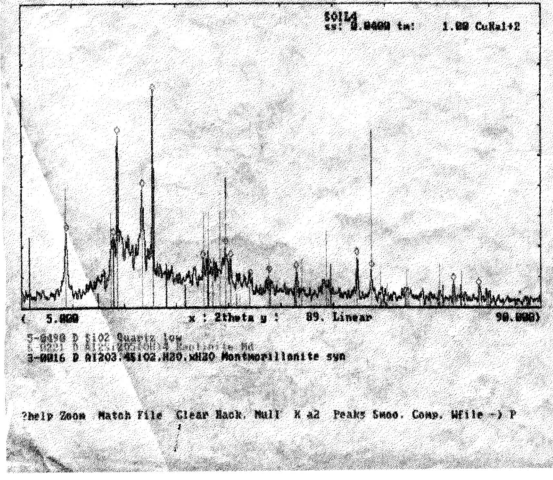
Sample: SOIL3 3-Jun-1999 11:04:06
Data file: SOIL3.RAW

Seq	2theta	d	rel. I
1	12.411	7.1275	35.21
2	20.212	4.3908	33.38
3	20.864	4.2550	80.61
4	24.957	3.5657	55.87
5	26.704	3.3362	100.00
6	34.890	2.5700	22.75
7	35.824	2.5051	19.18
8	38.626	2.3295	28.99
9	39.427	2.2841	22.63
10	42.630	2.1196	14.19
11	45.699	1.9841	15.86
12	50.102	1.8196	17.64
13	60.005	1.5408	23.93
14	62.378	1.4877	17.81
15	75.722	1.2553	11.86
16	79.859	1.2004	9.47

Seq	2theta	d	rel. I
5	26.704	3.3362	100.00
3	20.864	4.2550	80.61
4	24.957	3.5657	55.87
1	12.411	7.1275	35.21
2	20.212	4.3908	33.38
8	38.626	2.3295	28.99
13	60.005	1.5408	23.93
6	34.890	2.5700	22.75
9	39.427	2.2841	22.63
7	35.824	2.5051	19.18
14	62.378	1.4877	17.81
12	50.102	1.8196	17.64
11	45.699	1.9841	15.86
10	42.630	2.1196	14.19
15	75.722	1.2553	11.86
16	79.859	1.2004	9.47



APPENDIX B

LEVELS OF HEAVY METALS IN THE REFERENCE SOIL SAMPLE SO-2

Energy, Mines and Resources Canada

CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY

REFERENCE SOIL SAMPLE SO-2

CERTIFICATE OF ANALYSIS

	Recommended Values ± 95% Confidence Interval					
Si	29.99	±	0.23%	Sr	190	± 50 µg/g
Al	5.67	±	0.18%	Zn	124	± 5 µg/g
Fe	3.46	±	0.16%	V	64	± 10 µg/g
K	2.75	±	0.04%	Pb	21	± 4 µg/g
Ca	1.06	±	0.10%	Ce	16	± 2 µg/g
Ti	0.26	±	0.02%	Cu	7	± 1 µg/g
Mg	0.54	±	0.03%	Hg	0.082	± 0.009 µg/g
Mn	0.072	±	0.002%			

DESCRIPTION

SO-2 is of the B horizon of a Ferro-Humic Podzol developed in sandy till. The organic matter content is approximately 10%. The sampling site was in the Montmorency Forest about 47°20'N, 71°9'W, 72 km north of Quebec City at a depth of 10 to 30 cm.

The soil was dried in 70-kg batches at 105°C for 17 hours. The gravel fragments were removed and the soil was ball-milled to -74 µm. The batches were blended in one lot and bottled in 200-g units.

Six bottles were selected on a random basis to assess the homogeneity by X-ray fluorescence. Although some bottle-to-bottle differences were detected, these were assumed to be minor compared to the anticipated between-laboratory standard deviations. Indeed, the statistical treatment of the analytical results of the interlaboratory certification program indicated no abnormal inhomogeneity.

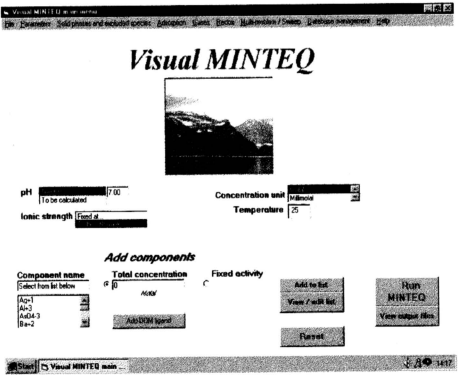
CERTIFICATION

SO-2 was characterized by an interlaboratory analysis method. The recommended values are the unweighted means of 81 to 235 accepted analytical results from 9 to 29 laboratories for the various constituents. Atomic absorption was the most widely used technique. X-ray fluorescence, emission spectroscopy, colorimetric, neutron activation analysis and titrimetric techniques were also employed.

APPENDIX C

VISUAL MINTEQA

Visual MINTEQA is a Windows version of MINTEQA2 ver 4.0, which was released by the USEPA in 1999. MINTEQA2 is a chemical equilibrium model for the calculation of metal speciation, solubility equilibria etc. for natural waters. It is probably the most widespread model for these purposes today, and it is renowned for its stability. MINTEQA2 ver 4.0 is a chemical equilibrium model for the calculation of metal speciation and solubility equilibria for natural solutions. MINTEQA2 is a DOS computer program designed by the USEPA to determine the activities and speciation of many soil constituents using a database of equilibrium constants



Visual MINTEQ has been developed to make the powerful features of MINTEQA2 more easily accessible for graduate and post-graduate students in soil and water chemistry. However also for research purposes the program has the potential of speeding up the management of input and output data. Visual MINTEQ has also been modernised to include new options for adsorption modelling. Here are some examples of what Visual MINTEQ can do:

- Ion speciation using equilibrium constants from the MINTEQA2 ver 4.0 database
- Solubility calculations involving solid phases
- Adsorption calculations with five surface complexation models (Diffuse Layer, Constant Capacitance, Triple Layer, Basic Stern and Three Plane)

APPENDIX D

BACKGROUND DISCUSSION FOR SOIL-PLANT-HUMAN EXPOSURE PATHWAY

The consumption of fruits and vegetables has been identified as the major pathway to contaminants to enter the human body. To address this pathway within guidance, the office of Emergency and Remedial Response of the United States Environmental Protection Agency (USEPA) develop methods to calculate the soil screening level (SSL) for the soil-plant-human exposure pathway

C1 SSL Calculation from empirical data

For the uptake of metals into edible parts for both belowground and aboveground plants, the USEPA, (1992) recommends a simple equation to estimate the SSL for the soil-plant-human exposure pathway. The Equation is given by:

$$SSL\ (mg/kg) = Cplant/Br$$

Parameter/ Definition (units)	**Default**
C_{plant}/ acceptable plant concentration (mg/kg Dw)	See section C2
Br/ plant-soil bioconcentration factor (mg metal/kgDW)(mg metal/kgsoil)$^{-1}$	Metal and plant specific

C2 Acceptable concentration in plant tissue (C_{plant})

The Acceptable concentration in plant tissue (C_{plant}) in mg/kgDW is backcalculated using the following equation:

$$Cplant = I \times BW/F \times CR$$

Parameter/ Definition (units)	Default
I/ acceptable daily intake of metal contaminant (mg/kg/day)	See section C3
BW/Body weight (Kg)	70
F/ fraction of fruit or vegetable consumed	See section C4
CR/ consumption rate of fruit or vegetable	0.0197 (aboveground) 0.0024 (belowground) See section C4

C3 Acceptable daily intake (I) of metal contaminants

The acceptable daily intake (I) of metal contaminants (I)in mg/kg/day is calculated at the target risk level, using default assumptions for exposure duration, exposure frequency, and averaging time as follows:

$$I = \frac{TR \times AT \times 365d/yr}{Ed \times EF \times CSF_{oral}}$$

Parameter/ Definition (units)	Default
TR/ target risk level (unitless)	10^{-6}
Ed/ averaging time (year)	70
ED/ exposure duration (years)	30
ER/ exposure frequency (day/year)	350
CSF_{oral}/ oral reference dose (mg/kg/day)	Chemical-specific

C4 Contaminated Fraction (F) and Consumption Rate (CR)

Default value (0.40) for the fraction of vegetables assumed to be contaminated (F) is recommended in the USEPA, (1999) Exposure Factor Handbook. The cited default values for the total fruit vegetable (CR) are 0.140 and 0.20 (U.SEPA, 1990).