UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

ASSESSMENT OF GEOCHEMICAL VARIABILITY AND A LISTING OF GEOCHEMICAL DATA FOR SURFACE SOILS OF EASTERN NORTH DAKOTA AND PARTS OF NORTHEASTERN SOUTH DAKOTA AND NORTHWESTERN MINNESOTA

by

R. C. Severson and S. A. Wilson*

Open-File Report 90-310

This report is preliminary and has not been reviewed for unconformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic code. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

*U.S. Geological Survey, DFC, Box 25046, MS 973, Denver, CO 80225

1990

CONTENTS

ILLUSTRATIONS

TABLES

APPENDIX TABLE

INTRODUCTION

Congress, in 1986, passed the Garrison Diversion Unit Reformulation Act, which mandates that soil surveys be conducted to assess soil characteristics that might result in toxic or hazardous irrigation return flows. Studies assessing the potential for trace element problems in soils are restricted to small geographic areas designated by the irrigation project (see for example; Goolsby, Severson, Wilson, and Webber 1989). An overview of the trace element content in soils is lacking for eastern North Dakota even though agricultural irrigation and drainage projects are being planned for and developed in eastern North Dakota.

A reconnaissance sampling of surface soils (A horizon, or 0-20 cm depth) from eastern North Dakota and parts of northeastern South Dakota and northwestern Minnesota (fig. 1) was conducted in 1988. A total of 228 samples was collected using a square grid-based sampling with an analysis-of-variance design. The grid consisted of decreasingly smaller cells (100km, 50km, and 25km) nested within each other. The geochemical composition (32 elements) of the soils was determined, and these data were used to meet the objectives of the landscape-variability study. These objectives were, 1) to provide background information on the geochemical composition of surface soils in this area, 2) to evaluate the spatial variability of the soils based on the geochemical data, and 3) either to use the information to prepare stable (reproducible) geochemical maps or to determine the additional sampling requirements for stable geochemical maps.

Contour maps representing an element's concentration in soil can be prepared at any scale by collecting samples on a grid at that scale. However, there are no assurances that a contour map prepared in this manner will reliably represent the true geochemical patterns of the landscape. Analysis-of-variance can be used to measure the magnitude and distribution of natural variability that exists at various geographic scales. From the variance components it is possible to estimate the feasibility of preparing geochemical maps of element distributions of known reliability in soils at various geographic scales. Feasibility is defined by the requirement to focus sampling at those geographic scales where the largest amount of variance occurs consistent with a practical ability to collect and analyze at least the minimum number of random samples required in each cell of a specified size.

METHODS

Sampling Design

General sampling locations for the landscape variability studies were determined with the aid of U.S. Geological Survey 1;100,000 scale topographic maps. All sampling sites were subject to relocation based on field observations and accessibility.

An unbalanced, nested, analysis-of-variance design was used to allocate sites for sampling based on 100-km, 50-km, and 25-km cells nested within each other. Thirteen 100-km cells were positioned to obtain the most complete coverage of the study area (fig. 1). Each of the 100-km cells was divided into four 50-km cells (resulting in 52 cells) and each of the 50-km cells was divided into 25-km cells (resulting in 208 cells). A single sampling location was randomly chosen within each of the 208 25-km cells, plus an additional sampling location was randomly chosen in 20 of the 208 25-km cells to estimate variability within 25-km cells. This resulted in a total of 228 sampling locations which are shown on figure 1.

Statistical Techniques

Anaysis-of-Variance

A five-level, unbalanced, nested, analysis-of-variance design was used in the landscape variability study. This statistical design allows the partitioning of the total measured natural variation into components (table 3). The first four components (levels) are related to the various sampling cell sizes of 100, 50, 25 and <25 km described above. In addition, 21 samples were chosen at random and split into two parts and each part analyzed independently. This duplicate analysis of samples represents the fifth level of the design and gives a component estimating all procedural errors, including field sampling, sample preparation, and sample analysis.

A further precaution was taken to convert any systematic error, which might occur in either sampling or analysis, into random errors. This was accomplished by analyzing all samples (original and duplicate samples) in a randomized sequence so that any geographic trend in the data is not confounded by any possible analytical trend.

Statistical analyses require complete numeric data sets. Some elements were reported as being below the lower limit of determination (censored data) of the analytical method (table 1). These elements are identified in table 2 as having detection ratios of <1:1. Where more that 20 percent of the determinations were below detection (Ag, Hg, Mo, Nb, and Sn) the element is omitted from further interpretation. Otherwise, the censored values for Be, Se, Th, and Yb were replaced with arbitrary values equal to 70 percent of their lower limit of determination. The replacement values are justified because their small number neither alters the statistical tests nor affects the interpretation of the data. For the elements with censored distributions, the geometric means and deviations were estimated by the technique of Cohen (1959) for singly truncated distributions.

Variance Ratios and Mapping Requirements

The variance-mean-ratio (Vm) (Miesch, 1976) is computed from estimates of variance components associated with sampling cell sizes described above. The Vm provides an index of relative stability of mean values used to construct geochemical maps. Vm values computed for different cell sizes are useful for evaluating the feasibility of mapping the distribution of an element at those different size cells. For example, Vm values for 50km cells would be computed as follows:

$$Vm = \frac{s^2_{100} + s^2_{50}}{n_{25}\, s^2_{25} + n_{<25}\, s^2_{<25} + n_e\, s^2_e}$$

where the numerator is the sum of the variance components (s^2) for the 100 and 50km cells and the denominator is the sum of the variance components (s^2) multiplied by the average number of samples (n) collected within each smaller cell, plus estimates of procedural errors. In other words, the numerator is the variance between 50km cells and the denominator is the variance within the 50km cells. A Vm equal to 1.0 is approximately equivalent to an F-test at a probability level of 80 percent. Taking a Vm equal to 1.0 as a threshold, for values less than 1.0 we judge that a map of element concentration prepared from the existing data, at the cell size indicated in the numerator of the equation above, tends not to faithfully reproduce the true geochemical pattern (Miesch, 1976, p. 102). As Vm increases, the map pattern increasingly reflects the true geochemical pattern.

Field Sampling and Sample Preparation

Sampling sites for the landscape variability study were randomly located to include the true extent of the natural variability in the samples collected. Random locations are necessary to provide an accurate assessment of the sampling intensity needed to prepare stable maps of element content in the soils sampled.

Sampling of soil by horizon was accomplished using the following general guidelines. At each sampling location, living vegetation was removed from the soil surface and a shallow soil pit was excavated by hand. An approximate 1-kg sample of the surface soil horizon (A horizon, or 0-20 cm depth) was placed in water-resistant paper bags and labeled as to it's location and position in the sampling design.

All soil samples were dried under forced air at ambient temperature. The dry samples were disaggregated using a mechanical ceramic mortar and pestle, sieved to minus 10 mesh (2 mm), and a split of the minus 2-mm sample was ground to minus 80 mesh. The minus 80-mesh material was used for all chemical analysis.

Laboratory Methods

Chemical analyses were performed by two main techniques, inductively coupled plasma atomic emission spectroscopy (ICP-AES) and continuous-flow hydride-generation atomic absorption spectroscopy (HGAAS). Additional determinations are described under the heading "*Miscellaneous determinations*"

Inductively Coupled Plasma Atomic Emission Spectroscopy

Samples were analyzed simultaneously for 38 elements using ICP-AES. Each soil sample (0.200g) was dissolved using a low-temperature digestion with concentrated hydrochloric, hydrofluoric, nitric, and perchloric acids (Crock and others, 1983). The acidic sample solution was taken to dryness and the residue was dissolved with 1mL of aqua regia and then diluted to 10g with demineralized water. Reference materials and sample replicates were digested by the same procedure and analyzed, along with reagent blanks, at the same time as the samples. The elements determined and their lower limits of determination are shown in Table 1. The elements Au, Bi, Cd, Ho, Ta, and U were below the lower limit of detection in all samples. The relative standard deviation (RSD) for replicate determinations of most elements is five percent or less.

Continuous-Flow Hydride-Generation Atomic Absorption Spectroscopy

Arsenic and selenium in soils were determined by HGAAS (Crock and Lichte, 1982; Sanzolone and Chao, 1987). A 0.25-gram portion of soil sample was digested with nitric, perchloric, and hydrofluoric acids. After digestion, the sample was diluted to 50mL with 6N HCl. Arsenic and selenium were determined independently using specifically designed continuous flow systems. In the procedure, the sample solution was reacted with sodium borohydride in order to generate the gaseous hydrides which were swept into the heated quartz furnace and measured by atomic absorption spectrometry. Arsenic and selenium were quantified using an aqueous standard calibration curve. Determination limits for arsenic and selenium are shown in Table 1. The RSD for the determination of both elements was about ten percent.

Miscellaneous Determinations

Mercury in soil was determined using an automated continuous-flow cold-vapor atomic absorption spectroscopic (CV-AAS) method (Kennedy and Crock, 1987). A 0.100 g sample was digested with nitric acid and sodium dichromate in a closed Teflon bottle and then diluted to 12 mL with deionized water. The sample solution was reacted with a sulfuric acid-hydroxylamine hydrochloride solution and a stannous chloride solution in a continuous-flow system. The gaseous mercury was separated by a phase separator and swept into a quartz cell positioned in the light path of an atomic absorption spectrometer. Mercury was quantified using an aqueous standard calibration curve.

Hot-water extractable boron in soil was measured using a 1:5 (soil:water) hot-water extract of the soil according to the method given in Crock and Severson (1980). Five grams of soil were mixed with 25 mL of demineralized water in a 50 mL polyethylene centrifuge tube, capped and placed in boiling water for one hour. The mixture was shaken occasionally. The sample was then centrifuged at 2500 RPM for 10 minutes, the clear liquid decanted, filtered through 0.45 micron filter disks, acidified with concentrated nitric acid, and then the boron content was measured using ICP-AES under standard conditions.

RESULTS

The sample site and generalized geologic map (fig 1.) show that samples were collected in each of the geologic units. The number of samples collected within each geologic unit is roughly proportional to the area each unit occupies. The geology in figure 1 is greatly simplified. However, the glacial sediments, whether they are till, outwash, eolian, river or lake sediment, are all derived from the underlying Cretaceous and Tertiary marine formations and Tertiary continental formations. Clayton and others (1980) have prepared a map showing details of the geology of North Dakota. The distribution of soil parent materials and soil formation is available in Omodt and others (1968) for North Dakota, and in Westin and others (1967) for South Dakota.

The 36 elements which were detected in the surface soil samples are summarized in table 2 by their detection ratio, geometric mean and deviation, observed range, and baseline value. A listing of the results of analysis for all surface soil samples is given in appendix table A1. The baseline value is computed as the expected 95-percent range of Tidball and Ebens (1976) for the distribution of values measured in samples from this study. This means that if a new soil sample were to be collected and analyzed for some element, there is only a 1-in-20 chance that the determined value for that element would be outside of this range. The observed range is simply the lowest and highest values measured. These summary statistics on the composition of soils provide an overview of their geochemistry, and the information is useful for making comparisons with the geochemistry of soils from other areas to determine, on a gross scale, whether the soils are typical or unusual in their chemical composition. However, this study was designed to provide, in addition to this general geochemical overview, information about the distibutions of elements in soils across the landscape.

As stated earlier, the major purposes for collecting samples based on an analysis-of-variance design are, to determine the amount of natural variability that exists at various geographic scales, and to use the spatial variability of the data to estimate the sampling requirements for preparing geochemical maps of element distributions in soils at various geographic scales. Components of variation measured over increments of distance for 32 elements in soils, plus estimates of procedural errors, are given in table 3. The variance components in table 3 show what proportion of the total natural variation can be explained by preparing contour maps at each sampling interval (expressed as cell sizes of 100km, 50km, and 25km). Estimates of sampling needs to prepare reliable geochemical maps for elements in surface soil horizons are given in table 4 for three cell sizes. These estimates were calculated following the methods of Miesch (1976). Table 4 gives the calculated Vm value based on the samples already collected for three cell sizes. If this value is 1.0 or greater, then a reliable geochemical map may be constructed for the element by plotting the mean values for the cell size indicated using the data already collected. If the Vm value is less than 1.0, then additional sampling is needed to prepare reliable geochemical maps. The values for Nr estimate the number of random samples that would need to be collected within the cell size specified to raise the value of Vm to 1.0 at the 80 percent and 95 percent probability levels, respectively. The Nr values at 95 percent in table 4 show that, for most elements and all three cell sizes, the amount of sampling to obtain this high degree of map reliability would be prohibited by the high costs. Calculated Vm and estimated Nr values conflict for some elements, especially in borderline cases. For example, an average of slightly greater than four samples were actually collected within each 50 km cell, however the Vm value for Ba and Ca at 50 km cells is 1.0 and the Nr value is five. With a Vm of 1.0, the Nr should be equal to or less than four, the actual number of samples collected. Apparently, the algorithm for estimating the value of Nr may introduce a rounding error of plus or minus one. Therefore, to be conservative, only the Vm values in table 4 will be considered when judging whether or not a reliable geochemical map can be prepared from the data already collected. If additional sampling is planned to prepare reliable maps, then the most conservative approach would be to add one sample to the Nr values reported in table 4 where the calculated value of Vm is near one.

The information in tables 3 and 4 can be used to determine if reliable maps can be prepared based on the data already collected or additional sampling is needed to prepare geochemical maps for specific elements at various sampling intervals. The numbers of samples that would need to be collected within each gridded cell of differing size, and the total number of samples necessary to prepare a reliable map for elements based on each gridded-cell size at the 80 percent probability level are given in figure 2. Figure 2 was constructed based on sampling 13 100-km cells, 52(13 X 4) 50-km cells, or 208(52 X 4) 25-km cells. The Nr value for each element (table 4) was then multiplied by this number of cells to determine the total number of samples. Maps for some elements can be prepared based on the data already collected--this information is summarized in table 5. For those elements with a Vm value greater than 1.0 and a significant or non-significant variance component, contour maps may be constructed with confidence that it is a reliable representation of the true geochemical pattern. Elements with a significant variance component, but with a Vm value less than 1.0, can also be represented on a map as cell means only, but any contouring of those means may not be reliable. A significant variance component indicates as a minimum that the smallest cell mean is significantly different from the largest cell mean. Contours should not be drawn, in this instance, because there is no assurance that adjacent cell means are significantly different from one another.

Geochemical maps for element concentrations in soils based on geometric means for 100km-cells are given in figures 3A-30; for 50km-cells in figures 4A-4F; and for 25km-cells in figures 5A-5D. The elements are presented in the same sequence as given in table 5. Each contoured geochemical map is accompanied by a map displaying cell means. In some cases, the contour map and cell-mean maps do not correspond exactly because the contouring was based on averaging the four nearest neighbors and the contours were estimated by an inverse-distance-squared algorithm. Cell means are plotted without contour lines for those elements with significant variance components but with a Vm of less than 1.0 (figures 3I-30 and 4D-4F). For elements with a Vm greater than 1.0, three contours are used to represent the geometric mean and the lower and upper baseline values of the data (table 2). The baseline value is computed as the expected 95-percent range of Tidball and Ebens (1976). The contour maps presented in figures

3-5 show varying amount of detail, or resolution. The resolution is dependent on the sampling interval (cell size) and the spatial variability associated with that cell size. Greater resolution for an element's distribution is obtained as the cell size is decreased from 100km to 50km to 25km, and as the amount of spatial variability explained increases. This trend can be seen for maps of barium (figs 3C, 4B, and 5A) where cell size is decreased and amount of variability explained increases from 17.2% (table 2) for 100-km cells to 21.3% (17.2% plus 4.1%, table 2) for 50-km cells to 76.1% (17.2% plus 4.1% plus 54.8%, table 3) for 25-km cells. Most of the maps of element concentration show only a single contour (the geometric mean) because the spatial variability between cells is very small (table 3). The majority of the variability occurs at sampling intervals of less-than 25km. Therefore, in order to prepare maps which account for most of the observed variability, it would be necessary to resample at the less-than 25-km interval. Based on previous work in the northern Great Plains (including the western part of North Dakota), sampling cells as small as 1km may be required (Severson and Tidball, 1979, table 1) to show the detail on the landscape. The distributions of variance components (table 3) and the maps showing element distributions (figs 3-5) show that the element concentrations in these soils are, on the average, relatively uniform over the study area of eastern North Dakota, but samples collected at very close distance increments are as variable as those collected over large distance increments.

Most of the geochemical maps (figs. 3-5) show a single contour representing the geometric mean traversing the study area from north-northwest to south-southeast dividing the study area in half. The west half of the study area is generally below the geometric mean for B, Ca, Mg, P, and Yb, but above the geometric mean for Ba. Selenium exhibits band of values above the mean trending north-south in the center of the study area. The other elements (K, Na, and Sr) also show a single contour representing the geometric mean, but the contour seems to represent an irregular pattern. All the geochemical maps presented in figs. 3-5 show no apparent relationship to differences in the geology generalized in figure 1.

Many elements could not be displayed on maps because this reconnaissance sampling resulted in too few samples within cells of different sizes to prepare reliable maps. For these elements, a high proportion of their spatial variability was measured at small distance increments. The best way to summarize their geochemical variability throughout eastern North Dakota is by the geometric mean and baseline value. These statistics are presented in table 2.

Geometric means and baseline values for elements in surface soils of eastern North Dakota (table 2), when compared to those for the A horizon for the glaciated portion of the northern Great Plains (table 6) (Severson and Tidball, 1979) tend to be slightly lower. However, the slight differences are probably not statistically significant. The summary statistics for the northern Great Plains represents only the glaciated terrain; except where there were no significant differences between glaciated and un-glaciated terrains, a single mean and range was used to characterize both terrains.

SUMMARY

Analysis-of-variance, with calculations based on the variance components for element concentration in surface soil horizons (A-horizons), was used to estimate the feasibility of preparing geochemical maps at various sampling cell sizes. Cell sizes of 100, 50, and 25km were evaluated. Our intent was to provide as much information on sampling requirements for as many elements as possible so that reliable maps of element distributions in soils could be prepared with the smallest possible sampling costs. Because of large sampling requirements for some elements, it is possible that some environmentally important elements could be overlooked. Simply minimizing sampling costs may not result in the most efficient sampling design.

Reliable geochemical maps were prepared for several elements at the 100-km, 50-km, and 25-km cell sizes based on geometric means for the samples collected within each cell. Most of the spatial variability of all elements occurs at the smallest sampling interval, and therefore, the maps show only small regional geochemical gradients in soils across eastern North Dakota. Based on an analysis of the present study, plus information on soil variability from previous studies, it will be necessary to sample at intervals as small as 1km to describe the predominant small-scale geochemical details of the landscape. Preparing geochemical maps at this small scale would require a minimum of about 10,000 samples.

ACKNOWLEDGEMENTS

Appreciation is extended to the Branch of Geochemistry staff, including Paul Briggs, David Fey, Kay Kennedy, Chris McDougal, Monty Wilch, and Mark Blanchard, for the timely collection and analysis of these samples. Assistance from and consultation with the personnel of the Bismark District Office of the Water Resources Division is also appreciated.

REFERENCES CITED

Cohen, A. C., Jr., 1959, Simplified estimators for the normal distribution when samples are singly censored or truncated: Technometrics, vol.1, p. 217-237.

Clayton, Lee, Moran, S. R., Bluemel, J. P., and Carlson, C. G., 1980, Geologic map of North Dakota, Scale 1:500,000: U.S. Geological Survey, Denver, Colorado, 1 sheet.

Crock, J. G. and Lichte, F. E., 1982, An improved method for the determination of trace levels of arsenic and antimony in geologic materials by automated hydride generation-atomic absorption spectroscopy: Analytica Chimica Acta, vol. 144, p. 223-233.

Crock, J. G., Lichte, F. E., and Briggs, P. E., 1983, Determination of elements in National Bureau of Standards Geologic Reference Materials SRM 278 obsidian and SRM 688 basalt by inductively coupled argon plasma-atomic emission spectrometry: Geostandards Newsletter, vol. 7, p. 335-340.

Crock, J. G. and Severson, R. C., 1980, Four reference soil and rock samples for measuring element availability in the Western Energy Regions: U.S. Geological Survey Circular 841, 16 p.

Goolsby, D. A., Severson, R. C., Wilson, S. A., and Webber, K., 1989, Geochemistry of soils and shallow ground water, with emphasis on arsenic and selenium, in part of the Garrison Diversion Unit, North Dakota, 1985-1987: U.S. Geological Survey Water-Resources Investigation Report 89-4104, 132p.

Kennedy, K. R. and Crock, J. G., 1987, Determination of mercury in geologic materials by continuous flow, cold vapor, atomic absorption spectrophotometry: Analytical Letters, vol. 20, p. 899-908.

Miesch, A. T., 1976, Geochemical Survey of Missouri--methods of sampling, laboratory analysis, and statistical reduction of data in a geochemical survey of Missouri, with sections on laboratory methods: U.S. Geological Survey Professional Paper 954-A, 39p.

Omodt, H. W., Jonsgard, G. A., Patterson, D. D., and Olson, O. P., 1968, The major soils of North Dakota: North Dakota State University, Agricultural Experiment Station Bulletin No. 472, 60p.

Sanzolone, R. F. and Chao, T. T., 1987, Determination of selenium in thirty two geochemical reference materials by continuous-flow hydride generation atomic absorption spectrophotometry: Geostandards Newsletter, vol. 11, p. 81-85.

Severson, R. C. and Tidball, R. R., 1979, Spatial variation in total element concentration in soil within the northern Great Plains coal region: U.S. Geological Survey Professional Paper 1134-A, 18p.

Tidball, R. R., and Ebens, R. J., 1976, Regional geochemical baselines in soils of the Powder River Basin, Montana-Wyoming, in Laudon, R. B., (ed.), Geology and energy resources of the Powder River: Wyoming Geological Association Guidebook, Twenty-eighth Annual Field Conference, Casper, Wyoming, September 1976, p.299-310.

Westin, F. C., Puhr, L. F., and Buntley, G. J., 1967, Soils of South Dakota: South Dakota State University, Agricultural Experiment Station Soil Survey Series No. 3, 32p.

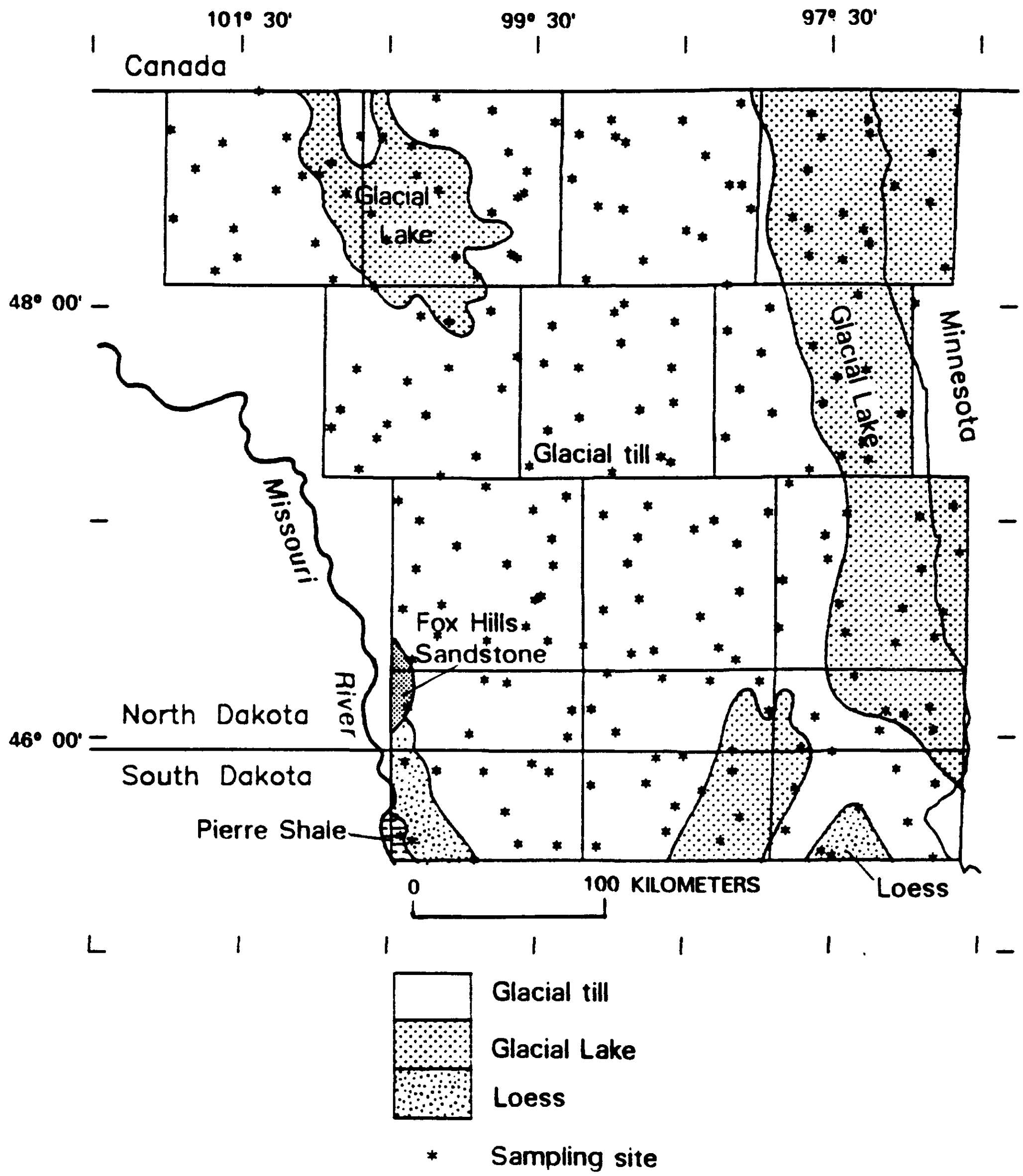


Figure 1.--Location of the study area, sampling sites, and geology of the area generalized from Omodt and others (1968) and Westin and others (1967).

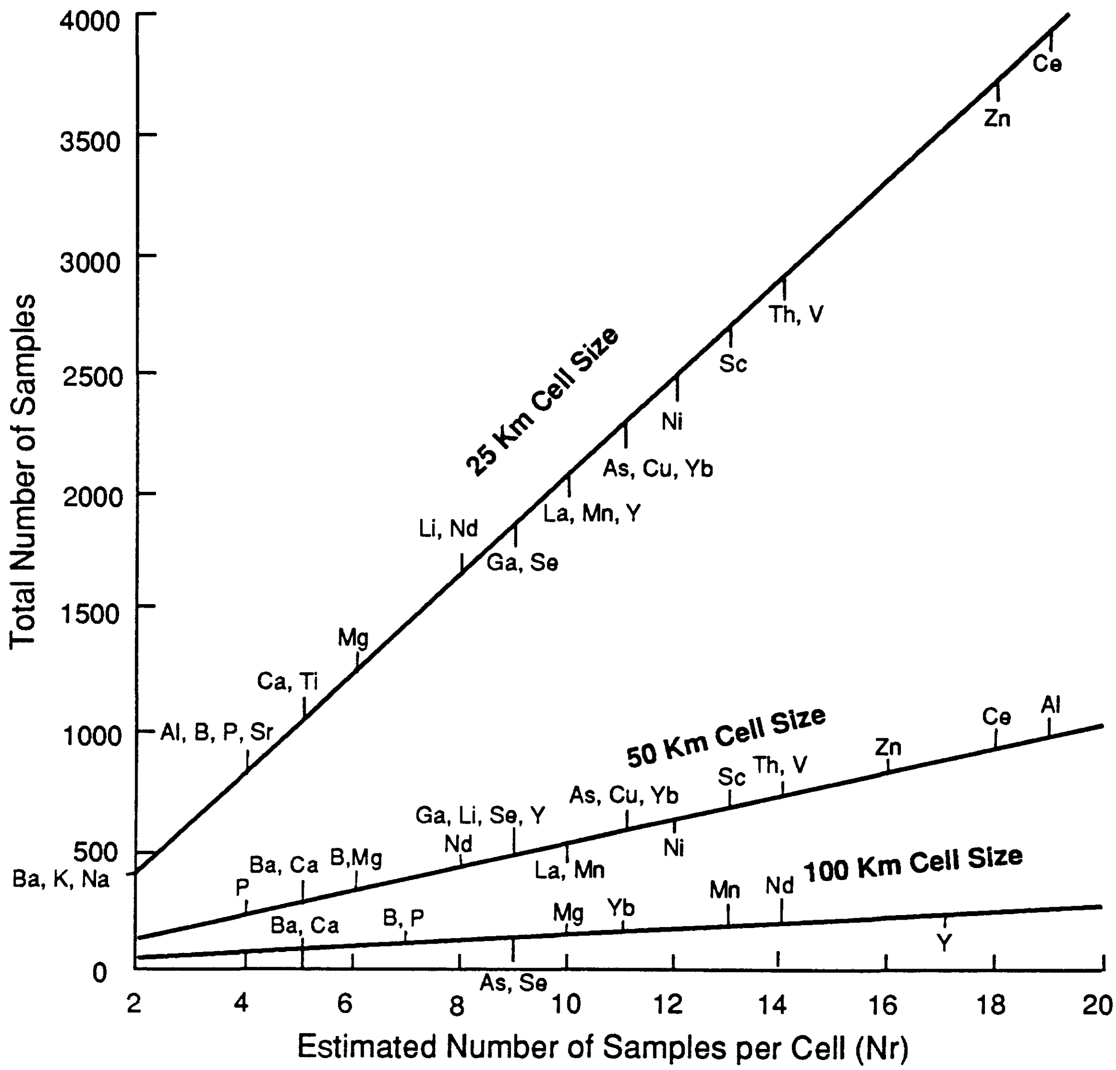


Figure 2.--Minimum numbers of samples required to prepare stable geochemical maps of element distributions in surface soils for 100km, 50km, and 25km cell sizes.

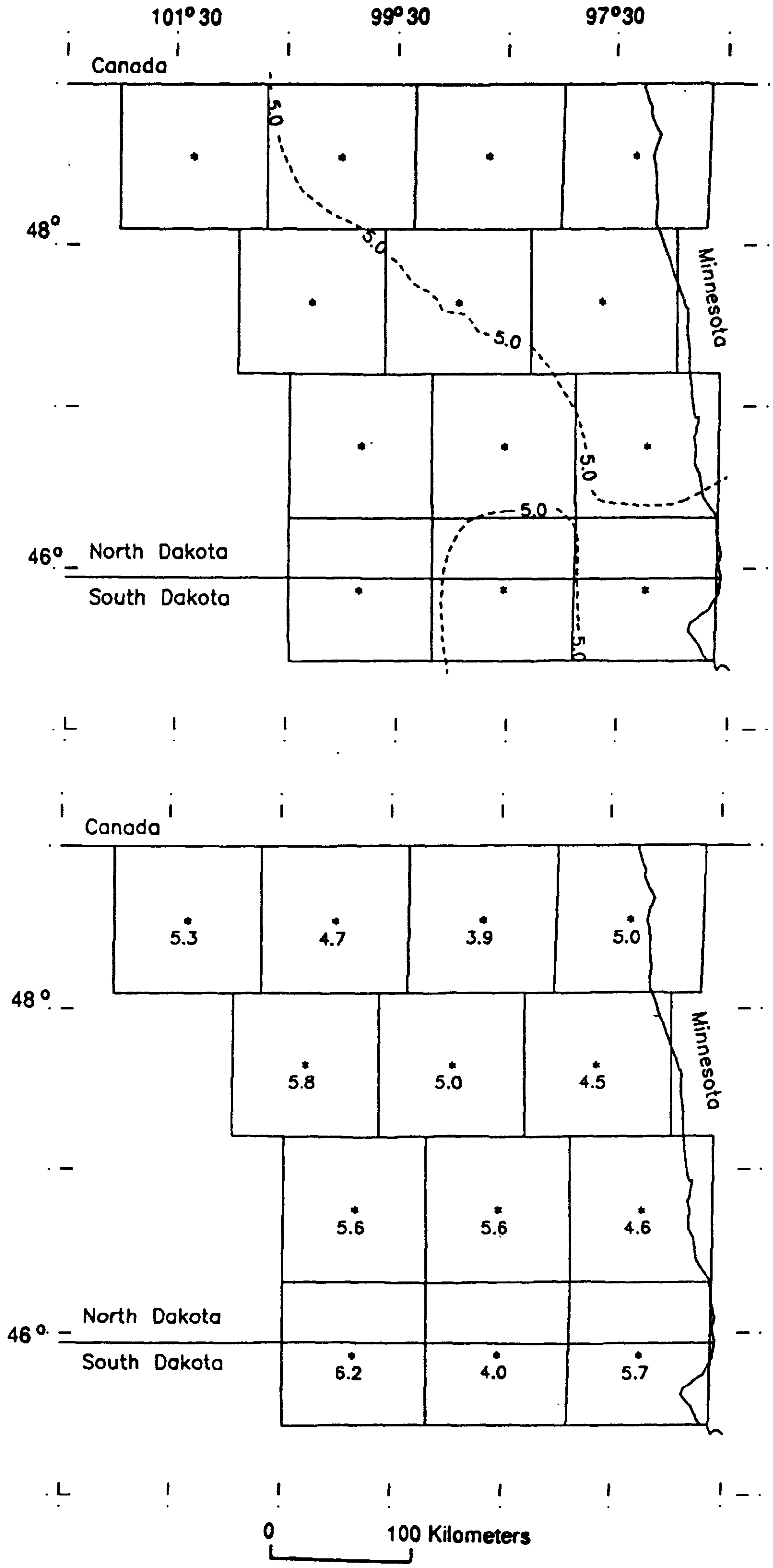


Figure 3A. Arsenic, in ppm; Upper figure, contour interval, GM=5.0, Baseline=2.0 to 13; Lower figure, GM's for each 100km cell.

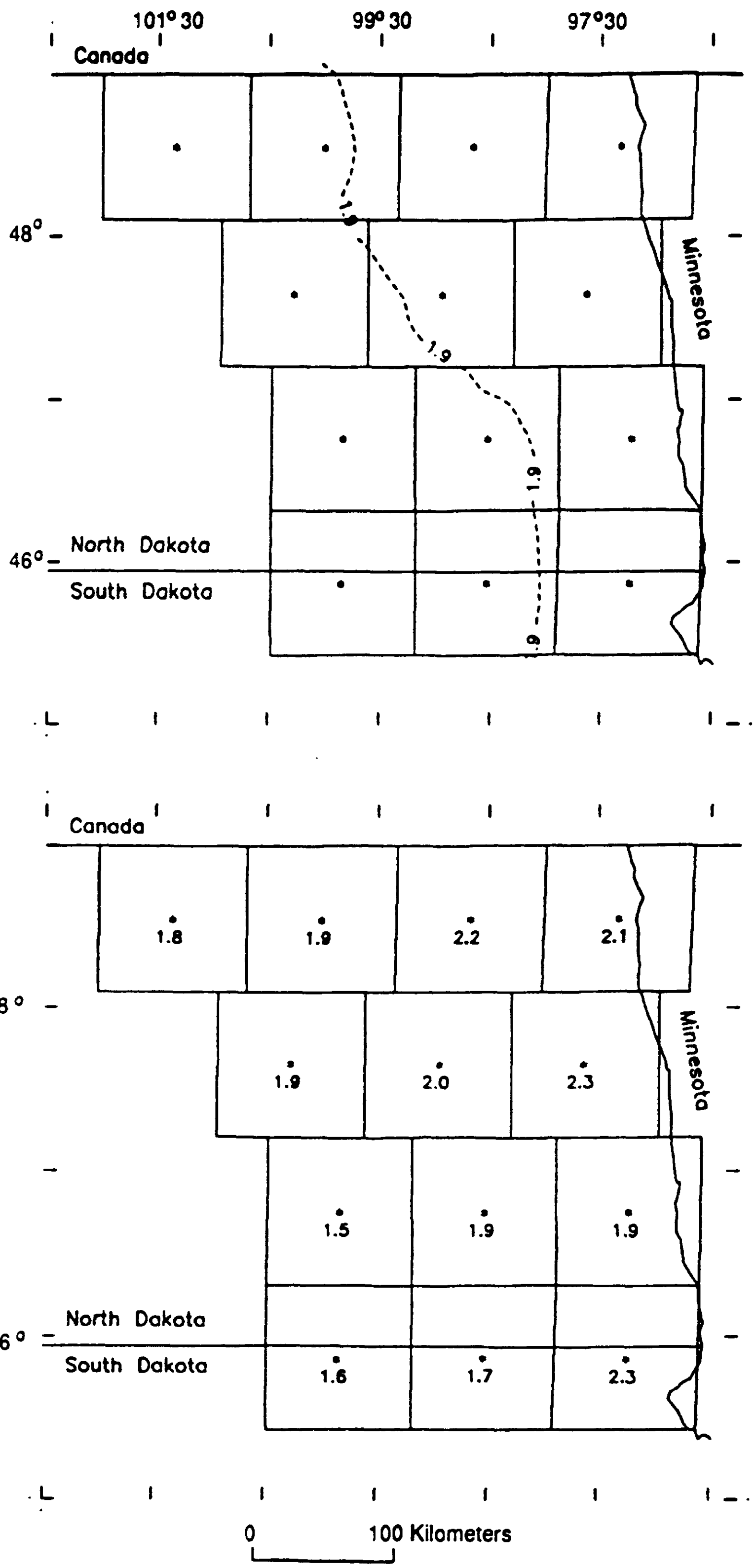


Figure 3B. Hot water-soluble boron, in ppm; Upper figure contour interval, GM=1.9, Baseline=1.0 to 3.6; Lower figure, GM's for each 100km cell.

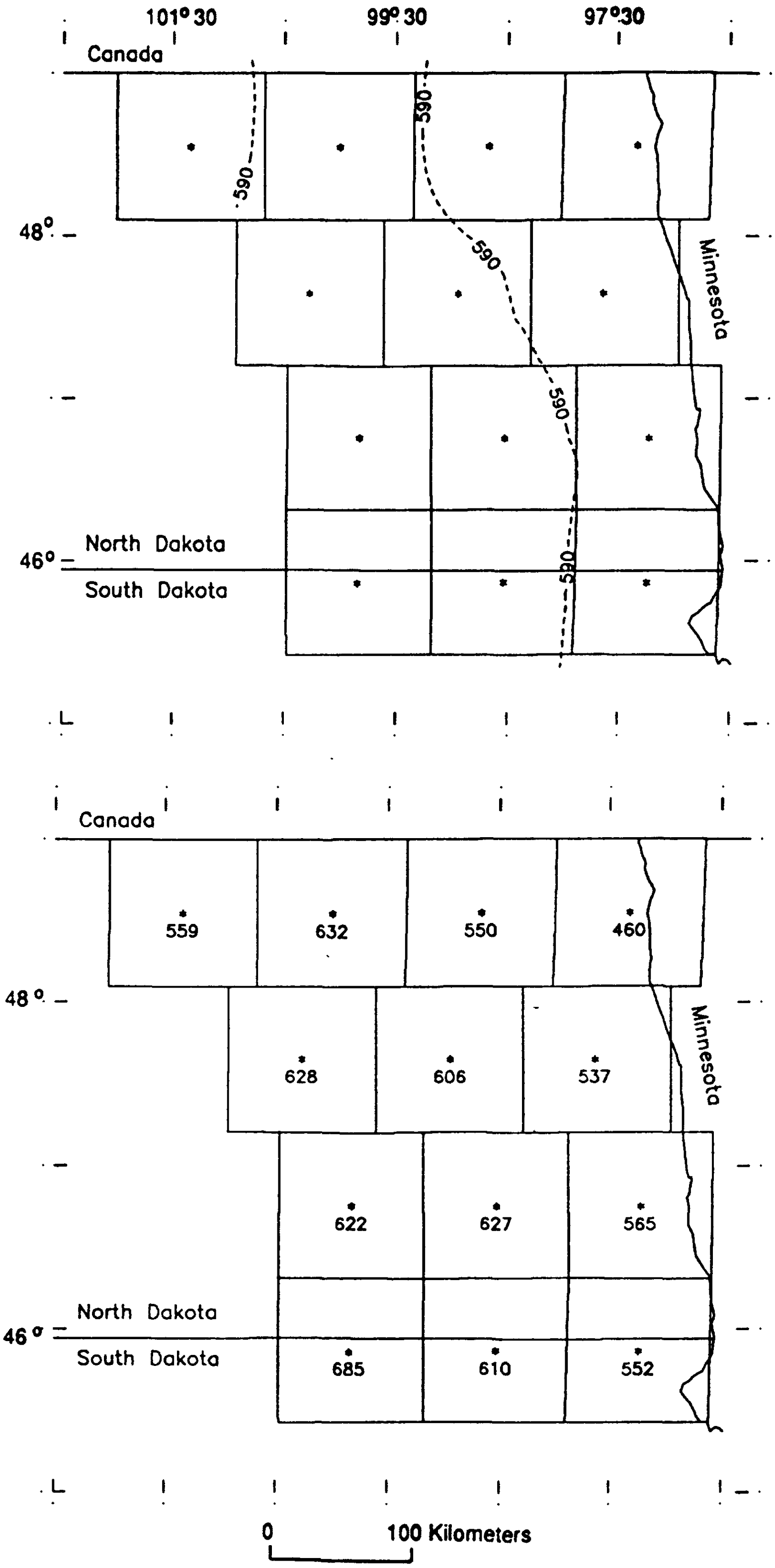


Figure 3C. Barium, in ppm; Upper figure, contour interval, GM=590, Baseline=390 to 890; Lower figure, GM's for each 100km cell.

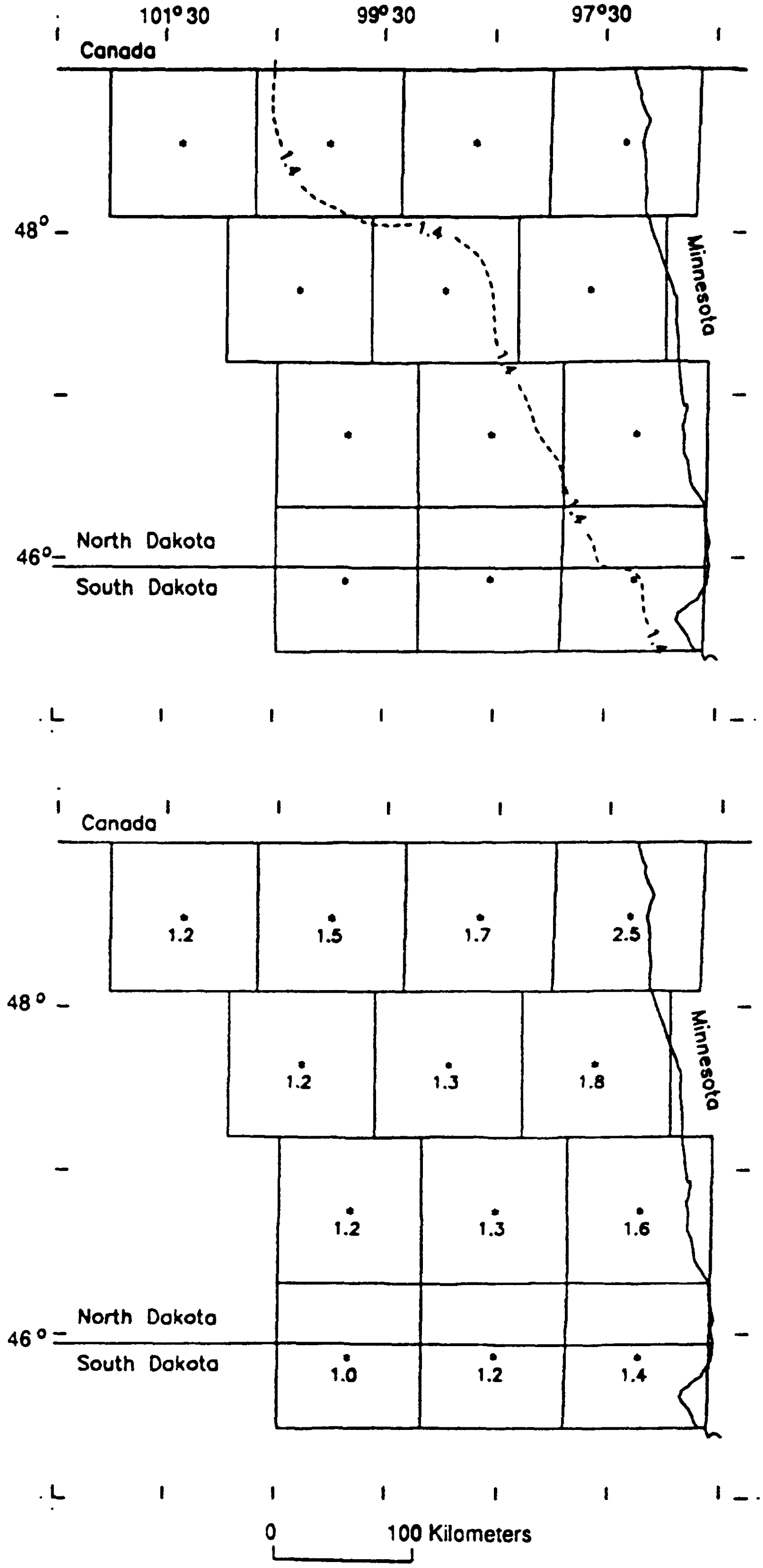


Figure 3D. Calcium, in %; Upper figure, contour interval, GM=1.4, Baseline=0.48 to 4.0; Lower figure, GM's for each 100km cell.

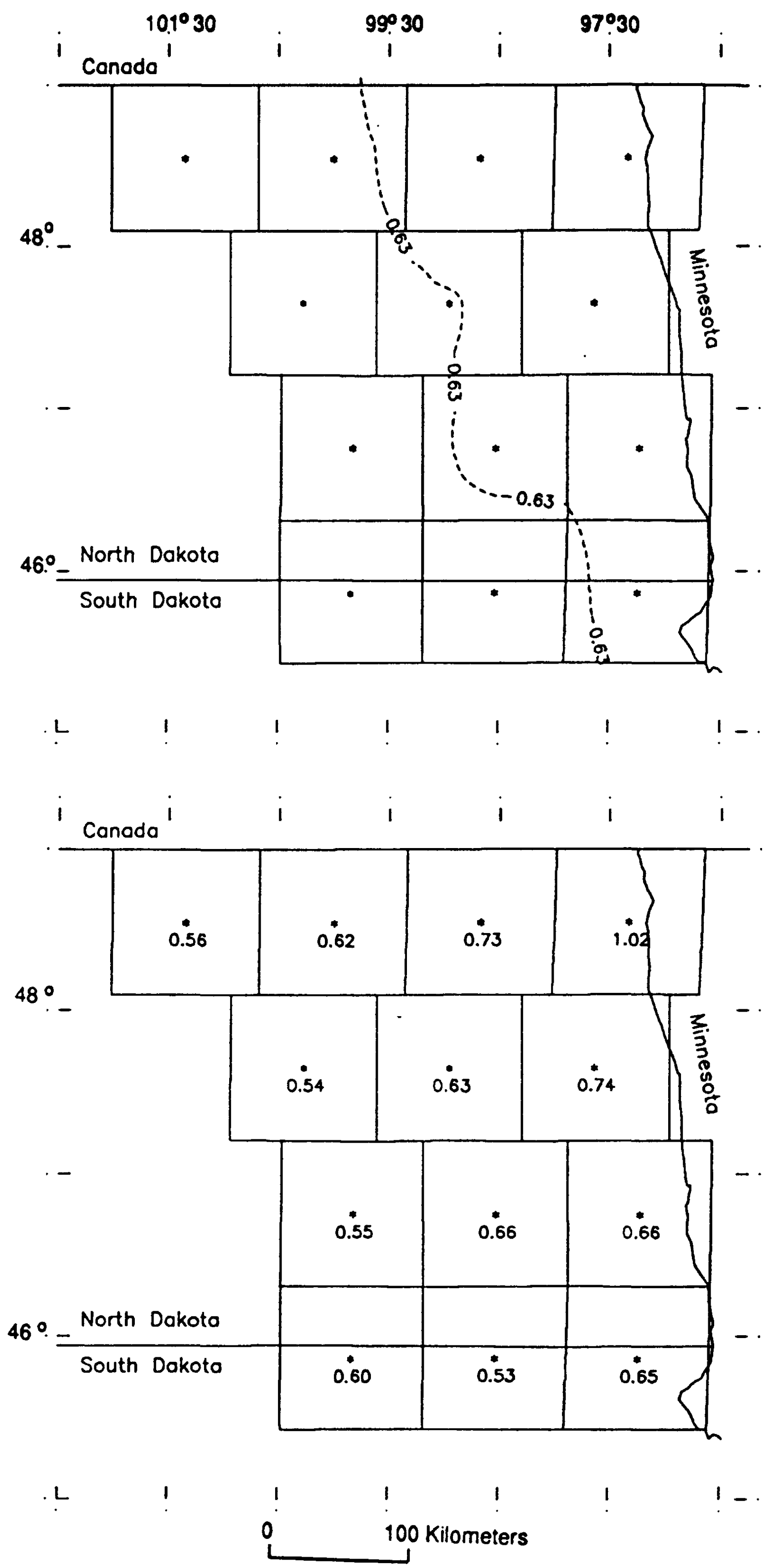


Figure 3E. Magnesium, in %; Upper figure, contour interval, GM=0.63, Baseline=0.26 to 1.6; Lower figure, GM's for each 100km cell.

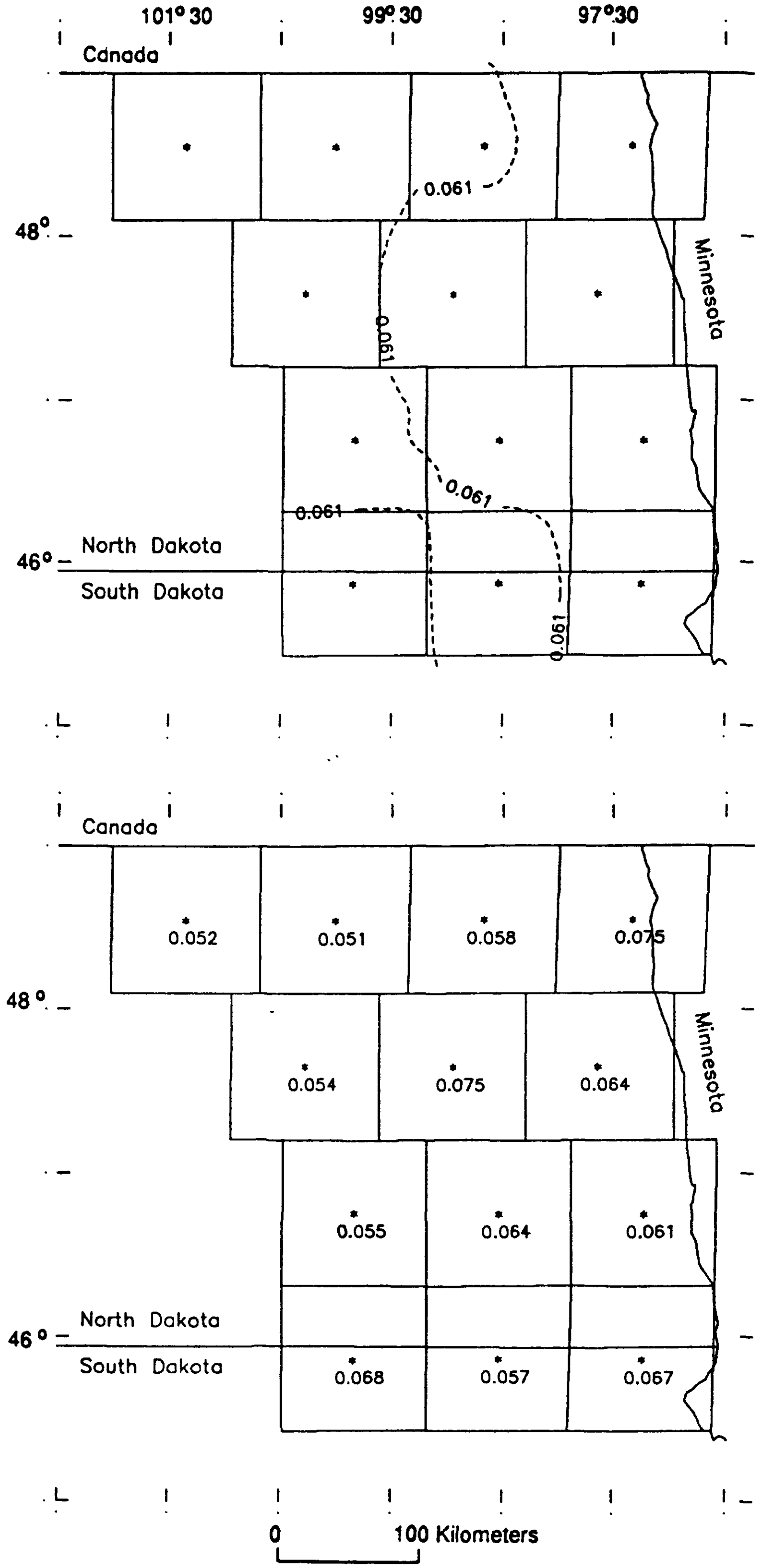


Figure 3F. Phosphorus, in %; Upper figure, contour interval, GM=0.061, Baseline=0.034 to 0.11; Lower figure, GM's for each 100km cell.

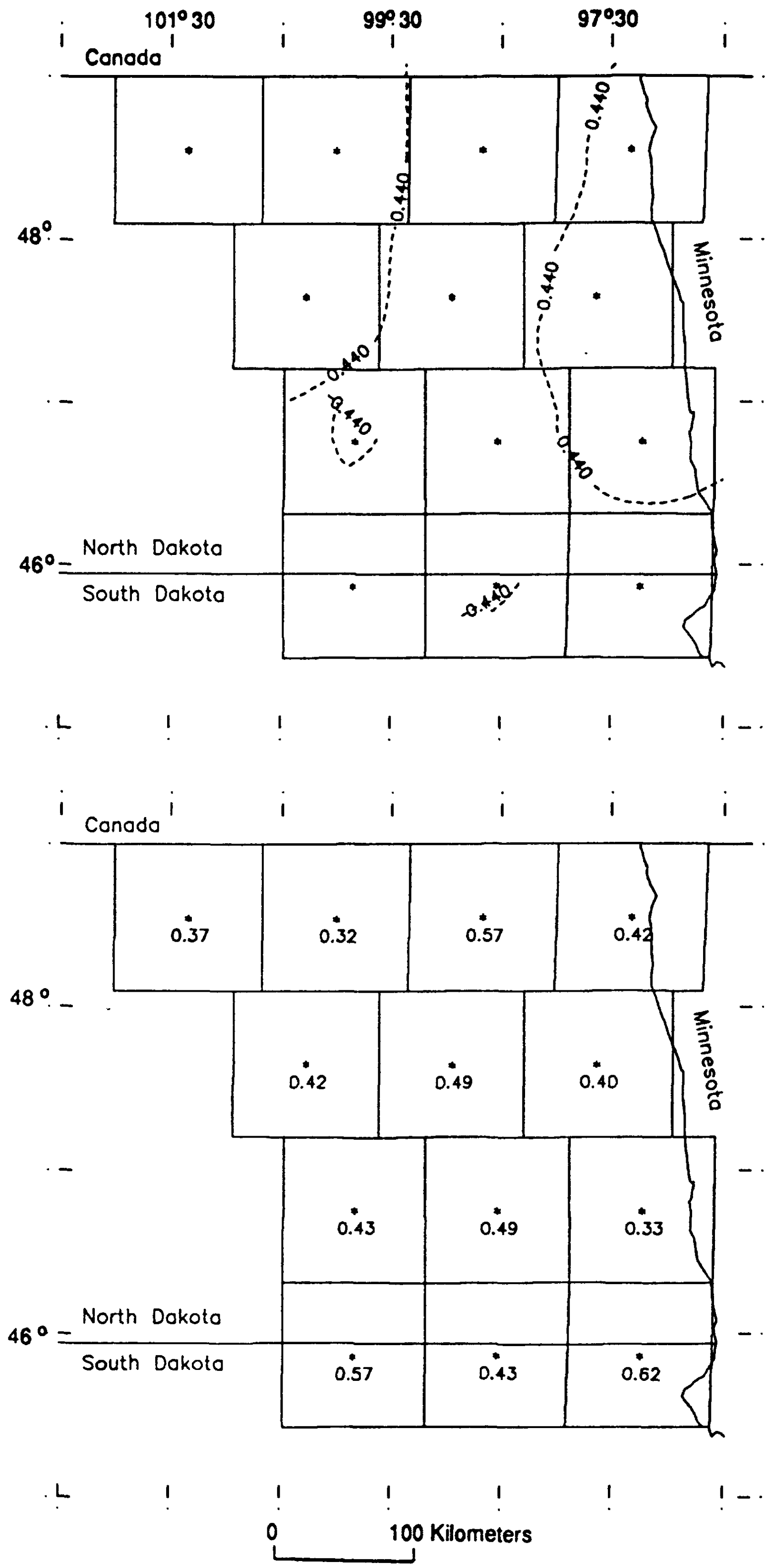
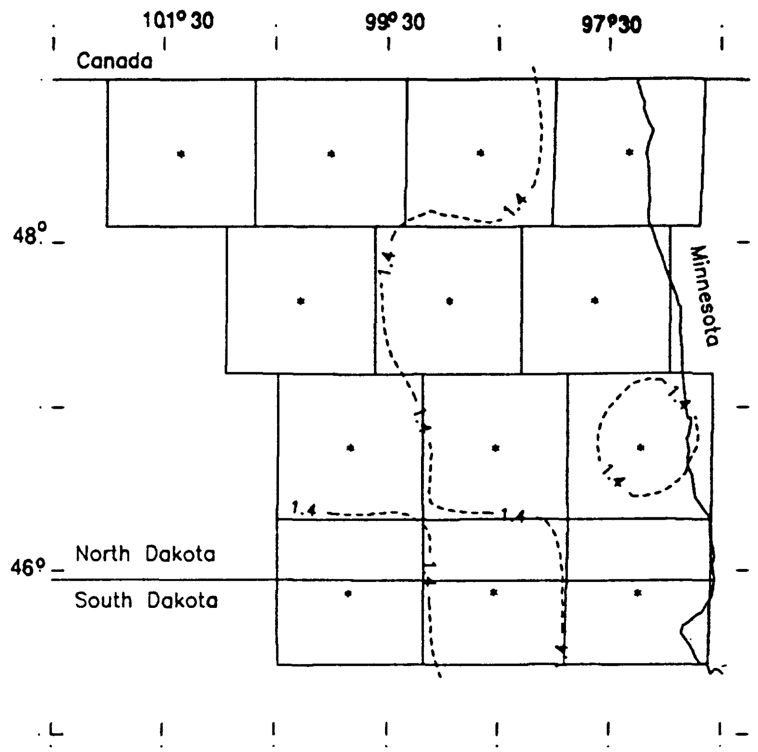


Figure 3G. Selenium, in ppm; Upper figure, contour interval, GM-0.44, Baseline-0.15 to 1.3; Lower figure, GM's for each 100km cell.



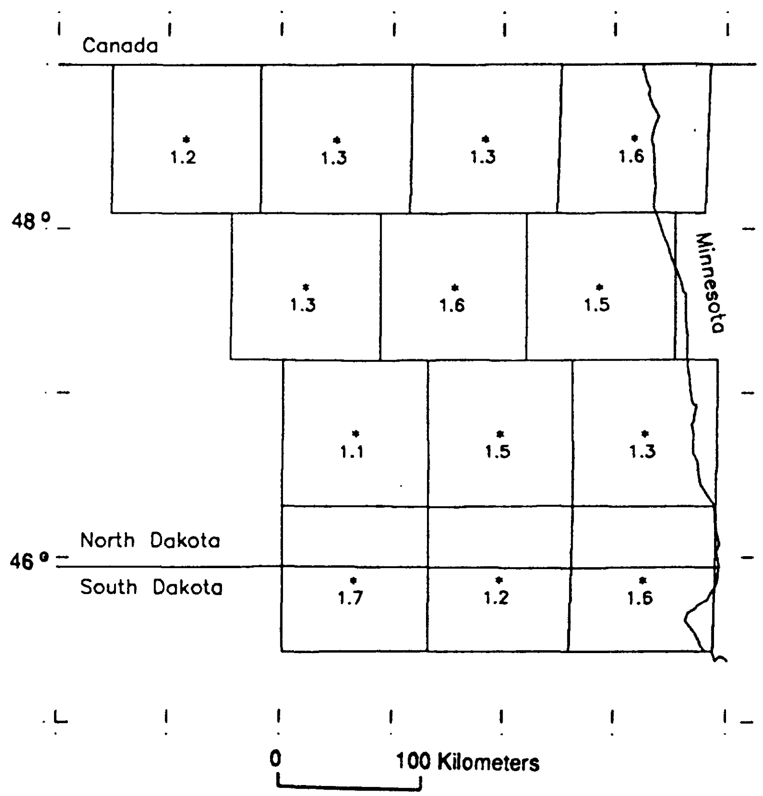


Figure 3H. Ytterbium, in ppm; Upper figure, contour interval, GM=1.4, Baseline=0.66 to 3.0; Lower figure, GM's for each 100km cell.

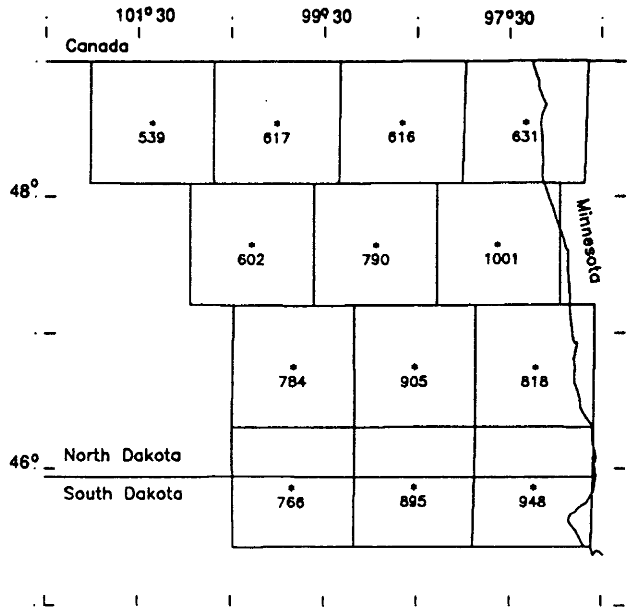


Figure 3I. Manganese, in ppm; GM=760, Baseline=260 to 2200; Figure shows GM's for each 100km cell.

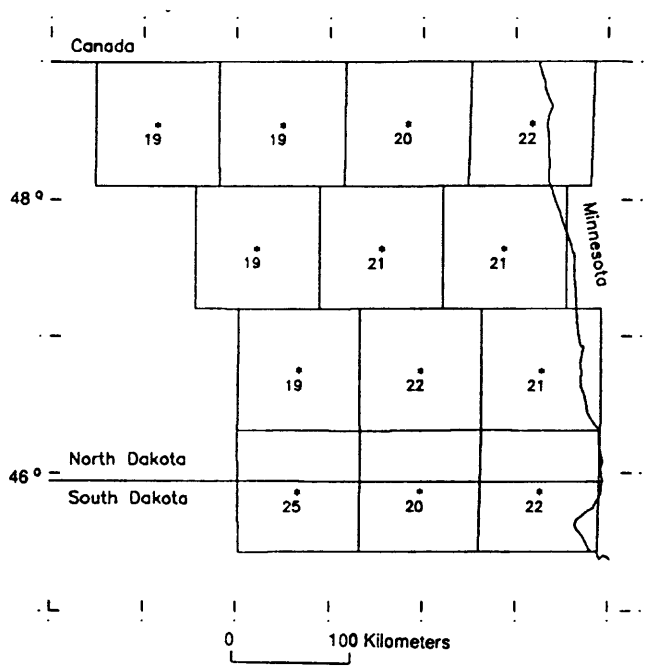


Figure 3J. Neodymium, in ppm; GM=21, Baseline=13 to 33; Figure shows GM's for each 100km cell.

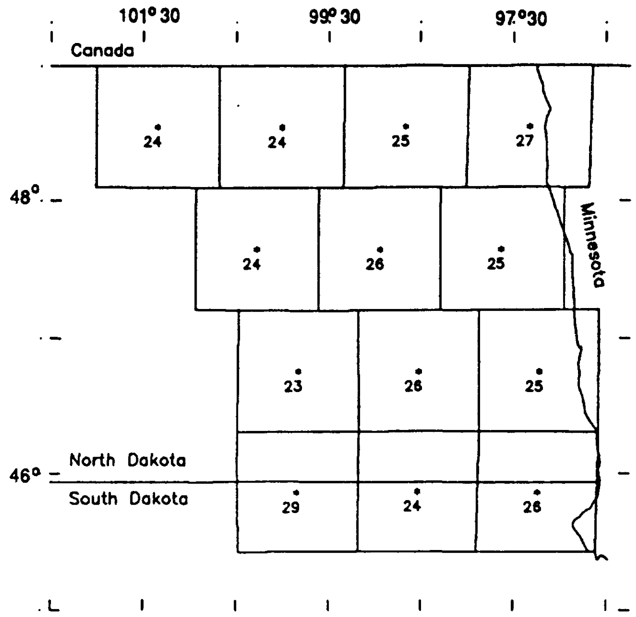


Figure 3K. Lanthanum, in ppm; GM=25, Baseline=17 to 38; Figure shows GM's for each 100km cell.

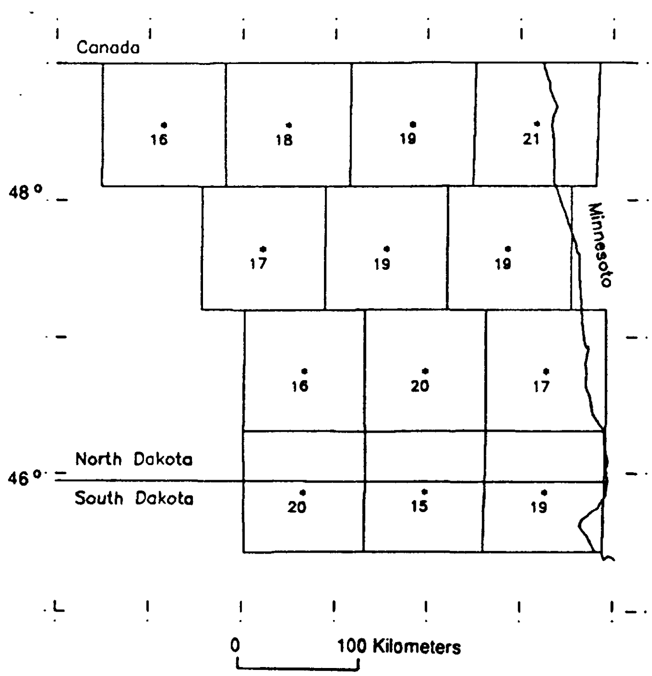


Figure 3L. Lithium, in ppm; GM=18, Baseline=8.7 to 37; Figure shows GM's for each 100km cell.

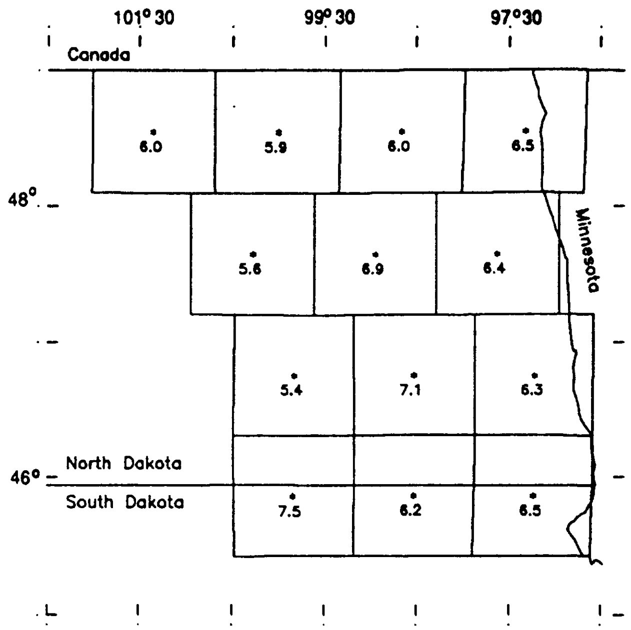


Figure 3M. Thorium, in ppm; GM=6.4, Baseline=3.7 to 11; Figure shows GM's for each 100km cell.

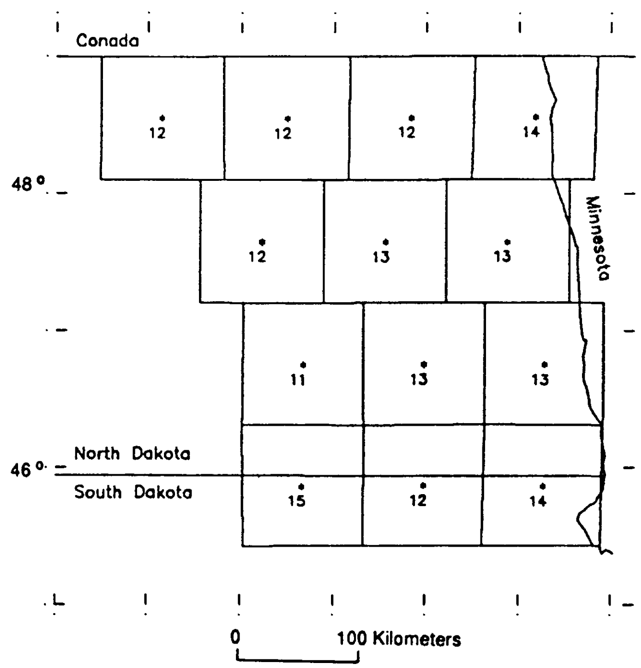


Figure 3N. Yttrium, in ppm; GM=13, Baseline=7.8 to 22; Figure shows GM's for each 100km cell.

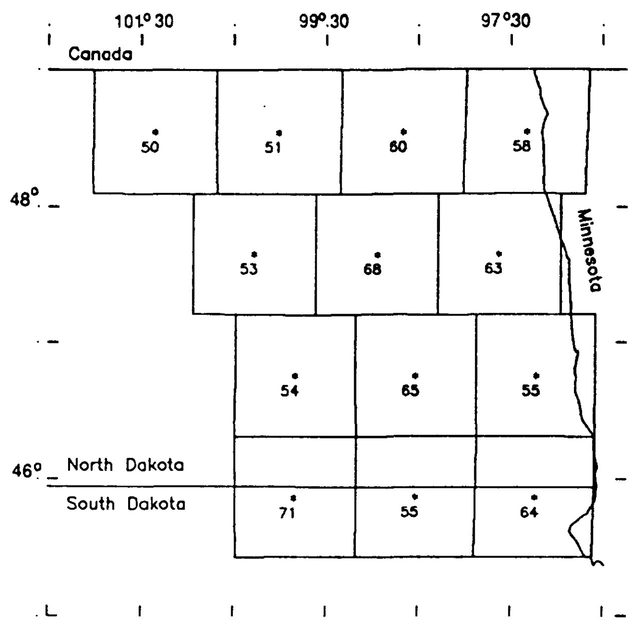


Figure 30. Zinc, in ppm; GM=58, Baseline=26 to 130; Figure shows GM's for each 100km cell.

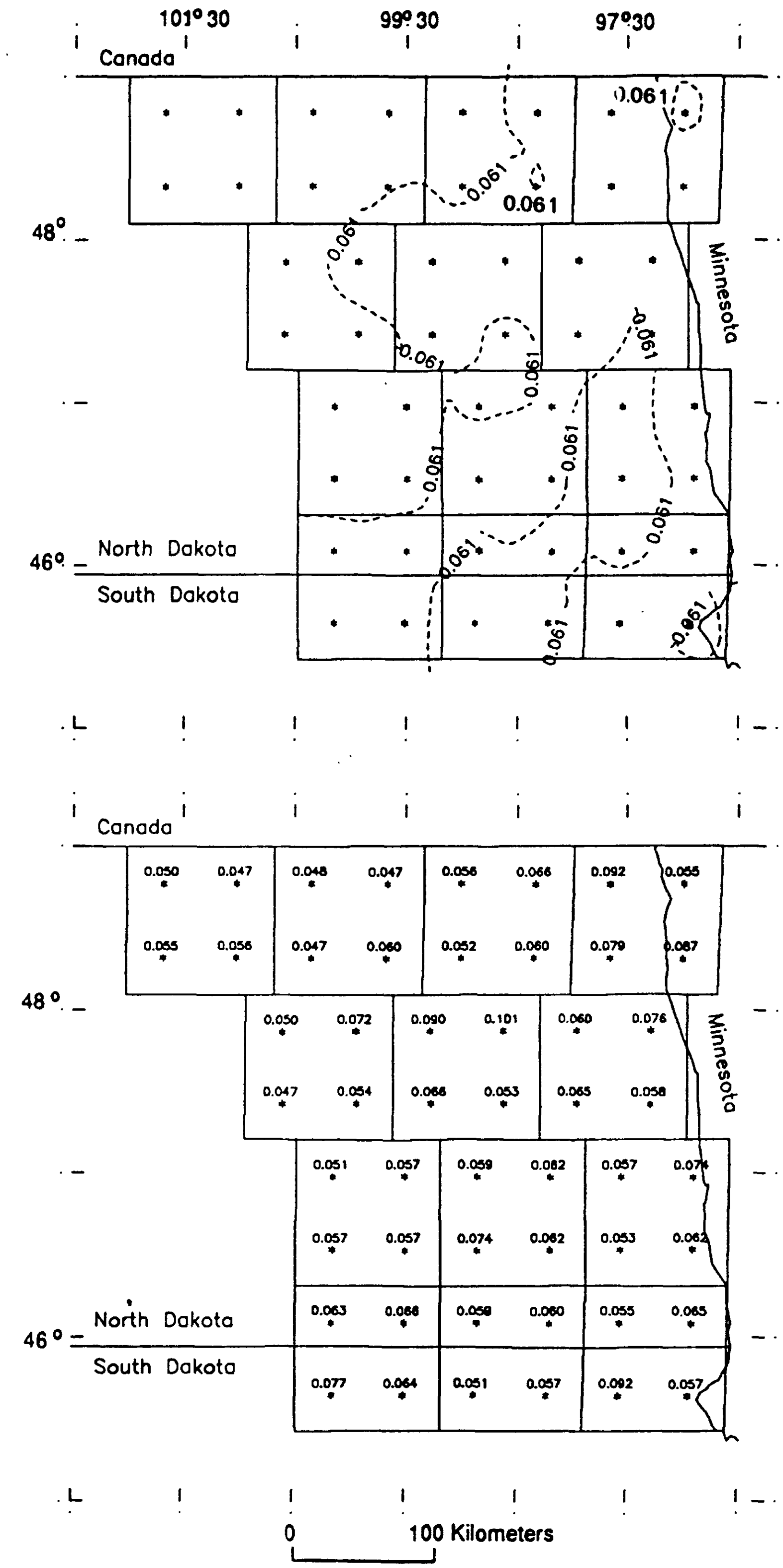


Figure 4A. Phosphorus, in %; Upper figure, contour interval, GM=0.061, Baseline=0.034 to 0.11; Lower figure, GM's for each 50km cell.

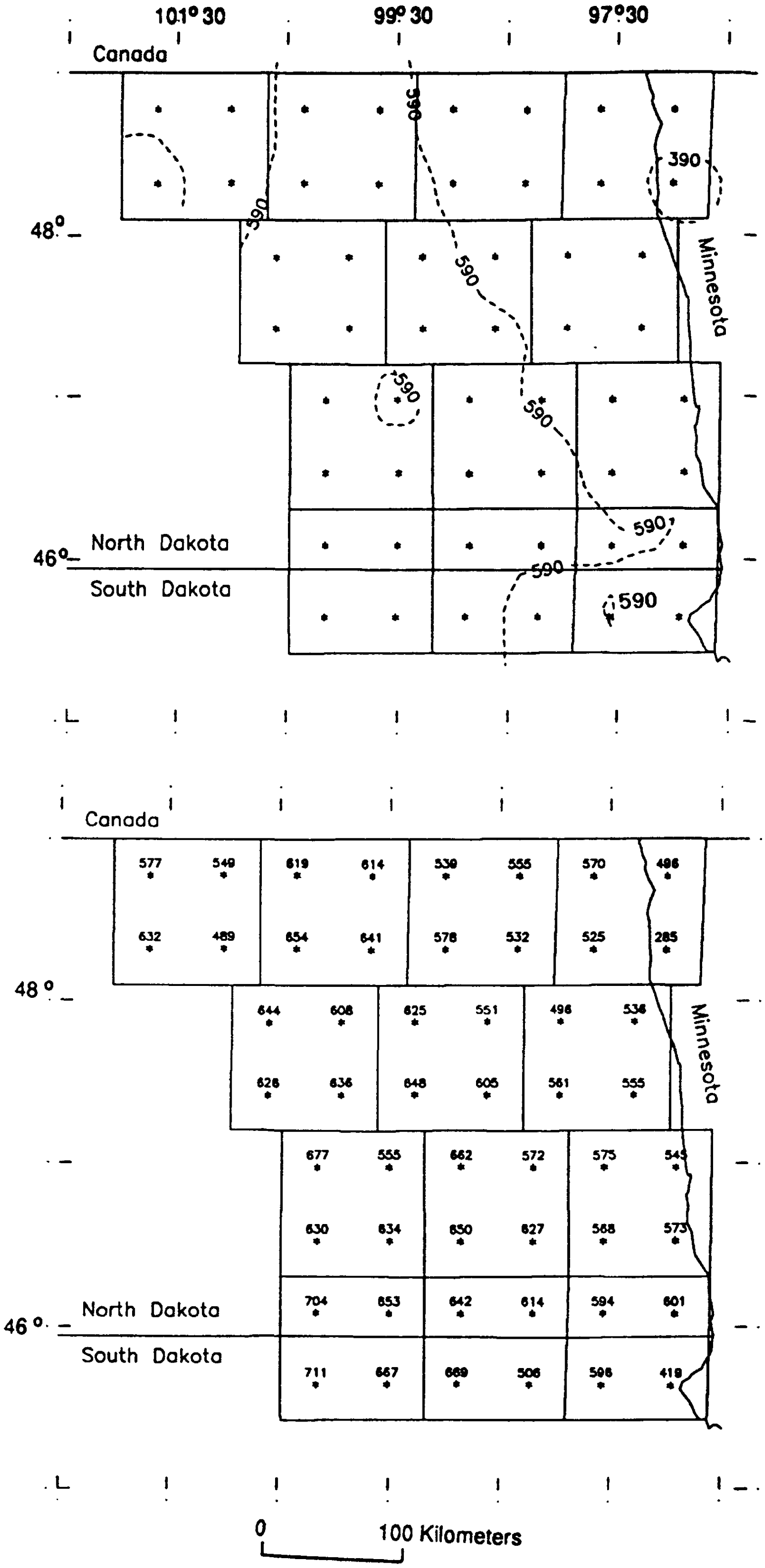


Figure 4B. Barium, in ppm; Upper figure, contour interval, GM=590, Baseline=390 to 890; Lower figure, GM's for each 50km cell.

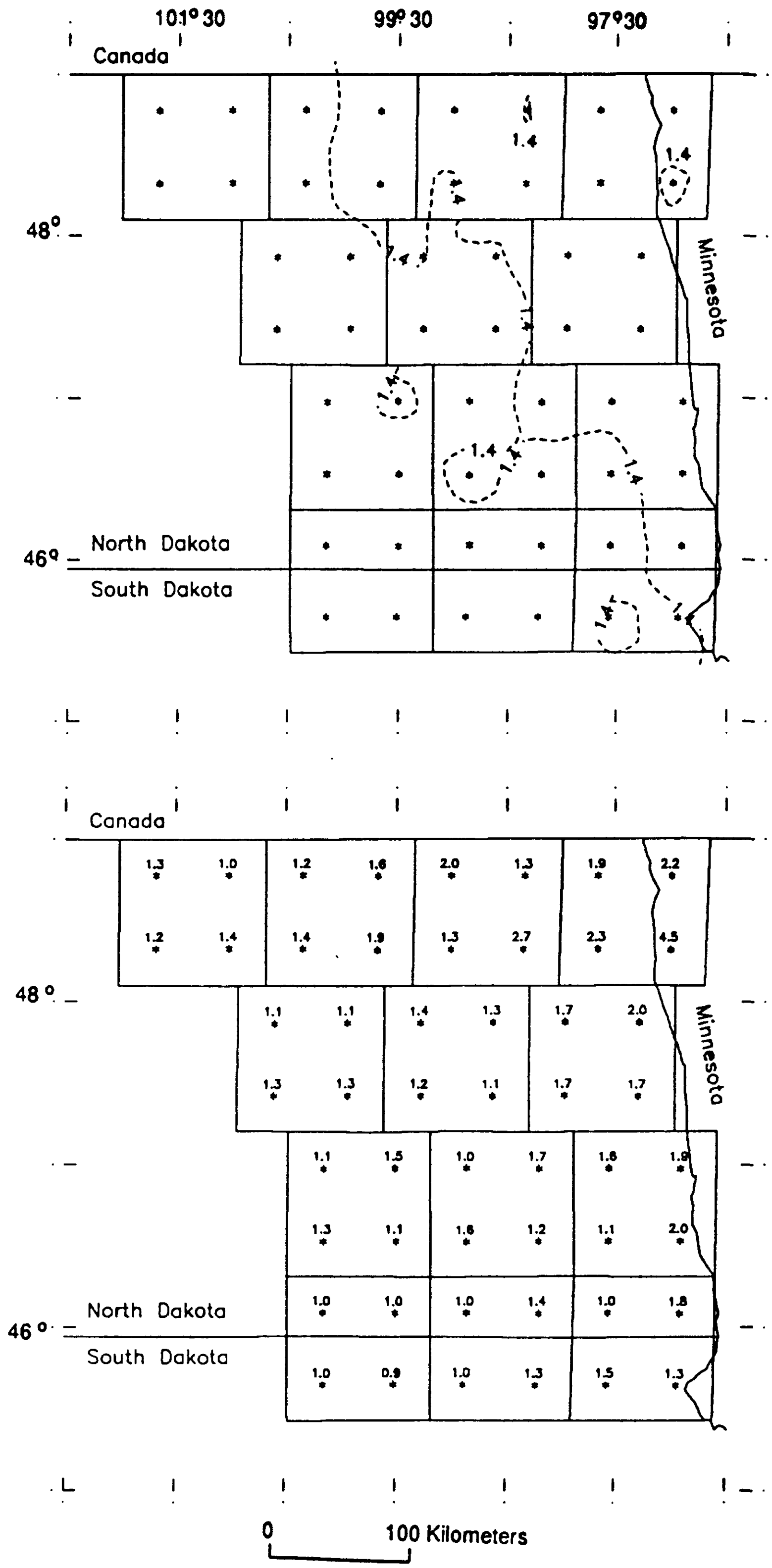


Figure 4C. Calcium, in %; Upper figure, contour interval, GM=1.4, Baseline=0.48 to 4.0; Lower figure, GM's for each 50km cell.

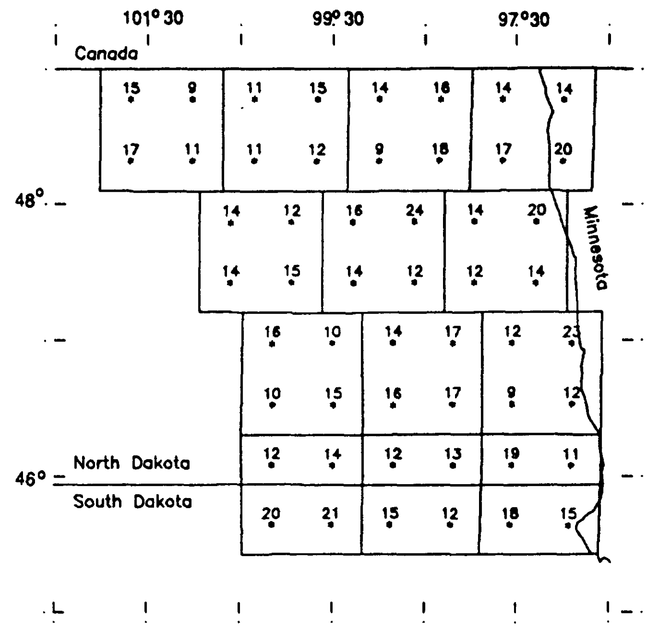


Figure 4D. Copper, in ppm; GM=14, Baseline=5.7 to 35; Figure shows GM's for each 50km cell.

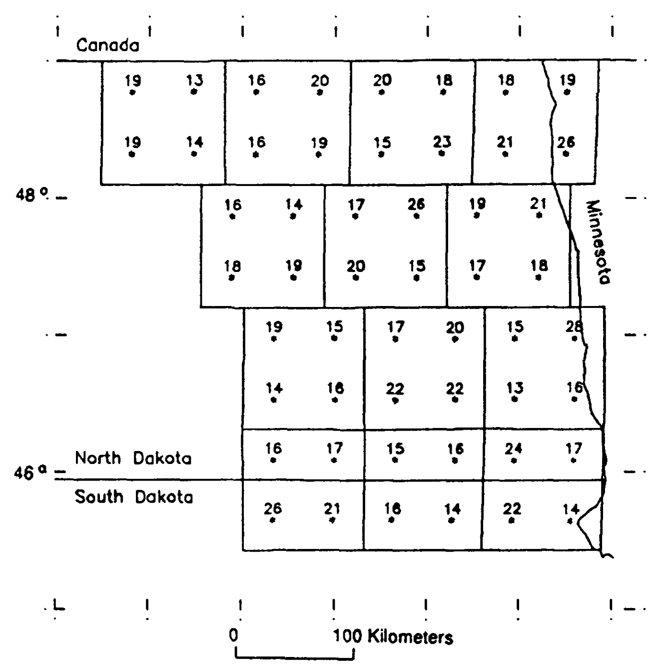


Figure 4E. Lithium, in ppm; GM=18, Baseline=8.7 to 37; Figure shows GM's for each 50km cell.

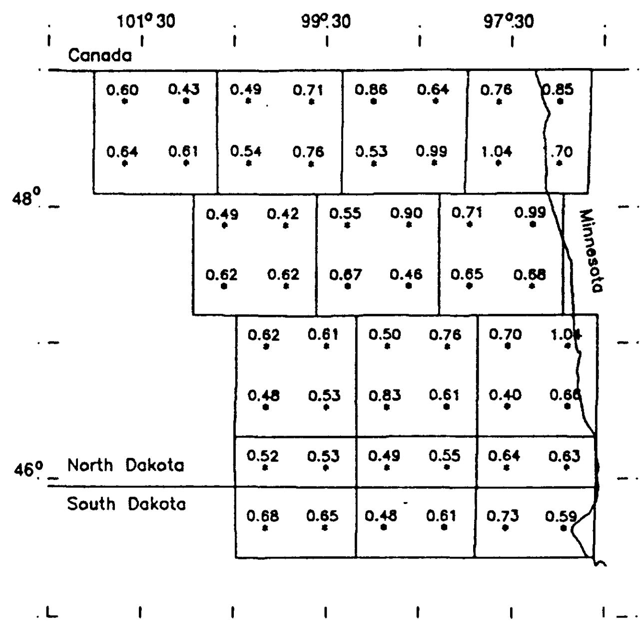


Figure 4F. Magnesium, in %; GM=0.63, Baseline=0.26 to 1.6; Figure shows GM's for each 50km cell.

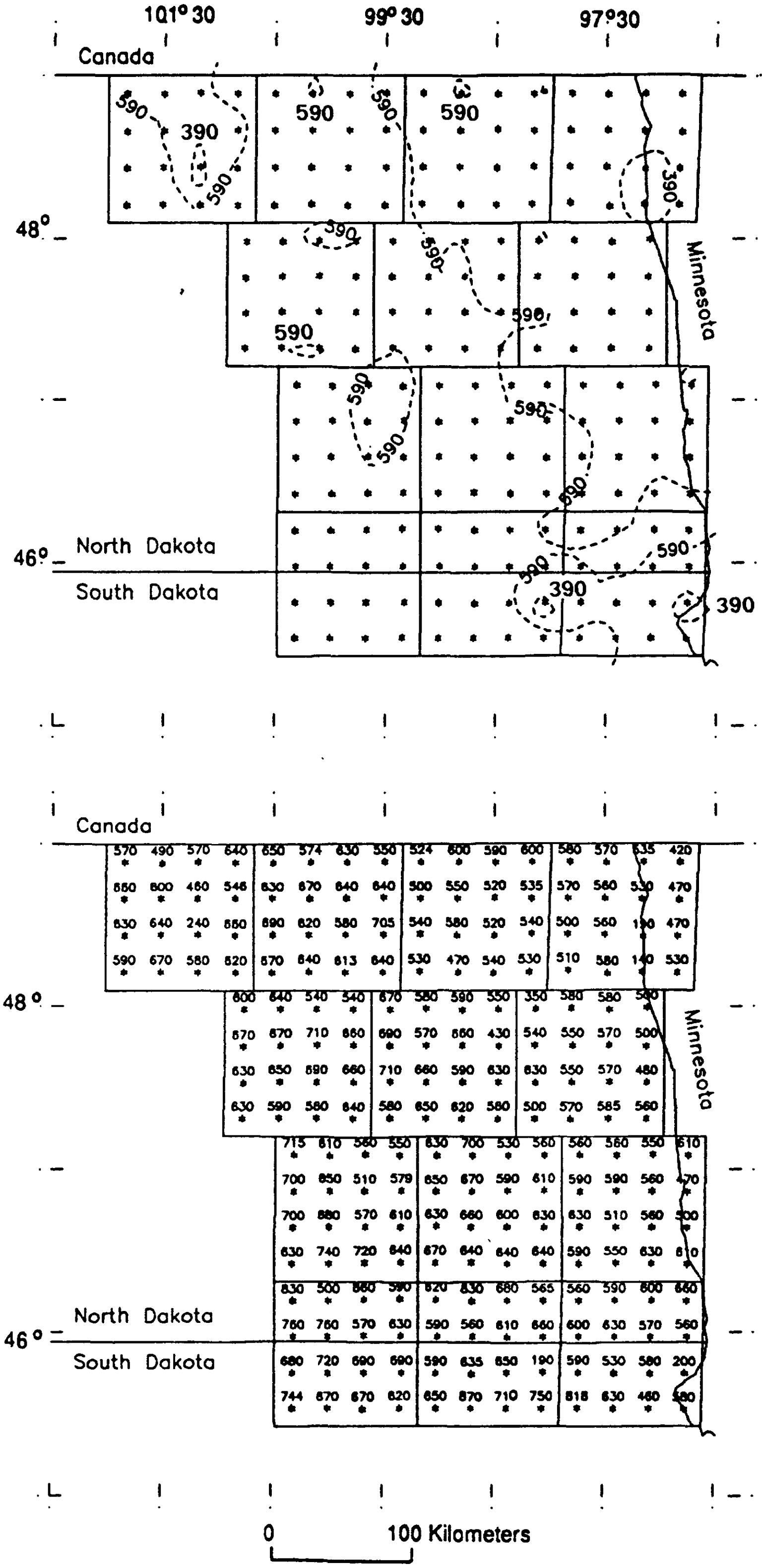


Figure 5A. Barium, in ppm; Upper figure, contour interval, GM=590, Baseline=390 to 890; Lower figure, GM's for each 25km cell.

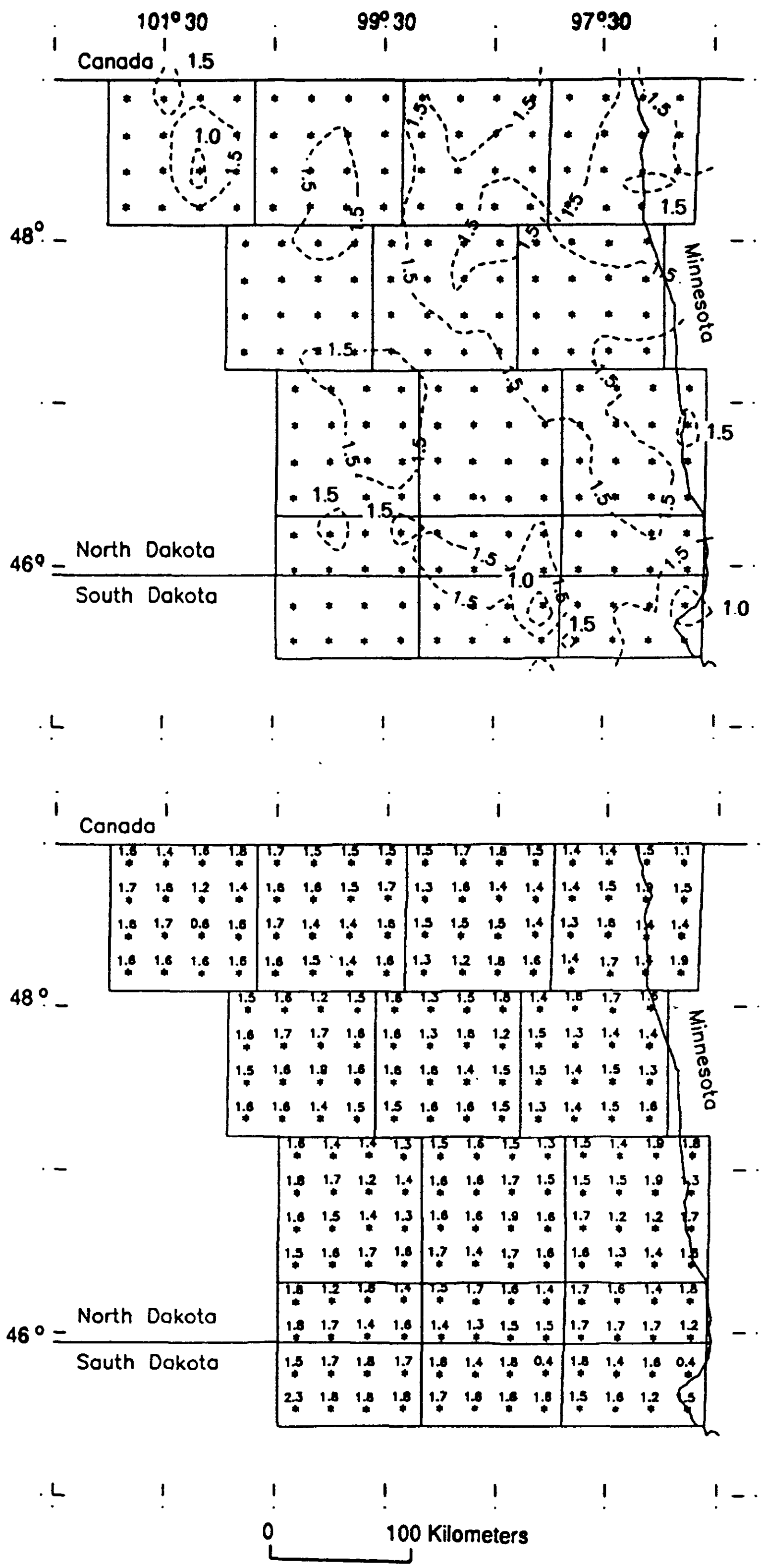


Figure 5B. Potassium, in %; Upper figure, contour interval, GM=1.5, Baseline=1.0 to 2.2; Lower figure, GM's for each 25km cell.

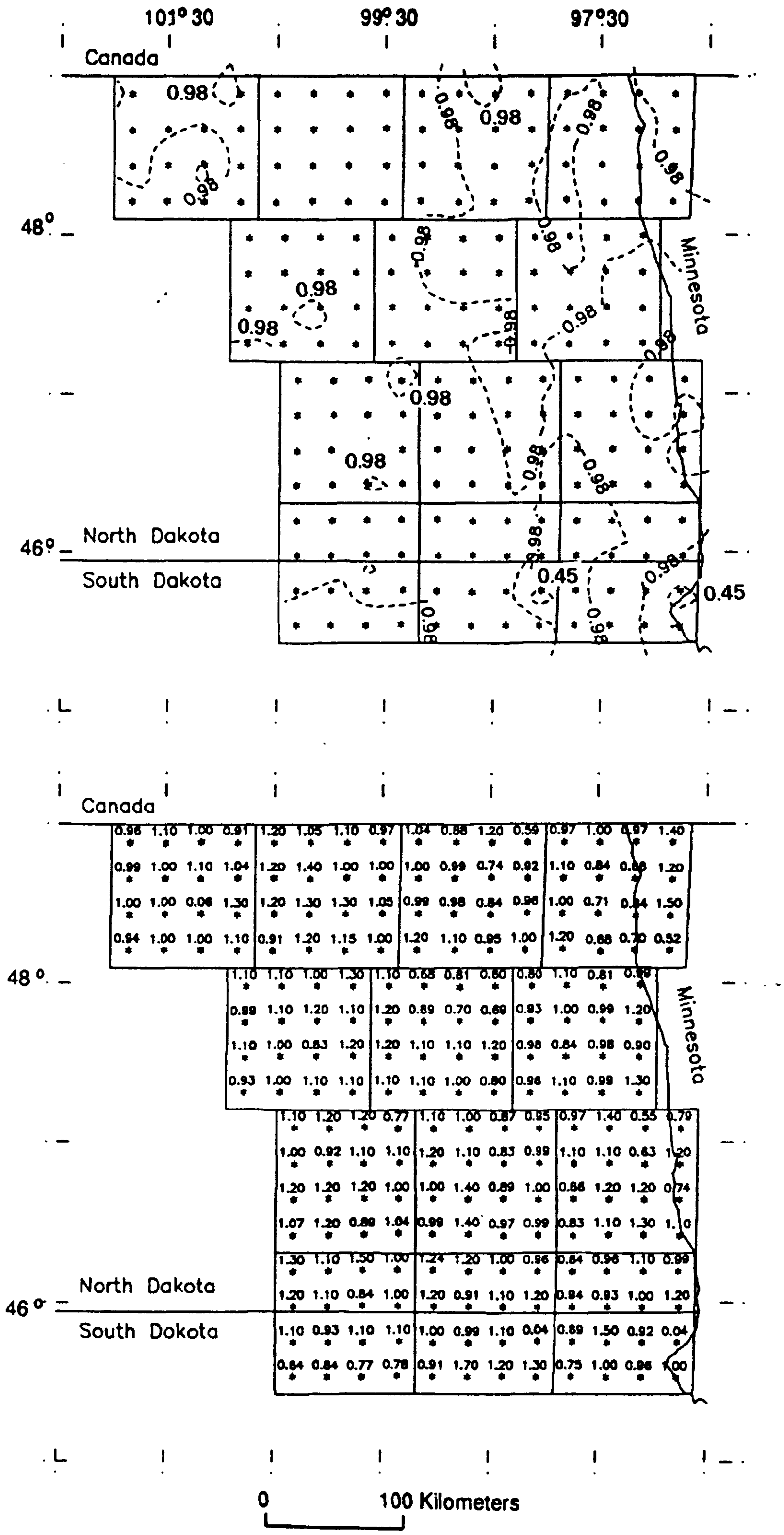


Figure 5C. Sodium, in %; Upper figure, contour interval, GM=0.98, Baseline=0.45 to 2.1; Lower figure, GM's for each 25km cell.

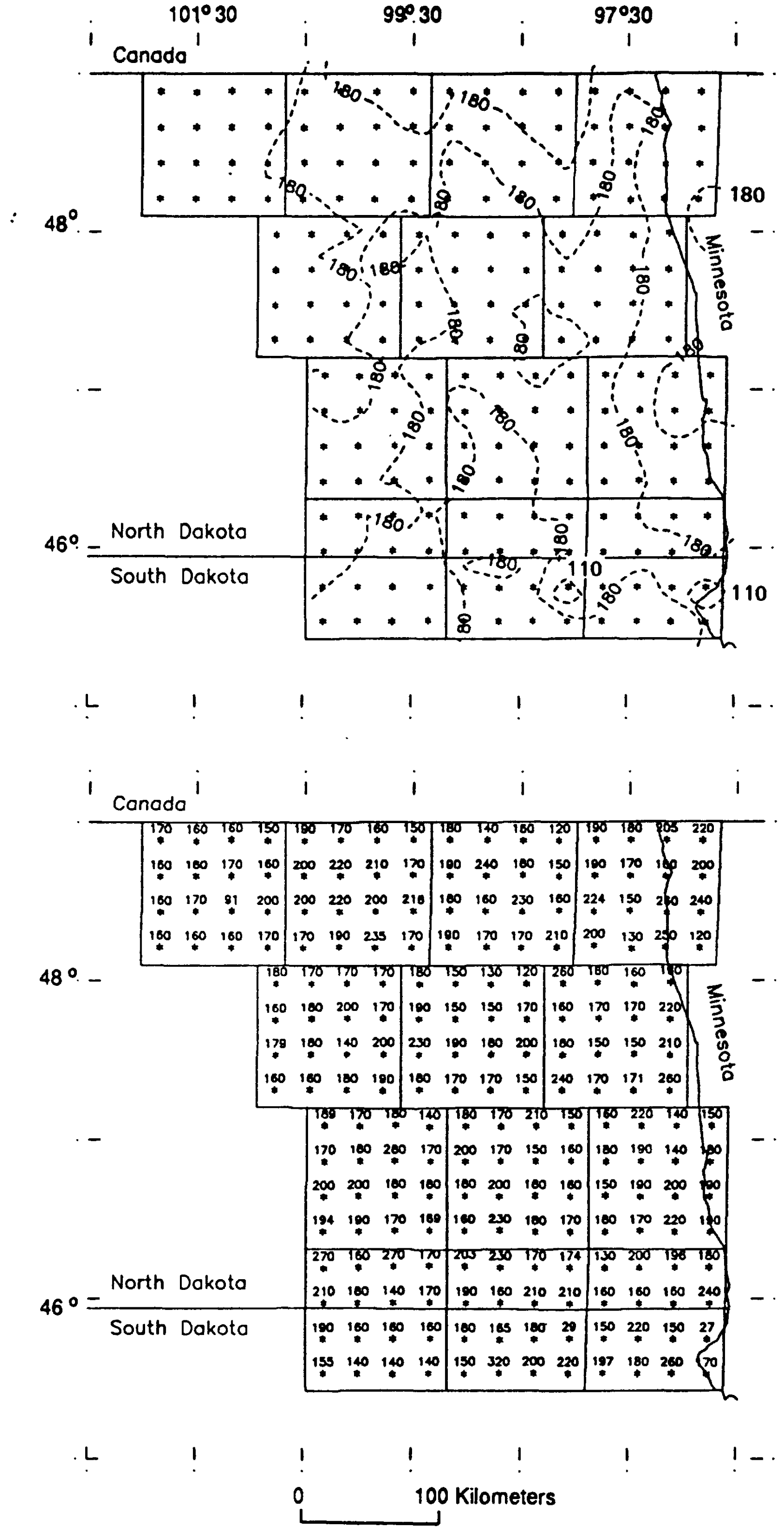


Figure 5D. Strontium, in ppm; Upper figure, contour interval, GM-180, Baseline-110 to 290; Lower figure, GM's for each 25km cell.

Table 1.--Analytical methods and lower limits of determination for elements reported.

Analytical method	Determination limit	Elements
Continuous flow hydride generation	0.1 ppm	As, Se
Induction coupled plasma	2.0 ppm	Ag, Cd, La, Li, Mo, Ni, Sc, Sr, V, Y
	0.05 %	Al, Ca, Fe, K, Mg, Na, P, Ti
	1.0 ppm	Ba, Be, Co, Cr, Cu, Yb
	4.0 ppm	Ce, Ga, Ho, Mn, Nb, Nd, Pb, Th, Zn
	8.0 ppm	Au
	10 ppm	Bi
	20 ppm	Sn
	40 ppm	Ta
	100 ppm	U
Hot-water extract	0.4 ppm	B
Continuous flow cold vapor	0.02 ppm	Hg

Table 2.--Summary statistics for element concentrations measured in surface soils from eastern North Dakota.

[Detection ratio, number of samples in which the element was found in measurable concentrations relative to the number of samples analyzed; Baseline value, expected 95-percent range; Observed range; minimum and maximum element concentrations measured]

Variable, unit of measure	Detection ratio	Geometric mean	Geometric deviation	Baseline value	Observed range
Ag, ppm	4:249	---[1]	---	---	<2.0 - 9.0
Al, %	249:249	4.6	1.19	3.2 - 6.5	1.6 - 7.9
As, ppm	249:249	5.0	1.60	2.0 - 13	1.0 - 22
B, ppm	249:249	1.9	1.38	1.0 - 3.6	0.8 - 6.9
Ba, ppm	249:249	590	1.23	390 - 890	140 - 870
Be, ppm	205:249	1.1	1.29	0.66 - 1.8	<1.0 - 2.0
Ca, %	249:249	1.4	1.70	0.48 - 4.0	0.51- 9.3
Ce, ppm	249:249	45	1.26	28 - 71	17 - 69
Co, ppm	249:249	9.2	1.34	5.1 - 17	3.0 - 19
Cr, ppm	249:249	43	1.49	19 - 95	13 - 230
Cu, ppm	249:249	14	1.57	5.7 - 35	2.0 - 35
Fe, %	249:249	1.9	1.34	1.1 - 3.4	0.75- 4.5
Ga, ppm	249:249	11	1.22	7.4 - 16	5.0 - 19
Hg, ppm	177:249	---	---	---	<0.02- 0.40
K, %	249:249	1.5	1.20	1.0 - 2.2	0.35- 2.5
La, ppm	249:249	25	1.23	17 - 38	11 - 40
Li, ppm	249:249	18	1.44	8.7 - 37	5.0 - 67
Mg, %	249:249	0.63	1.57	0.26 - 1.6	0.16- 2.6
Mn, ppm	249:249	760	1.71	260 -2200	170 -7700
Mo, ppm	14:249	---	---	---	<2.0 - 12
Na, %	249:249	0.98	1.48	0.45 - 2.1	0.04- 1.7
Nb, ppm	38:249	---	---	---	<4.0 - 10
Nd, ppm	249:249	21	1.26	13 - 33	9.0 - 32
Ni, ppm	249:249	21	1.46	9.9 - 45	7.0 - 66
P, %	249:249	0.061	1.34	0.034- 0.11	0.03- 0.16
Pb, ppm	249:249	14	1.28	8.5 - 23	7.0 - 61
Sc, ppm	249:249	5.9	1.34	3.3 - 11	2.0 - 13
Se, ppm	247:249	0.44	1.71	0.15 - 1.3	<0.10- 1.4
Sn, ppm	1:249	---	---	---	<10 - 20
Sr, ppm	249:249	180	1.27	110 - 290	27 - 320
Th, ppm	231:249	6.4	1.32	3.7 - 11	<4.0 - 11
Ti, %	249:249	0.20	1.38	0.11 - 0.38	0.02- 0.35
V, ppm	249:249	66	1.50	29 - 150	17 - 220
Y, ppm	249:249	13	1.29	7.8 - 22	6.0 - 24
Yb, ppm	226:249	1.4	1.46	0.66 - 3.0	<1.0 - 3.0
Zn, ppm	249:249	58	1.48	26 - 130	11 - 120

[1] Not determined

Table 3.--Distance-related and procedural variance components for elements measured in surface soils from eastern North Dakota.

Variable, unit of measure	Total log10 variance	Percentage of variance: Between 100km cells	Between 50km cells	Between 25km cells	Within 25km cells	Procedural error
Al, %	0.00599	1.2	2.5	24.0	58.9*	13.4
As, ppm	0.05450	6.4*	0.0	0.0	87.4*	6.2
B, ppm	0.01964	12.7*	3.0	9.8	58.5*	16.0
Ba, ppm	0.00816	17.2*	4.1	54.8*	22.3*	1.6
Be, ppm	0.01484	2.5	6.9*	25.3	0.0	65.3
Ca, %	0.56738	17.4*	0.0	1.8	63.3*	17.6
Ce, ppm	0.01316	2.6	1.3	0.0	66.4*	29.7
Co, ppm	0.02751	0.0	0.0	0.0	90.0*	10.0
Cr, ppm	0.03743	0.0	2.6	0.0	55.2*	42.2
Cu, ppm	0.06307	0.3	6.1*	0.0	76.9*	16.7
Fe, %	0.03019	0.5	2.8	0.0	86.0*	10.7
Ga, ppm	0.00912	1.2	7.8	0.0	76.0*	15.9
K, %	0.00638	1.4	0.0	69.0*	22.5*	7.1
La, ppm	0.01101	3.4*	3.8	0.0	66.1*	26.7
Li, ppm	0.03326	1.9*	7.1*	0.0	87.2*	3.8
Mg, %	0.05066	7.9*	7.7*	0.0	81.8*	2.6
Mn, ppm	0.07083	5.6*	2.3	0.0	90.1*	2.0
Na, %	0.03019	0.0	0.0	72.9*	18.3*	8.8
Nd, ppm	0.01231	5.1*	4.9	0.0	68.8*	21.2
Ni, ppm	0.04159	1.7	4.1	0.0	71.7*	22.5
P, %	0.01695	11.3*	11.4*	0.0	57.2*	20.1
Pb, ppm	0.02143	0.5	2.6	0.0	82.2*	14.7
Sc, ppm	0.03039	0.8	4.9	0.0	81.7*	12.6
Se, ppm	0.09890	8.7*	0.4	0.0	85.9*	5.0
Sr, ppm	0.01155	0.0	0.0	33.1	52.9*	14.0
Th, ppm	0.02658	3.1*	1.9	0.0	66.3*	31.7
Ti, %	0.02009	1.7	0.0	16.1	66.9*	15.3
V, ppm	0.04801	0.7	4.5	0.0	78.8*	16.0
Y, ppm	0.01950	4.0*	4.0	0.0	72.1*	19.9
Yb, ppm	0.04041	7.1*	0.0	0.0	71.5*	21.4
Zn, ppm	0.04366	2.9*	1.4	0.0	83.0*	12.7

* Statistically significant at the 0.05 probability level.

Table 4--Variance-mean ratio, and estimated numbers of samples necessary within a cell of specified size to prepare stable geochemical maps at the 80% and 95% probability levels for variables in surface soils of eastern North Dakota.

[Vm, variance mean ratio; Nr, number of random samples necessary to construct stable geochemical maps at probability levels of 80% and 95%]

Variable, unit of measure	100 KM Cells			50 KM Cells			25 KM Cells		
		Nr			Nr			Nr	
	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%
Al, %	0.2	>20	>20	0.2	19	>20	0.7	4	10
As, ppm	1.2	11	>20	0.3	11	>20	0.1	11	>20
B, ppm	2.2	7	>20	0.8	6	17	0.7	4	10
Ba, ppm	2.7	5	16	1.0	5	13	5.9	2	3
Ca, %	3.6	5	16	1.0	5	16	0.5	5	14
Ce, ppm	0.5	>20	>20	0.2	18	>20	0.1	18	>20
Co, ppm	<0.1	>20	>20	<0.1	>20	>20	<0.1	>20	>20
Cr, ppm	---[1]	---	---	0.1	>20	>20	0.1	>20	>20
Cu, ppm	<0.1	>20	>20	0.3	11	>20	0.1	11	>20
Fe, %	0.1	>20	>20	0.2	>20	>20	0.1	>20	>20
Ga, ppm	0.2	>20	>20	0.5	9	>20	0.2	9	>20
K, %	0.2	>20	>20	0.1	>20	>20	4.7	2	3
La, ppm	0.5	20	>20	0.4	10	>20	0.2	10	>20
Li, ppm	0.3	>20	>20	0.4	9	>20	0.2	9	>20
Mg, %	1.1	10	>20	0.8	6	17	0.3	6	17
Mn, ppm	0.9	13	>20	0.4	10	>20	0.2	10	>20
Na, %	---	---	---	---	---	---	5.6	2	3
Nd, ppm	0.8	14	>20	0.5	8	>20	0.2	8	>20
Ni, ppm	0.3	>20	>20	0.3	12	>20	0.1	12	>20
P, %	1.5	7	>20	1.4	4	12	0.6	4	12
Pb, ppm	0.1	>20	>20	0.2	>20	>20	0.1	>20	>20
Sc, ppm	0.1	>20	>20	0.3	13	>20	0.1	13	>20
Se, ppm	1.6	9	>20	0.5	9	>20	0.2	9	>20
Sr, ppm	---	---	---	---	---	---	1.0	4	8
Th, ppm	0.5	>20	>20	0.3	14	>20	0.1	14	>20
Ti, %	0.3	>20	>20	0.1	>20	>20	0.4	5	15
V, ppm	0.1	>20	>20	0.3	14	>20	0.1	14	>20
Y, ppm	0.6	17	>20	0.4	9	>20	0.2	10	>20
Yb, ppm	1.3	11	>20	0.4	11	>20	0.2	11	>20
Zn, ppm	0.5	>20	>20	0.2	16	>20	0.1	16	>20

[1] Not determined

Table 5.--Grouping of elements based on significant variance components and variance-mean ratios for three sampling cell sizes.

Cell size	Variance-mean ratio	Variance component: Significant	Variance component: Non-significant
100km	Vm>1.0	As, B, Ba, Ca, Mg, P, Se, Yb	---
	Vm<1.0	Mn, Nd, La, Li, Th, Y, Zn	---
50km	Vm>1.0	P	Ba, Ca
	Vm<1.0	Cu, Li, Mg	---
25km	Vm>1.0	Ba, K, Na	Sr
	Vm<1.0	---	---

Table 6.--Baseline data for elements in samples of A-horizons of soils from the Northern Great Plains (Severson and Tidball, 1976)

[Baseline value, expected 95-percent range]

Variable, unit of measure	Geometric mean	Baseline value
Al, %	5.3	4.1 - 6.9
As, ppm	7.1	2.6 - 19
Be, ppm	1.5	0.8 - 2.6
Ca, %	1.0	0.2 - 4.6
Co, ppm	6.4	2.8 - 14
Cu, ppm	19	8.0 - 43
Fe, %	2.1	1.1 - 4.2
Ga, ppm	11	6.0 - 19
Hg, ppm	0.026	0.013- 0.051
K, %	1.8	1.5 - 2.1
Li, ppm	19	10 - 37
Mg, %	0.7	0.2 - 1.8
Mn, ppm	720	570 - 910
Mo, ppm	3.8	1.1 - 13
Na, %	0.86	0.50 - 1.2
Ni, ppm	18	10 - 32
Se, ppm	0.5	0.2 - 1.1
Sn, ppm	0.9	0.3 - 2.2
Sr, ppm	180	140 - 240
Th, ppm	8.4	6.5 - 10
Ti, %	0.25	0.22 - 0.28
V, ppm	64	13 - 120
Y, ppm	18	10 - 36
Zn, ppm	63	40 - 86

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested anlysis-of-variance sampling design in eastern North Dakota.

[Sample ID; first two digits identify the 100km cell (01-13), the third digit identifies the 50km cell within the 100km cell (1-4), the fourth digit identifies the 25km cell within the 50km cell (1-4), the fifth digit identifies the sample collected within the 25km cell (1-2), and the last digit identifies samples that were split for the determination of procedural errors (1-2).]

Sample ID	Latitude	Longitude	Ag, ppm	Al, ppm	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
011111	484905	1015857	<2	4.6	7.4	1.7	570	1	1.8	44
011211	485947	1012313	<2	4.0	4.9	1.2	490	<1	1.6	34
011311	484524	1013755	<2	4.8	5.9	2.1	600	1	0.98	47
011411	483813	1014838	<2	5.5	7.6	1.9	660	1	0.94	56
012111	484705	1011156	<2	4.4	5.4	1.4	570	1	0.98	52
012211	484736	1004213	<2	5.5	7.1	2.5	640	2	0.88	60
012212	484735	1004212	<2	4.9	5.7	2.5	620	1	1.4	44
012311	483636	1005821	<2	3.3	1.5	1.4	480	<1	0.89	36
012321	483955	1005332	<2	5.3	7.6	2.3	620	1	0.97	54
012411	483617	1010528	<2	3.0	1.0	1.8	460	<1	1.6	17
013111	483220	1011600	<2	2.2	7.3	2.8	240	<1	4.4	36
013211	483126	1004749	<2	4.5	5.0	1.1	660	1	1.2	42
013311	480727	1005256	<2	4.6	4.4	1.8	620	1	0.91	44
013411	481736	1010011	<2	4.8	5.4	1.8	580	1	0.77	41
014111	482419	1015739	<2	4.8	5.7	2.3	630	1	0.95	42
014211	482135	1013316	<2	5.4	9.0	2.0	640	1	0.95	44
014311	481327	1013144	<2	4.6	5.3	2.2	670	1	0.70	42
014411	480944	1014044	<2	5.2	11	1.9	590	1	3.6	43
021111	484701	1003315	<2	4.8	6.6	1.8	650	1	1.0	40
021211	485809	1001126	<2	4.4	3.2	2.0	550	1	1.0	41
021212	485809	1001126	<2	4.4	3.8	2.1	540	1	1.0	43
021221	484826	1001223	<2	4.7	6.0	3.0	600	1	0.95	45
021311	483630	1001905	<2	4.5	3.5	1.6	670	1	1.3	37
021312	483630	1001905	<2	4.4	3.5	1.5	680	1	1.3	40
021411	484441	1002112	<2	4.3	5.3	2.6	630	1	1.8	40
022111	485439	994838	<2	4.8	5.2	2.3	630	1	1.0	47
022211	485124	992253	<2	4.8	9.3	1.4	550	1	1.3	46
022311	483743	993422	<2	5.4	9.1	1.7	640	1	1.3	54
022411	484305	994147	<2	4.6	6.8	1.5	640	1	4.3	39
023111	482609	994837	<2	4.0	3.8	1.3	580	<1	0.94	27
023211	483031	993759	<2	4.9	6.0	2.5	730	1	6.2	48
023221	483142	993530	<2	4.9	5.5	2.1	680	1	1.1	50
023311	481333	993807	<2	5.1	8.5	1.3	640	1	1.4	52
023411	480828	995423	<2	3.6	1.7	2.8	570	<1	4.2	32
023421	481440	994047	<2	4.7	4.5	1.9	660	1	1.2	47
024111	482553	1003733	<2	4.8	4.6	2.2	690	1	1.6	46
024211	483223	1001021	<2	4.1	3.1	1.4	620	<1	1.7	36
024311	481354	1000305	<2	4.3	6.4	1.8	640	1	1.1	43
024411	481833	1003126	<2	5.7	1.0	1.6	670	1	1.1	52
031111	484804	991310	<2	4.6	2.6	2.9	550	1	2.4	47
031121	485202	990005	<2	4.3	5.2	1.9	500	1	1.7	40
031211	484733	985823	<2	5.6	3.6	1.9	600	1	0.89	57
031311	484550	985420	<2	4.6	4.9	3.0	550	1	4.2	47
031411	483533	991550	<2	3.7	3.6	2.7	500	<1	2.1	27
032111	485153	983109	<2	4.6	3.0	2.2	590	1	1.2	53
032211	485631	980725	<2	4.2	5.6	2.2	600	1	1.1	53
032311	483358	981152	<2	4.2	3.2	2.9	540	1	0.99	46

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Latitude	Longitude	Ag, ppm	Al, ppm	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
032321	483350	980639	<2	4.3	4.4	2.0	530	1	0.94	42
032411	484206	982123	<2	4.2	3.3	2.1	520	1	3.3	44
033111	482117	982920	8	4.3	4.2	2.7	520	1	5.0	44
033211	482708	980259	<2	4.3	4.2	2.1	540	1	1.3	46
033311	480607	981229	<2	4.5	1.5	2.8	530	1	3.3	47
033411	481923	982244	<2	4.5	3.9	1.9	540	1	2.3	45
034111	482803	990521	<2	4.5	5.5	1.8	540	1	3.3	43
034211	482714	985459	<2	4.5	4.1	2.3	580	1	1.2	49
034311	481301	984652	<2	3.2	3.3	2.1	470	<1	0.70	24
034411	480733	991003	<2	3.8	2.8	1.7	530	<1	2.5	33
041111	485329	973855	<2	4.4	4.4	2.0	580	1	2.1	51
041211	484705	973457	<2	4.3	8.8	2.6	570	1	1.5	43
041311	434213	972822	<2	4.7	8.6	2.6	560	1	2.0	58
041411	483751	973955	<2	3.9	4.0	2.6	570	<1	2.1	40
042111	484803	971520	<2	3.7	3.7	1.4	540	<1	3.3	25
042121	485147	971553	<2	5.5	5.1	1.9	530	1	2.2	61
042211	485408	963950	<2	4.0	1.5	2.1	420	<1	1.3	27
042311	484245	964945	<2	5.2	3.4	1.9	470	1	1.3	40
042411	483336	970459	<2	6.4	8.5	1.7	530	2	3.9	63
043111	482120	971731	<2	4.2	5.5	2.5	190	1	7.7	49
043211	481049	964422	<2	4.4	2.4	1.9	470	<1	4.1	31
043311	482905	965040	<2	7.1	9.4	1.4	530	2	1.4	65
043312	482905	965040	<2	7.0	11	1.3	520	2	1.3	64
043411	481726	971511	<2	4.4	7.9	1.8	140	1	9.3	49
044111	482442	974609	<2	4.0	2.1	1.9	480	<1	5.0	47
044121	482130	973941	<2	4.0	2.9	2.4	520	1	2.5	43
044211	482545	972536	<2	5.0	11	2.8	560	2	3.2	58
044311	481257	972553	<2	5.6	9.3	3.2	560	2	1.2	60
044312	481258	972552	<2	3.8	10	1.9	630	<1	4.5	30
044411	481407	973932	<2	4.4	5.3	2.4	510	1	1.4	45
051111	480523	1003611	<2	4.2	6.8	1.4	600	<1	1.7	36
051211	475717	1001712	<2	4.7	6.0	1.1	640	1	0.76	43
051311	473858	1002245	<2	5.2	7.0	2.2	670	1	0.93	48
051312	473857	1002244	<2	5.1	6.7	2.2	670	1	0.93	51
051411	474232	1004319	<2	4.9	8.2	1.7	670	1	1.0	49
052111	475542	1000545	<2	3.2	2.2	1.9	540	<1	0.71	21
052211	475846	994854	<2	3.5	3.1	6.1	540	<1	1.7	32
052311	474559	993756	<2	4.6	5.0	2.0	660	1	1.2	47
052411	474249	1000554	<2	5.0	5.6	2.2	710	1	1.1	43
052412	474251	1000559	<2	4.9	6.5	1.6	710	1	1.0	45
053111	472936	1001455	<2	6.2	11	1.6	690	2	1.6	60
053211	473659	994411	<2	4.5	5.2	2.0	660	1	0.87	42
053311	471819	995439	<2	4.7	4.7	2.0	640	1	0.97	45
053411	471244	1000856	<2	4.5	7.3	1.4	560	1	2.2	39
054111	473058	1004904	<2	3.9	2.7	1.8	620	<1	0.91	29
054121	472556	1005317	<2	5.4	8.9	1.4	640	1	0.88	50
054211	472703	1003045	<2	5.3	6.8	2.1	650	1	1.1	46
054311	472314	1003459	9	5.2	8.7	1.7	590	1	1.5	47
054411	471429	1004209	<2	5.2	7.1	1.7	630	1	2.9	47
061111	475438	992343	<2	4.8	7.0	1.4	670	1	1.5	53
061211	475828	985829	<2	4.0	3.8	1.2	580	1	2.1	42

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Latitude	Longitude	Ag, ppm	Al, ppm	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
061311	474301	991256	<2	3.8	5.1	1.9	570	<1	1.3	40
061411	474413	992657	<2	4.9	5.9	1.5	690	1	0.98	51
062111	480055	985433	<2	4.5	6.4	2.0	590	1	1.2	50
062211	475556	983346	<2	6.5	4.5	1.9	550	2	1.0	59
062311	474256	983509	<2	3.9	8.6	4.0	430	1	1.8	37
062411	474950	985551	<2	5.2	4.7	2.6	660	2	1.4	51
063111	473112	984756	<2	4.1	4.5	1.1	590	1	0.84	50
063211	473312	983415	<2	4.2	2.7	1.4	630	<1	0.98	34
063311	471636	983515	<2	4.5	4.5	2.9	580	1	1.4	45
063411	471812	983904	<2	4.8	4.2	1.6	620	1	1.2	48
064111	472524	992512	<2	4.9	5.7	3.6	710	1	1.9	48
064211	472903	991224	<2	4.6	5.5	2.0	660	1	1.0	45
064311	471348	985859	<2	4.9	6.6	2.9	650	1	1.0	41
064411	471536	993236	<2	4.5	3.4	1.7	580	1	1.2	36
071111	475310	981230	<2	4.3	4.2	2.3	350	1	5.4	39
071211	475934	975520	<2	4.7	4.7	2.3	580	1	1.1	54
071311	474847	973745	<2	3.9	7.8	1.7	550	1	1.3	42
071411	474709	975845	<2	4.3	4.8	2.1	540	1	1.2	48
072111	480315	971941	<2	5.5	7.0	2.0	580	2	1.3	60
072211	480055	965639	<2	4.9	4.1	1.9	500	1	5.0	50
072311	474208	971619	<2	4.5	3.3	3.2	500	1	1.7	43
072411	474006	972754	<2	3.8	5.3	1.9	570	1	1.4	52
073111	473242	973332	<2	4.9	3.8	2.8	570	1	1.1	48
073211	472952	970148	<2	4.0	2.8	2.4	480	1	5.0	49
073311	471703	971455	<2	4.8	4.1	5.0	560	1	2.6	44
073411	472150	971714	<2	4.0	3.1	1.5	590	<1	0.91	26
073421	471813	972546	<2	5.4	7.9	2.7	580	2	1.1	55
074111	473648	980721	<2	4.7	6.2	2.2	630	1	0.92	51
074211	473005	975358	<2	4.3	6.5	2.1	550	1	1.7	46
074311	471422	973849	<2	4.3	5.9	1.8	570	1	1.2	43
074411	472332	981251	<2	3.4	1.6	3.2	500	<1	4.9	32
081111	470541	1002604	<2	5.9	11	1.1	730	1	1.5	49
081121	470023	1001732	<2	5.3	9.5	2.0	700	1	0.92	44
081211	470946	995031	<2	4.6	5.2	1.3	610	1	1.2	39
081311	465311	1000217	<2	5.2	7.7	1.9	650	1	0.82	54
081411	464648	1001847	<2	5.7	8.6	1.5	700	2	0.99	53
082111	470323	993102	<2	4.3	5.0	1.3	560	1	1.0	38
082211	470659	991733	<2	4.4	6.1	1.7	550	1	1.0	44
082311	465516	992331	<2	4.3	6.7	1.1	610	1	2.0	39
082312	465516	992331	<2	4.4	8.1	1.0	620	1	1.9	38
082321	464801	992247	<2	4.6	4.3	1.1	550	1	1.0	36
082411	464823	994156	<2	3.3	2.8	3.7	510	<1	4.0	21
083111	463820	993018	<2	4.1	5.4	1.5	570	<1	1.1	30
083211	463920	992752	<2	4.2	3.1	1.9	610	1	0.99	41
083311	462659	992447	<2	4.7	5.6	1.4	640	1	0.98	47
083321	462532	991032	<2	5.2	8.2	1.7	640	1	1.2	49
083411	463058	993354	<2	5.3	8.7	1.8	720	2	1.1	57
084111	463554	1002406	<2	4.3	3.9	1.3	700	<1	0.74	42
084211	463701	1000817	<2	4.1	3.2	1.1	680	1	0.84	34
084212	463701	1000817	<2	4.1	3.1	1.3	670	<1	0.85	34
084311	462656	994954	<2	4.6	5.2	1.1	740	1	0.91	46

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Latitude	Longitude	Ag, ppm	Al, ppm	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
084411	462137	1002011	<2	4.4	8.9	1.3	530	1	2.8	42
084421	462820	1000957	<2	5.5	8.6	1.2	760	1	0.91	52
091111	470201	990227	<2	4.7	5.6	1.4	630	1	1.0	50
091211	470429	984429	<2	4.9	5.6	1.4	700	1	0.91	49
091311	465541	984830	<2	4.7	5.0	2.6	670	1	0.79	50
091411	464842	985243	<2	4.8	6.9	1.4	650	1	1.2	48
092111	470034	981728	<2	4.3	3.0	3.2	530	1	3.4	51
092211	470233	975514	<2	4.1	5.2	2.0	560	1	1.4	40
092311	465356	980809	<2	4.6	8.7	2.2	610	1	1.2	47
092411	465806	982527	<2	5.1	9.9	1.3	590	1	1.3	53
093111	463351	982245	<2	5.5	5.1	1.4	600	1	2.6	50
093211	464044	980656	<2	4.9	7.6	1.7	630	1	0.76	52
093311	462143	980824	<2	4.9	4.9	2.3	640	1	0.94	46
093411	462502	981525	<2	5.2	5.9	2.0	640	1	1.1	48
094111	463529	990228	<2	5.0	7.5	1.1	630	1	0.96	54
094211	463847	984757	<2	4.5	3.7	3.5	660	1	1.8	43
094311	462429	984152	<2	3.9	2.6	2.2	640	<1	4.7	35
094411	462329	985058	<2	5.2	8.2	1.7	670	1	0.87	50
101111	471034	974655	<2	4.7	4.8	2.8	560	1	1.2	46
101211	470214	972333	<2	4.2	3.5	1.5	560	<1	4.3	25
101311	464935	973116	<2	4.5	6.1	3.0	590	1	1.2	50
101411	465604	973218	<2	4.4	3.8	1.9	590	1	1.1	48
102111	470122	965407	<2	7.0	10	1.5	550	2	2.1	63
102211	470417	964036	<2	5.6	4.6	2.3	610	2	1.7	67
102311	465120	963749	<2	4.0	3.6	2.1	470	1	1.5	44
102411	464647	965319	<2	6.6	8.7	1.7	560	2	2.6	61
103111	463554	970051	<2	3.6	3.1	1.8	560	<1	1.9	34
103112	463556	970051	<2	3.7	3.1	2.2	550	<1	2.0	34
103211	463445	964428	<2	5.3	5.7	2.2	500	1	5.0	55
103311	462747	964803	<2	4.5	2.5	2.3	610	1	1.7	62
103312	462748	964800	<2	4.3	3.1	2.5	580	1	1.6	59
103411	462614	970350	7	4.0	3.5	2.0	630	<1	1.0	42
104111	464352	974920	<2	5.2	7.1	2.1	630	1	1.3	56
104211	463701	972637	<2	3.6	2.0	1.1	510	<1	0.91	28
104212	463710	972639	<2	3.6	2.2	1.4	530	<1	0.94	27
104311	462902	972400	<2	3.3	2.4	1.5	550	<1	0.73	21
104312	462902	972359	<2	3.3	3.7	1.4	530	<1	0.75	30
104411	463030	975058	<2	5.1	15	2.2	590	1	1.6	57
111111	460825	1002139	<2	5.9	9.0	1.2	830	2	1.3	58
111211	461606	995038	<2	3.7	3.1	1.3	500	<1	0.94	38
111311	460109	995649	<2	5.2	6.1	1.7	780	1	0.95	54
111411	455319	1002250	<2	5.5	6.4	1.4	760	1	0.96	57
112111	461510	994124	<2	5.7	5.2	1.6	860	1	1.0	51
112211	460732	991454	<2	4.2	4.6	1.4	590	1	1.1	43
112311	460018	991633	<2	5.2	6.7	2.0	630	2	0.93	52
112411	455256	993116	<2	4.3	5.5	0.9	570	1	1.1	41
113111	453922	994211	<2	5.2	7.1	1.9	690	1	0.85	54
113211	455037	992410	<2	5.3	6.7	1.3	690	1	0.83	49
113212	455034	992411	<2	5.2	6.4	1.5	680	1	0.86	47
113311	452946	992044	<2	5.6	2.8	2.6	620	2	0.88	56
113411	453028	993632	<2	5.8	7.0	1.8	670	2	1.0	52

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Latitude	Longitude	Ag, ppm	Al, ppm	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm
114111	455051	1001004	<2	4.5	5.0	1.6	680	1	0.86	42
114211	455046	995057	<2	5.5	7.2	1.7	720	2	0.94	60
114212	455045	995055	<2	5.4	7.8	1.8	720	2	0.91	65
114311	452550	995434	<2	5.1	4.8	2.3	670	1	0.73	57
114312	452549	995435	<2	5.2	4.5	2.5	660	1	0.71	58
114411	453235	1002441	<2	5.7	9.4	1.8	780	2	0.93	60
114421	453111	1001954	<2	7.9	22	1.2	710	2	1.6	66
121111	461744	990044	<2	4.5	5.7	1.6	610	1	0.94	39
121112	461744	990044	<2	4.9	7.1	1.4	660	1	1.50	48
121121	460801	990659	<2	4.3	4.2	1.4	630	<1	1.0	35
121211	461642	983811	<2	6.1	3.6	1.7	830	2	1.2	53
121311	455432	984043	<2	4.0	4.3	2.1	580	1	1.0	42
121411	460143	985708	<2	4.3	5.5	0.9	590	1	1.7	38
121412	460144	985706	<2	4.4	4.2	1.2	600	1	1.8	40
122111	461559	981843	<2	5.0	6.4	1.6	680	1	1.0	50
122211	461541	975828	<2	4.1	3.5	2.6	560	1	1.5	36
122221	460726	975440	7	4.7	2.0	6.9	570	1	1.1	42
122311	455642	980917	<2	4.5	3.2	1.6	660	1	1.0	38
122411	455459	982927	<2	4.3	5.0	1.4	610	1	3.0	36
123111	454520	982147	<2	4.7	5.4	1.4	650	1	0.90	45
123211	455046	980924	<2	1.6	2.0	0.8	190	<1	1.3	39
123311	453756	980624	<2	4.9	4.5	1.6	750	1	1.3	45
123411	453122	981411	<2	5.2	4.5	2.6	710	1	1.8	53
124111	454655	990709	<2	4.7	3.8	2.0	590	1	1.2	45
124112	454655	990709	<2	4.8	3.5	2.3	600	1	1.2	55
124211	454106	983250	<2	4.5	3.3	1.9	660	1	0.93	42
124221	454729	984450	<2	4.0	3.4	2.2	610	1	0.77	52
124311	453357	983623	<2	6.0	4.1	1.2	870	1	1.2	35
124411	452936	990456	<2	4.9	5.5	1.9	650	1	0.75	51
131111	460549	973602	<2	4.9	5.1	2.4	560	1	1.0	49
131211	461701	972018	<2	4.9	2.3	2.8	590	1	1.0	50
131311	455607	972909	<2	5.9	12	1.5	630	2	0.94	59
131312	455607	972911	<2	5.8	10	1.7	630	2	0.99	64
131411	455715	974140	<2	4.9	4.9	1.6	600	1	1.2	52
132111	460725	970729	<2	4.7	7.2	2.1	600	1	1.3	51
132121	460629	970004	<2	3.6	2.3	2.1	600	<1	3.0	27
132211	460822	964946	<2	4.9	6.4	2.7	660	1	1.2	52
132311	460210	964810	<2	3.9	3.1	3.9	580	<1	2.7	32
132411	460205	970958	<2	5.1	7.5	1.9	570	1	1.4	46
133111	455130	970304	<2	5.3	10	2.5	580	1	0.91	53
133112	455732	970304	<2	5.2	7.3	2.4	590	2	0.92	53
133211	454711	964723	<2	2.0	8.0	2.3	200	<1	0.51	49
133311	452239	964806	<2	4.8	7.3	1.9	580	1	1.1	48
133411	453619	965833	<2	3.8	4.7	3.6	460	<1	6.2	33
134111	454547	974352	<2	5.4	5.6	1.7	590	2	1.1	69
134211	454022	971817	<2	4.6	4.6	2.2	530	1	1.5	36
134311	452708	972907	<2	5.0	9.4	2.0	630	1	1.2	51
134411	452816	973319	<2	4.7	5.4	3.7	510	1	3.3	51
134421	453415	974747	<2	4.8	7.0	2.4	750	1	1.0	51

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
011111	9	52	13	2.0	11	0.02	1.6	26	21	0.69
011211	7	32	16	1.6	10	<0.02	1.4	20	14	0.53
011311	9	54	14	2.1	11	0.22	1.6	26	18	0.54
011411	11	60	19	2.5	13	0.02	1.7	30	26	0.66
012111	9	33	15	1.7	10	<0.02	1.6	28	14	0.48
012211	13	50	18	2.8	13	0.04	1.8	32	24	0.68
012212	10	57	15	2.0	12	0.02	1.5	26	17	0.61
012311	4	13	4	0.93	7	<0.02	1.2	21	7	0.23
012321	11	43	16	2.4	12	0.02	1.7	31	21	0.60
012411	3	18	3	0.75	6	<0.02	1.2	11	7	0.32
013111	8	30	12	1.6	6	0.02	0.58	22	10	1.6
013211	8	21	8	1.4	10	<0.02	1.6	24	13	0.41
013311	9	43	12	1.8	10	0.02	1.6	24	16	0.47
013411	9	45	13	2.1	11	0.02	1.6	23	18	0.46
014111	9	50	17	2.2	11	<0.02	1.6	24	17	0.57
014211	10	49	18	2.3	13	0.02	1.7	25	21	0.63
014311	9	42	13	1.9	11	0.04	1.6	23	17	0.43
014411	11	52	19	2.3	12	0.02	1.6	25	22	1.1
021111	9	32	12	1.8	10	<0.02	1.7	22	17	0.50
021211	11	40	15	1.5	10	<0.02	1.5	20	16	0.43
021212	11	42	20	1.5	10	0.02	1.5	20	16	0.43
021221	10	33	13	2.0	11	<0.02	1.5	26	18	0.56
021311	6	31	7	1.2	10	<0.02	1.6	21	12	0.41
021312	6	25	7	1.2	9	<0.02	1.6	22	12	0.41
021411	8	37	10	1.6	10	0.02	1.6	23	17	0.60
022111	12	34	15	1.9	11	0.02	1.5	24	18	0.51
022211	10	38	16	2.2	11	0.02	1.5	25	18	0.61
022311	13	93	17	2.4	12	0.04	1.7	30	22	0.76
022411	10	33	14	1.9	11	<0.02	1.5	24	22	1.1
023111	6	33	8	1.3	9	<0.02	1.4	17	10	0.30
023211	11	47	17	2.2	12	<0.02	1.6	27	32	2.2
023221	11	52	14	2.1	11	0.02	1.7	27	17	0.56
023311	11	45	15	2.3	12	0.04	1.6	28	21	0.76
023411	5	27	10	1.1	8	<0.02	1.4	20	22	1.3
023421	9	32	13	1.8	10	<0.02	1.5	26	17	0.53
024111	9	43	16	1.7	11	<0.02	1.7	26	18	0.60
024211	5	16	6	1.2	9	<0.02	1.4	21	12	0.50
024311	8	45	9	1.7	10	<0.02	1.5	24	14	0.41
024411	11	51	17	2.4	14	<0.02	1.6	30	23	0.70
031111	9	34	15	2.0	12	<0.02	1.5	28	23	1.1
031121	9	27	11	1.8	11	0.02	1.5	24	17	0.75
031211	12	68	18	2.6	14	0.02	1.7	31	23	0.64
031311	10	46	17	2.0	10	0.04	1.6	27	24	1.5
031411	7	66	11	1.4	7	<0.02	1.3	17	14	0.61
032111	8	38	14	1.9	11	0.02	1.8	27	17	0.52
032211	15	36	21	2.3	12	0.04	1.5	27	19	0.61
032311	10	37	14	2.0	10	0.02	1.4	23	17	0.57
032321	10	47	13	2.0	11	0.02	1.4	23	16	0.53
032411	9	37	18	1.9	11	0.02	1.4	26	21	1.1
033111	11	39	21	2.1	10	0.02	1.5	26	32	1.4

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
033211	10	48	15	2.0	11	<0.02	1.4	25	19	0.77
033311	9	49	16	1.9	11	0.02	1.6	27	24	1.0
033411	9	48	19	2.0	11	0.04	1.6	27	20	0.88
034111	12	32	18	2.0	11	0.04	1.5	26	23	1.5
034211	10	53	16	2.0	10	0.02	1.5	26	17	0.59
034311	3	15	2	0.78	7	<0.02	1.2	14	7	0.16
034411	6	26	8	1.1	8	<0.02	1.3	19	13	0.84
041111	10	36	15	2.0	11	0.02	1.4	28	22	0.98
041211	9	39	15	1.8	10	0.14	1.4	26	17	0.60
041311	12	44	23	2.5	13	0.12	1.5	32	24	0.98
041411	6	52	8	1.3	8	0.08	1.4	23	13	0.58
042111	5	17	6	0.89	8	0.02	1.3	17	14	0.83
042121	11	70	32	2.7	13	0.04	1.8	35	29	1.3
042211	6	23	7	1.1	9	0.02	1.1	14	8	0.31
042311	8	51	15	1.8	12	0.04	1.5	23	19	0.66
042411	15	100	29	3.1	16	0.02	1.9	36	39	2.0
043111	9	46	22	1.9	10	0.04	1.4	29	27	1.9
043211	6	23	8	1.2	10	<0.02	1.4	20	13	1.3
043311	17	95	34	3.5	19	0.04	1.9	36	41	1.3
043312	16	91	32	3.5	18	0.02	1.9	36	41	1.3
043411	10	59	27	2.2	11	0.02	1.4	29	34	2.6
044111	9	39	15	1.7	10	0.02	1.4	27	22	1.6
044121	8	37	9	1.5	9	0.04	1.3	26	14	0.66
044211	13	42	25	2.8	14	0.04	1.6	33	29	1.5
044311	13	72	31	3.0	15	0.06	1.7	34	29	0.96
044312	7	28	9	1.5	10	0.04	1.4	19	21	1.3
044411	9	59	12	2.1	10	0.02	1.4	25	17	0.80
051111	7	64	11	1.6	8	<0.02	1.5	22	12	0.49
051211	9	52	13	1.9	11	0.02	1.6	25	16	0.39
051311	10	52	17	2.3	12	0.02	1.7	26	20	0.55
051312	10	39	15	2.3	12	0.06	1.7	27	20	0.55
051411	10	51	16	2.2	12	0.04	1.6	26	19	0.57
052111	4	19	5	0.82	7	<0.02	1.2	13	8	0.20
052211	6	32	19	1.5	8	0.04	1.5	20	16	0.66
052311	9	45	16	1.9	10	0.02	1.6	26	17	0.51
052411	9	46	14	2.0	11	0.02	1.7	24	17	0.48
052412	9	43	12	2.0	11	0.02	1.6	25	16	0.48
053111	13	75	26	3.1	16	0.04	1.9	33	30	1.0
053211	8	24	10	1.6	11	0.02	1.6	24	17	0.41
053311	10	37	14	1.9	12	0.04	1.5	24	17	0.56
053411	9	36	13	2.0	10	0.02	1.4	23	16	0.66
054111	5	22	7	1.0	8	<0.02	1.4	18	10	0.30
054121	11	43	17	2.4	13	0.02	1.6	29	21	0.67
054211	11	56	18	2.4	13	0.02	1.6	25	20	0.63
054311	10	53	16	2.2	11	0.04	1.6	27	20	0.74
054411	10	42	18	2.3	13	<0.02	1.6	28	21	0.97
061111	11	35	13	2.1	12	0.04	1.6	29	19	0.66
061211	11	48	27	2.0	12	0.02	1.3	25	18	0.56
061311	8	23	15	1.7	9	0.04	1.3	23	14	0.54

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
061411	10	48	14	2.0	11	0.02	1.6	28	17	0.47
062111	11	51	21	2.3	12	0.04	1.5	27	20	0.62
062211	16	75	29	3.1	16	0.02	1.8	33	34	1.0
062311	8	77	23	1.9	9	0.08	1.2	23	24	1.1
062411	12	49	22	2.8	14	0.04	1.6	28	29	0.95
063111	7	39	6	1.5	9	0.04	1.4	27	14	0.34
063211	7	30	8	1.2	9	<0.02	1.5	20	11	0.32
063311	9	51	21	2.0	11	0.04	1.5	26	19	0.63
063411	10	52	18	2.2	11	<0.02	1.6	27	19	0.65
064111	10	45	15	2.1	11	<0.02	1.6	27	29	1.3
064211	9	44	14	1.9	10	0.04	1.6	25	17	0.50
064311	10	46	15	2.1	10	0.02	1.6	24	18	0.56
064411	8	29	11	1.6	10	<0.02	1.5	21	17	0.56
071111	9	47	17	2.0	11	0.02	1.4	23	26	1.2
071211	12	48	16	2.2	13	0.04	1.6	28	22	0.75
071311	8	40	11	1.6	9	0.04	1.3	23	12	0.47
071411	10	43	14	2.0	11	0.04	1.5	24	18	0.61
072111	13	62	23	2.9	14	0.02	1.7	34	27	0.90
072211	11	230	27	2.1	11	0.06	1.6	28	24	1.9
072311	9	49	16	1.9	11	0.02	1.4	24	24	1.1
072411	9	29	15	1.7	10	0.22	1.4	29	13	0.52
073111	11	62	17	2.2	12	0.02	1.5	27	22	0.70
073211	9	44	16	1.7	10	0.04	1.3	29	22	1.6
073311	9	40	14	1.7	10	0.02	1.6	26	19	0.68
073411	6	57	6	1.1	9	<0.02	1.4	15	8	0.23
073421	19	55	25	2.7	14	0.04	1.7	31	27	0.81
074111	12	46	13	2.3	13	0.04	1.5	26	17	0.56
074211	11	55	17	2.2	10	0.04	1.4	24	19	0.73
074311	8	33	10	1.7	10	0.02	1.4	24	13	0.48
074411	7	30	10	1.3	8	0.02	1.3	19	18	0.89
081111	12	42	19	2.6	14	0.02	1.7	28	23	0.95
081121	10	110	12	2.3	11	0.02	1.5	25	17	0.49
081211	8	45	11	2.1	11	<0.02	1.4	23	14	0.52
081311	11	61	18	2.3	12	0.40	1.7	30	20	0.55
081411	12	68	20	2.4	13	0.02	1.8	29	24	0.70
082111	8	140	9	1.7	9	<0.02	1.4	21	11	0.38
082211	9	55	18	2.0	10	0.04	1.3	25	16	0.54
082311	9	41	11	2.1	10	0.04	1.4	22	13	0.63
082312	9	25	12	2.2	10	0.02	1.5	22	14	0.64
082321	8	25	11	1.7	10	<0.02	1.5	22	16	0.45
082411	5	23	6	0.81	7	<0.02	1.2	15	20	1.4
083111	7	22	9	1.4	8	<0.02	1.4	18	12	0.46
083211	7	36	15	1.7	10	0.04	1.3	23	14	0.42
083311	9	31	12	1.7	10	<0.02	1.6	26	15	0.43
083321	11	56	22	2.5	12	0.04	1.6	26	20	0.71
083411	13	58	18	2.8	12	0.02	1.7	31	20	0.69
084111	6	21	7	1.4	10	<0.02	1.6	23	12	0.30
084211	6	36	8	1.2	10	<0.02	1.5	19	11	0.30
084212	6	21	7	1.2	9	<0.02	1.4	21	11	0.29
084311	11	37	12	1.9	12	0.04	1.6	25	14	0.41

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
084411	9	50	15	1.8	10	<0.02	1.5	24	19	0.80
084421	11	42	14	2.5	13	0.04	1.6	30	18	0.56
091111	9	45	13	2.1	11	0.02	1.5	27	15	0.52
091211	11	56	18	2.1	11	0.02	1.6	26	18	0.50
091311	9	27	14	1.9	12	0.02	1.6	26	17	0.44
091411	9	30	12	2.0	11	0.02	1.6	27	18	0.54
092111	9	37	17	1.8	10	0.02	1.5	28	25	1.1
092211	10	51	14	2.1	10	0.04	1.3	21	15	0.58
092311	11	80	15	2.1	11	0.02	1.5	26	18	0.63
092411	12	44	21	2.6	13	0.04	1.7	30	24	0.81
093111	11	62	21	2.4	13	0.04	1.9	29	25	0.87
093211	11	91	15	2.1	11	0.04	1.6	28	20	0.50
093311	10	59	16	2.0	11	<0.02	1.6	27	19	0.50
093411	10	56	18	2.2	12	0.04	1.7	27	23	0.64
094111	11	51	17	2.5	12	0.04	1.6	29	19	0.58
094211	9	61	20	1.9	10	0.02	1.6	24	27	0.91
094311	7	29	10	1.5	10	<0.02	1.4	20	22	1.4
094411	11	37	18	2.3	12	0.02	1.7	29	21	0.64
101111	10	51	20	2.0	11	0.04	1.5	26	19	0.61
101211	7	29	8	1.4	10	<0.02	1.4	17	11	1.2
101311	9	42	12	1.9	10	0.04	1.5	29	17	0.58
101411	9	32	12	1.8	11	0.04	1.5	26	16	0.57
102111	16	77	31	3.6	17	0.04	1.9	36	45	1.4
102211	15	58	30	2.7	13	0.04	1.8	35	29	1.1
102311	8	25	10	1.5	10	<0.02	1.3	24	12	0.54
102411	15	87	29	3.2	17	0.04	1.9	34	41	1.4
103111	6	24	6	1.2	8	<0.02	1.2	19	11	0.49
103112	6	35	6	1.3	8	<0.02	1.2	20	11	0.52
103211	11	65	29	2.6	13	0.02	1.7	33	31	1.8
103311	12	37	18	1.9	11	0.04	1.6	33	19	0.76
103312	11	30	14	1.8	10	0.02	1.6	33	18	0.73
103411	6	35	7	1.2	8	<0.02	1.4	22	10	0.29
104111	12	61	18	2.5	13	0.04	1.7	30	23	0.74
104211	5	65	5	0.99	8	<0.02	1.2	17	8	0.24
104212	5	25	8	1.0	7	<0.02	1.2	15	8	0.25
104311	5	22	3	1.0	7	<0.02	1.3	12	7	0.20
104312	5	38	4	0.99	7	<0.02	1.2	17	7	0.19
104411	17	47	25	2.5	12	0.04	1.6	31	23	0.71
111111	11	43	13	2.7	14	<0.02	1.8	33	21	0.71
111211	6	29	8	1.3	9	<0.02	1.2	22	9	0.34
111311	11	36	15	2.2	12	0.02	1.7	31	18	0.55
111411	10	41	12	2.2	12	<0.02	1.8	32	19	0.57
112111	10	40	15	2.0	13	0.02	1.8	27	18	0.47
112211	8	28	12	1.8	11	0.04	1.4	23	14	0.50
112311	11	51	15	2.3	13	0.04	1.6	28	20	0.62
112411	9	52	16	2.0	11	0.04	1.4	24	16	0.53
113111	10	58	18	2.1	11	0.02	1.8	31	20	0.59
113211	11	50	16	2.2	13	0.06	1.7	28	19	0.56
113212	10	51	15	2.2	13	0.04	1.6	28	18	0.54
113311	8	66	28	2.2	13	0.04	1.8	32	21	0.64
113411	12	67	24	2.8	15	0.04	1.8	32	25	0.85

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
114111	9	24	11	1.6	11	0.02	1.5	24	14	0.43
114211	12	53	20	2.5	13	0.02	1.7	32	24	0.77
114212	13	44	20	2.5	14	<0.02	1.8	34	23	0.78
114311	7	56	22	2.0	12	0.04	1.8	32	19	0.51
114312	7	35	19	1.9	11	<0.02	1.8	33	18	0.49
114411	12	57	20	2.6	14	<0.02	2.1	35	26	0.73
114421	17	170	35	4.5	19	0.08	2.5	40	67	1.2
121111	8	50	13	1.7	10	0.02	1.6	22	15	0.43
121112	11	46	17	2.1	12	0.02	1.6	26	18	0.65
121121	5	28	7	1.1	9	0.02	1.4	21	10	0.27
121211	13	85	17	3.4	14	<0.02	1.7	31	23	0.76
121311	7	42	14	1.8	11	0.04	1.3	22	17	0.46
121411	8	54	11	1.9	11	0.04	1.4	22	13	0.70
121412	8	37	12	1.8	11	<0.02	1.4	22	13	0.72
122111	11	48	18	2.2	13	0.02	1.6	27	20	0.58
122211	9	81	12	1.6	8	0.02	1.4	22	15	0.61
122221	9	45	16	1.9	11	0.20N	1.5	25	18	0.54
122311	8	40	9	1.5	11	<0.02	1.5	22	14	0.43
122411	8	45	10	1.6	9	<0.02	1.5	22	15	0.60
123111	9	34	14	1.9	10	0.02	1.6	26	17	0.48
123211	7	18	9	1.5	5	<0.02	0.35	23	5	0.46
123311	9	43	13	1.7	11	0.02	1.6	26	17	0.56
123411	9	46	14	2.1	11	<0.02	1.6	29	24	1.1
124111	8	48	14	1.9	11	0.04	1.6	26	18	0.68
124112	8	48	18	1.9	12	0.02	1.6	32	19	0.69
124211	10	45	17	1.8	12	0.04	1.4	24	17	0.54
124221	8	34	15	1.4	10	0.04	1.4	27	14	0.36
124311	9	39	10	1.8	12	0.02	1.8	21	15	0.41
124411	10	50	19	2.0	12	0.04	1.7	29	18	0.49
131111	9	51	23	2.0	12	0.02	1.7	28	19	0.53
131211	10	46	13	1.9	11	<0.02	1.6	28	30	0.81
131311	14	63	22	2.9	15	0.02	1.7	32	30	0.61
131312	14	60	22	2.9	14	0.06	1.6	33	29	0.60
131411	10	40	19	2.1	12	0.02	1.7	29	21	0.65
132111	11	37	16	2.1	11	0.02	1.5	29	18	0.59
132121	5	25	3	0.92	8	<0.02	1.3	16	10	0.49
132211	10	44	19	2.2	12	0.02	1.8	28	20	0.64
132311	7	23	10	1.2	8	0.02	1.2	20	16	0.75
132411	11	61	19	2.5	13	0.04	1.7	26	23	0.74
133111	11	66	22	2.5	12	0.04	1.6	29	22	0.59
133112	11	53	18	2.5	12	0.06	1.6	29	22	0.60
133211	9	28	12	1.9	6	0.04	0.42	25	6	0.42
133311	10	44	16	2.2	11	<0.02	1.5	27	18	0.51
133411	8	21	12	1.6	10	0.02	1.2	21	18	0.93
134111	14	55	27	2.6	15	0.04	1.8	36	32	0.84
134211	8	30	10	1.8	11	0.02	1.4	21	13	0.48
134311	11	42	18	2.3	13	0.04	1.6	29	21	0.63
134411	10	38	18	2.1	11	0.02	1.6	28	32	1.2
134421	18	54	23	2.4	15	0.06	1.4	27	20	0.66

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Mo, ppm	Mn, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
011111	<2	470	0.96	<4	22	23	5	13	6	0.5
011211	<2	540	1.1	<4	16	17	5	13	5	0.5
011311	<2	660	1.0	<4	22	18	5	13	7	0.6
011411	<2	600	0.99	<4	26	24	5	17	8	0.4
012111	<2	690	1.0	<4	21	16	4	13	6	0.3
012211	<2	870	0.91	<4	28	28	8	16	8	0.6
012212	<2	670	1.1	<4	22	29	5	11	6	0.7
012311	<2	270	1.1	<4	14	7	3	9	3	0.1
012321	<2	690	0.98	<4	25	26	6	14	8	0.7
012411	<2	190	1.1	<4	10	7	4	10	3	<0.1
013111	<2	540	0.06	<4	17	19	7	11	4	0.3
013211	<2	360	1.3	<4	19	16	5	12	5	0.2
013311	<2	650	1.1	<4	20	16	7	14	6	0.5
013411	<2	520	1.0	<4	19	20	4	14	6	0.4
014111	<2	1100	1.0	<4	19	18	6	12	7	0.8
014211	<2	450	1.0	<4	19	26	5	16	7	0.6
014311	<2	560	1.0	<4	19	16	6	13	6	0.6
014411	<2	700	0.94	<4	21	30	5	15	7	0.3
021111	<2	480	1.2	<4	17	20	5	13	6	0.2
021211	<2	1000	1.0	5	15	18	5	15	5	0.5
021212	<2	1000	1.0	<4	18	18	5	14	5	0.5
021221	<2	740	1.1	<4	21	21	5	13	6	0.7
021311	<2	290	1.4	<4	18	13	4	11	4	0.1
021312	<2	300	1.4	<4	18	13	5	9	4	0.1
021411	<2	500	1.2	<4	17	17	5	13	5	0.5
022111	<2	950	1.1	<4	16	18	4	13	6	0.5
022211	<2	850	0.97	<4	19	22	5	14	6	0.5
022311	<2	790	1.0	<4	23	43	5	15	7	0.5
022411	<2	570	1.0	<4	18	22	5	11	6	0.4
023111	<2	410	1.3	<4	13	12	4	10	4	0.3
023211	3	570	1.0	<4	27	27	8	14	7	0.2
023221	<2	740	1.1	<4	22	22	6	13	7	0.5
023311	<2	610	1.0	<4	23	28	7	15	7	0.4
023411	<2	380	1.2	<4	18	10	5	10	4	0.1
023421	<2	1000	1.1	<4	22	19	7	13	6	0.5
024111	<2	570	1.2	<4	22	18	6	13	6	0.4
024211	<2	330	1.3	<4	16	11	4	10	4	0.3
024311	<2	490	1.2	<4	19	19	5	12	5	0.4
024411	<2	1500	0.91	6	24	36	4	14	7	<0.1
031111	<2	970	0.99	<4	24	23	5	13	6	0.4
031121	<2	670	1.1	<4	20	20	5	12	6	0.5
031211	<2	780	0.88	<4	27	30	6	14	8	0.8
031311	<2	760	0.99	<4	21	26	6	14	6	0.4
031411	<2	610	1.0	<4	11	27	6	14	4	0.4
032111	<2	820	1.2	<4	21	16	7	12	6	0.6
032211	<2	2200	0.59	<4	24	33	11	26	7	0.6
032311	<2	1300	0.87	<4	18	20	6	13	6	0.5
032321	<2	1300	0.97	<4	19	20	4	14	6	0.7
032411	<2	970	0.74	<4	22	21	7	13	6	0.7
033111	<2	960	0.84	<4	23	29	7	12	7	0.9

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Mo, ppm	Mn, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
033211	<2	1100	0.96	<4	21	21	5	13	6	0.5
033311	<2	540	1.0	<4	20	19	6	11	6	0.4
033411	<2	710	0.95	<4	22	21	6	15	6	0.6
034111	<2	990	0.99	<4	21	28	8	14	6	0.8
034211	<2	960	0.98	<4	22	19	6	13	6	0.6
034311	<2	170	1.1	<4	11	8	3	7	3	0.5
034411	<2	270	1.2	<4	15	12	5	11	4	0.2
041111	<2	630	0.97	<4	24	22	9	15	6	0.4
041211	<2	680	1.0	<4	21	22	8	15	6	0.8
041311	<2	710	0.84	<4	29	29	11	16	7	0.6
041411	<2	500	1.1	<4	20	20	9	13	4	0.4
042111	<2	380	1.3	<4	15	11	6	9	3	0.5
042121	<2	400	0.72	7	29	28	7	18	9	0.5
042211	<2	490	1.4	<4	11	8	4	12	4	0.4
042311	<2	390	1.20	4	18	20	5	14	7	0.3
042411	<2	650	0.68	<4	27	39	6	20	10	0.3
043111	<2	560	0.84	<4	25	23	10	13	6	0.3
043211	<2	320	1.5	<4	17	13	7	11	4	0.3
043311	<2	790	0.52	9	31	44	8	18	13	0.4
043312	<2	750	0.52	6	30	42	8	19	12	0.6
043411	<2	660	0.70	<4	23	26	10	11	7	0.5
044111	<2	770	0.91	<4	25	23	9	13	6	0.3
044121	<2	780	1.1	<4	23	19	7	11	5	0.3
044211	<2	1100	0.71	<4	30	32	14	18	8	0.8
044311	<2	1300	0.68	7	28	37	7	20	9	0.6
044312	<2	840	1.4	<4	17	14	8	15	4	0.7
044411	<2	1100	1.2	<4	21	30	5	14	6	0.3
051111	2	430	1.1	<4	14	22	4	11	4	0.3
051211	<2	550	1.1	<4	21	18	4	12	6	0.4
051311	<2	630	1.1	<4	21	21	5	14	7	0.4
051312	<2	620	1.1	4	23	19	5	12	7	0.5
051411	<2	850	0.99	<4	23	21	8	15	7	0.4
052111	<2	190	1.0	<4	9	7	4	8	3	0.1
052211	<2	650	1.3	<4	16	14	16	26	4	0.6
052311	<2	670	1.1	4	23	17	7	14	6	0.5
052411	<2	560	1.2	<4	19	18	6	14	6	0.5
052412	<2	570	1.2	<4	21	17	7	15	6	0.4
053111	<2	720	0.83	<4	26	35	6	15	10	0.8
053211	<2	570	1.2	<4	17	14	4	14	5	0.5
053311	<2	1100	1.1	<4	21	19	7	15	6	0.6
053411	<2	870	1.1	<4	18	21	5	10	6	0.5
054111	<2	350	1.3	<4	14	10	3	10	3	0.1
054121	<2	690	0.93	<4	25	24	5	15	8	0.8
054211	<2	810	1.0	<4	21	22	5	15	7	0.5
054311	<2	540	1.0	<4	21	28	5	13	7	0.5
054411	<2	740	0.93	<4	23	26	6	13	7	0.5
061111	<2	720	1.1	<4	26	24	8	15	7	0.4
061211	<2	3000	0.68	5	20	24	15	14	6	0.7
061311	<2	1000	0.89	<4	19	16	9	12	5	0.8

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Mo, ppm	Mn, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
061411	<2	610	1.2	<4	25	18	6	15	6	0.3
062111	<2	1600	0.81	<4	24	26	12	14	7	0.6
062211	<2	950	0.60	<4	27	40	7	19	11	0.6
062311	3	280	0.69	<4	18	30	9	18	6	1.3
062411	<2	1300	0.70	<4	25	29	14	17	9	0.7
063111	<2	420	1.1	<4	21	13	4	11	5	0.2
063211	<2	510	1.2	<4	16	14	5	10	4	0.2
063311	<2	860	0.80	6	21	22	8	15	7	0.7
063411	<2	1100	1.0	<4	23	24	5	13	7	0.4
064111	<2	890	1.2	<4	23	22	8	14	7	0.6
064211	<2	550	1.1	<4	23	17	6	13	6	0.4
064311	<2	650	1.1	<4	19	21	8	11	7	0.7
064411	<2	490	1.1	<4	16	18	5	11	5	0.3
071111	<2	740	0.80	<4	20	23	6	13	6	0.4
071211	<2	1300	1.1	<4	24	26	6	17	7	0.6
071311	<2	1100	1.0	<4	19	22	5	12	5	0.2
071411	<2	1200	0.93	<4	20	25	7	16	6	0.5
072111	<2	1200	0.81	<4	30	35	5	16	9	0.4
072211	12	550	0.99	<4	25	65	8	16	7	0.5
072311	<2	870	1.2	<4	19	22	7	13	6	0.6
072411	<2	970	0.99	<4	27	21	12	61	5	0.5
073111	<2	1100	0.98	<4	24	28	5	13	7	0.6
073211	<2	770	0.90	<4	27	26	9	13	5	0.4
073311	<2	630	1.3	<4	22	20	7	12	6	0.3
073411	3	550	1.4	<4	12	19	3	9	3	0.1
073421	<2	1800	0.70	<4	25	39	7	17	9	0.8
074111	<2	1800	0.98	<4	22	30	7	14	7	0.3
074211	<2	1800	0.84	<4	19	28	7	13	6	0.4
074311	<2	880	1.1	<4	19	18	6	13	5	0.3
074411	<2	960	0.96	<4	15	15	6	11	4	0.5
081111	<2	430	1.0	<4	25	30	6	13	8	0.8
081121	6	580	1.2	<4	20	43	4	12	6	0.9
081211	<2	1100	1.2	4	18	18	5	12	6	0.4
081311	<2	1300	0.92	<4	24	23	5	16	7	0.8
081411	<2	650	1.0	<4	24	28	6	15	8	0.6
082111	7	840	1.2	<4	17	36	5	12	4	0.4
082211	<2	1100	0.77	<4	19	23	7	14	6	0.8
082311	<2	1300	1.1	<4	17	18	7	13	5	0.4
082312	<2	1300	1.1	<4	18	19	6	15	5	0.5
082321	<2	550	1.1	<4	16	19	4	12	5	0.3
082411	<2	720	1.1	<4	12	8	6	9	2	0.2
083111	<2	860	1.2	<4	14	13	4	12	4	0.2
083211	<2	1200	1.0	5	21	15	6	13	5	0.5
083311	<2	820	1.2	<4	20	17	5	12	5	0.3
083321	<2	1100	0.91	5	22	26	7	16	8	0.5
083411	<2	1500	0.89	<4	24	27	7	15	8	0.7
084111	<2	240	1.2	<4	20	13	4	10	4	0.3
084211	<2	460	1.2	<4	17	14	6	9	4	0.4
084212	<2	440	1.2	<4	16	11	5	10	4	0.4
084311	<2	2100	1.2	<4	22	22	7	14	5	0.4

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Mo, ppm	Mn, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
084411	<2	800	0.96	<4	20	24	7	13	6	0.5
084421	<2	570	1.2	<4	23	24	5	15	7	0.6
091111	<2	1000	1.1	<4	21	19	5	15	6	0.5
091211	<2	1000	1.0	<4	21	21	7	13	6	0.6
091311	<2	720	1.1	<4	21	17	7	14	6	0.5
091411	<2	580	1.2	<4	23	19	5	14	6	0.5
092111	<2	1100	0.87	<4	24	23	7	14	6	0.6
092211	<2	1800	0.95	<4	17	22	7	12	5	0.5
092311	3	1400	0.99	<4	20	34	5	14	6	0.3
092411	<2	1100	0.83	<4	26	32	6	14	8	0.7
093111	<2	500	0.89	4	25	27	6	16	8	0.4
093211	<2	730	1.0	<4	22	29	5	14	6	0.5
093311	<2	720	0.99	<4	20	25	7	13	7	0.5
093411	<2	710	0.97	4	24	24	7	15	7	0.4
094111	<2	1100	1.0	<4	25	26	8	14	7	0.6
094211	3	1200	1.4	<4	17	25	7	14	6	0.4
094311	<2	860	1.4	<4	19	13	9	15	4	0.4
094411	<2	750	0.99	<4	24	21	6	15	7	0.7
101111	<2	940	0.97	5	21	21	6	15	6	0.6
101211	<2	1100	1.4	<4	13	15	5	11	4	0.2
101311	<2	990	1.1	<4	21	22	5	13	5	0.5
101411	<2	810	1.1	<4	21	19	7	15	6	0.4
102111	<2	1400	0.55	<4	29	47	6	19	11	0.4
102211	<2	1100	0.79	<4	29	34	8	18	9	0.4
102311	<2	560	1.2	<4	20	18	9	13	5	0.3
102411	<2	1100	0.63	7	32	42	7	19	11	0.4
103111	<2	370	1.2	<4	16	12	5	10	4	0.1
103112	<2	360	1.2	<4	15	12	5	9	4	0.1
103211	<2	560	0.74	<4	29	30	8	15	8	0.8
103311	<2	910	1.1	<4	28	25	9	25	6	0.4
103312	<2	870	1.0	<4	30	24	8	27	6	0.5
103411	<2	360	1.3	<4	17	11	4	11	4	0.2
104111	<2	970	0.86	<4	24	27	6	16	8	0.7
104211	3	370	1.2	<4	13	22	3	9	3	0.1
104212	<2	370	1.2	<4	11	9	3	10	3	0.1
104311	3	570	1.1	<4	9	9	5	11	3	0.2
104312	<2	520	1.2	<4	11	12	3	10	3	0.1
104411	<2	3700	0.83	<4	25	53	9	18	7	0.6
111111	<2	480	1.3	5	28	21	9	15	9	0.5
111211	<2	940	1.1	<4	19	15	5	11	4	0.3
111311	<2	1400	1.1	<4	24	22	6	14	7	0.5
111411	<2	470	1.2	6	29	21	6	12	7	0.4
112111	<2	560	1.5	<4	23	17	5	11	6	0.6
112211	<2	1900	1.0	<4	20	20	9	14	5	0.5
112311	<2	1100	1.0	<4	23	28	6	16	7	0.3
112411	<2	990	0.84	<4	19	25	7	12	6	0.6
113111	<2	880	1.1	<4	25	24	7	17	6	0.5
113211	<2	1400	1.1	6	23	27	5	15	7	0.5
113212	<2	1300	1.1	<4	21	25	5	15	7	0.7
113311	<2	270	0.78	7	26	23	6	18	9	1.0
113411	<2	770	0.77	6	27	30	8	19	9	0.8

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Mo, ppm	Mn, ppm	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm
114111	<2	970	1.1	<4	20	17	5	13	5	0.4
114211	<2	1300	0.93	6	25	28	6	16	8	0.6
114212	<2	1300	0.93	<4	28	31	7	19	8	0.6
114311	<2	380	0.84	7	29	19	9	18	8	1.4
114312	<2	380	0.84	<4	26	19	9	17	7	1.2
114411	<2	780	0.89	4	30	28	9	19	8	0.6
114421	5	330	0.46	10	32	66	11	21	13	1.0
121111	<2	800	1.1	<4	18	22	5	12	5	0.4
121112	<2	720	1.2	<4	21	24	6	13	6	0.4
121121	<2	290	1.4	<4	17	14	4	10	4	0.8
121211	<2	630	1.2	<4	26	36	7	14	9	0.4
121311	<2	2300	0.91	<4	19	20	7	13	5	0.7
121411	<2	2500	1.2	<4	17	23	7	15	5	0.5
121412	<2	2500	1.3	<4	20	19	7	14	5	0.5
122111	<2	860	1.0	5	23	21	9	15	7	0.6
122211	6	930	1.0	<4	16	37	6	11	5	0.3
122221	<2	780	0.93	<4	20	18	7	58	6	0.3
122311	<2	540	1.2	5	19	19	4	11	5	0.2
122411	<2	600	1.1	<4	18	22	5	11	5	0.3
123111	<2	780	1.1	<4	21	18	6	12	6	0.6
123211	<2	880	0.04	<4	18	17	5	9	4	0.2
123311	<2	630	1.3	<4	21	18	5	12	6	0.5
123411	<2	1100	1.2	<4	24	24	7	15	7	0.4
124111	<2	690	1.0	<4	22	21	6	14	6	0.6
124112	<2	750	0.99	5	25	21	7	15	6	0.6
124211	<2	3900	0.90	6	20	36	5	13	6	0.3
124221	<2	1600	1.1	5	23	16	5	15	5	0.5
124311	<2	420	1.7	<4	17	18	4	11	6	0.5
124411	<2	830	0.91	5	25	19	6	15	7	0.8
131111	<2	590	0.84	6	24	21	6	16	7	0.7
131211	<2	560	0.96	<4	22	28	5	13	6	0.3
131311	<2	2400	0.93	5	27	47	6	17	8	1.3
131312	<2	2300	0.95	6	29	44	7	17	8	1.2
131411	<2	680	0.94	<4	25	24	5	16	7	0.6
132111	<2	760	1.0	<4	25	25	6	13	7	0.5
132121	<2	290	1.2	<4	15	10	5	9	3	0.2
132211	<2	990	0.99	<4	24	23	9	17	7	0.5
132311	<2	470	1.2	<4	17	15	6	11	4	0.9
132411	<2	1200	1.0	<4	22	28	7	14	7	0.6
133111	<2	860	0.92	<4	24	29	5	16	7	0.8
133112	<2	840	0.91	<4	24	27	6	27	8	0.8
133211	<2	800	0.04	<4	20	23	6	12	4	0.6
133311	2	1200	1.0	<4	24	30	6	15	6	0.5
133411	<2	720	0.96	<4	17	19	6	13	4	0.9
134111	<2	2200	0.69	<4	31	38	10	22	8	0.7
134211	<2	590	1.5	<4	15	17	8	12	5	0.5
134311	<2	1200	1.0	4	25	27	7	14	7	0.8
134411	<2	810	0.81	<4	26	27	13	16	7	1.0
134421	<2	7700	0.70	4	25	49	9	15	7	0.7

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Sn, ppm	Sr, ppm	Ti, %	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
011111	<10	170	0.21	8	71	13	1	47
011211	<10	160	0.15	4	48	10	<1	41
011311	<10	160	0.22	7	73	13	2	61
011411	<10	160	0.25	7	90	16	2	73
012111	<10	160	0.19	8	55	13	1	60
012211	<10	150	0.29	9	100	16	2	89
012212	<10	170	0.20	7	69	12	1	50
012311	<10	170	0.11	8	25	7	<1	21
012321	<10	150	0.26	9	94	16	2	73
012411	<10	170	0.09	<4	17	6	<1	13
013111	<10	91	0.05	<4	52	9	<1	53
013211	<10	200	0.17	5	50	12	1	37
013311	<10	170	0.22	6	55	13	1	60
013411	<10	160	0.18	7	69	13	2	52
014111	<10	160	0.23	6	74	13	2	72
014211	<10	170	0.23	6	83	13	2	55
014311	<10	160	0.24	6	59	12	1	59
014411	<10	160	0.22	6	93	13	1	58
021111	<10	190	0.20	5	67	12	1	56
021211	<10	160	0.20	6	67	8	1	48
021212	<10	160	0.19	6	66	9	1	49
021221	<10	180	0.22	7	71	13	2	58
021311	<10	220	0.16	6	42	11	1	36
021312	<10	230	0.17	5	44	10	1	36
021411	<10	200	0.18	4	49	11	1	45
022111	<10	160	0.25	8	82	9	1	64
022211	<10	150	0.20	6	89	13	1	60
022311	<10	170	0.25	6	95	15	2	70
022411	<10	210	0.20	6	79	12	1	50
023111	<10	200	0.13	5	34	8	<1	33
023211	<10	260	0.24	7	84	14	2	57
023221	<10	180	0.21	7	78	14	2	69
023311	<10	170	0.25	7	86	14	2	58
023411	<10	290	0.14	5	31	10	1	31
023421	<10	190	0.21	6	62	13	1	60
024111	<10	200	0.23	7	57	15	2	67
024211	<10	220	0.15	<4	37	9	1	30
024311	<10	190	0.18	6	48	11	1	39
024411	<10	170	0.24	9	100	14	2	68
031111	<10	180	0.19	9	73	13	2	69
031121	<10	180	0.17	7	64	12	1	47
031211	<10	140	0.25	9	100	16	2	90
031311	<10	240	0.19	5	70	13	1	67
031411	<10	190	0.13	<4	44	8	<1	47
032111	<10	160	0.18	7	63	13	1	56
032211	<10	120	0.22	7	120	13	2	110
032311	<10	140	0.20	5	97	12	1	60
032321	<10	160	0.19	6	78	12	1	56
032411	<10	180	0.22	8	91	12	1	71
033111	<10	230	0.20	6	86	13	1	80

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Sn, ppm	Sr, ppm	Ti, %	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
033211	<10	160	0.20	7	78	13	1	61
033311	<10	210	0.22	6	69	13	2	68
033411	<10	170	0.20	5	73	14	2	75
034111	<10	160	0.21	7	84	13	1	66
034211	<10	160	0.21	8	70	14	2	74
034311	<10	170	0.08	<4	17	6	<1	11
034411	<10	190	0.15	5	42	9	1	29
041111	<10	190	0.21	6	68	16	2	65
041211	<10	180	0.18	6	75	15	2	65
041311	<10	170	0.25	9	83	19	2	81
041411	<10	190	0.17	5	46	13	1	52
042111	<10	280	0.12	4	31	7	<1	28
042121	<10	150	0.29	10	99	19	2	88
042211	<10	220	0.15	5	28	6	<1	19
042311	<10	200	0.20	6	74	12	1	51
042411	<10	160	0.29	8	130	17	2	88
043111	<10	260	0.20	8	71	17	2	67
043211	<10	240	0.12	<4	36	8	<1	31
043311	<10	120	0.34	11	160	19	2	100
043312	<10	120	0.34	10	160	18	2	95
043411	<10	250	0.23	7	94	15	2	61
044111	<10	210	0.17	5	62	16	2	57
044121	<10	240	0.17	6	57	16	2	45
044211	<10	150	0.27	9	110	18	2	86
044311	<10	130	0.27	9	120	20	2	110
044312	<10	230	0.14	4	36	9	1	45
044411	<10	200	0.18	7	69	14	2	54
051111	<10	180	0.15	4	45	10	1	34
051211	<10	170	0.21	5	60	12	1	56
051311	<10	180	0.23	7	71	15	2	62
051312	<10	180	0.24	7	72	14	2	61
051411	<10	160	0.24	6	73	13	1	64
052111	<10	170	0.12	<4	23	6	<1	19
052211	<10	170	0.14	4	40	10	1	120
052311	<10	170	0.22	7	59	15	2	63
052411	<10	200	0.23	6	63	13	2	58
052412	<10	200	0.25	4	60	13	1	55
053111	<10	140	0.31	8	120	16	2	91
053211	<10	200	0.20	6	51	12	1	45
053311	<10	190	0.23	6	64	12	1	60
053411	<10	180	0.18	6	66	11	1	41
054111	<10	200	0.12	<4	29	8	1	24
054121	<10	160	0.26	9	88	15	2	64
054211	<10	160	0.23	7	83	14	2	66
054311	<10	160	0.22	6	78	13	1	54
054411	<10	160	0.23	8	88	14	2	61
061111	<10	180	0.26	7	69	16	2	60
061211	<10	150	0.19	7	90	13	2	110
061311	<10	150	0.17	6	45	11	1	71

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Sn, ppm	Sr, ppm	Ti, %	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
061411	<10	190	0.22	8	62	15	2	54
062111	<10	130	0.23	8	100	14	2	79
062211	<10	120	0.31	10	140	18	2	100
062311	<10	170	0.19	5	80	13	1	100
062411	<10	150	0.29	8	100	16	2	110
063111	<10	180	0.19	9	47	11	1	31
063211	<10	200	0.15	5	41	10	1	38
063311	<10	150	0.23	8	77	15	2	86
063411	<10	170	0.24	7	81	14	2	77
064111	<10	230	0.26	6	65	14	2	71
064211	<10	190	0.21	7	56	14	2	56
064311	<10	170	0.23	7	70	13	2	62
064411	<10	180	0.16	5	55	10	1	45
071111	<10	260	0.18	6	84	12	2	67
071211	<10	160	0.23	8	84	14	2	67
071311	<10	170	0.16	5	65	14	1	55
071411	<10	160	0.21	5	77	13	1	63
072111	<10	160	0.27	9	110	19	2	100
072211	<10	190	0.21	6	71	16	2	68
072311	<10	220	0.17	6	62	13	1	66
072411	<10	170	0.17	8	62	18	2	89
073111	<10	150	0.22	7	84	14	2	82
073211	<10	210	0.17	8	63	16	2	56
073311	<10	260	0.21	7	58	14	2	57
073411	<10	210	0.12	<4	32	7	<1	23
073421	<10	140	0.26	9	130	16	2	100
074111	<10	160	0.24	8	86	14	2	68
074211	<10	150	0.21	7	100	13	2	68
074311	<10	170	0.18	6	59	12	1	51
074411	<10	240	0.13	5	43	9	<1	47
081111	<10	170	0.27	8	83	14	2	66
081121	<10	210	0.22	5	79	12	1	48
081211	<10	170	0.19	6	53	12	1	53
081311	<10	160	0.27	6	85	15	2	89
081411	<10	170	0.27	8	88	14	2	69
082111	<10	180	0.15	5	42	10	1	39
082211	<10	140	0.20	5	74	12	1	86
082311	<10	170	0.18	5	55	11	1	55
082312	<10	180	0.17	6	54	12	1	57
082321	<10	170	0.17	5	58	10	1	42
082411	<10	260	0.10	<4	25	6	<1	28
083111	<10	180	0.14	<4	42	9	1	40
083211	<10	160	0.17	7	48	12	1	71
083311	<10	190	0.21	6	59	13	1	58
083321	<10	150	0.23	7	87	15	2	82
083411	<10	170	0.25	7	100	16	2	81
084111	<10	200	0.16	7	41	9	<1	36
084211	<10	200	0.17	<4	38	9	1	43
084212	<10	210	0.16	5	39	9	1	41
084311	<10	190	0.19	6	51	12	1	59

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Sn, ppm	Sr, ppm	Ti, %	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
084411	<10	180	0.18	6	71	11	1	63
084421	<10	210	0.23	6	69	14	2	57
091111	<10	180	0.18	10	62	13	1	57
091211	<10	170	0.24	7	76	14	2	76
091311	<10	170	0.23	7	59	12	1	60
091411	<10	200	0.20	8	61	12	1	49
092111	<10	210	0.21	6	72	13	2	71
092211	<10	150	0.19	6	81	12	1	60
092311	<10	160	0.21	7	84	14	2	68
092411	<10	150	0.25	8	110	16	2	84
093111	<10	180	0.27	8	88	17	2	77
093211	<10	160	0.24	8	70	14	2	61
093311	<10	170	0.22	8	69	13	2	67
093411	<10	180	0.24	9	77	15	2	68
094111	<10	160	0.24	9	79	14	2	66
094211	<10	200	0.20	4	53	12	1	71
094311	<10	230	0.15	5	37	10	1	46
094411	<10	160	0.24	7	81	14	2	68
101111	<10	160	0.21	6	72	14	2	69
101211	<10	220	0.11	4	36	8	<1	27
101311	<10	190	0.20	7	66	13	1	56
101411	<10	180	0.22	7	57	13	1	56
102111	<10	140	0.31	9	170	19	2	110
102211	<10	150	0.32	10	110	19	2	89
102311	<10	180	0.19	7	44	11	1	41
102411	<10	140	0.32	10	150	19	2	100
103111	<10	200	0.18	4	40	10	1	27
103112	<10	200	0.18	<4	41	10	1	27
103211	<10	190	0.26	9	95	17	2	82
103311	<10	190	0.23	8	67	20	2	79
103312	<10	180	0.20	8	61	19	2	73
103411	<10	220	0.20	6	39	11	1	29
104111	<10	150	0.25	8	100	16	2	81
104211	<10	190	0.12	<4	29	8	<1	22
104212	<10	200	0.13	<4	29	8	<1	24
104311	<10	170	0.11	<4	25	6	<1	26
104312	<10	170	0.11	<4	26	7	<1	25
104411	<10	160	0.23	8	120	17	2	110
111111	<10	270	0.35	7	82	16	2	65
111211	<10	160	0.13	6	52	12	1	41
111311	<10	180	0.26	8	71	15	2	68
111411	<10	210	0.27	8	78	15	2	58
112111	<10	270	0.27	7	67	12	1	57
112211	<10	170	0.19	6	53	12	1	61
112311	<10	170	0.25	5	88	14	2	62
112411	<10	140	0.19	6	78	13	2	79
113111	<10	180	0.24	8	71	14	2	79
113211	<10	180	0.23	8	79	15	2	62
113212	<10	180	0.23	7	79	14	2	61
113311	<10	140	0.27	9	88	18	2	100
113411	<10	140	0.27	8	97	20	2	99

Table A1.--Listing of analytical data for element concentration in samples of surface soils collected according to a nested analysis-of-variance sampling design in eastern North Dakota (continued).

Sample ID	Sn, ppm	Sr, ppm	Ti, %	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
114111	<10	190	0.20	7	51	12	1	53
114211	<10	160	0.28	8	96	16	2	79
114212	<10	160	0.29	8	89	16	2	78
114311	<10	140	0.27	9	75	18	2	78
114312	<10	140	0.27	8	75	16	2	76
114411	<10	160	0.27	8	100	18	2	92
114421	<10	150	0.35	11	220	24	3	120
121111	<10	180	0.18	6	58	11	1	48
121112	<10	180	0.22	7	73	13	1	53
121121	<10	230	0.15	5	34	9	<1	28
121211	<10	230	0.35	8	100	17	2	73
121311	<10	160	0.18	7	64	12	1	75
121411	<10	190	0.17	5	52	11	1	48
121412	<10	190	0.15	5	51	11	1	51
122111	<10	170	0.24	6	73	15	2	67
122211	<10	190	0.16	5	50	11	1	50
122221	<10	160	0.21	7	67	12	1	65
122311	<10	210	0.19	6	50	11	1	43
122411	<10	210	0.17	4	49	11	1	37
123111	<10	180	0.22	7	64	13	1	61
123211	<10	29	0.02	6	24	9	<1	35
123311	<10	220	0.24	7	60	14	2	58
123411	<10	200	0.25	7	80	15	2	72
124111	<10	180	0.20	6	68	13	1	61
124112	<10	170	0.21	10	69	14	2	66
124211	<10	160	0.20	7	81	14	2	73
124221	<10	170	0.19	7	47	13	1	54
124311	<10	320	0.20	5	56	10	1	50
124411	<10	150	0.24	8	69	15	2	78
131111	<10	130	0.24	6	79	15	2	81
131211	<10	200	0.21	7	71	14	2	76
131311	<10	160	0.28	9	110	18	2	76
131312	<10	160	0.27	11	120	18	2	78
131411	<10	160	0.24	7	80	15	2	74
132111	<10	160	0.23	8	81	15	2	60
132121	<10	240	0.13	<4	29	8	<1	22
132211	<10	180	0.26	8	83	15	2	90
132311	<10	240	0.15	4	41	9	1	47
132411	<10	160	0.23	7	93	15	2	58
133111	<10	150	0.24	6	100	15	2	74
133112	20	150	0.26	8	100	15	2	72
133211	<10	27	0.04	7	46	12	1	52
133311	<10	170	0.21	7	81	14	2	66
133411	<10	260	0.13	4	48	10	1	48
134111	<10	150	0.30	10	110	19	2	120
134211	<10	220	0.16	6	50	11	1	41
134311	<10	180	0.24	8	82	15	2	66
134411	<10	260	0.24	7	79	14	2	74
134421	<10	150	0.21	9	120	16	2	100