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AN ASSESSMENT OF THE GEOCHEMICAL VARIABILITY FOR PLANTS AND SOILS AND AN EVALUATION OF INDUSTRIAL EMISSIONS NEAR THE KENAI NATIONAL WILDLIFE REFUGE, ALASKA

by

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AN ASSESSMENT OF THE GEOCHEMICAL VARIABILITY FOR PLANTS AND SOILS AND AN EVALUATION OF INDUSTRIAL EMISSIONS NEAR THE KENAI NATIONAL WILDLIFE REFUGE, ALASKA

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SUMMARY

Investigations on the Kenai Peninsula, including areas within the Kenai National Wildlife Refuge, had two major objectives: (1) to determine the feasibility of preparing maps showing regional trends for elements in native plants and soils; and, (2) to define possible element additions to the environment from industries north of the town of Kenai. The first objective was accomplished using an unbalanced, nested analysis-of-variance (ANOVA) barbell design. The second was accomplished by establishing three generally west-to-east transects with sample localities positioned at geometric intervals beginning 0.5 km away from the industrial complex. At each locality, samples of _Hylocomium splendens_ (feather moss, whole plant), _Picea glauca_ (white spruce, twigs and needles), and soil horizons (02, B2, and C) were collected and analyzed for their major and trace total element concentrations.

Results of the barbell ANOVA show that intensive soil or plant sampling would be needed to reliably map the geochemistry of the area, chiefly because of the large local variability found for the concentrations of most elements in the materials sampled. For example, producing reliable element maps of feather moss using a 50-km cell would require sampling densities of from 4 samples per cell for aluminum, cobalt, iron, lanthanum, lithium, and vanadium to more than 15 samples per cell for copper, lead, selenium, and zinc.

Using geometric means and geometric deviations, expected baseline values were calculated for elements which were above the limits of determination in a sufficient number of the barbell samples for each of the sampling media. Baseline value ranges for the 02-horizon samples compare very favorably with published values of Gough and others (1988) for observed concentration ranges in Alaskan surficial materials.

Our study of possible industrial contamination revealed no strong trends in soils, but feather moss collected on the north transect showed a logarithmic decrease with increasing distance for several elements, including aluminum, cobalt, sulfur, and vanadium. Comparison of the transect samples to the expected ranges as calculated from the barbell study did not show any obvious element outliers, with the exception of sulfur in some samples of feather moss. For each of the three transects, six samples exceeded or equaled the upper baseline limit for sulfur in feather moss. This is probably not due to sea spray effects because the pattern of the stable isotopes of sulfur is relatively flat (Jackson and Gough, 1989). The correlation between elements in plants with the soil horizons show that the feather moss had higher correlations than the white spruce, and the correlations are stronger for the 02-horizon than the C-horizon for both plants. There are numerous strong correlations between the feather moss and white spruce, possibly indicating similar plant accumulation controls.

Necrotic vegetation was observed close to the industrial complex. However, because there were not many strong directional or distance related features seen in the total soil chemistry, a mild partial-extraction of the

soils was investigated. Selected samples of O2- and C-horizon soils were extracted with demineralized water and three extracted anions determined. The O2-horizon samples had considerably higher values of chloride, sulfate, and nitrate than the companion C-horizon sample. There were several O2-horizon samples that had very high nitrate concentrations present. This high nitrate content may be a result of nitrous oxide, ammonia, or urea emissions from the industrial complex. Further study would be required to confirm this.

INTRODUCTION

The Kenai National Moose Range was established in 1941 by President Roosevelt and was expanded to include almost 2 million acres in 1980 when the Alaska National Interest Lands Conservation Act was enacted. This Act also changed the name of the Reserve to the Kenai National Wildlife Refuge (KNWR). This name more appropriately reflects the multifaceted landuse of the management area. KNWR is located on the Kenai Peninsula in southcentral Alaska, south of Anchorage (figure 1). KNWR is a very diverse area made up of lowland spruce-birch forests with hundreds of lakes. The Kenai Mountains form the eastern boundary of the Refuge.

Vegetation and organic-rich soils have been used with success to assess the influence of industrial emissions [for example, Folkeson (1981), Godbeer and others (1981), LeBlanc and de Sloover (1970), Markert and Weckert (1989), Onianwa (1988), Pilegaard (1987), and Thomas and others (1984)]. Folkeson (1981) used a feather moss (Pleurozium schreberi) to monitor heavy metal contamination resulting from peat-fired power facilities in Finland. Increases in cadmium, copper, lead, vanadium, and zinc and a decrease in manganese were observed downwind from the facilities. This trend in manganese was attributed to an increase in the sulfur dioxide in the plume gases close to these facilities. The solubility (and the phyto-availability) of manganese decreases as soil pH decreases. Godbeer and others (1981) did a similar study using cleaned Sphagnum moss enclosed in fine mesh envelopes placed on stakes. The moss was used as a biomonitor of trace element input from a power station in New South Wales, Australia. Seasonal variations in the trace element contents of the moss were observed. Slight decreases were noted as the distance from the power station increased. Le Blanc and Sloover (1970) used the presence or absence of various mosses and their tolerances for toxins as a method of mapping the long range effects of air pollution. Polytrichum formosum (moss) was sampled seasonally over three years by Markert and Weckert (1989) and also found strong seasonal variations in its metal content. They proposed that to obtain comparable results, samples must be taken at the same time of year, preferably in September. They also proposed that moss would be an effective global monitoring medium for air pollution. In Greenland for the Ilimaussaq mafic intrusion, Hylocomiun splendens was used by Pilegaard (1987) to indicate the mineralization seen in the country rock. Trends in heavy metals in the feather moss were mirrored in the substrate's geochemistry. Heavy metal concentrations in top soil, litter (humus layer of soils), and mosses were used by Onianwa (1988) to monitor air pollution in Nigeria. He found that the mosses tended to have higher levels of metals than the soil materials, but all three media were effective monitors of aerial deposition of heavy metals. Thomas and others (1984) demonstrated that various trees, both deciduous and coniferous, and soil litter were all suitable monitors for both man-made organic compounds and heavy metals resulting from aerial deposition from an industrial area in Sweden. They also suggest that contamination levels observed in mosses and lichens may be used to predict the pollution levels in higher vegetation.

The two objectives of the reconnaissance sampling of soils and native vegetation, completed between August 1 and August 12, 1988, were: (1) to determine the feasibility of preparing geochemical maps showing regional trends for elements in native plants and soils; and, (2) to define possible element additions to the environment from an industrial complex north of the town of Kenai. The first objective was accomplished by use of an unbalanced, nested analysis-of-variance (ANOVA) design of the barbell type (Fig.2). Results of the ANOVA were interpreted to assess spatial variability over increments of distance in order to arrive at an estimate for a grid interval necessary to most efficiently map element concentrations in soils and plants.

Samples of feather moss clumps (Hylocomium splendens (Hedw.) BSG), white spruce twigs and needles (Picea glauca (Moench) Voss), and soil horizons were collected at each barbell location. Two samples of elderberry twigs and leaves (Sambucus callicarpa Greene) were collected also. Only the O2- and B2-horizons were sampled for the spatial variability study.

The second objective used log-linear transects away (down-wind) from the industrial complex at Kenai, Alaska to assess trace elements and sulfur additions to the environment resulting from air emissions. Along linear transects, at logarithmic intervals, samples of the O2-, B2-, and C-horizons and vegetation (same as in the barbell study) were collected.

METHODS

Sampling Design

General Considerations

General sampling locations for the landscape variability and industrial emissions studies were predetermined based on a set of sample site criteria, and placed on U.S. Geological Survey 15-minute topographic maps. Once in the field, all sampling sites were subject to relocation based on field observations and accessibility.

Landscape Variability

An unbalanced, nested, analysis-of-variance design was used to assess spatial variability over increments of distance for element content of feather moss, white spruce, and O2- and C-horizons of soil. Sites for sampling were located using a barbell-cluster design (Fig. 2). The major axis of the barbell was positioned in a general north-south orientation to correspond to the geometry of the Refuge boundaries. The four minor axes were oriented with the constraint that the sites be accessible by road. The five axes shown (Fig. 2) represent distances of 50 km, 25 km, 5 km, 1 km, and 0.1 km. Samples of plants and soils were collected at 24 locations, 16 of which are shown in figure 3. A totally balanced sampling design would have resulted in 32 sampling locations. The unbalanced sampling design is illustrated by a dendrogram in figure 2.

Industrial Emissions

Three transects were established to assess element additions to the environment from the industrial complex at Kenai, Alaska. The Unocal ammonia plant was chosen as the starting point for the transects. From this point, transects that progressed, generally in north, east, and south directions were established with log-linear sampling intervals of approximately 0.5, 1, 2, 4, 8, 16, 32, and 64 km. Locations of sampling sites are shown in figure 3. At each sampling site, feather moss, white spruce, and O2-, B-, and C-horizons of soil were collected for trace and major element analysis.

Statistical Techniques

Analysis-of-Variance

The analysis-of-variance design allows the partitioning of the total measured natural variation into components. The components are related to the various sampling intervals (50, 25, 5, 1, and 0.1 km). In addition, several samples were chosen at random and split into two parts in the laboratory and each part was analyzed independently. This duplicate analysis represents the sixth level of the design and gives an estimate of all procedural errors.

A further precaution was taken to convert any systematic error, which might occur in either sampling or analysis, into random error. This was accomplished by analyzing all samples (original and duplicate) in a randomized sequence so that samples collected in the field to represent some geographic progression would not be analyzed in that same progression.

The variance components associated with different distance increments are useful in determining the optimum sampling interval and minimum number of samples necessary for the preparation of maps showing spatial distributions of the element concentrations in plants and soils.

Variance Ratios and Mapping Requirements

The variance-mean-ratio (Vm) (Miesch, 1976) is computed from estimates of variance components associated with distance increments described above. The Vm provides an index of relative stability of mean values used to construct geochemical maps. Vm values computed for different distance increments are useful for evaluating the feasibility of mapping the distribution of an element at those different intervals. For example, Vm values for 25 km cells would be computed as follows:

$$Vm = \frac{s^2_{50} + s^2_{25}}{n_5 s^2_5 + n_1 s^2_1 + n_{0.1} s^2_{0.1} + n_e s^2_e}$$

where the numerator is the sum of the variance components (s^2) for the 50 and 25 km distance increments and the denominator is the sum of the variance components (s^2) multiplied by the average number of samples (n) collected at each smaller distance increment, plus estimates of procedural error. In other words, the numerator is the variance between 25km distance increments and the denominator is the variance within the 25km distance increments. A Vm equal to 1.0 is approximately equivalent to an F-test probability level of 80 percent. For Vm values less than 1.0, a map of element concentrations prepared from the existing data would not faithfully reproduce the true geochemical pattern (Miesch, 1976, p. 102). As Vm increases, the map pattern increasingly reflects the true geochemical pattern.

Regression Analysis

The effects of point-source industrial emissions on element concentrations in plants or soils with increasing distance from the emission source were evaluated by regression analysis. A least-squares criterion was used for the regression and the prediction equation took the following form:

$$\log_{10} Y = a + b \log_{10} X$$

where "Y" is an estimate of the element concentration in the plant or soil sample, and "X" is the measured distance from the industrial emission source. The expected logarithmic concentration at 1 km is "a", and the slope of the regression line is "b". The correlation coefficient (r) is not used as an indication of statistical significance because the values for distance were selected and cannot be considered random variables. The coefficient of determination (r^2) is a measure of the proportion of total observed variation that is explained simply by the distance from the industrial emission source and is used as an indicator of important relations.

Baseline values

The baseline value is computed as the expected 95-percent element concentration range (Tidball and Ebens, 1976). This means that if a new sample is collected and analyzed for some element, there is a 5-percent chance that the determined value for that element will be outside of this range. These summary statistics provide an overview of soil and plant chemistry. This information is useful for making comparisons between the chemistry of soils and plants of this study with similar soils and plants from other similar areas. These comparisons help determine, on a gross scale, whether the newly collected soils and plants are typical or unusual in their chemical composition.

Field Sampling and Sample Preparation

General Considerations

Sampling sites for the landscape variability study were randomly located, to the extent possible considering accessibility constraints, to include the true extent of the natural variability in the samples collected.

Sampling sites for the industrial emissions study were selected to be as similar to one another as possible. All sites were evaluated for similar soil, vegetation, geology, slope, and aspect so that any variation observed in element content of plants or soils could be attributed to distance-related rather than site-related effects. Plant and soil samples were collected in close proximity to each other for both studies. Voucher specimens of all plant species were collected.

Feather Moss and White Spruce

Moss samples were collected from the forest floor where it was found growing over decaying logs. The moss samples consisted of very dense, uniform mats and included old as well as young material. Rhizome material with attached organic detritus was removed in the field. Needles and twigs (terminal 15 cm) were collected from white spruce by clipping with stainless steel sheers. A composite sample of numerous low branches was made from around a single tree. Field notes were made and samples were labeled as to location, placed in Hubco cloth bags, allowed to air dry, and then mailed to the Denver laboratories. At the laboratory, samples were further dried in a forced air oven at 40°C. Dry samples were ground to minus 10 mesh using a Wiley mill. A split of the ground sample was ashed in a muffle furnace at 450°C, and ash percent calculated. Moss and spruce samples were not washed, but processed as received from the field.

Soil Horizons

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 using hand tools. The sequence of horizons was examined and described using commonly accepted procedures. A typical cross section of the non-peat, mineral soils that were sampled consisted of: (1) O2-horizon - organic floor mat, 5-15 cm thick; (2) A2-horizon - oxidized and leached grey zone, 2-5 cm thick; (3) B2-horizon - oxidized, red colored zone of accumulation, 1-15 cm thick; (4) C-horizon - unweathered, yellow-brown colored volcanic ash, 50-100 cm thick; and, (5) glacio-fluvial deposits of till or outwash. The properties and classification of the majority of the soils derived from volcanic ash on the Kenai Peninsula have been described in detail by Ping and others (1989) and Shoji and others (1988). Typically an O2, B2, and C sequence of soil horizons was encountered. Soil horizons selected for sampling were placed in water-resistant paper bags and labeled as to their location and position in the sampling design and field notes were made. The samples were mailed to the U.S. Geological Survey laboratories in Denver, Colorado.

Samples of the O2-, B-, and C-horizons were collected for the industrial emissions study while only O2- and C-horizons were collected for the landscape variability study. B-horizons were not collected because sampling locations selected randomly may or may not contain soils with a B-horizon.

At the laboratory, all soil samples were dried under forced air at ambient temperature. All of 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 of mineral soil (B- and C-horizons) was ground to minus 80 mesh. Sample splits of the O2-horizon were ground to minus 100 mesh with an agate shatter box and a split of the minus 100 mesh material was ashed in a muffle furnace at 450°C and ash yield was calculated. Both the raw and the ashed material were used for analysis, depending on the method of 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). U. S. Geological Survey quality assurance and quality control procedures were followed throughout (Arbogast, 1990). 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 or soil-ash sample (0.200 g) and plant ash sample (0.100 g) 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 1 mL of aqua regia and then diluted to 10 g with demineralized water. Reagent blanks, reference materials, and sample replicates were all digested by the same procedure and analyzed at the same time as the samples. The elements determined and their limits of determination are shown in Table 1. The elements silver, gold, bismuth, cadmium, holmium, tin, tantalum, and uranium were below 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 g sample of soil was digested with concentrated nitric, perchloric, and hydrofluoric acids. After digestion, the sample was brought to 50 mL with 6N hydrochloric acid. Arsenic and selenium were determined independently using specifically designed continuous-flow systems. In the procedure, the sample solution was reacted with sodium borohydride to generate the gaseous hydrides, which were swept into the heated quartz furnace of an atomic absorption spectrometer. Arsenic and selenium were determined 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.

Arsenic and selenium in the vegetation were determined by HGAAS (Crock and Lichte, 1982; Sanzolone and Chao, 1987). A 1.000 g plant sample was digested with nitric and perchloric acids and 30 percent hydrogen peroxide. After digestion, the clear, colorless solution was diluted to 50 mL with 6N hydrochloric acid. Arsenic was then determined by the same technique as used for soil. An in-house, standard alfalfa sample and a National Bureau of Standards standard citrus leaves were carried through the entire sample preparation and analysis procedure. Unfortunately, both the standards and the majority of the samples were below the detection limit of 0.05 part per million (ppm) arsenic or selenium.

Miscellaneous Determinations

Mercury in soil and plants was determined using an automated continuous-flow, cold-vapor atomic absorption spectroscopic method (Kennedy and Crock, 1987). A 0.100 g soil sample or a 0.200 g plant sample was digested with nitric acid and sodium dichromate in a closed teflon bottle and then diluted to 12 mL with deionized water. The solution was reacted with a sulfuric acid-hydroxylamine hydrochloride solution and stannous chloride solution in a continuous-flow system. The gaseous mercury was separated in a phase separator and swept into a quartz cell of an atomic absorption spectrometer. Mercury was determined using an aqueous standard calibration curve.

Soil pH was determined by a 1:1 extraction according to the method given by Crock and Severson (1980). A standard 1:1 (20 g soil to 20 mL demineralized-deionized water) extraction was made and the solution pH measured using a standard pH meter and combination pH electrode calibrated with pH 7 and pH 10 buffer solutions. A 1:3 extraction was used for the O2-horizon samples because there was no free-standing water with the 1:1 method.

Total sulfur in both soils and plants was determined using a Leco SC-132 automated analyzer. The sample and a vanadium pentoxide flux were combusted in an oxygen-rich atmosphere at 1370°C and the evolved sulfur dioxide measured by an IR (infra-red) detector (Jackson and others, 1987). Ten white spruce samples were analyzed for their stable sulfur isotope content by Coastal Science Laboratories, Inc., Austin, Texas. The ground, raw plant material was combusted in a Parr bomb, with all the sulfur converted to barium sulfate. The stable sulfur isotopes were then measured on this precipitate using a Micromass isotope ratio mass spectrometer.

RESULTS

Landscape Variability

Feather Moss

Components of variation over increments in distance are given for 30 elements and ash yield in feather moss in table 2. Elements not included, because a large proportion of the samples were below the limit of detection (the values referred to as censored) of the analytical method, are cadmium, molybdenum, thorium, and tungsten. Statistical significance of variance components was determined by using the conventional F-test. The F-value was computed by dividing the mean-square value for the component by the mean-square value for the next smaller sampling interval. If a component is not significant, then preparing a map based on the sampling interval represented by that component would be impractical because the same general map patterns would be obtained by mapping at the next greater interval, involving much less sampling. The greatest number of significant variance components occurs at the smallest sampling interval (0.1 km), however the majority of variance components greater than 50 percent occur at the largest sampling interval (table 2).

The major purpose for computing variation over increments of distance is to use that information to compute estimates of map stability (Vm) and to determine the minimum number of random samples that would need to be collected within a grid based on the various sampling intervals. Estimates of sampling needed to prepare stable geochemical maps for elements in feather moss are given in table 3 for four sampling intervals.

The information in tables 2 and 3 can be used to determine the optimum sampling interval necessary to prepare geochemical maps for specific elements. For example, a geochemical map for sulfur in feather moss could best be prepared based on a 25 km sampling interval. At both the 50 km and 5 km intervals, no variation was observed. A map prepared at 25 km would give the same resolution as one prepared at 5 km, and nearly the same detail as one prepared at 1 km (only and additional 1.4% of the variation would be explained, as is shown in table 2). While the same number of samples within a sampling interval would be needed to prepare a stable map at 25, 5, and 1 km (table 3) the total number of samples would increase by a factor of 25 between a map based on a 25 km versus a 5 km sampling interval, and a factor of 125 between a map based on a 25 km versus a 1 km sampling interval because many more locations would need to be sampled.. A geochemical map of sulfur in feather moss prepared at a 25 km interval would reliably show the patterns on the landscape (Vm of 5.8, table 3); however, it would not reflect the small scale (0.1 km) variation which, in the case of sulfur, is quite large (37.3% of the total variation, table 2).

Most elements show large and significant variance components at the 50 km sampling interval (table 2). However in order to prepare maps for environmentally important elements such as arsenic, mercury, lead, and sulfur, it is necessary to sample at the 25 km interval.

Summary statistics for the elements detected in feather moss samples from the barbell sampling design are given in table 16. These include the geometric mean, the geometric deviation, and the expected baseline value range. A listing of the results of analysis for all feather moss samples is given in appendix table A1.

White Spruce

Components of variation over increments in distance are given for 28 elements and ash yield in white spruce in table 4. Elements not included, because a large proportion of the samples were censored, are cadmium, molybdenum, scandium, selenium, yttrium, and ytterbium. Procedural error is greater than 50 percent of the total variation for cerium and tungsten, and therefore, the data for these elements should be interpreted with the knowledge that natural variation is obscured by procedural errors. Most variables show statistical significance, or a large percentage of their total variance, at the two smallest (0.1 and 1 km) sampling intervals (table 4). This is in contrast to the distribution of variance components for the feather moss, where most of the variation was at the larger sampling intervals. Only a few elements in white spruce show a large proportion (statistical significant) of their variance components at the 25 and 50 km sampling intervals.

Map stability (Vm) and sampling intensity (n_r) estimates (table 5) for white spruce show that, in order to prepare maps for most elements, a 1 km, or possibly 5 km, sampling interval is needed. At 25 km, only 10 elements exhibit a value for Vm greater than one.

Summary statistics for the elements detected in white spruce samples from the barbell sampling design are given in table 17. These include the geometric mean, the geometric deviation, and the expected baseline value range. A listing of the results of analysis for all white spruce samples is given in appendix table A2.

Soil 02-Horizon

Components of variation over increments in distance are given for 29 elements, pH, and ash yield in 02-horizons of soils in table 6. Elements not included, because a large proportion of the samples were censored are silver, gold, beryllium, bismuth, cadmium, holmium, molybdenum, niobium, tin, tantalum, thorium, uranium, and ytterbium. Procedural error is greater than 50 percent of the total variation for chromium, and therefore, the data for this element should be interpreted with the knowledge that natural variation is obscured by procedural errors. Most variables show statistical significance, or a large percentage of their total variance, at the smallest (0.1 km) sampling interval (table 6). A few elements in 02-horizons of soils show significant variance components scattered over the 50, 25, 5, and 1 km sampling intervals, but few of these significant components account for a large proportion of the total variation.

In order to prepare stable geochemical maps of element distribution in 02-horizons of soils for a large number of elements from a single sampling, it would be necessary to sample at a 5 km or less interval (table 7). Sampling at intervals of 50 or 25 km would result in stable maps for only 8 to 14 elements (Vm greater than 1.0, table 7).

Summary statistics for the elements detected in surface soil O2-horizon samples from the barbell sampling design are given in table 14. These include the geometric mean, the geometric deviation, and the expected baseline value range. This baseline range for the O2-horizon compares very favorably with the values reported for surface materials from Alaska by Gough and others (1988). A listing of the results of analysis for all samples of O2-horizons of soils is given in appendix table A3.

Soil C-Horizon

Components of variation over increments in distance are given for 28 elements and pH for C-horizons of soils in table 8. Elements not included, because a large proportion of the samples were censored are silver, gold, beryllium, bismuth, cadmium, holmium, molybdenum, niobium, tin, tantalum, thorium, and uranium. Procedural error is greater than 50 percent of the total variation for lead and zinc, and therefore, the data for these elements should be interpreted with the knowledge that natural variation is obscured by procedural errors. Significant variance components and a large portion of the total variation is shown for the greatest number of elements at the 50 km sampling interval. Several additional elements with significant variance components occur at the 25 km sampling interval.

A suitable sampling interval for the preparation of geochemical maps showing element distribution in C-horizons of soils can be determined from the data in table 9. Most of the elements show high map stability (Vm greater than 1.0) at both the 50 and 25 km sampling intervals, however the 25 km interval would seem preferable because of greater map resolution.

Summary statistics for the elements detected in surface soil C-horizon samples from the barbell sampling design are given in table 15. These include the geometric mean, the geometric deviation, and the expected baseline value range. A listing of the results of analysis for all samples of C-horizons of soils is given in appendix table A5.

Industrial Emissions

General Considerations

Transects from the industrial complex at Kenai were established to determine whether element concentration variables exhibited systematic decreases in concentration with increasing distance and were thus related to emissions from the industrial complex (see the Methods section). The industrial complex just north of Kenai, Alaska is composed of a Unocal chemical factory (urea/ammonia), a Phillips LNG facility, a Tesoro petroleum refinery, and a Chevron petroleum refinery and tank farm. The Phillips LNG facility is the second largest of its type in North America producing over 3600 tons per day of ammonia and 3500 tons per day of urea. The majority of this is used as agricultural fertilizer and is sold mainly to oriental markets. This facility emits to the atmosphere 40 to 60 tons of ammonia per day which has resulted in the etching of glass and car paint in the immediate area of the facility (Ritchey, R., U.S. Fish and Wildlife Service, KNWR, Personal Communication, August, 1988). The Unocal facility also releases ammonia as well as heavy metals into the air as sited by the local press. (For example, The Kenai, Alaska Peninsula Clarion published on August 9, 1988 an article entitled "What is the Unocal plant putting into the air?". This article discusses a host of contaminants that the facility is suspected of emitting.) There was no available emissions information for the Chevron or Tesoro facilities at the time of this investigation.

A wind-rose diagram (fig. 4) shows that the winds are predominantly from the north/northeast from September to May, and from the south/southwest during June through August. The annual mean hourly wind speed based on a 19 year average is 6.6 mph (Climatological Data Summary, Department of Commerce, ESSA-Environmental Data Service [pre-1970 data]). On the Kenai Peninsula, the period of maximum precipitation is June through October, with a mean of 3.6 inches for September for that 19 year period.

Feather Moss

Coefficients of determination (CD) for the relation between element concentration and distance are shown for three transects in table 10. Three variables along the east transect, 14 variables along the north transect, and one variable along the south transect show CD values of 0.50 or greater. Regression equations for these 18 variables are given in table 11. All 18 equations show negative slopes, indicating a decrease in variable concentration with increasing distance. Graphs showing a regression line fit to the data for the regression model, described previously, are given for aluminum (fig. 5); cerium, cobalt, and chromium (fig. 7); iron (fig. 8); lanthanum, lithium, and sodium (fig. 9); nickel and scandium (fig. 10); sulfur (fig. 11); titanium and vanadium (fig. 12); and yttrium and ytterbium (fig. 13).

The data given in Appendix Table A1 for the three transects was compared to the calculated range for detected elements as given in table 16. Only sulfur exceeded the upper limit of the 95% expected range. This may indicate that the feather moss is showing an industrial addition to its sulfur content.

White Spruce

Coefficients of determination (CD) for the relation between element concentration and distance are shown for three transects in table 10. One variable along the east transect, four variables along the north transect, and no variables along the south transect show CD values of 0.50 or greater. Regression equations for these five variables are given in table 11. Only two equations, both for sulfur, show negative slopes, indicating a decrease in variable concentration with increasing distance. Graphs showing a regression line fit to the data for the regression model, described previously, are given for sulfur (fig. 11).

Radloff (1989) describes an aluminum-induced calcium deficiency in spruce trees due to excess nitrogen in soils derived from atmospheric pollution. The visual symptoms described in Radloff's report are similar to those observed in the spruce trees close to the Kenai industrial site. Figure 14 shows the acute necrosis that is characteristic of older spruce needles. Whether the damage to the spruce is due to physiological deficiencies or excesses of micro-nutrients or toxic metals remains to be determined. However, appendix Table A7 lists the analytical data of young spruce twigs (labeled KTN.51-2, one- to two-year old twig segments) and older spruce twigs (labeled KTN.53-5, three- to five-year old twig segments) which were collected from a single tree 0.5 km from the Unocal facility. These data indicate that the older twigs have higher concentrations of aluminum, calcium, chromium, iron, manganese, sodium, nickel, lead, strontium, vanadium, and zinc than the younger twigs (commonly by a factor of two or slightly less).

Similarly, samples of elderberry leaves (Fig. 15) showing necrosis and curling were collected 0.5 km from the Unocal facility (ELDER1, appendix table A6). Samples of leaves without necrosis or curling were collected from an area considered uncontaminated 32 km east of the facility (ELDER2, appendix table A6). Concentrations of aluminum, iron, potassium, lithium, manganese, sodium, nickel, and sulfur were found to be considerably higher in the close-in sample (ELDER1) and concentrations of barium, calcium, molybdenum, neodymium, and strontium, were higher in the presumed uncontaminated sample (ELDER2). We can only speculate that the higher concentrations of metals as well as sulfur are the result of the industrial complex. The biochemistry of barium, calcium, and strontium in plants is similar and the decreased concentration of these elements in the samples from the contaminated site may reflect physiological exclusion or competition.

Soil O2-Horizon

Coefficients of determination (CD) for the relation between element concentration and distance are shown for three transects in table 12. No variables along the east or south transects, and only one variable along the north transect show CD values of 0.50 or greater. A regression equation for copper is given in table 11. This equation shows a negative slope, indicating a decrease in copper concentration with increasing distance. A graph showing a regression line fit to the data for the regression model, described previously, is given for copper (fig. 7).

Soil B-Horizon

Coefficients of determination (CD) for the relation between element concentration and distance are shown for three transects in table 12. Eight variables along the east transect, three variables along the north transect, and two variables along the south transect show CD values of 0.50 or greater. Regression equations for these 13 variables are given in table 11. Only two equations, calcium and strontium, show negative slopes, indicating a decrease in variable concentration with increasing distance. Graphs showing a regression line fit to the data for the regression model, described previously, are given for calcium (fig. 6) and strontium (fig. 12). A listing of the results of analysis for all samples of B-horizons of soils is given in appendix table A4.

Soil C-Horizon

Coefficients of determination (CD) for the relation between variable concentration and distance are shown for three transects in table 12. Ten variables along the east transect, six variables along the north transect, and one variable along the south transect show CD values of 0.50 or greater. Regression equations for these 17 variables are given in table 11. Ten equations show negative slopes, indicating a decrease in variable concentration with increasing distance. Graphs showing a regression line fit to the data for the regression model, described previously, are given for aluminum (fig. 5); calcium (fig. 6); gallium and mercury (fig 8); phosphorus and selenium (fig 10); strontium (fig. 12); and yttrium (fig. 13).

Data for white spruce and the two soil horizons from the transect samplings were compared to the calculated ranges from the barbell study. No element for any of the three media exceeded the upper limit of the 95%

expected range. This implies that the industrial outputs may not be affecting these media for the elements analyzed.

Correlation coefficients between elements in the two soil horizons and the two plants and between the two plants are presented in table 18. There are numerous significant correlations in all cases at the 99% confidence level. Generalized statements would be that the feather moss correlated better to the O2-horizon than the C-horizon; the moss correlated better to the soil horizons than the white spruce for most elements; and, many of the controlling factors for a given element are similar for both plants because of the large number of correlations between plants.

Soil extractions

Extraction data for three common anions, chloride, sulfate, and nitrate, from a simple 1:5 (sample:demineralized water) extraction procedure are given in table A8. Since the total chemistry of the soils did not show any strong relationships with distance, partial chemistry of the soils was examined. The O2-horizons tended to have more extractable anions than the C-horizons at each site and there does not appear to be any trends for chloride or sulfate. This would indicate minimal or consistent sea spray influence on these anions.

The nitrate data is interesting because of the aerial trends and because some high values observed. Nitrate was not detected in either horizon of the samples collected furthest away from the industrial complex; these data therefore, can be considered as background. The sample closest to the complex, SOKTN.51, contains 55 ppm nitrate and is considered very high. There does appear to be an influence by the complex on nitrogen levels in the soil. Further, the values obtained from these samples should be considered minimum values because of the way the samples were handled. In order to prevent the transformation of nitrogen species in soil, the samples should be frozen in the field and the nitrate determinations performed under controlled atmosphere conditions. An alternative method is to do the extraction and nitrate determination in the field. Our samples were dried and nitrate was determined almost a year after collection. The amount of nitrogen lost due to microbial activity following collection is unknown and must be determined in some future study.

CONCLUSIONS AND RECOMMENDATIONS

Landscape Variability

Analysis-of-variance, with calculations based on the variance components, for element concentrations in two plants (feather moss and white spruce) and two soil horizons (O- and C-horizons) were used to estimate the feasibility of preparing biogeochemical or geochemical maps at various sampling intervals. Intervals of 50, 25, 5, 1, and 0.1 km were evaluated. Our intent was to provide as much background information for as many elements as possible in each of the sampling media with the smallest sampling cost.

In order to most efficiently map the chemistry of feather moss (table 3) and soil C-horizon (table 9), a 25 km cell size is suggested with a minimum of three moss samples and four soil samples within each cell. With these sampling intensities, reliable biogeochemical or geochemical maps can be prepared for most elements. Increasing the number of moss samples to five per cell will add nickel and selenium as mappable elements, and increasing the samples to six per cell will add copper and zinc. Increasing the samples of the soil C-horizon to five samples per cell will add potassium, lead, and selenium as mappable elements, six samples per cell will add cobalt and magnesium , and eight samples per cell will add copper. Whether the cost of additional sampling is justified to prepare maps for one or two elements depends on the need for information on those specific elements.

Reliable biogeochemical or geochemical maps for white spruce (table 5) and the soil O2-horizon (table 7) require sampling based on a cell size of 5 km or less. Five to ten samples of white spruce are necessary within each 5 km cell, and within a 1 km cell four to five samples are necessary. Most elements in O2-horizons of soils can be mapped with four to five samples collected in either the 5 km or 1 km cell. Because of the small cell size and the intensity of sampling within each cell, the effort would be very expensive.

Industrial Emissions

The elements showing a decrease in concentration with increasing distance from the industrial complex at Kenai, Alaska (figs. 5-13) for two plants (feather moss and white spruce) and three soil horizons (O-, B-, and C-horizons) do not provide conclusive information to state that the trends observed are related to industrial emissions. Elements related to airborne industrial emissions should show consistent trends in both feather moss and O2-horizons of soils along down-wind transects. While several elements show decreases with distance along all three transects in feather moss, the only element showing a similar pattern in O2-horizons of soils is copper along the north transect (table 12), but copper in feather moss is not considered. Sulfur (fig. 11) trends suggest an industrial emission source for feather moss and white spruce along two transects each, however the two transects are not the same in all cases; feather moss along the north and south transects and white spruce along the north and east transects. Sulfur trends in soil O2-horizons are not considered important by the criteria chosen.

Selected samples of white spruce were analyzed for their stable sulfur isotope ratios as follows:

Transect	Distance (km)	del$^{34}S_{CDT}$
North	1	+4.9
	2	+6.4
	4	+5.4
	8	+4.5
	16	+4.7
South	1	+6.8
	2	+6.9
	4	+4.7
	8	+5.2
	16	+4.9

$del^{34}S_{CDT}$ represents the enrichment factor for ^{34}S and is expressed as del^{34}sulfur in parts per thousand (o/oo) or per mil. The equation used to calculate $del^{34}S_{CDT}$ is:

$$del^{34}S_{CDT} \text{ o/oo} = \frac{[^{34}S / ^{32}S] \text{ sample}}{[^{34}S / ^{32}S] \text{ Canyon Diablo Troilite Meteorite}} - 1.000 \times 1000$$

The use of stable sulfur isotopes to evaluate anthropogenic and natural sources of atmospheric sulfur and the natural sulfur cycle is described by Jackson and Gough (1989). The data here may represent a weak trend of decreasing inputs from natural sources, but the data are inconclusive.

We speculate that the trends observed with increasing distance from the industrial complex may reflect the differences in aerial deposition of volcanic ash. The source of the ash is from the same direction as the industrial complex (Alaska Range to the west and across the Cook Inlet). Whatever the true reason is for the measured trends, the data of this investigation can be used as a baseline against which to assess future changes in the biogeochemical and geochemical environment due to additions to or changes in the industry of the Kenai Peninsula.

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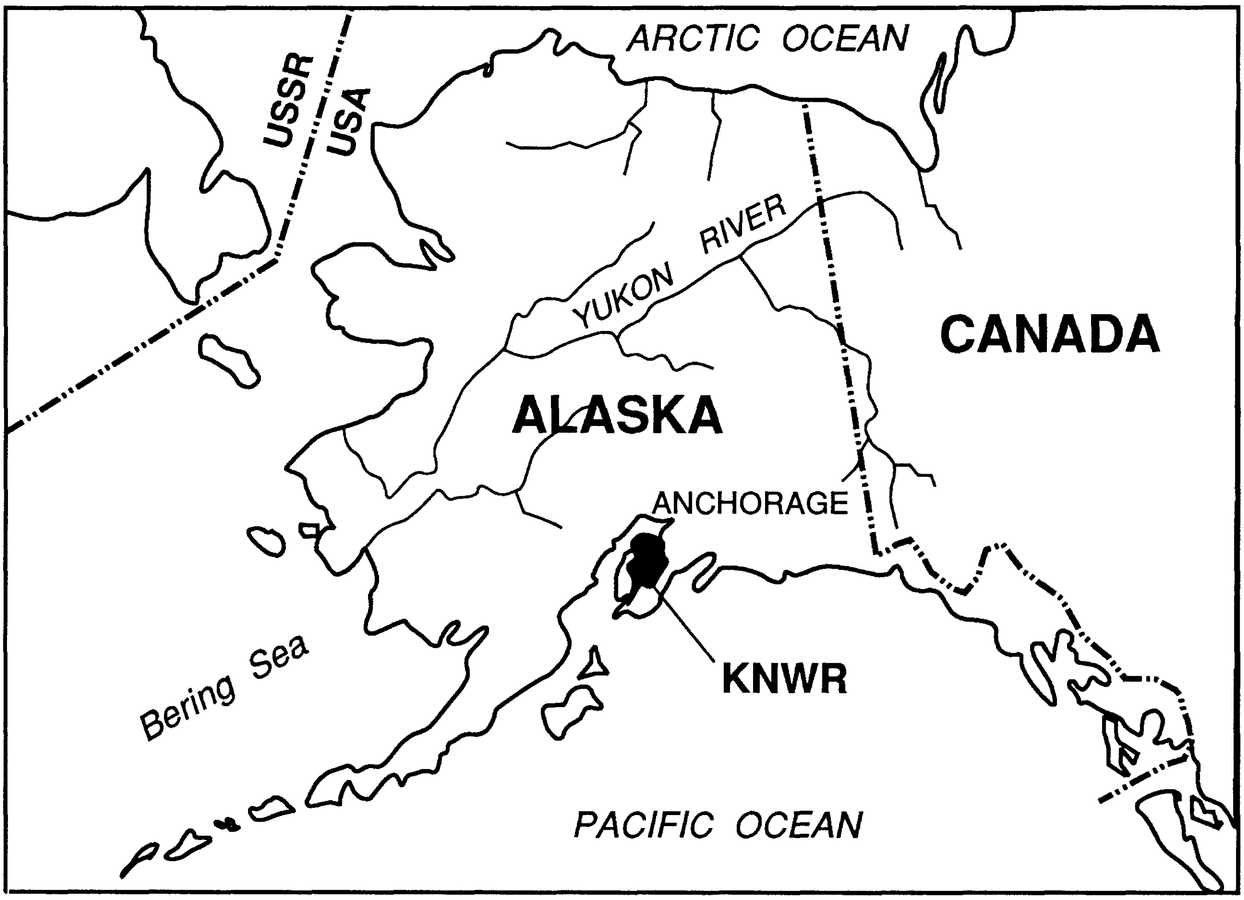

Fig 1. Index map showing location of the Kenai National Wildlife Refuge (KNWR), Alaska

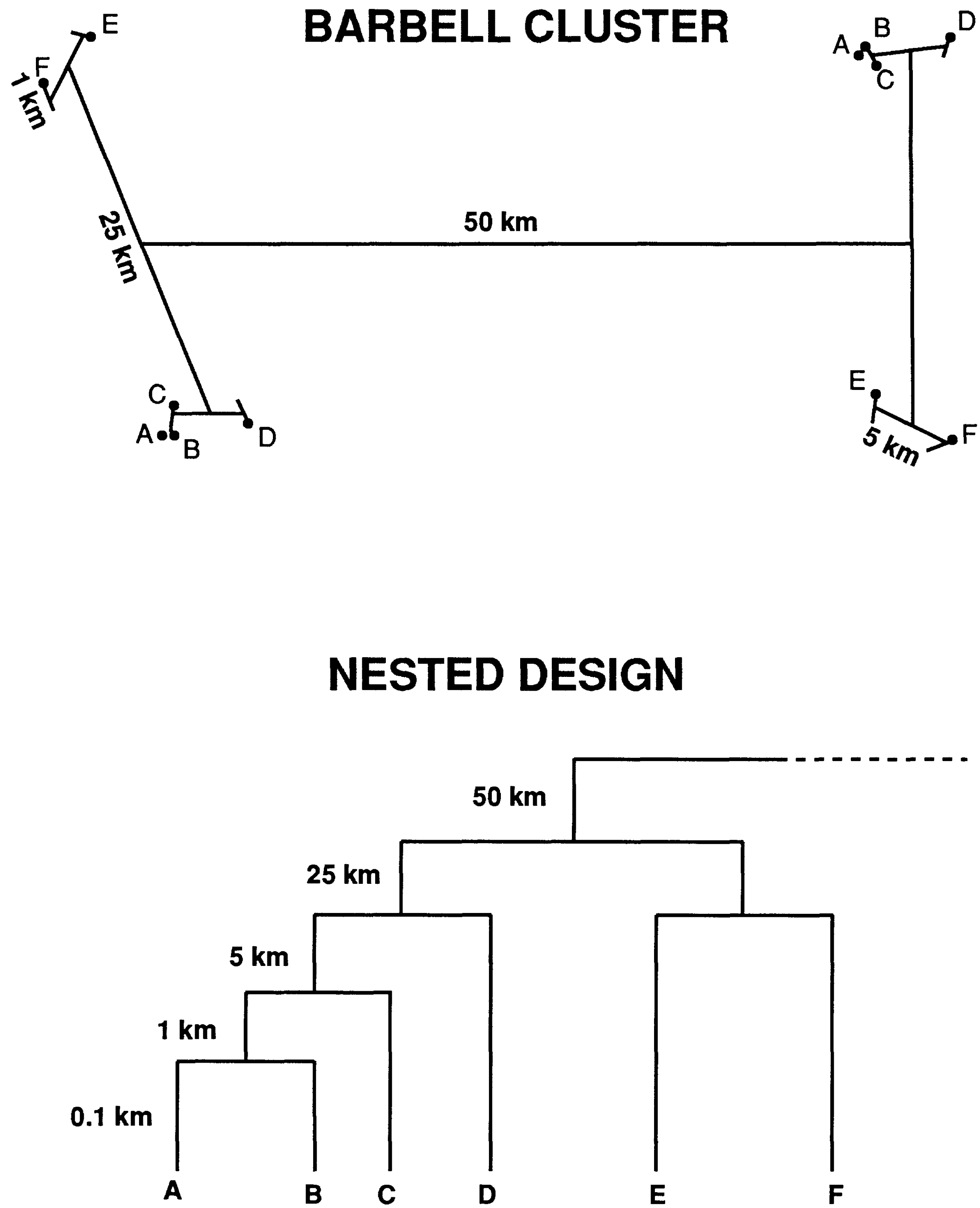

Fig. 2 Dendrogram illustrating the unbalanced, nested,analysis-of-variance sampling design.

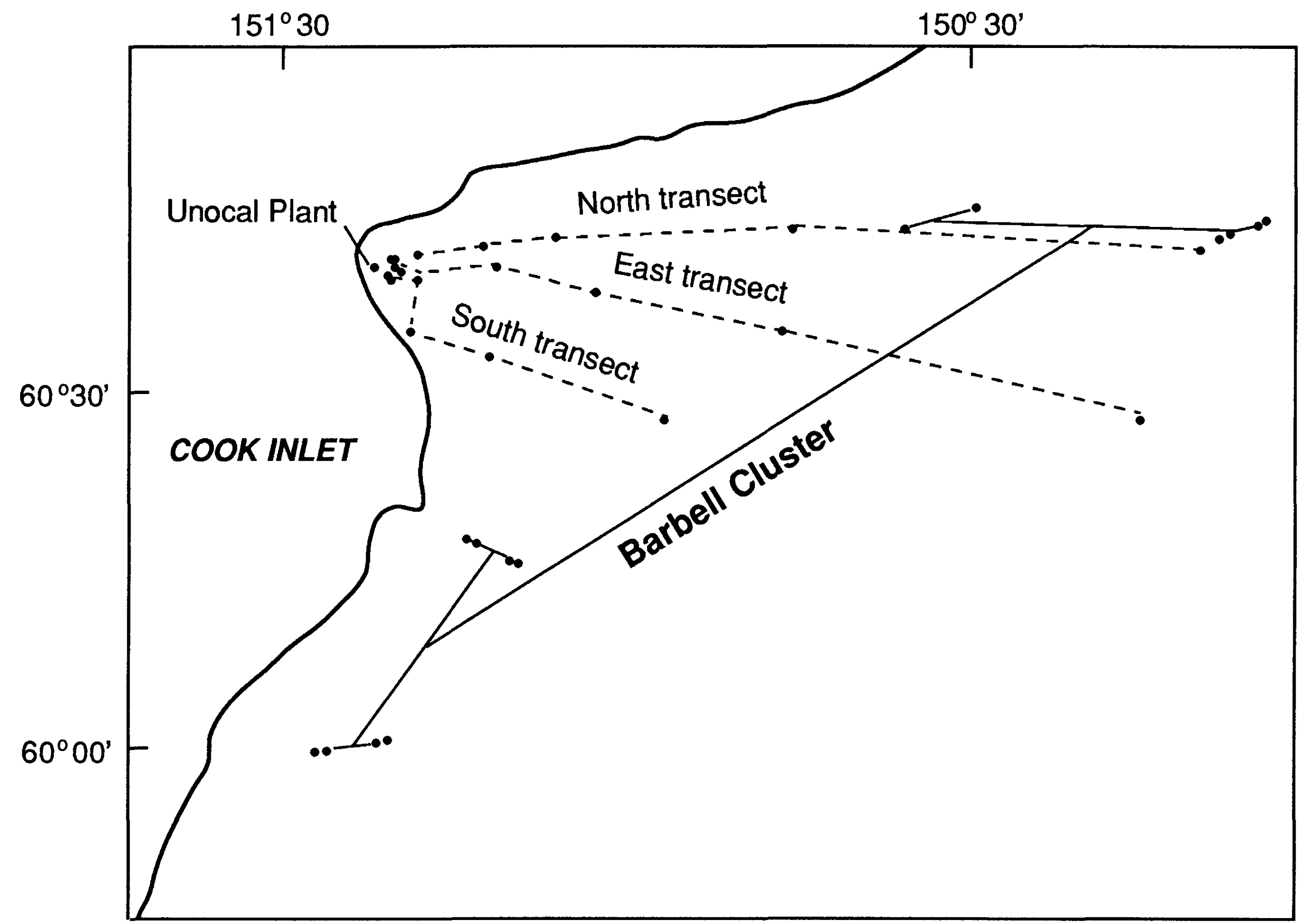

Fig. 3 Map showing location of sampling sites for landscape variability studies and industrial emissions studies.

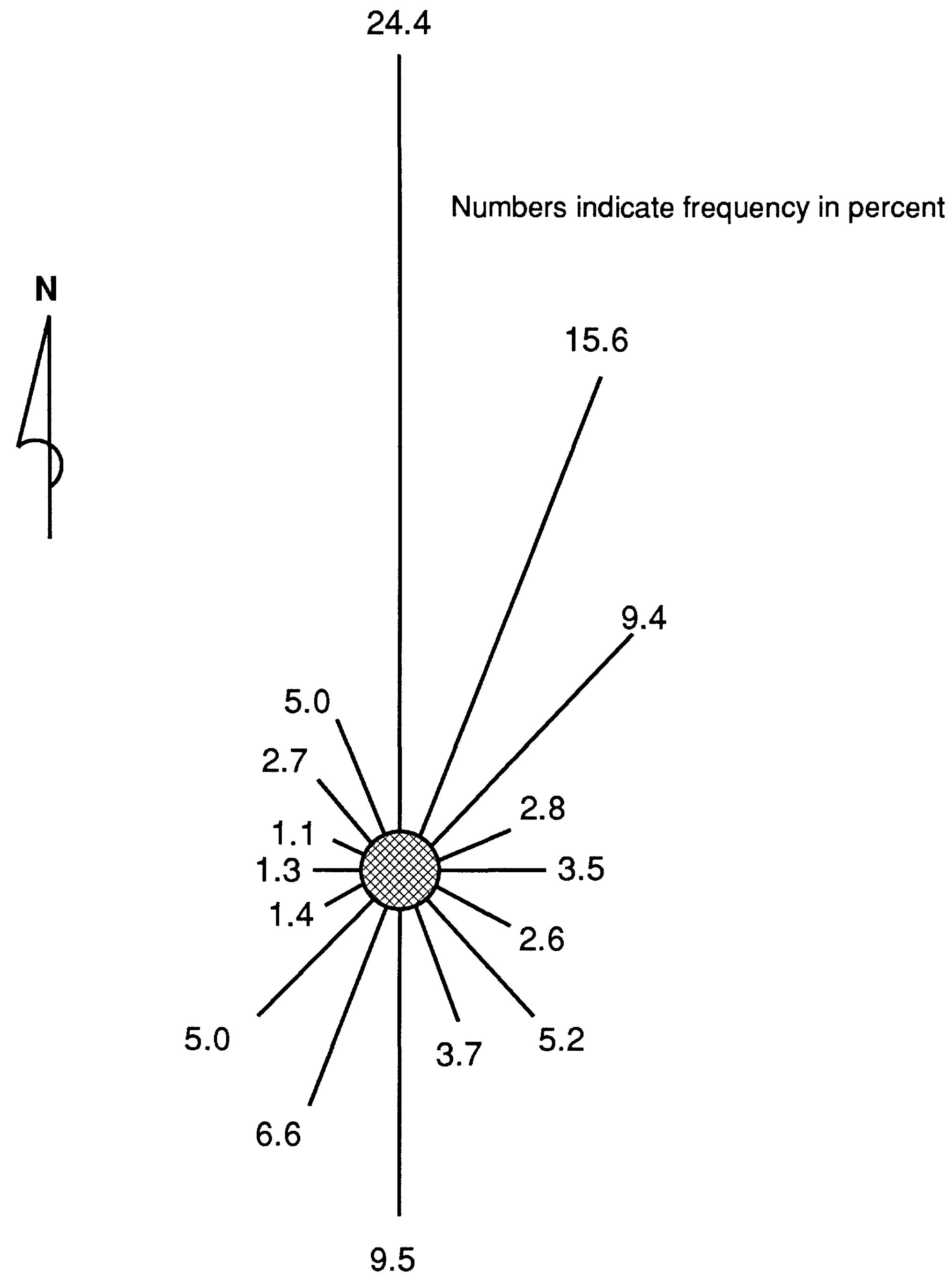

Fig. 4 Wind-rose diagram

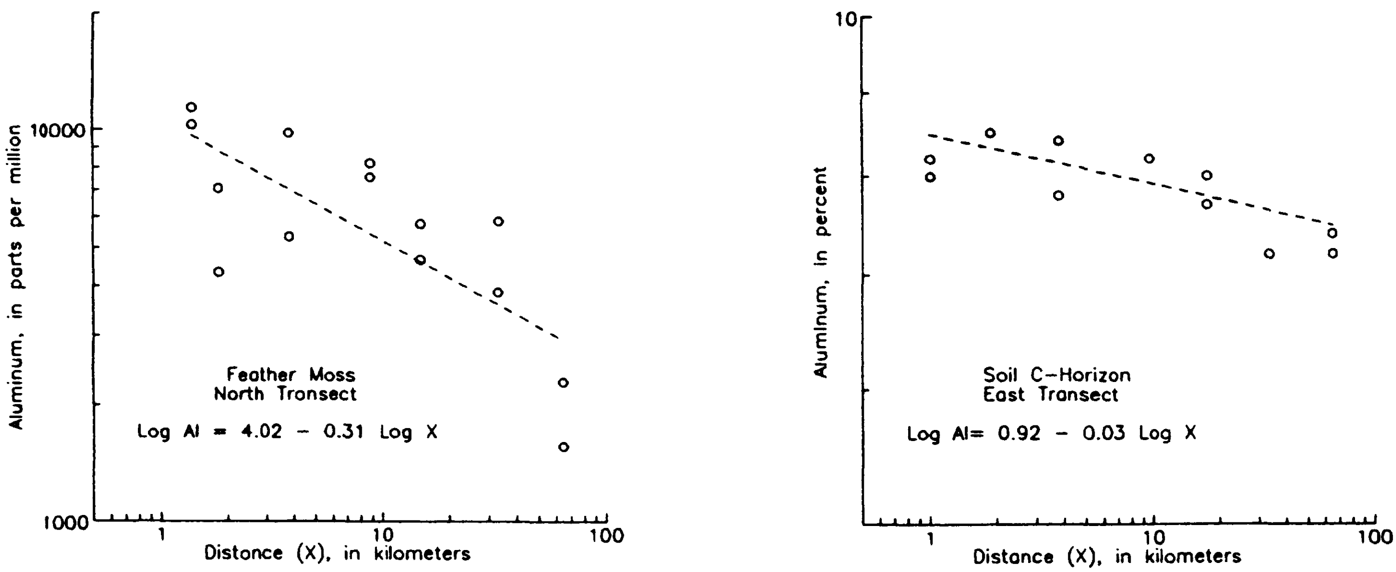

Figure 5.--Graphs of aluminum concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

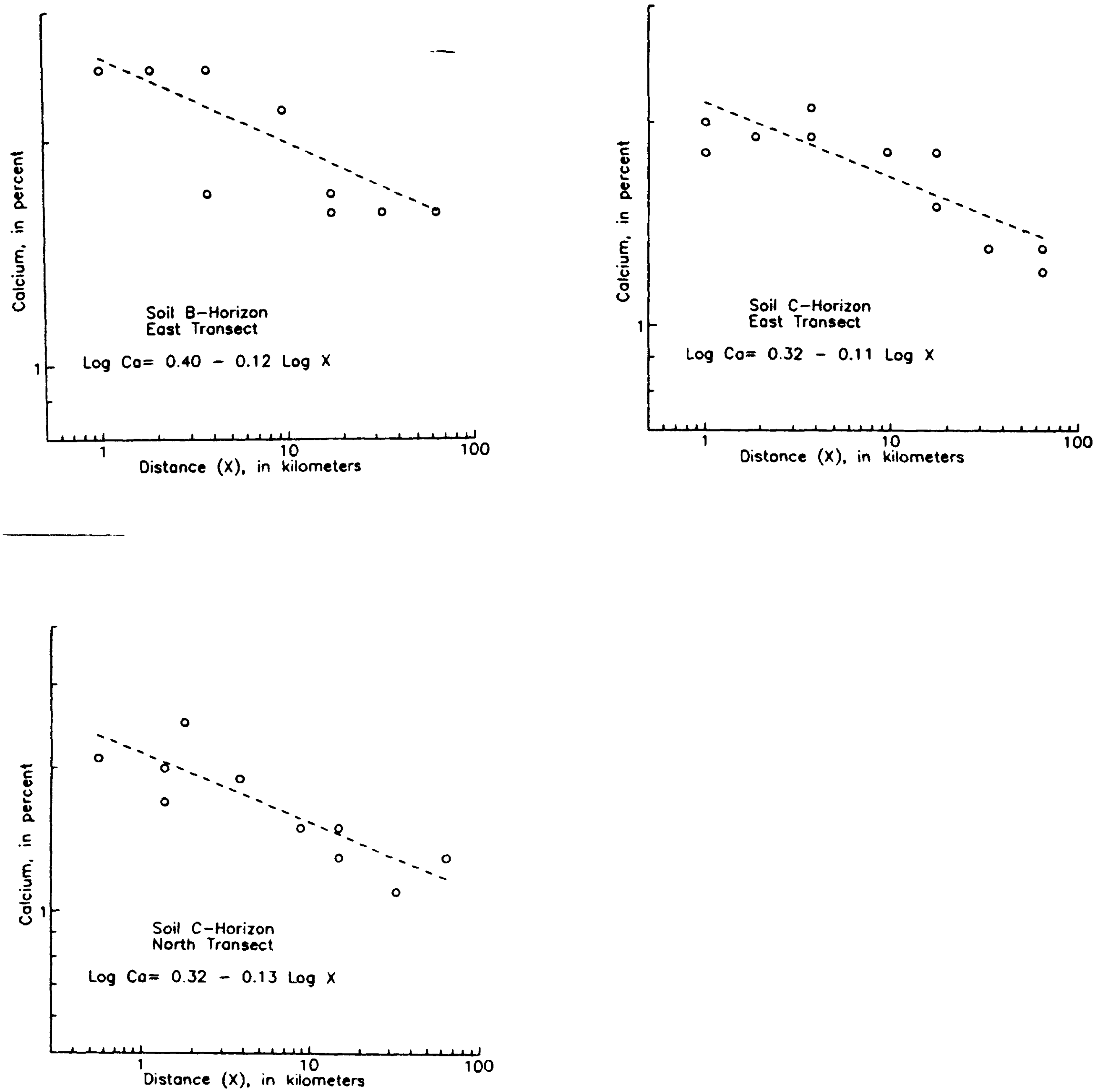

Figure 6.--Graphs of calcium concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

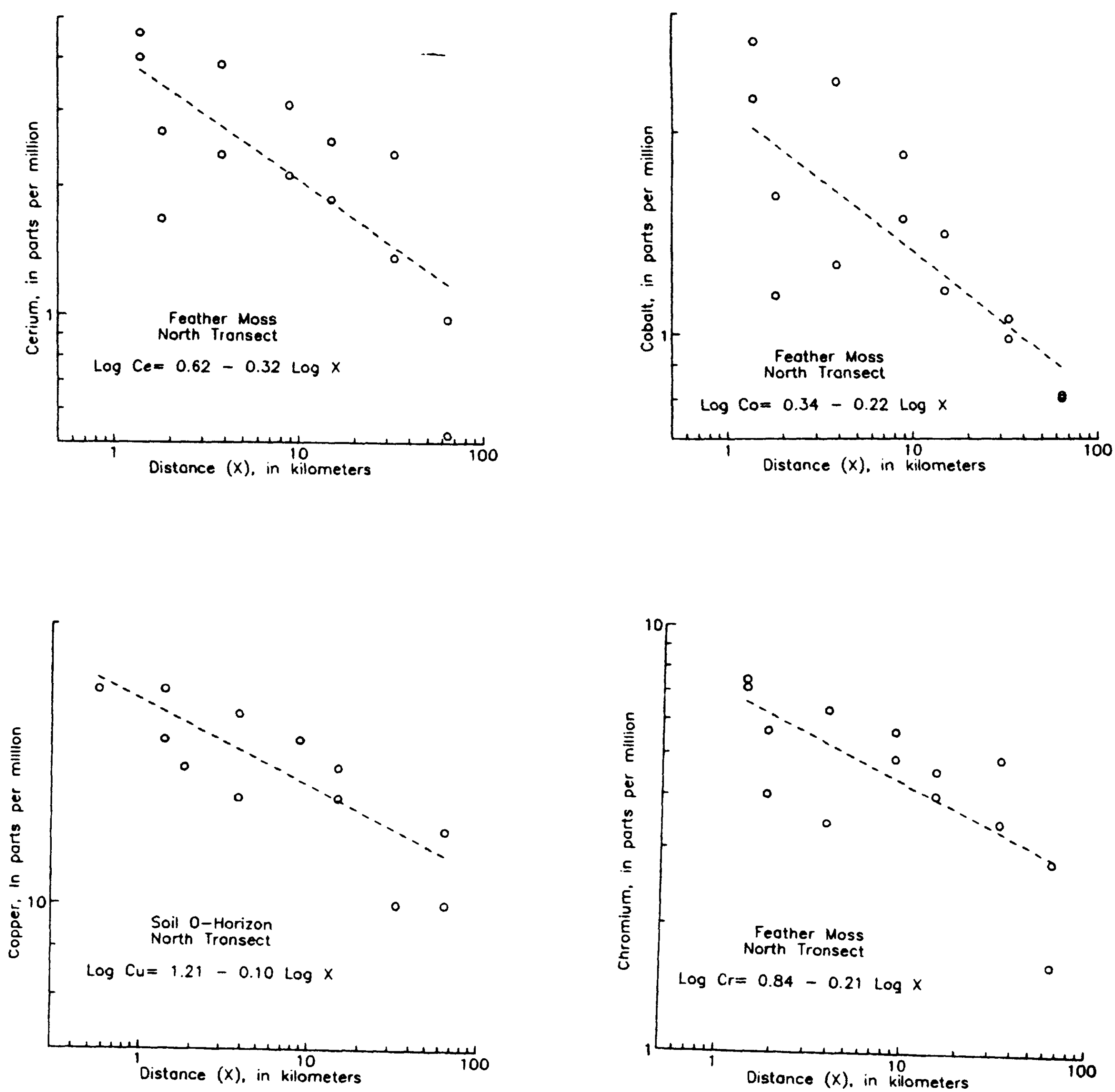

Figure 7.--Graphs of cerium, copper, cobalt, and chromium concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

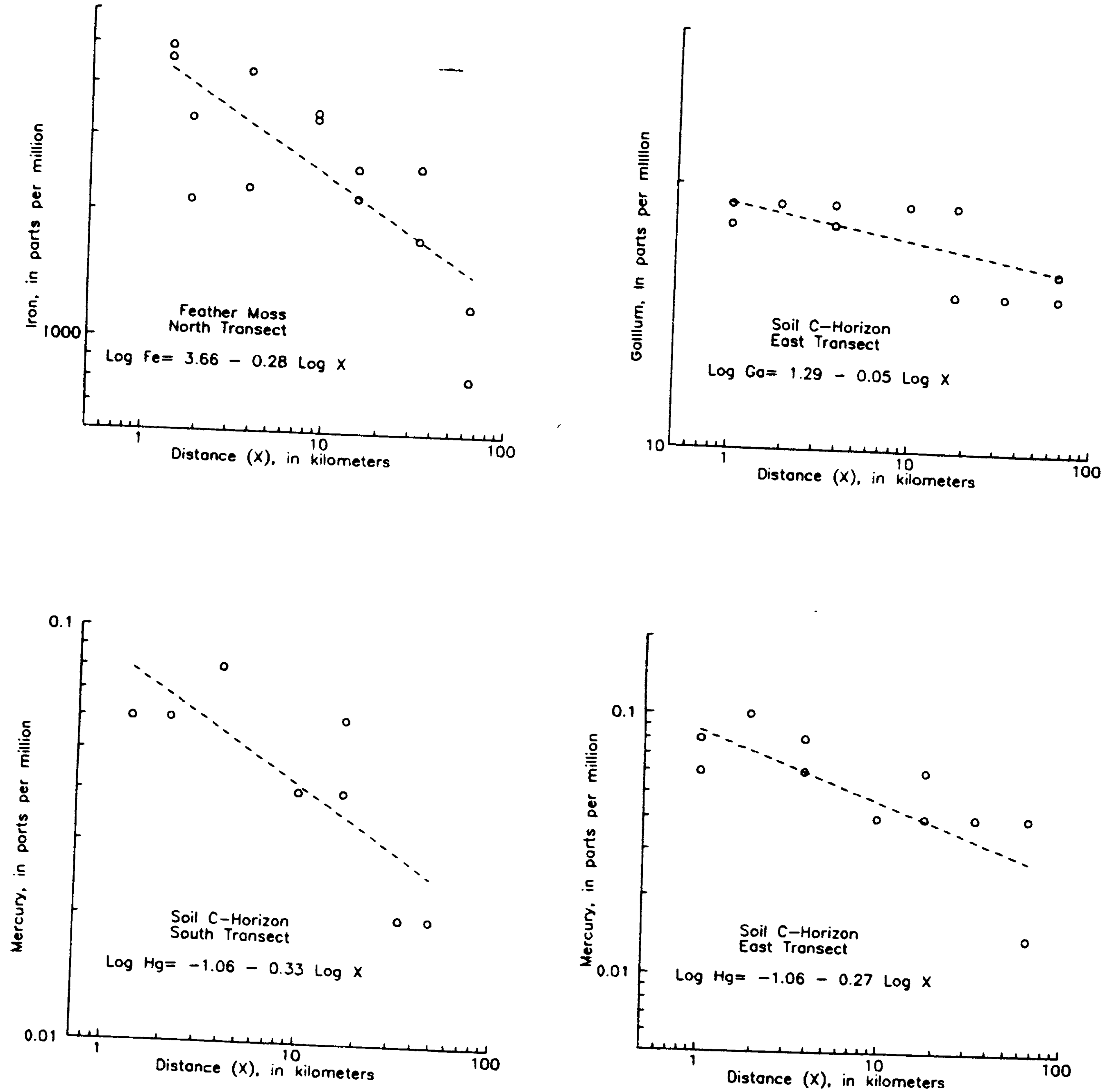

Figure 8.--Graphs of iron, gallium, and mercury concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

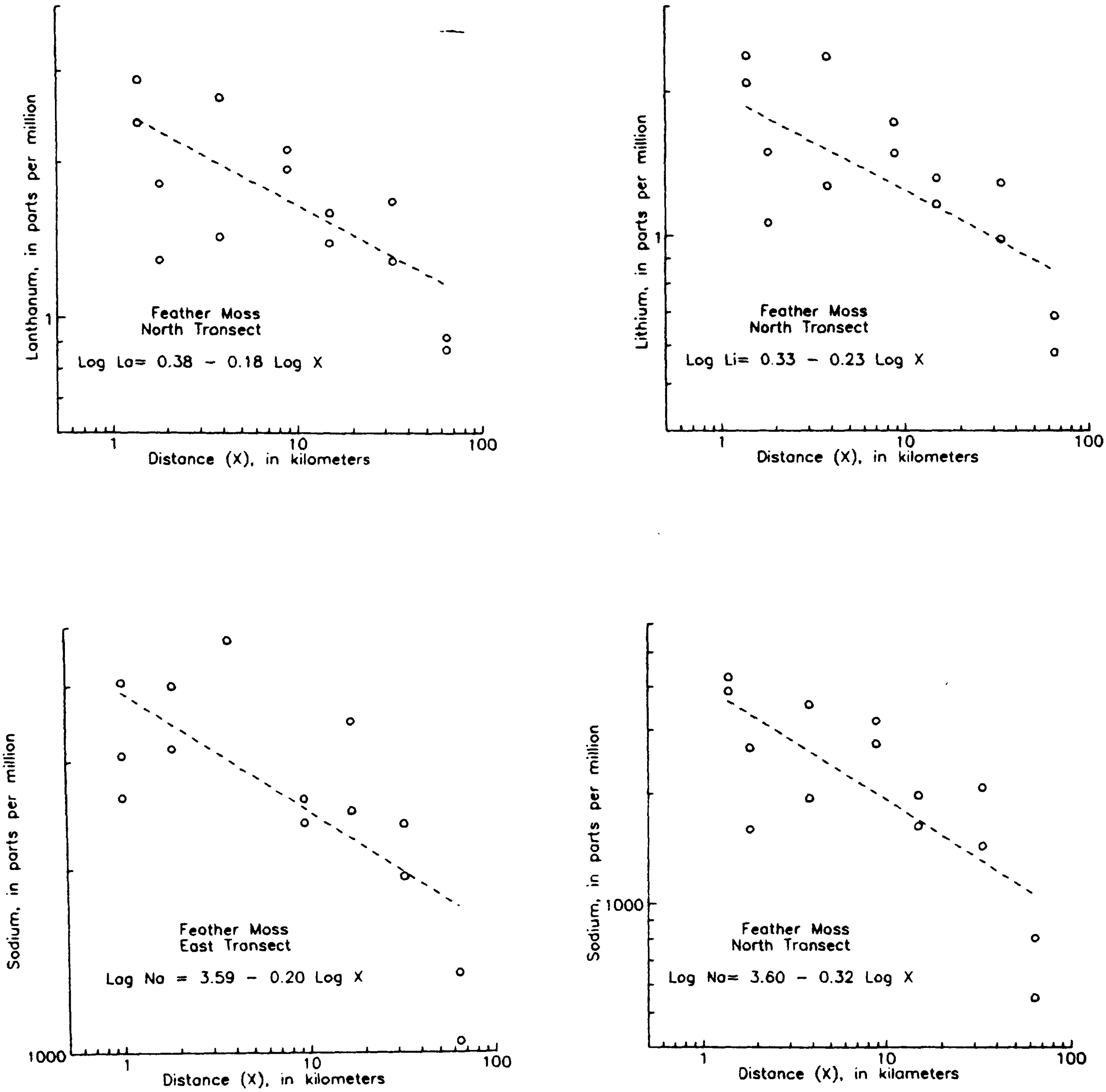

Figure 9.--Graphs of lanthanum, lithium, and sodium concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

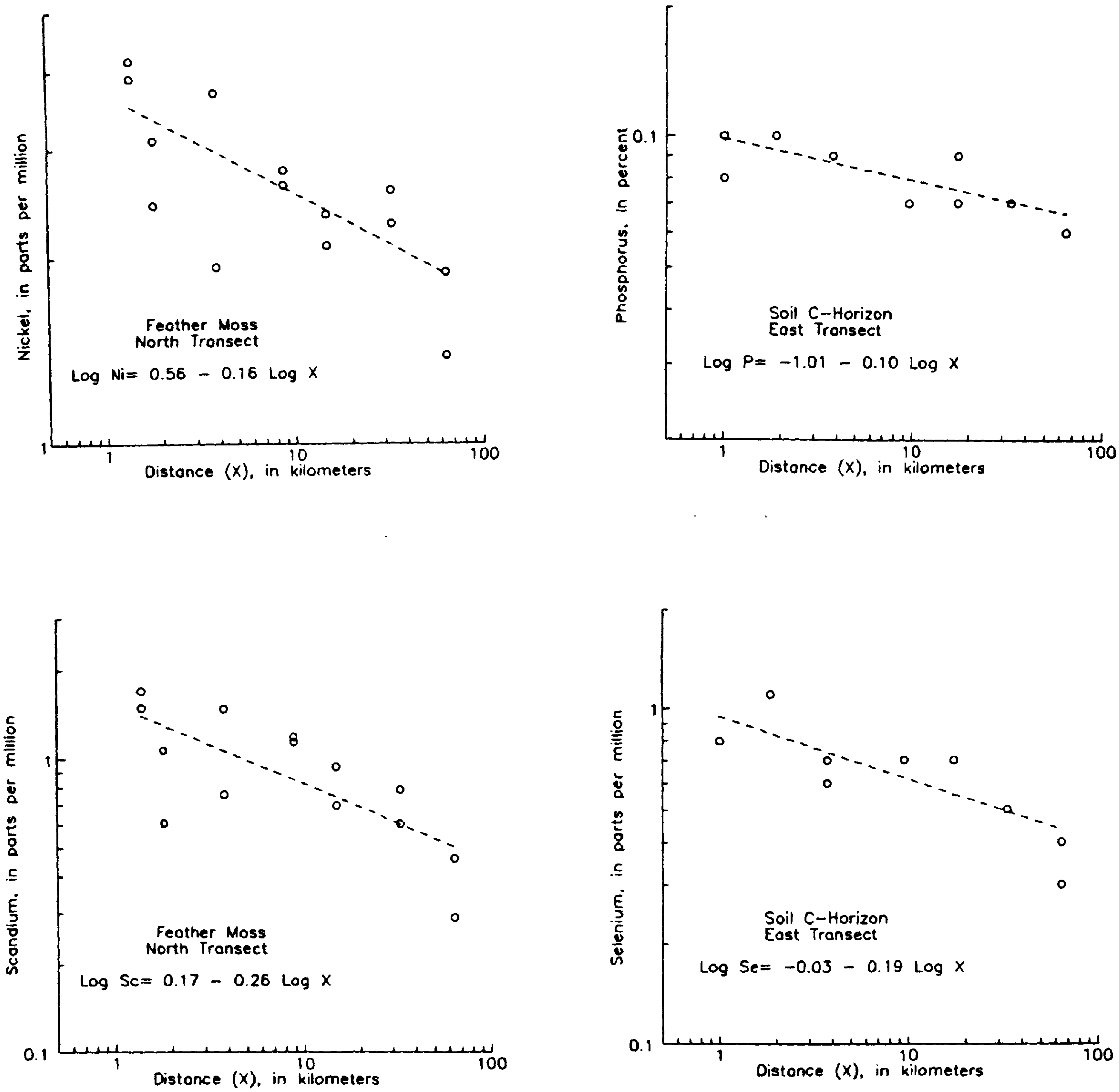

Figure 10.--Graphs of nickel, phosphorus, scandium, and selenium concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

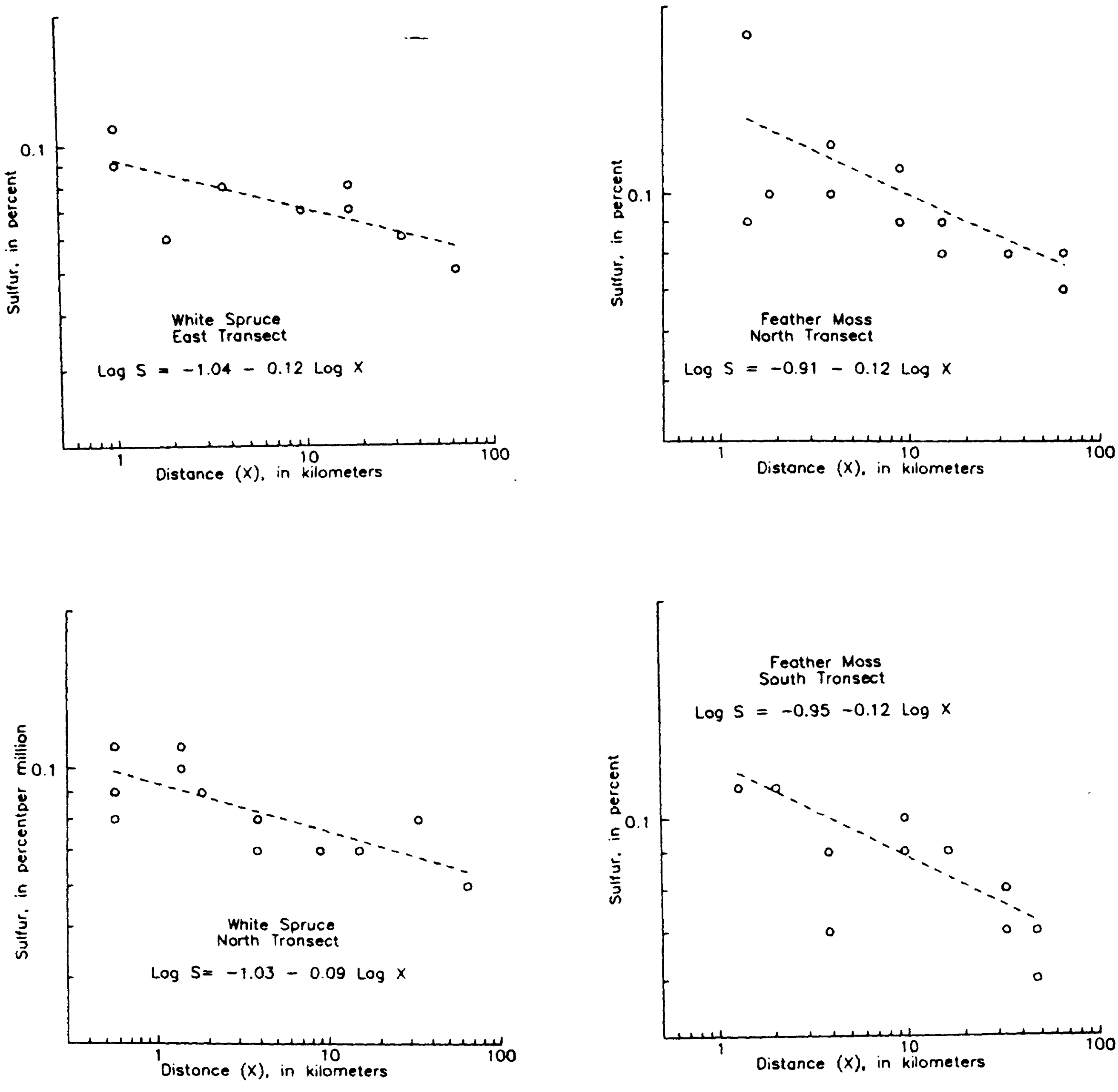

Figure 11.--Graphs of sulfur concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

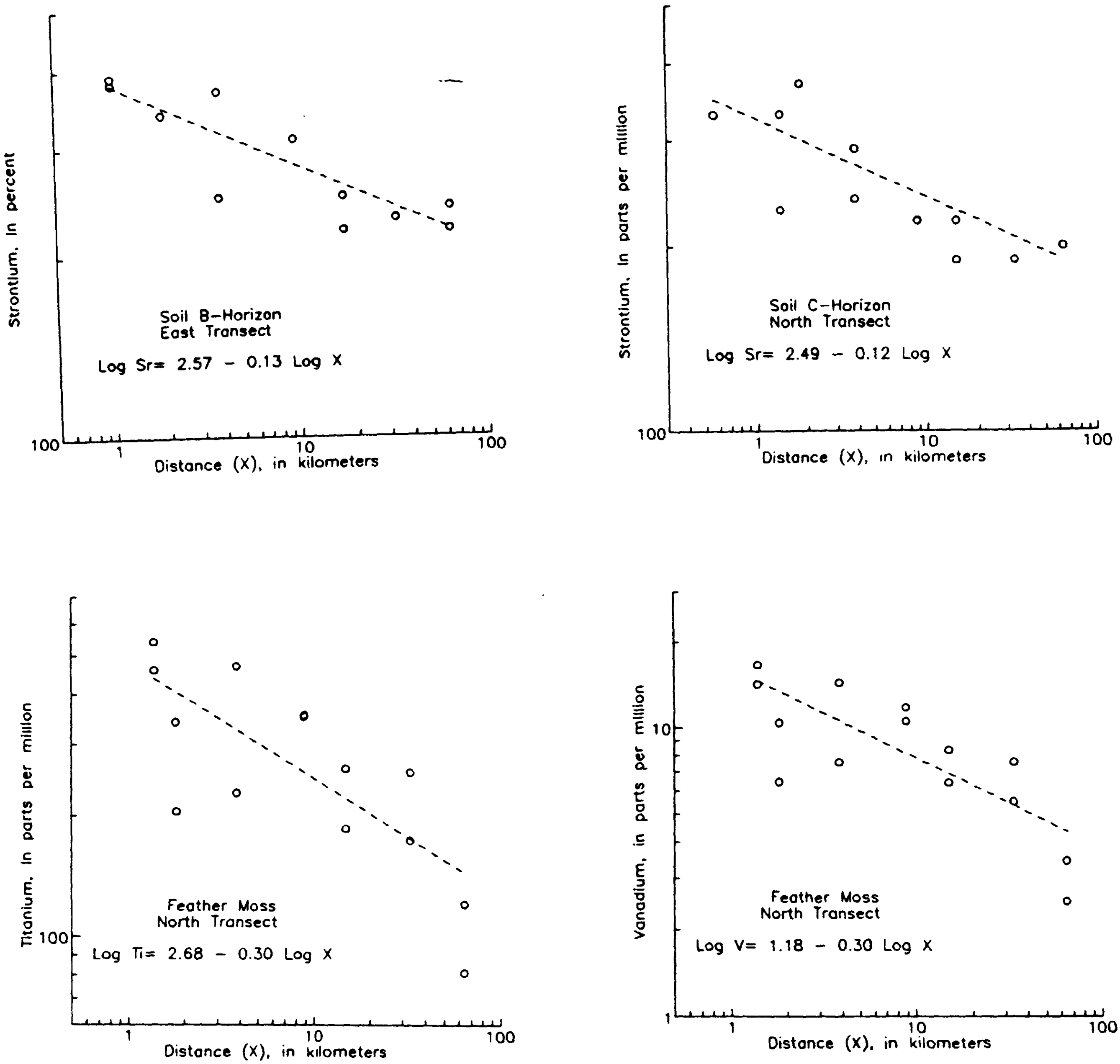

Figure 12.--Graphs of strontium, titanium, and vanadium concentrations in relation to increasing distance media away from the industrial complex at Kenai, Alaska for various sampling media.

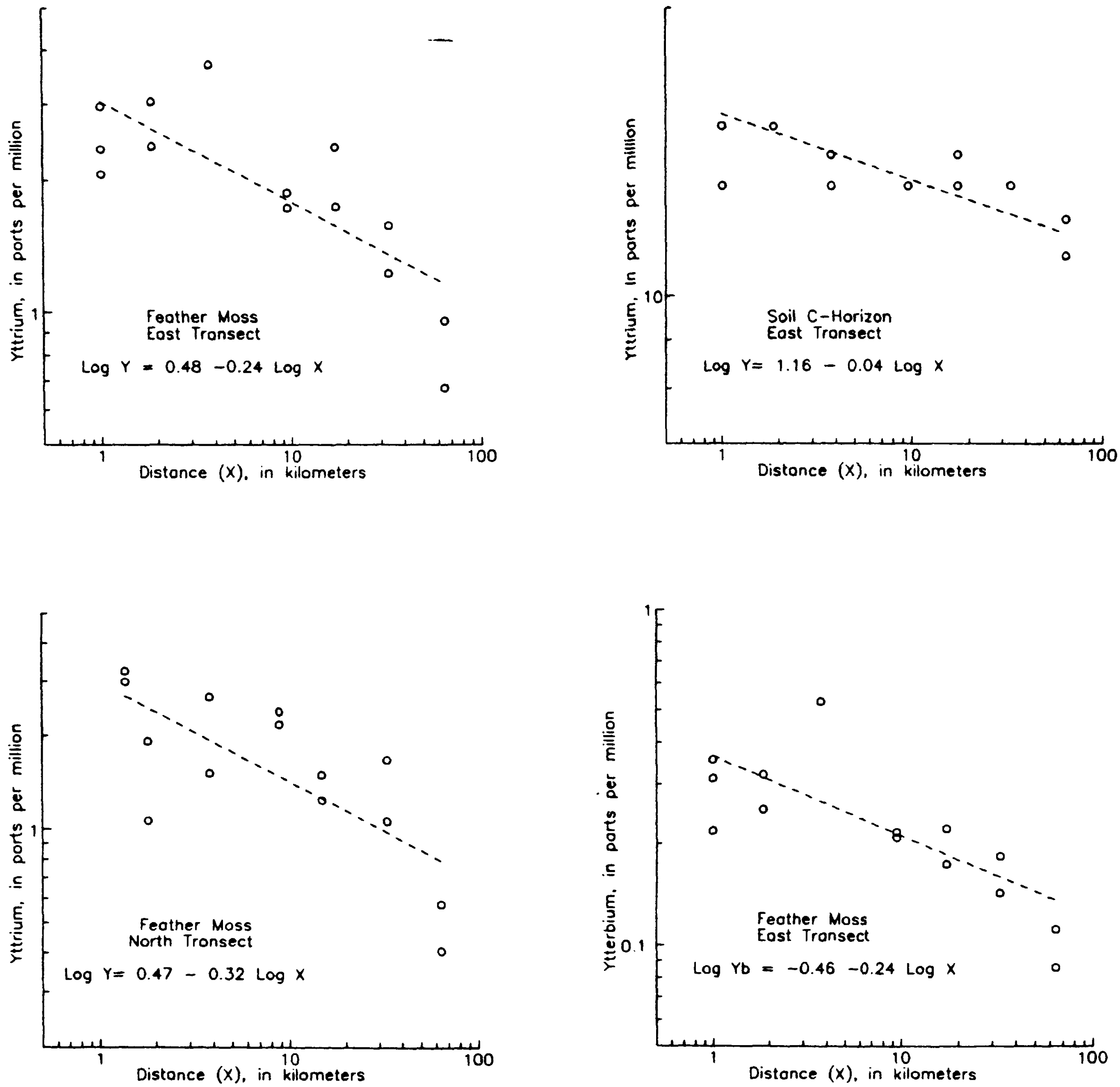

Figure 13.--Graphs of yttrium and ytterbium concentrations in relation to increasing distance away from the industrial complex at Kenai, Alaska for various sampling media.

Figure 14.--A mature white spruce stand located 0.5 km from the Unocal and Tesoro facilities showing needle loss, a general lack of forest understory shrubs, and a robust ground cover composed of Calamagrostis canadensis (bluejoint grass).

Figure 15.--Necrosis and curling of Sambucus callicarpa (elderberry) leaves was occasionally observed through the study area but was most pronounced and prevalent within about 5 km of the industrial complex.

Table 1. Listing of approximate limits of determination for pH and elements reported.

Analytical method	Medium	Determination limit	Variables
Continuous-flow hydride generation	Soil	0.1 ppm	As, Se
	Plant[1]	0.05 ppm	
Inductively-coupled argon plasma optical emission spectroscopy	Soil and Plant[2,3]	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
Continuous-flow cold vapor	Soil	0.02 ppm	Hg
	Plant[1]	0.01 ppm	
Water slurry	Soil	0.1 units	pH
Combustion-IR	Soil Plant[1]	0.05%	S

[1] Determined on dry plant material.
[2] Determined on plant ash.
[3] Sample mass for plant ash was one-half that for soils, so determination limits for plant ash are twice those listed for soils. Values reported are listed on a dry weight basis.

Table 2.--Distance-related and procedural variance for element concentrations measured in feather moss.

Variable, unit of measure	Total log10 variance	Percentage of variance:					
		50 km	25 km	5 km	1 km	0.1 km	Procedural error
Ash, %	0.04622	76.6*	1.9	6.8	5.7	8.5	0.5
Al, ppm	0.10780	69.4	12.8*	5.7	6.9	5.0	0.2
As, ppm	0.08903	0.0	37.6*	0.0	22.7*	0.0	39.7
Ba, ppm	0.12088	34.1	26.3*	0.2	0.0	37.1*	2.3
Ca, ppm	0.02918	43.6*	13.6	0.0	0.0	41.8*	1.0
Ce, ppm	0.06653	42.1*	13.9	1.9	23.3	18.5*	0.3
Co, ppm	0.06362	62.8*	0.0	0.2	25.5	11.2*	0.3
Cr, ppm	0.05007	48.4*	0.0	27.6*	15.0*	4.6*	4.4
Cu, ppm	0.00876	13.6	0.1	12.1	15.7	54.2*	4.3
Fe, ppm	0.08652	66.5*	9.1	8.9	8.8*	5.8	0.9
Ga, ppm	0.05602	55.4	10.4*	5.8	15.2	11.0	2.2
Hg, ppm	0.03022	0.0	36.4*	13.3	0.0	48.2*	2.1
K, ppm	0.00739	0.0	12.6	0.0	71.8*	12.0	3.6
La, ppm	0.04136	67.7*	0.0	6.6	12.2	12.2*	1.3
Li, ppm	0.05728	56.5*	0.0	14.3	16.7	12.2*	0.3
Mg, ppm	0.02924	55.0*	0.0	9.6	14.1	21.0*	0.3
Mn, ppm	0.04778	0.0	41.5*	0.0	12.3	46.0*	0.2
Na, ppm	0.10492	68.6	14.7*	5.5	5.1	5.9*	0.2
Nd, ppm	0.06529	62.0*	18.3	6.2*	6.6	4.3	2.6
Ni, ppm	0.02868	20.5*	0.0	34.3*	31.9	12.1*	1.2
P, ppm	0.00831	0.0	13.9	0.0	54.8	30.5*	0.8
Pb, ppm	0.08204	1.1	58.3*	9.5	13.1	16.8*	1.2
S, %	0.01044	0.0	56.0*	0.0	1.4	37.2	5.4
Sc, ppm	0.09605	67.1*	9.8	7.5*	9.9	5.5*	0.2
Se, ppm	0.09711	14.5	3.4	0.0	44.2	13.6	24.3
Sr, ppm	0.06391	55.0*	0.0	7.6*	0.0	37.3*	0.1
Ti, ppm	0.10945	76.5*	2.5	6.1	9.4*	4.4	1.1
V, ppm	0.09782	68.4	9.3*	6.3	10.0	5.5*	0.5
Y, ppm	0.08883	63.2	18.6*	0.8	11.3	6.0*	0.1
Yb, ppm	0.06294	69.1	11.2*	1.6	11.6	6.2*	0.3
Zn, ppm	0.03390	6.5	0.0	0.0	58.7	34.7*	0.1

* Statistically significant at the 0.05 probability level.

Table 3. Variance mean ratio and estimated number of samples necessary within a cell of specificed size to prepare stable geochemical maps for feather moss.

[Vm, variance mean ratio; n_r, number of samples required; 80% and 95%, probability levels]

Variable, unit of measure	---50 km cell---			---25 km cell---			----5 km cell---			--- 1 km cell---		
		n_r			n_r			n_r			n_r	
	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%
Ash, %	16.0	2	3	10.3	2	3	12.8	2	3	18.8	2	3
Al, ppm	7.2	3	4	12.5	2	3	14.7	2	3	32.9	2	2
As, ppm	---[1]	---	---	2.6	3	7	1.6	3	7	4.6	3	4
Ba, ppm	1.9	3	8	6.9	3	4	4.2	3	4	2.8	3	4
Ca, ppm	3.8	3	6	6.1	3	4	3.6	3	4	2.4	3	4
Ce, ppm	3.1	3	6	4.3	3	4	2.8	3	4	7.8	2	3
Co, ppm	11.3	3	4	5.7	3	4	3.3	3	4	14.0	2	3
Cr, ppm	4.4	3	5	2.2	3	5	6.5	2	3	22.7	2	3
Cu, ppm	1.1	6	>15	0.6	6	>15	0.8	4	10	1.3	3	6
Fe, ppm	7.2	3	4	8.1	2	3	11.1	2	3	26.3	2	2
Ga, ppm	5.1	3	5	5.9	3	4	5.3	2	3	12.6	2	3
Hg, ppm	---	---	---	2.0	3	7	2.7	3	5	1.8	3	5
K, ppm	---	---	---	0.5	7	>15	0.3	7	>15	10.7	2	3
La, ppm	12.7	3	4	6.4	3	4	6.2	2	3	11.9	2	3
Li, ppm	6.9	3	4	3.5	3	4	4.9	2	3	12.7	2	3
Mg, ppm	7.5	3	5	3.7	3	5	4.0	3	4	6.7	2	3
Mn, ppm	---	---	---	2.9	3	6	1.7	3	6	2.1	3	5
Na, ppm	6.6	3	4	13.7	2	3	16.9	2	3	28.1	2	2
Nd, ppm	4.9	3	4	11.4	2	3	14.1	2	3	28.9	2	2
Ni, ppm	1.3	5	13	0.6	5	13	2.3	3	5	12.1	2	3
P, ppm	---	---	---	0.6	6	>15	0.3	6	>15	4.0	3	4
Pb, ppm	<0.1	>15	>15	4.4	3	4	4.8	3	4	8.4	2	3
S, %	---	---	---	5.8	3	4	3.5	3	4	2.6	3	4
Sc, ppm	7.2	3	4	8.8	2	3	10.7	2	3	30.3	2	3
Se, ppm	1.1	6	>15	0.8	5	15	0.5	5	15	4.0	3	4
Sr, ppm	8.8	3	5	4.4	3	5	4.5	3	4	3.0	3	4
Ti, ppm	14.9	2	3	10.3	2	3	11.4	2	3	33.9	2	2
V, ppm	7.8	3	4	9.6	2	3	10.4	2	3	29.2	2	2
Y, ppm	5.2	3	4	14.7	2	3	9.2	2	3	27.7	2	2
Yb, ppm	7.9	3	4	13.0	2	3	8.9	2	3	26.2	2	2
Zn, ppm	0.5	11	>15	0.2	11	>15	0.1	11	>15	3.4	3	4

[1] Not determined

Table 4. Distance-related and procedural variance for element concentrationsmeasured in white spruce.

Variable, unit of measure	Total log10 variance	Percentage of variance: 50 km	25 km	5 km	1 km	0.1 km	Procedural error
Ash, %	0.00396	15.1	0.0	0.0	47.9	36.9*	0.1
Al, ppm	0.07843	0.0	29.9	30.8*	4.2	34.6*	0.5
As, ppm	0.00000	0.0	0.3	0.0	0.0	99.7	0.0
Ba, ppm	0.03035	2.0	0.0	0.0	49.2	26.5	22.3
Ca, ppm	0.01771	2.5	0.0	20.2	0.0	75.5*	1.8
Ce, ppm	0.01530	1.2	0.0	0.0	27.2*	0.0	71.6
Co, ppm	0.02321	0.0	0.0	28.0*	34.1	34.4	3.5
Cr, ppm	0.05073	0.0	39.3*	19.5	0.0	40.6*	0.6
Cu, ppm	0.00793	5.0	4.7	0.0	73.3*	13.4	3.6
Fe, ppm	0.07079	0.0	44.0*	21.8	2.3	31.7*	0.2
Ga, ppm	0.01490	12.3	8.8	0.0	0.1	78.8*	0.0
Hg, ppm	0.02418	0.0	26.6*	4.4	0.0	69.0*	0.0
K, ppm	0.01602	0.0	0.0	12.7	38.4	48.9*	0.0
La, ppm	0.01694	0.0	7.1	34.6*	0.0	50.2	8.1
Li, ppm	0.05850	0.0	0.0	36.0*	0.0	51.9	12.1
Mg, ppm	0.00962	0.0	0.0	0.0	79.4*	19.6*	1.0
Mn, ppm	0.05430	0.0	27.7	0.0	60.3*	11.5*	0.5
Na, ppm	0.08146	0.0	29.4*	6.0	23.1	41.4*	0.1
Nd, ppm	0.02132	0.0	0.0	0.0	25.4	26.4	48.2
Ni, ppm	0.06557	55.3*	1.4	0.0	30.0	13.1*	0.2
P, ppm	0.00945	0.0	13.9	1.0	60.6	23.8*	0.7
Pb, ppm	0.02907	0.0	17.3*	28.1	0.0	54.6*	0.0
S, %	0.00699	28.3*	12.6	21.3	10.0	27.8	0.0
Sr, ppm	0.03279	4.6	0.0	0.0	60.8	33.8*	0.8
Th, ppm	0.01019	0.0	9.0	0.0	76.6*	14.4*	0.0
Ti, ppm	0.17221	0.0	18.9*	20.6	0.0	46.3	14.2
V, ppm	0.11320	0.0	33.2*	17.1	0.5	48.3*	0.9
W, ppm	0.01517	0.0	6.2	0.0	19.7	2.3	71.8
Zn, ppm	0.02973	0.0	16.7	0.0	39.0	44.2*	0.1

* Statistically significant at the 0.05 probability level.

Table 5. Variance mean ratio and estimated number of samples necessary within a cell of specificed size to prepare stable geochemical maps for white spruce.

[Vm, variance mean ratio; n_r, number of samples; 80% and 95%, probability levels]

Variable, unit of measure	---50 km cell---			---25 km cell---			----5 km cell---			--- 1 km cell---		
		n_r			n_r			n_r			n_r	
	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%
Ash, %	1.3	6	>15	0.6	6	>15	0.4	6	>15	3.1	3	4
Al, ppm	---[1]	---	---	1.1	4	9	3.9	3	4	3.3	3	4
As, ppm	---	---	---	---	---	---	---	---	---	<0.1	>15	>15
Ba, ppm	0.2	>15	>15	0.1	>15	>15	<0.1	>15	>15	2.3	3	5
Ca, ppm	0.2	>15	>15	0.1	>15	>15	0.8	4	12	0.5	4	12
Ce, ppm	0.1	>15	>15	0.1	>15	>15	<0.1	>15	>15	1.2	4	9
Co, ppm	---	---	---	---	---	---	0.8	4	9	3.1	3	4
Cr, ppm	---	---	---	2.0	3	7	3.8	3	4	2.6	3	4
Cu, ppm	0.3	14	>15	0.3	8	>15	0.2	8	>15	9.6	2	3
Fe, ppm	---	---	---	2.2	3	6	4.9	3	4	3.8	3	4
Ga, ppm	0.9	7	>15	1.2	5	13	0.7	5	13	0.5	5	13
Hg, ppm	---	---	---	1.5	4	10	1.2	4	9	0.8	4	9
K, ppm	---	---	---	---	---	---	0.3	7	>15	1.9	3	5
La, ppm	---	---	---	0.2	10	>15	2.0	3	6	1.4	3	6
Li, ppm	---	---	---	---	---	---	1.6	3	7	1.1	3	7
Mg, ppm	---	---	---	---	---	---	---	---	---	7.1	2	3
Mn, ppm	---	---	---	1.2	4	10	0.7	4	10	13.5	2	3
Na, ppm	---	---	---	1.5	4	9	1.2	3	7	2.5	3	4
Nd, ppm	---	---	---	---	---	---	---	---	---	0.8	4	10
Ni, ppm	7.7	3	5	4.4	3	4	2.5	3	4	11.8	2	3
P, ppm	---	---	---	0.5	6	>15	0.3	6	>15	5.6	2	3
Pb, ppm	---	---	---	0.6	5	>15	2.2	3	6	1.5	3	6
S, %	1.7	4	9	1.9	3	6	3.8	3	4	4.7	2	3
Sr, ppm	0.3	15	>15	0.2	15	>15	0.1	15	>15	3.4	3	4
Th, ppm	---	---	---	0.3	9	>15	0.2	9	>15	10.7	2	3
Ti, ppm	---	---	---	0.8	5	14	1.9	3	7	1.3	3	7
V, ppm	---	---	---	1.6	3	8	2.7	3	5	1.9	3	5
W, ppm	---	---	---	0.3	12	>15	0.2	12	>15	1.0	4	10
Zn, ppm	---	---	---	0.7	5	>15	0.4	5	>15	2.3	3	5

[1] Not determined

Table 6. Distance-related and procedural variance for pH, ash yield, and element concentrations measured in the O-horizon of soils.

Variable, unit of measure	Total log10 variance	Percentage of variance: 50 km	25 km	5 km	1 km	0.1 km	Procedural error
pH[1]	0.21830	0.0	28.3*	0.3	0.0	70.8*	0.6
Al, %	0.03703	11.4	6.6	29.0	13.9	38.6*	0.5
As, ppm	0.04275	5.0	18.3	0.0	0.0	76.8*	0.0
Ash, %	0.03148	15.5	9.1	0.0	22.4	52.8*	0.2
Ba, ppm	0.05676	0.0	23.0*	0.0	0.0	76.9*	0.1
Ca, %	0.02818	35.9	24.7*	0.0	0.0	38.5*	0.9
Ce, ppm	0.03216	0.0	0.0	34.9	0.0	61.6*	3.5
Co, ppm	0.04683	20.2	31.7*	5.7	0.0	39.0*	3.4
Cr, ppm	0.05009	0.0	12.2	10.1	0.0	17.0	60.7
Cu, ppm	0.00945	0.0	32.3*	20.0	22.4	21.2*	4.3
Fe, %	0.04328	22.2	0.0	38.5*	8.4	30.0*	0.9
Ga, ppm	0.05261	19.7	0.0	11.1	0.0	67.3*	1.9
Hg, ppm	0.02255	16.1*	21.7	0.0	33.6	22.1*	6.5
K, %	0.01962	0.1	10.2	25.9	0.0	58.9*	4.9
La, ppm	0.02716	0.0	21.3	14.9	0.0	63.1*	0.0
Li, ppm	0.03366	1.9	0.0	9.1	26.4	60.9*	1.7
Mg, %	0.03363	36.4*	9.6	16.3	10.1	26.7*	0.9
Mn, ppm	0.23996	6.7	0.0	17.6	0.0	75.8*	0.0
Na, %	0.03769	16.3	2.4	26.9	18.4	35.7*	0.3
Nd, ppm	0.05508	0.0	0.0	43.7	0.0	50.9*	5.5
Ni, ppm	0.03712	0.0	46.9*	1.9	8.4	0.0	42.7
P, %	0.00665	0.3	0.0	4.0	0.0	94.4*	1.3
Pb, ppm	0.14951	0.0	20.1*	0.0	0.0	72.0*	7.9
S, %	0.01210	0.0	12.8	0.0	60.4	18.6*	8.3
Sc, ppm	0.04339	15.0	0.0	30.2	23.3	31.5	0.0
Se, ppm	0.04236	0.0	22.5	33.8*	0.0	7.8	35.9
Sr, ppm	0.02709	9.8	47.4*	0.0	1.9	39.1*	1.8
Ti, %	0.04381	10.3	0.0	36.1	14.8	38.0*	0.8
V, ppm	0.02828	2.2	0.0	37.4	17.6	42.4*	0.4
Y, ppm	0.03888	31.1*	0.0	22.0	20.7	24.8*	1.4
Zn, ppm	0.05521	1.8	0.0	0.7	0.0	97.4*	0.1

[1] Measured in standard units, not transformed to logarithms.

* Statistically significant at the 0.05 probability level.

Table 7. Variance mean ratio and estimated number of samples necessary within a cell of specificed size to prepare stable geochemical maps for the O-horizon of soils.

[Vm, variance mean ratio; n_r, number of samples; 80% and 95%, probability levels]

Variable, unit of measure	---50 km cell---			---25 km cell---			----5 km cell---			--- 1 km cell---		
		n_r			n_r			n_r			n_r	
	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%
pH, std.	---[1]	---	---	1.8	4	9	1.1	4	9	0.7	4	9
Ash, %	1.1	6	>15	1.4	4	12	0.7	4	11	1.6	3	5
Al, ppm	0.6	7	>15	0.6	5	15	2.1	3	5	2.8	3	4
As, ppm	0.3	14	>15	1.4	4	12	0.8	4	12	0.5	4	12
Ba, ppm	---	---	---	1.3	4	12	0.8	4	12	0.5	4	12
Ca, ppm	2.2	3	7	7.0	3	4	4.1	3	4	2.8	3	4
Ce, ppm	---	---	---	---	---	---	1.5	3	7	1.0	3	7
Co, ppm	0.9	5	13	4.2	3	5	3.7	3	4	2.5	3	4
Cr, ppm	---	---	---	0.6	7	>15	1.0	4	12	0.8	4	12
Cu, ppm	---	---	---	1.3	4	8	2.4	3	5	5.7	2	3
Fe, ppm	1.4	4	12	0.7	4	12	3.7	3	4	4.1	3	4
Ga, ppm	1.8	5	14	0.9	5	14	1.2	4	9	0.8	4	9
Hg, ppm	0.8	6	>15	2.2	3	7	1.3	3	7	4.9	2	3
K, ppm	<0.1	>15	>15	0.4	8	>15	1.6	3	7	1.1	3	7
La, ppm	---	---	---	1.0	4	12	1.6	3	7	1.0	3	7
Li, ppm	0.1	>15	>15	0.1	>15	>15	0.3	7	>15	1.1	3	7
Mg, ppm	2.6	3	7	2.5	3	6	3.8	3	4	4.8	2	3
Mn, ppm	0.5	11	>15	0.3	11	>15	0.9	4	11	0.6	4	11
Na, ppm	1.0	5	>15	0.6	5	14	1.9	3	6	3.2	3	4
Nd, ppm	---	---	---	---	---	---	2.1	3	6	1.5	3	6
Ni, ppm	---	---	---	4.3	3	5	3.1	3	5	4.0	3	4
P, ppm	<0.1	>15	>15	<0.1	>15	>15	0.1	>15	>15	0.1	>15	>15
Pb, ppm	---	---	---	1.2	5	13	0.7	5	13	0.5	5	13
S, %	---	---	---	0.5	7	>15	0.3	7	>15	5.6	2	3
Sc, ppm	1.0	6	>15	0.5	6	>15	1.8	3	6	3.9	3	4
Se, ppm	---	---	---	0.8	4	12	4.7	3	4	3.5	3	4
Sr, ppm	0.3	8	>15	5.9	3	4	3.5	3	4	2.6	3	4
Ti, ppm	0.6	8	>15	0.3	8	>15	2.0	3	6	2.9	3	4
V, ppm	0.1	>15	>15	0.1	>15	>15	1.5	3	7	2.4	3	4
Y, ppm	2.5	4	8	1.2	4	8	2.4	3	5	5.2	2	3
Zn, ppm	0.2	>15	>15	0.1	>15	>15	0.1	>15	>15	<0.1	>15	>15

[1] Not determined

Table 8. Distance-related and procedural variance for pH and element concentrations measured in the C-horizon of soils.

Variable, unit of measure	Total log10 variance	Percentage of variance: 50 km	25 km	5 km	1 km	0.1 km	Procedural error
pH[1]	0.05764	0.0	0.0	5.3	47.0*	0.0	47.7
Al, %	0.00090	34.8*	0.0	13.3	11.9	0.0	40.0
As, ppm	0.07052	72.0	14.5*	0.0	0.0	13.0	0.5
Ba, ppm	0.00168	51.2	18.2*	0.0	3.4	21.1	6.1
Ca, %	0.01909	83.9*	1.7	0.0	0.0	13.5*	0.9
Ce, ppm	0.00701	56.0*	0.0	5.1	11.5	15.3	12.1
Co, ppm	0.00610	13.2*	0.0	0.0	66.3*	13.9	6.6
Cr, ppm	0.03239	83.8*	0.6	0.0	1.1	7.9	6.6
Cu, ppm	0.00491	0.0	9.3	0.0	78.8*	8.9	3.0
Fe, %	0.00151	26.5	25.7*	0.0	6.9	13.4	27.5
Ga, ppm	0.00211	0.9	8.1	0.0	0.0	45.8	45.2
Hg, ppm	0.07755	0.0	28.7*	4.1	23.4*	0.0	43.8
K, %	0.00271	0.0	18.2*	0.0	0.0	75.4*	6.4
La, ppm	0.00337	29.7	0.0	25.7*	0.0	35.9	8.7
Li, ppm	0.01340	79.5*	4.3	0.0	0.0	11.5	4.7
Mg, %	0.00361	0.0	15.6*	0.0	0.0	74.8*	9.6
Mn, ppm	0.01201	48.6	26.2*	0.0	15.1*	6.6	3.5
Na, %	0.00106	29.9*	8.2	0.0	27.1	6.8	28.0
Nd, ppm	0.00609	24.2*	0.0	14.7	22.6	0.0	38.5
Ni, ppm	0.07415	70.2*	7.6	0.0	0.0	22.0*	0.2
P, %	0.04476	57.2*	0.0	22.9*	4.9	9.7	5.3
Pb, ppm	0.01096	18.3*	0.0	22.4*	0.0	0.0	59.3
Sc, ppm	0.00280	49.2*	0.0	0.1	31.3*	0.0	19.4
Se, ppm	0.01032	0.0	20.0	0.0	20.9	59.1*	0.0.
Sr, ppm	0.01114	77.6*	1.2	0.0	9.9	10.1*	1.2
Ti, %	0.00233	54.6*	0.1	0.0	0.0	34.2	11.1
V, ppm	0.00522	57.5	14.8*	0.0	0.0	24.9*	2.8
Y, ppm	0.00237	2.3	0.0	31.8	0.0	54.9*	11.0
Yb, ppm	0.01542	0.0	0.2	32.0*	0.0	67.8	0.0
Zn, ppm	0.01007	2.4	6.1	0.0	35.4	0.0	56.1

[1] Measured in standard units, not transformed to logarithms.

* Statistically significant at the 0.05 probability level.

Table 9. Variance mean ratio and estimated number of samples necessary within a cell of specificed size to prepare stable geochemical maps for the C-horizon of soils.

[Vm, variance mean ratio; n_r, number of samples; 80% and 95%, probability levels]

Variable, unit of measure	---50 km cell---			---25 km cell---			----5 km cell---			--- 1 km cell---		
		n_r			n_r			n_r			n_r	
	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%	Vm	80%	95%
pH, std.	---[1]	---	---	---	---	---	0.1	14	>15	3.3	3	5
Al, ppm	3.9	3	8	1.9	3	8	2.8	3	5	4.5	3	4
As, ppm	8.3	2	3	29.3	2	3	17.4	2	3	11.7	2	3
Ba, ppm	4.1	3	5	10.2	3	4	6.1	3	4	5.3	2	3
Ca, ppm	34.7	2	3	27.2	2	3	16.2	2	3	11.0	2	3
Ce, ppm	9.3	3	4	4.6	3	4	3.9	3	4	5.8	2	3
Co, ppm	1.0	6	>15	0.5	6	>15	0.3	6	>15	8.0	2	3
Cr, ppm	44.1	2	3	26.2	2	3	16.0	2	3	12.9	2	3
Cu, ppm	---	---	---	0.3	8	>15	0.2	8	>15	14.8	2	3
Fe, ppm	1.5	4	10	5.3	3	5	3.3	3	5	3.5	3	4
Ga, ppm	0.1	>15	>15	0.5	9	>15	0.3	9	>15	0.2	9	>15
Hg, ppm	---	---	---	1.6	4	9	1.3	4	8	3.9	3	4
K, ppm	---	---	---	1.0	5	15	0.6	5	15	0.4	5	15
La, ppm	2.5	4	9	1.3	4	9	3.5	3	5	2.4	3	5
Li, ppm	21.0	2	3	25.1	2	3	15.3	2	3	10.5	2	3
Mg, ppm	---	---	---	0.9	6	>15	0.5	6	>15	0.3	6	>15
Mn, ppm	2.9	3	5	10.6	2	3	6.1	2	3	18.6	2	3
Na, ppm	2.6	4	9	2.5	3	7	1.5	3	7	5.0	3	4
Nb, ppm	0.3	13	>15	0.3	13	>15	0.5	7	>15	0.4	7	>15
Nd, ppm	1.1	4	11	1.1	4	11	1.7	3	7	4.8	3	4
Ni, ppm	15.8	2	3	15.8	2	3	9.4	2	3	6.3	2	3
P, ppm	3.3	3	4	3.3	3	4	10.2	2	3	11.9	2	3
Pb, ppm	0.8	5	15	0.8	5	15	2.7	3	6	2.1	3	6
Sc, ppm	3.6	3	5	3.6	3	5	2.1	3	5	12.4	2	3
Se, ppm	1.0	5	13	1.0	5	13	0.6	5	13	1.2	3	6
Sr, ppm	13.7	2	3	13.7	2	3	7.9	2	3	14.7	2	3
Ti, ppm	5.8	3	5	5.8	3	5	3.5	3	5	2.4	3	5
V, ppm	12.0	2	3	12.0	2	3	7.2	2	3	4.9	2	3
Y, ppm	0.1	>15	>15	0.1	>15	>15	1.5	3	8	1.0	3	8
Yb, ppm	<0.1	>15	>15	<0.1	>15	>15	1.3	4	8	0.9	4	8
Zn, ppm	0.4	9	>15	0.4	9	>15	0.2	9	>15	2.4	3	6

[1] Not determined

Table 10. Coefficient of determination between logarithmic distance and element concentration, or ash yield for white spruce and feather moss along three transects.

Variable, unit of measure	East Transect		North Transect		South Transect	
	Spruce	Moss	Spruce	Moss	Spruce	Moss
Ash, %	0.12	0.31	0.64	0.49	0.19	0.36
Al, %	0.19	0.48	0.03	0.56	0.12	0.32
As, ppm	0.21	0.16	0.02	0.08	0.15	0.04
Ba, ppm	0.45	<0.01	0.48	0.35	0.12	0.05
Ca, %	0.42	<0.01	0.81	0.11	0.04	0.18
Ce, ppm	0.12	0.40	0.11	0.56	0.17	0.31
Co, ppm	0.08	0.11	0.07	0.61	0.01	0.23
Cr, ppm	0.38	0.02	0.19	0.52	0.20	0.03
Cu, ppm	0.46	0.05	0.11	0.49	0.35	0.26
Fe, %	0.15	0.34	0.11	0.61	0.11	0.24
Ga, ppm	0.07	0.35	0.12	0.49	0.19	0.28
Hg, ppm	0.19	0.14	0.14	0.02	0.02	0.21
K, %	0.30	0.02	0.04	0.45	0.14	0.31
La, ppm	0.18	0.23	0.36	0.50	0.28	0.25
Li, ppm	0.49	0.09	<0.01	0.58	0.20	0.14
Mg, %	<0.01	<0.01	0.48	0.49	0.03	0.45
Mn, ppm	0.07	0.08	0.18	<0.01	0.04	<0.01
Na, %	0.10	0.55	0.27	0.58	0.13	0.42
Nd, ppm	0.27	0.25	0.03	0.44	0.05	0.24
Ni, ppm	0.23	0.06	<0.01	0.56	0.18	0.16
P, %	0.46	0.18	0.16	<0.01	0.25	0.05
Pb, ppm	0.48	0.32	0.10	0.18	<0.01	0.01
S, %	0.62	0.17	0.64	0.50	0.27	0.62
Sc, ppm	-.-	0.40	-.-	0.52	-.-	0.22
Se, ppm	-.-	0.23	-.-	0.25	-.-	0.16
Sr, ppm	0.36	0.01	0.62	0.01	<0.01	0.21
Th, ppm	0.21	-.-	<0.01	-.-	0.28	-.-
Ti, %	0.28	0.44	0.01	0.58	0.34	0.26
V, ppm	0.16	0.45	0.13	0.58	0.03	0.29
W, ppm	0.01	-.-	0.24	-.-	0.03	-.-
Y, ppm	-.-	0.64	-.-	0.53	-.-	0.46
Yb, ppm	-.-	0.62	-.-	0.46	-.-	0.45
Zn, ppm	0.11	0.01	0.30	0.40	0.02	0.31

Table 11. Regression equations for variables in plants and soils with coefficients of determination greater than 0.50.

Variable	Transect direction	Sample medium	Regression equation[1]	N[2]	CD[3]
Ash	North	White spruce	Log Ash= 0.43 +0.13 LogX	14	0.64
Aluminum	East	C horizon	Log Al = 0.92 -0.03 LogX	12	0.62
	North	Feather moss	Log Al = 4.02 -0.31 LogX	14	0.56
Arsenic	East	B horizon	Log As = 0.62 +0.21 LogX	12	0.58
	North	B horizon	Log As = 0.64 +0.00 LogX	14	0.62
		C horizon	Log As = 0.72 +0.24 LogX	15	0.69
Calcium	East	B horizon	Log Ca = 0.40 -0.12 LogX	12	0.74
		C horizon	Log Ca = 0.32 -0.11 LogX	12	0.72
	North	White spruce	Log Ca = 3.48 +0.25 LogX	14	0.81
		C horizon	Log Ca = 0.32 -0.13 LogX	15	0.74
Cerium	North	Feather moss	Log Ce = 0.62 -0.32 LogX	14	0.56
Cobalt	North	Feather moss	Log Co = 0.34 -0.22 LogX	14	0.61
Chromium	East	B horizon	Log Cr = 1.44 +0.20 LogX	12	0.60
		C horizon	Log Cr = 1.67 +0.16 LogX	12	0.71
	North	Feather moss	Log Cr = 0.84 -0.21 LogX	14	0.52
		B horizon	Log Cr = 1.37 +0.26 LogX	14	0.69
		C horizon	Log Cr = 1.59 +0.19 LogX	15	0.67
Copper	North	O horizon	Log Cu = 1.21 -0.10 LogX	13	0.71
Iron	North	Feather moss	Log Fe = 3.66 -0.28 LogX	14	0.61
Gallium	East	C horizon	Log Ga = 1.29 -0.05 LogX	12	0.53
Mercury	East	C horizon	Log Hg =-1.06 -0.27 LogX	12	0.59
	South	C horizon	Log Hg =-1.06 -0.33 LogX	11	0.69
Lanthanum	North	Feather moss	Log La = 0.38 -0.18 LogX	14	0.50
Lithium	East	B horizon	Log Li = 1.21 +0.13 LogX	12	0.66
		C horizon	Log Li = 1.39 +0.06 LogX	12	0.62
	North	Feather moss	Log Li = 0.33 -0.23 LogX	14	0.58
		C horizon	Log Li = 1.33 +0.13 LogX	15	0.59
	South	B horizon	Log Li = 1.22 +0.10 LogX	10	0.64
Sodium	East	Feather moss	Log Na = 3.59 -0.20 LogX	14	0.55
	North	Feather moss	Log Na = 3.60 -0.32 LogX	14	0.58
Nickel	East	B horizon	Log Ni = 0.81 +0.22 LogX	12	0.52
		C horizon	Log Ni = 1.15 +0.19 LogX	12	0.77
	North	Feather moss	Log Ni = 0.56 -0.16 LogX	14	0.56
		B horizon	Log Ni = 0.68 +0.31 LogX	14	0.58
		C horizon	Log Ni = 1.00 +0.31 LogX	15	0.72
Phosphorus	East	C horizon	Log P =-1.01 -0.10 LogX	12	0.67
	South	B horizon	Log P =-1.13 +0.23 LogX	10	0.83
Sulfur	East	White spruce	Log S =-1.04 -0.12 LogX	11	0.62
	North	Feather moss	Log S =-0.91 -0.12 LogX	14	0.50
		White spruce	Log S =-1.03 -0.09 LogX	14	0.64
	South	Feather moss	Log S =-0.95 -0.12 LogX	14	0.62
Scandium	East	B horizon	Log Sc = 0.95 +0.06 LogX	12	0.50
	North	Feather moss	Log Sc = 0.17 -0.26 LogX	14	0.52
Selenium	East	C horizon	Log Se =-0.03 -0.19 LogX	12	0.66
Strontium	East	B horizon	Log Sr = 2.57 -0.13 LogX	12	0.76
	North	White spruce	Log Sr = 1.21 +0.29 LogX	14	0.62
		C horizon	Log Sr = 2.49 -0.12 LogX	15	0.67
Titanium	East	B horizon	Log Ti =-0.47 +0.06 LogX	12	0.72
	North	Feather moss	Log Ti = 2.68 -0.30 LogX	14	0.58
Vanadium	North	Feather moss	Log V = 1.18 -0.30 LogX	14	0.58
Yttrium	East	Feather moss	Log Y = 0.48 -0.24 LogX	14	0.64
		C horizon	Log Y = 1.16 -0.04 LogX	12	0.53
	North	Feather moss	Log Y = 0.47 -0.32 LogX	14	0.53
Ytterbium	East	Feather moss	Log Yb =-0.46 -0.24 LogX	14	0.62

[1] LogX is distance, in kilometers.
[2] Number of samples.
[3] Coefficient of determination

Table 12. Coefficient of determination between logarithmic distance and element concentrations, pH, or ash yield for three soil horizons along three transects.

Variable, unit of measure	East Transect, horizon			North Transect, horizon			South Transect, horizon		
	O2	B	C	O2	B	C	O2	B	C
pH[1]	0.17	0.05	0.06	0.07	0.01	0.21	<0.01	0.38	0.03
Ash, %	0.01	-.-	-.-	0.18	-.-	-.-	0.37	-.-	-.-
Al, %	0.03	0.37	0.62	0.26	0.08	0.24	0.36	0.06	<0.01
As, ppm	0.22	0.58	0.46	0.03	0.62	0.69	0.03	0.12	<0.01
Ba, ppm	0.12	0.14	0.49	0.02	0.02	0.30	<0.01	0.08	0.05
Ca, %	0.02	0.74	0.72	0.21	0.36	0.74	0.11	0.12	<0.01
Ce, ppm	0.10	0.34	0.02	0.06	0.02	0.38	0.30	0.01	0.01
Co, ppm	0.08	0.08	0.03	0.44	0.03	0.16	0.07	0.19	0.01
Cr, ppm	<0.01	0.60	0.71	0.10	0.69	0.67	0.06	0.23	0.12
Cu, ppm	0.04	0.15	0.16	0.71	0.21	<0.01	0.31	0.49	0.23
Fe, %	<0.01	0.12	0.19	0.31	0.05	0.07	0.27	0.14	<0.01
Ga, ppm	<0.01	0.01	0.53	0.10	0.05	0.16	0.30	0.25	<0.01
Hg, ppm	0.21	0.37	0.59	0.08	0.24	0.42	0.08	0.41	0.69
K, %	<0.01	<0.01	0.37	0.04	0.04	0.04	0.27	0.01	0.02
La, ppm	0.02	0.08	0.05	0.01	<0.01	0.46	0.21	0.21	0.01
Li, ppm	0.02	0.66	0.62	0.09	0.05	0.59	0.21	0.64	0.05
Mg, %	0.04	0.03	0.41	0.30	0.07	0.07	0.30	0.08	0.13
Mn, ppm	0.14	<0.01	0.42	0.20	0.10	0.04	0.04	0.12	0.07
Na, %	0.03	0.21	0.06	0.24	0.07	0.36	0.30	0.01	0.07
Nb, ppm	-.-	0.22	0.34	-.-	0.02	0.04	-.-	0.45	0.01
Nd, ppm	0.10	0.14	0.32	0.01	<0.01	0.26	0.36	0.12	<0.01
Ni, ppm	<0.01	0.52	0.77	<0.01	0.58	0.72	0.10	0.30	0.10
P, %	0.38	0.03	0.67	0.41	0.02	0.27	0.32	0.83	0.21
Pb, ppm	0.08	0.01	0.25	0.16	0.01	0.01	0.08	<0.01	0.04
S, %	0.03	-.-	-.-	0.08	-.-	-.-	0.01	-.-	-.-
Sc, ppm	<0.01	0.50	0.24	0.09	<0.01	0.14	0.37	0.18	0.06
Se, ppm	0.01	0.21	0.66	0.02	0.14	0.27	0.03	<0.01	0.30
Sr, ppm	<0.01	0.76	0.42	0.10	0.32	0.67	0.03	0.14	0.01
Ti, %	<0.01	0.72	0.31	0.18	0.02	0.02	0.34	0.27	0.03
V, ppm	0.01	0.46	<0.01	0.27	0.29	0.03	0.34	0.14	0.01
Y, ppm	<0.01	0.01	0.53	0.24	0.07	<0.01	0.30	0.06	0.02
Yb, ppm	-.-	0.16	-.-	-.-	0.15	<0.01	-.-	0.04	0.04
Zn, ppm	0.01	<0.01	0.05	0.30	<0.01	0.13	0.05	0.07	0.01

[1] Measured in standard units, not transformed to logarithms.

Table 13. Baseline data for element concentrations in samples of surficial materials from Alaska (Gough and others, 1988).

Variable, unit of measure	Geometric mean	Geometric deviation	Observed range
pH[1]	5.5	1.20	3.7 - 9.0
Al, %	6.2	1.38	1.2 - 10
As, ppm	6.7	2.31	<10 - 750
Ash, %	85	1.33	6.6 - 99.7
Ba, ppm	595	1.67	39 -3100
Ca, %	1.3	2.61	0.04- 10
Ce, ppm	28	1.84	<5 - 180
Co, ppm	13	1.67	<2 - 55
Cr, ppm	50	2.00	5 - 390
Cu, ppm	24	1.81	3 - 810
Fe, %	3.5	1.52	0.55- 10
Ga, ppm	15	1.44	<4 - 32
K, %	1.2	1.57	0.09- 4.1
La, ppm	19	1.68	<2 - 120
Li, ppm	26	1.74	<2 - 130
Mg, %	0.98	1.84	0.13- 7.4
Mn, ppm	510	2.07	<200 -4000
Na, %	1.2	1.74	<0.07- 3.6
Nd, ppm	23	1.73	<4 - 120
Ni, ppm	24	2.17	<3 - 320
P, %	0.078	1.55	<0.02- 0.34
Pb, ppm	12	1.74	<4 - 310
Sc, ppm	13	1.67	<2 - 39
Sr, ppm	159	1.93	21 - 760
Ti, %	0.48	1.48	0.09- 1.5
V, ppm	112	1.69	11 - 490
Y, ppm	14	1.55	<4 - 100
Yb, ppm	1.4	1.60	<1 - 6
Zn, ppm	70	1.64	<20 -2700

[1] Measured in standard units, not transformed to logarithms.

Table 14. Summary statistics for element concentrations in soil O2-horizon samples from the barbell sample design.

[Detection ratio, number of samples in which the element was found in measurable concentrations relative to the number of samples analyzed; Baseline, expected 95-percent range.]

Variable, unit of measure	Detection ratio	Geometric mean	Geometric deviation	Baseline
pH[1]	24:24	4.00	1.09	3.37- 4.75
Al, %	24:24	2.0	1.52	0.87- 4.6
Ash, %	24:24	30.4	1.47	14.4 - 65.7
As, ppm	24:24	0.7	1.50	0.3 - 1.5
Ba, ppm	24:24	310	1.39	160 - 610
Ca, %	24:24	1.2	1.37	0.63- 2.2
Ce, ppm	24:24	9	1.46	4 - 21
Co, ppm	24:24	4	1.55	2 - 11
Cr, ppm	24:24	17	1.56	6 - 42
Cu, ppm	24:24	12	1.22	9 - 18
Fe, %	24:24	0.97	1.52	0.42- 2.2
Ga, ppm	16:24	5	1.58	2 - 12
Hg, ppm	24:24	0.19	1.34	0.10- 0.34
K, %	24:24	0.41	1.35	0.22- 0.74
La, ppm	24:24	6	1.42	4 - 12
Li, ppm	24:24	5	1.50	2 - 10
Mg, %	24:24	0.34	1.45	0.16- 0.72
Mn, ppm	24:24	570	2.04	140 -2300
Na, %	24:24	0.70	1.52	0.30- 1.6
Nd, ppm	17:24	5	1.59	2 - 13
Ni, ppm	24:24	7	1.46	3 - 16
P, %	24:24	0.14	1.13	0.11- 0.18
Pb, ppm	17:24	5	1.92	1 - 18
S, %	24:24	0.11	1.25	0.07- 0.18
Sc, ppm	24:24	4	1.51	2 - 9
Se, ppm	24:24	0.2	1.46	0.1 - 0.4
Sr, ppm	24:24	120	1.40	63 - 240
Ti, %	24:24	0.12	1.54	0.05- 0.28
V, ppm	24:24	31	1.46	14 - 71
Y, ppm	24:24	5	1.47	2 - 12
Zn, ppm	24:24	44	1.57	17 - 110

[1] Measured in standard units, not transformed to logarithms.

Table 15. Summary statistics for element concentrations in soil C-horizon samples from the barbell sample design.

[Detection ratio, number of samples in which the element was found in measurable concentrations relative to the number of samples analyzed; Baseline, expected 95-percent range.]

Variable, unit of measure	Detection ratio	Geometric mean	Geometric deviation	Baseline
pH[1]	24:24	5.51	1.03	5.19- 5.85
Al, %	24:24	7.2	1.05	6.5 - 7.9
As, ppm	24:24	7.2	1.59	2.8 - 18.
Ba, ppm	24:24	570	1.08	490 -670
Ca, %	24:24	1.7	1.26	1.1 - 2.7
Ce, ppm	24:24	31	1.17	23 - 42
Co, ppm	24:24	13	1.15	10 - 17
Cr, ppm	24:24	57	1.37	31 -110
Cu, ppm	24:24	18	1.14	14 - 23
Fe, %	24:24	3.5	1.08	3.0 - 4.1
Ga, ppm	24:24	17	1.08	14 - 19
Hg, ppm	24:24	0.03	1.52	0.02- 0.07
K, %	24:24	0.95	1.08	0.81- 1.1
La, ppm	24:24	17	1.12	14 - 22
Li, ppm	24:24	25	1.22	17 - 38
Mg, %	24:24	0.91	1.09	0.77- 1.1
Mn, ppm	24:24	660	1.22	440 -980
Na, %	24:24	2.0	1.06	1.7 - 2.2
Nb, ppm	24:24	5	1.39	2 - 9
Nd, ppm	24:24	15	1.15	11 - 20
Ni, ppm	24:24	17	1.60	7 - 44
P, %	24:24	0.08	1.46	0.03- 0.17
Pb, ppm	24:24	10	1.18	7 - 14
Sc, ppm	24:24	11	1.10	9 - 14
Se, ppm	24:24	0.4	1.22	0.3 - 0.6
Sr, ppm	24:24	250	1.20	180 -370
Ti, %	24:24	0.39	1.08	0.33- 0.46
V, ppm	24:24	110	1.13	88 -140
Y, ppm	24:24	12	1.10	10 - 15
Yb, ppm	24:24	2	1.22	1 - 3
Zn, ppm	24:24	56	1.18	39 - 81

[1] Measured in standard units, not transformed to logarithms.

Table 16. Summary statistics for element concentrations in feather moss samples from the barbell sample design.

[Detection ratio, number of samples in which the element was found in measurable concentrations relative to the number of samples analyzed; Baseline, expected 95-percent range.]

Variable, unit of measure	Detection ratio	Geometric mean	Geometric deviation	Baseline
Al, %	21:21	5.0	1.29	3.0 - 8.3
As, ppm	21:21	0.1	1.64	<0.1 - 0.3
Ash, %	21:21	7.47	1.48	3.41- 16.4
Ba, ppm	21:21	930	1.45	440 -2000
Ca, %	21:21	9.2	1.33	5.2 - 16.
Ce, ppm	21:21	18	1.29	11 - 30
Co, ppm	21:21	14	1.26	9 - 22
Cr, ppm	21:21	46	1.19	32 - 65
Cu, ppm	21:21	61	1.34	34 - 110
Fe, %	21:21	2.4	1.23	1.6 - 3.6
Ga, ppm	21:21	12	1.15	9 - 16
Hg, ppm	21:21	0.09	1.37	0.05- 0.17
K, %	21:21	5.6	1.51	2.5 - 13.
La, ppm	21:21	16	1.10	13 - 19
Li, ppm	21:21	12	1.18	9 - 17
Mg, %	21:21	2.2	1.26	1.4 - 3.5
Mn, %	21:21	0.60	1.75	0.20- 1.8
Na, %	21:21	1.8	1.28	1.1 - 2.9
Nd, ppm	21:21	17	1.22	11 - 25
Ni, ppm	21:21	26	1.30	15 - 44
P, %	21:21	1.6	1.57	0.65- 3.9
Pb, ppm	21:21	27	2.29	5 - 140
S, %	21:21	0.07	1.21	0.05- 0.10
Sc, ppm	21:21	8	1.25	5 - 13
Se, ppm	21:21	0.1	1.73	<0.1 - 0.3
Sr, ppm	21:21	600	1.35	330 -1100
Ti, %	21:21	0.23	1.28	0.14- 0.38
V, ppm	21:21	71	1.25	45 - 110
Y, ppm	21:21	13	1.24	8 - 20
Zn, ppm	21:21	450	1.72	150 -1300

Table 17. Summary statistics for element concentrations in white spruce samples from the barbell sample design.

[Detection ratio, number of samples in which the element was found in measurable concentrations relative to the number of samples analyzed; Baseline, expected 95-percent range.]

Variable, unit of measure	Detection ratio	Geometric mean	Geometric deviation	Baseline
Al, %	22:22	5.4	1.73	1.8 - 16.
Ash, %	22:22	3.75	1.13	2.94- 4.79
Ba, ppm	22:22	400	1.43	200 - 820
Ca, %	22:22	16	1.18	11 - 22
Co, ppm	22:22	5	1.34	3 - 9
Cr, ppm	22:22	14	1.50	6 - 32
Cu, ppm	22:22	72	1.22	48 - 110
Fe, %	22:22	0.29	1.66	0.11- 0.80
Hg, ppm	22:22	0.02	1.33	0.01- 0.04
K, %	22:22	14	1.37	7.5 - 26
La, ppm	22:22	7	1.24	5 - 11
Mg, %	22:22	2.7	1.19	1.9 - 3.8
Mn, %	22:22	1.0	1.68	0.35- 2.8
Na, %	22:22	0.26	1.75	0.09- 0.80
Ni, ppm	22:22	23	1.59	9 - 58
P, %	22:22	4.0	1.30	2.4 - 6.8
S, %	22:22	0.07	1.19	0.05- 0.10
Sr, ppm	22:22	1000	1.34	560 -1800
Ti, %	18:22	0.02	2.33	<0.01- 0.11
V, ppm	22:22	6	2.07	1 - 26
Zn, ppm	22:22	1100	1.46	520 -2300

Table 18. Correlation coeffients between element concentrations in the O2- and C-horizons of soils and two plants and also between the two plants.

[*, correlation coeffient is significant at the 0.01 probability level when greater than 0.354 for 50 degrees of freedom]

Variable, unit of measure	O-horizon-Feather Moss n=51	O-horizon-White Spruce n=54	C-horizon-Feather Moss n=51	C-horizon-White Spruce n=54	White spruce-Feather moss n=53
Ash, %	0.34	0.10	----[1]	----	0.57*
Al, ppm	0.50*	0.31	0.34	0.21	0.24
As, ppm	0.33	0.13	-0.05	-0.06	0.56*
Ba, ppm	0.80*	-0.06	0.09	0.17	-0.15
Ca, ppm	-0.50*	-0.20	-0.33	-0.35	0.52*
Ce, ppm	0.39*	0.13	0.05	-0.25	0.21
Co, ppm	0.25	0.45*	0.19	-0.06	0.16
Cr, ppm	0.05	-0.04	0.30	0.08	0.54*
Cu, ppm	-0.37*	0.22	-0.16	0.20	-0.25
Fe, ppm	0.47*	0.35	-0.18	0.06	0.40*
Ga, ppm	0.28	0.18	0.08	0.27	0.30
Hg, ppm	0.24	0.06	0.16	0.21	0.38*
K, ppm	-0.19	0.12	0.05	-0.14	-0.17
La, ppm	0.32	0.32	0.13	0.30	0.38*
Li, ppm	0.45*	0.27	0.03	-0.05	0.59*
Mg, ppm	-0.21	-0.01	0.28	-0.19	-0.05
Mn, ppm	0.06	-0.04	-0.13	-0.04	0.03
Na, ppm	0.48*	0.34	-0.05	0.11	0.41*
Nd, ppm	0.12	0.35	0.20	0.04	-0.06
Ni, ppm	0.17	0.01	0.42*	-0.10	0.35*
P, ppm	0.23	-0.15	-0.29	0.19	-0.11
Pb, ppm	0.54*	0.90*	-0.24	0.00	0.59*
S, %	0.20	0.19	----	----	0.57*
Sc, ppm	0.36	0.17	0.01	0.02	0.33
Se, ppm	0.10	----	0.26	----	----
Sr, ppm	-0.17	0.14	-0.15	0.00	0.60*
Ti, ppm	0.32	0.31	-0.31	0.06	0.23
V, ppm	0.44*	0.30	-0.15	0.06	0.28
Y, ppm	0.43*	0.13	0.30	0.14	0.12
Zn, ppm	0.34	0.39*	0.25	0.29	0.09

[1] Not determined.

EXPLANATION OF APPENDIXES

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Tables A1, A2, A6, and A7

These four tables give the sample identification, location, and chemical composition of the plant samples taken in this study of the Kenai, Alaska area. The sample identifications are keyed as follows:

Barbell Study: first position (H or P) for feather moss or white spruce; second position (1 or 2) for the 50 km level; third position (1 or 2) for the 25 km level; forth position (1 or 2) for the 5 km level; fifth position (1 or 2) for the 1 km level; sixth position (1 or 2) for the 0.1 km level; and, seventh position (blank or X) for laboratory duplicates.

Transect Studies: first position (H or P) for feather moss or white spruce; second position (K) for the Kenai study of 1988; third position (T) for the transect; forth position (E, N, or S) for which of the transects (east, north, or south); fifth and sixth position for the distance in km away from the industrial complex at Kenai, Alaska (.5, 01, 02, 04, 08, 16, 32, or 64); seventh position (1 or 2) for field duplicates about 10 m apart; and, eighth position (blank or X) for laboratory duplicates.

Tables A3, A4, A5, and A8

These four tables give the sample identification, location, and chemical composition of the soil horizon samples taken in this study of the Kenai, Alaska area. The sample identifications are keyed as follows:

Barbell Study: first position (S) for soil sample; second position (O, B, or C) for the soil horizon sampled; third position (1 or 2) for the 50 km level; forth position (1 or 2) for the 25 km level; fifth position (1 or 2) for the 5 km level; sixth position (1 or 2) for the 1 km level; seventh position (1 or 2) for the 0.1 km level; and, eighth position (1 or 2) for laboratory duplicates.

Transect Studies: first position (S) for soil sample; second position (O, B, or C) for the soil horizon sampled; third position (K) for the Kenai study of 1988; forth position (T) for the transect or X for laboratory duplicate; fifth position (E, N, or S) for which of the transects (east, north, or south); sixth and seventh position for the distance in km away from the industrial complex at Kenai, Alaska (.5, 01, 02, 04, 08, 16, 32, or 64); and, eighth position (1 or 2) for field duplicates about 10 m apart.

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Figure 1.--Index map showing location of the Kenai National Wildlife Refuge, Alaska.

Table A1. Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barball and transect sampling designs.

Sample ID	Latitude	Longitude	Ash, %	Al, %	As, ppm	Ba, ppm	Ca, %	Cd, ppm	Ce, ppm	Co, ppm
					Barbell Sampling Design					
H11111	604528	1503023	6.27	5.8	0.2	880	5.8	7	24	13
H11121	604503	1503022	6.37	4.3	0.2	1800	10	<4	20	12
H11211	604359	1503640	6.38	5.7	0.2	1300	7.6	<4	25	13
H11211X	604359	1503640	6.35	5.5	0.1	1300	7.2	<4	24	14
H11221	604354	1503608	5.28	5.4	0.2	1100	6.9	<4	23	15
H12111	604422	1500426	6.12	4.0	0.2	1400	12	<4	20	13
H12112	604422	1500426	4.52	4.4	0.2	470	10	<4	20	15
H12112X	604422	1500426	4.75	4.4	0.1	600	9.9	<4	19	14
H12121	604407	1500458	4.73	3.5	0.1	750	13	<4	16	13
H12211	604257	1500849	5.67	4.0	0.1	790	13	<4	18	14
H12212	604250	1500849	5.90	2.8	0.1	380	18	<4	13	14
H12221	604317	1500752	3.57	3.2	0.1	600	14	<4	8	26
H21111	601516	1511049	5.48	4.7	0.1	1200	9.5	<4	15	10
H21112	601516	1511049	7.22	4.8	0.1	1400	11	<4	18	12
H21121	601507	1511154	9.45	6.0	0.3	1300	8.7	<4	23	25
H21211	601720	1511459	12.8	6.4	0.3	1000	7.5	<4	23	19
H21211X	601720	1511459	12.0	6.4	0.2	1000	7.5	<4	23	20
H21212	601720	1511459	10.2	5.9	0.2	960	6.7	<4	17	17
H21221	601659	1511420	10.4	5.6	0.3	1200	7.9	<4	20	13
H22111	601516	1511049	10.3	6.4	0.1	840	7.9	<4	15	13
H22121	595907	1512720	10.4	6.3	0.0	870	7.5	<4	17	14
H22211	595934	1512206	14.1	6.3	0.1	920	7.9	<4	17	13
H22212	595934	1512206	12.5	6.6	0.1	860	7.7	<4	18	12
H22221	595917	1512312	10.7	6.2	0.0	700	7.9	<4	16	14
					East Transect					
HKTE011	603949	1511845	15.6	7.0	0.3	1000	5.7	<4	24	12
HKTE011	604034	1512121	10.9	6.4	0.2	1200	6.1	<4	25	15
HKTE012	604034	1512121	11.8	6.8	0.2	1000	5.1	<4	24	15
HKTE012X	604034	1512121	11.6	6.6	0.2	1000	5	<4	29	15
HKTE021	604031	1512024	12.6	6.7	0.2	980	4.9	<4	28	15
HKTE022	604030	1512024	16.0	6.9	0.3	1000	5.1	<4	25	15
HKTE042	603949	1511845	17.6	7.2	0.2	870	5.3	<4	25	13
HKTE081	604041	1511220	10.8	5.8	0.1	1300	8.2	<4	19	17
HKTE082	604041	1511220	10.4	6.6	0.1	990	5.7	<4	27	18
HKTE082X	604041	1511220	10.0	6.4	0.1	970	5.6	<4	26	17
HKTE161	603830	1510340	15.8	6.4	0.6	4900	5.7	<4	23	22
HKTE162	603830	1510340	12.4	5.8	0.4	3300	7	<4	19	18
HKTE321	603540	1504702	10.2	5.5	0.4	1600	7.4	<4	24	14
HKTE321X	603540	1504702	10.3	5.5	0.4	1500	7.2	<4	24	16
HKTE322	603540	1504702	13.1	5.3	0.4	1300	7.7	<4	24	14
HKTE641	602723	1501550	6.13	4.8	0.3	1200	8.4	<4	19	16
HKTE642	602722	1501520	7.95	5.0	0.4	820	8.3	<4	23	17

Table A1.--Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barbell and transect sampling designs (continued).

Sample ID	Latitude	Longitude	Ash, %	Al, %	As, ppm	Ba, ppm	Ca, %	Cd, ppm	Ce, ppm	Co, ppm
					North Transect					
HKTN011	604112	1512137	17.0	6.7	0.2	1100	5.0	<4	27	16
HKTN012	604112	1512137	14.9	6.9	0.3	1100	4.9	<4	27	15
HKTN021	604118	1512106	7.60	5.7	0.2	1200	6.3	<4	22	15
HKTN022	604118	1512106	10.7	6.6	0.2	990	5.0	<4	25	15
HKTN041	604142	1511853	8.44	6.3	0.3	1100	5.1	<4	28	15
HKTN042	604142	1511853	14.8	6.6	0.5	1100	5.8	<4	26	16
HKTN081	604241	1511338	13.2	6.2	0.1	970	5.8	<4	16	14
HKTN082	604241	1511338	11.4	6.6	0.2	1200	6.5	<4	27	13
HKTN161	604328	1510707	7.74	6.0	0.2	1200	7.1	7	24	15
HKTN162	604328	1510706	9.38	6.1	0.2	1200	7.2	<4	27	15
HKTN321	604407	1504630	9.86	5.9	0.2	1200	6.9	<4	24	10
HKTN322	604406	1504630	7.55	5.1	0.2	1300	8.7	<4	18	14
HKTN641	604158	1501028	5.74	4.0	0.2	1400	13	<4	17	14
HKTN642	604158	1501028	5.80	2.7	0.2	340	18	<4	9	14
					South Transect					
HKTS011	603956	1512149	15.0	6.9	0.2	1000	5.5	<4	25	12
HKTS011X	603956	1512149	14.9	7.0	0.2	1100	5.4	<4	28	15
HKTS012	603956	1512149	15.9	7.1	0.3	1000	5	<4	29	15
HKTS021	603933	1512127	12.1	6.4	0.2	780	5.4	<4	23	12
HKTS022	603933	1512127	10.3	5.4	0.2	850	6.3	<4	22	15
HKTS041	603858	1511943	14.2	6.7	0.1	840	5.9	<4	25	17
HKTS042	603858	1511943	17.4	7.5	0.2	720	5.3	<4	24	14
HKTS081	602535	1511949	16.2	6.8	0.6	1800	5.6	<4	25	18
HKTS082	603525	1511949	16.8	6.8	0.6	1500	5.3	<4	25	17
HKTS161	603252	1511253	8.75	6.2	0.3	1300	6.1	<4	25	17
HKTS162	603252	1511253	10.1	6.2	0.4	1500	6.9	<4	23	18
HKTS321	602732	1505735	14.8	7.3	0.4	930	5.1	<4	30	16
HKTS322	602732	1505735	9.80	6.6	0.5	1000	4.9	<4	24	13
HKTS641	601516	1511049	5.67	4.6	0.1	920	8.9	<4	17	12
HKTS642	601516	1511049	7.16	4.7	0.2	1400	11	<4	20	12

Table A1.--Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barbell and transect sampling designs (continued).

Sample ID	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm
					Barbell Sampling Design					
H11111	52	69	2.7	14	0.08	8.5	18	13	1.9	4800
H11121	51	64	2.2	10	0.10	7.1	17	12	2.4	7200
H11211	53	61	2.7	15	0.06	5.4	18	14	1.5	6700
H11211X	51	57	2.5	13	0.06	5.7	19	14	1.5	6800
H11221	57	74	2.5	14	0.08	9.6	17	13	2.7	12000
H12111	50	89	2.2	12	0.17	6.3	18	13	2.6	12000
H12112	57	110	2.4	12	0.13	6.9	17	13	2.9	11000
H12112X	43	110	2.3	13	0.15	7.0	18	13	2.9	11000
H12121	47	89	1.7	12	0.11	8.8	17	10	2.9	15000
H12211	48	78	2.0	12	0.12	6.9	17	12	2.3	13000
H12212	37	61	1.4	11	0.09	6.3	15	10	2.4	8500
H12221	36	100	1.6	9	0.07	11	14	9	3.9	8600
H21111	40	56	2.1	9	0.06	8.8	16	10	2.0	3500
H21112	29	50	2.1	10	0.06	6.4	17	10	1.8	4300
H21121	44	59	2.6	13	0.08	3.7	18	14	2.2	4900
H21211	56	43	3.0	12	0.05	2.6	18	16	2.4	1600
H21211X	53	43	2.8	13	0.05	2.9	18	16	2.5	1700
H21212	51	46	2.7	11	0.08	3.7	17	13	1.9	3500
H21221	52	50	2.5	12	0.08	5.0	17	15	1.6	4400
H22111	43	52	2.8	13	0.08	4.1	14	10	1.9	4000
H22121	43	50	2.7	13	0.08	4.7	14	11	2.0	6800
H22211	39	56	2.8	14	0.16	2.8	14	10	1.8	6100
H22212	42	40	2.8	12	0.08	3.4	15	10	1.7	3800
H22221	44	41	2.7	14	0.08	4.7	14	10	1.9	4100
					East Transect					
HKTE011	46	53	3.2	14	0.30	3.7	17	14	1.7	3300
HKTE011	42	48	2.7	16	0.11	5.0	17	14	1.5	3300
HKTE012	41	49	2.9	13	0.09	4.4	17	14	1.6	2800
HKTE012X	41	48	3.0	15	0.09	4.5	17	14	1.6	2800
HKTE021	33	53	2.9	15	0.08	4.6	18	15	1.6	3200
HKTE022	48	48	3.2	16	0.08	3.3	17	15	1.9	4200
HKTE042	44	50	3.2	16	0.14	3.0	17	14	1.6	2900
HKTE081	40	51	2.5	13	0.09	5.9	16	11	2.5	6200
HKTE082	47	67	3.0	16	0.18	5.6	17	13	2.3	11000
HKTE082X	45	67	3.0	14	0.17	5.5	17	13	2.2	11000
HKTE161	69	58	3.1	14	0.10	3.5	19	17	1.8	5200
HKTE162	56	67	2.7	17	0.09	5.0	17	15	2.5	9400
HKTE321	75	59	2.8	12	0.10	4.5	19	19	1.7	4500
HKTE321X	71	59	2.7	13	0.12	4.7	20	20	1.8	4600
HKTE322	65	48	2.7	13	0.12	3.5	18	17	1.5	6300
HKTE641	66	77	2.6	10	0.06	8.6	17	15	3.1	4100
HKTE642	67	72	2.7	14	0.08	7.4	19	18	2.9	9200

Table A1.--Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barbell and transect sampling designs (continued).

Sample ID	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm
					North Transect					
HKTN011	44	59	2.9	14	0.14	3.8	17	14	1.9	5900
HKTN012	48	62	3.1	15	0.08	4.5	16	14	2.0	5300
HKTN021	53	71	2.8	12	0.10	7.6	17	14	2.7	5300
HKTN022	53	59	3.1	15	0.08	5.7	17	14	1.9	3600
HKTN041	41	53	2.7	15	0.07	4.3	17	15	1.8	7700
HKTN042	43	59	2.9	17	0.14	4.6	18	16	2.0	9600
HKTN081	43	52	2.6	15	0.10	6.2	16	13	2.2	13000
HKTN082	43	71	2.9	16	0.10	4.3	17	13	1.9	10000
HKTN161	52	79	2.8	17	0.09	6.1	18	15	2.9	20000
HKTN162	49	65	2.7	16	0.10	5.2	17	14	2.4	15000
HKTN321	50	45	2.6	14	0.09	4.4	17	13	1.7	6200
HKTN322	46	57	2.3	11	0.10	5.3	17	13	1.8	6500
HKTN641	49	80	2.1	9	0.13	6.5	16	12	2.2	12000
HKTN642	28	64	1.4	8	0.10	6.6	15	10	2.4	8500
					South Transect					
HKTS011	44	45	3.1	13	0.09	3.3	17	14	1.6	2900
HKTS011X	44	48	3.0	15	0.09	3.6	18	14	1.6	3300
HKTS012	42	48	3.1	14	0.14	2.8	18	14	1.5	2900
HKTS021	44	55	2.8	14	0.12	6.5	17	13	1.7	2800
HKTS022	29	56	2.4	12	0.11	7.4	16	12	2.2	5800
HKTS041	31	51	2.8	12	0.10	4.0	17	13	2.0	2500
HKTS042	55	37	3.4	15	0.08	2.7	16	13	1.5	2300
HKTS081	68	52	3.3	15	0.12	3.1	18	17	1.6	3100
HKTS082	66	52	3.4	15	0.12	2.8	18	17	1.6	3300
HKTS161	63	72	3.0	13	0.07	5.7	18	17	2.1	6300
HKTS162	67	83	3.1	12	0.08	4.5	17	16	2.0	4100
HKTS321	66	45	3.6	15	0.16	2.4	20	19	1.5	4000
HKTS322	76	51	3.3	15	0.08	3.7	19	20	1.7	8600
HKTS641	31	56	2.0	9	0.06	8.7	16	11	2.0	3500
HKTS642	40	55	2.1	10	0.06	6.6	18	9	1.8	4500

Table A1.--Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barbell and transect sampling designs (continued).

Sample ID	Na, %	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Se, ppm	Sr, ppm	Th, ppm
					Barbell Sampling Design					
H11111	2.1	20	28	1.9	26	0.05	8	0.01	340	<8
H11121	1.6	19	35	2.2	28	0.07	8	0.11	680	<8
H11211	2.0	23	28	1.4	24	0.05	9	0.04	470	<8
H11211X	2.0	20	26	1.4	23	0.05	9	0.02	470	<8
H11221	1.8	18	34	2.4	30	0.06	8	0.08	430	<8
H12111	1.4	18	40	2.4	110	0.10	7	0.12	620	<8
H12112	1.5	18	48	2.5	130	0.07	8	0.05	540	<8
H12112X	1.5	17	43	2.4	130	0.08	8	0.04	530	<8
H12121	1.3	12	29	3.1	73	0.08	6	0.07	650	<8
H12211	1.4	10	30	2.1	86	0.08	7	0.03	610	<8
H12212	0.9	12	25	2.0	55	0.08	5	0.07	1300	<8
H12221	1.2	14	25	3.6	41	0.06	5	0.04	1000	<8
H21111	1.7	19	21	2.0	21	0.06	7	0.07	640	<8
H21112	1.7	18	19	1.6	20	0.07	7	0.07	770	<8
H21121	2.1	18	24	1.2	21	0.08	9	0.10	770	<8
H21211	2.2	18	26	0.6	22	0.07	10	0.08	760	<8
H21211X	2.2	16	27	0.6	20	0.07	10	0.05	800	<8
H21212	2.0	20	24	0.9	23	0.07	9	0.07	570	<8
H21221	1.9	17	26	1.4	23	0.08	9	0.06	550	<8
H22111	2.2	19	20	1.2	17	0.09	10	0.08	480	<8
H22121	2.2	16	21	1.2	9	0.07	11	0.05	470	<8
H22211	2.3	18	19	1.0	11	0.10	10	0.09	460	<8
H22212	2.3	17	18	0.9	<8	0.07	10	0.10	490	<8
H22221	2.2	18	20	1.0	9	0.08	10	0.06	500	<8
					East Transect					
HKTE011	2.6	18	24	1.1	32	0.13	11	0.15	410	<8
HKTE011	2.4	18	27	0.9	43	0.09	10	0.10	440	<8
HKTE012	2.6	18	24	0.8	48	0.09	10	0.07	380	<8
HKTE012X	2.5	18	24	0.9	48	0.09	10	0.07	370	<8
HKTE021	2.5	17	27	0.9	54	0.09	10	0.07	400	<8
HKTE022	2.5	19	26	0.7	50	0.08	11	0.10	400	<8
HKTE042	2.7	18	22	0.7	19	0.10	11	0.10	370	<8
HKTE081	2.2	19	20	1.5	11	0.10	9	0.07	660	<8
HKTE082	2.5	15	30	1.6	31	0.12	11	0.06	450	<8
HKTE082X	2.4	19	30	1.6	33	0.11	11	0.09	450	<8
HKTE161	2.2	15	31	1.1	26	0.11	10	0.07	470	<8
HKTE162	2.0	20	27	1.4	28	0.10	9	0.06	500	<8
HKTE321	1.9	19	33	1.2	40	0.08	10	0.09	530	<8
HKTE321X	1.9	17	35	1.3	39	0.08	10	0.08	530	<8
HKTE322	1.8	21	31	1.0	37	0.08	9	0.09	500	<8
HKTE641	1.7	21	32	2.2	24	0.07	8	0.09	600	<8
HKTE642	1.7	17	32	2.0	34	0.08	9	0.04	570	<8

Table A1.--Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barbell and transect sampling designs (continued).

Sample ID	Na, %	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Se, ppm	Sr, ppm	Th, ppm
					North Transect					
HKTN011	2.5	18	23	0.96	34	0.09	10	0.09	410	<8
HKTN012	2.6	19	28	1.0	34	0.18	10	0.10	390	<8
HKTN021	2.1	18	32	1.5	53	0.10	8	0.09	450	<8
HKTN022	2.5	21	29	1.0	43	0.10	10	0.09	360	<8
HKTN041	2.3	16	23	1.0	17	0.10	9	0.09	410	<8
HKTN042	2.4	14	25	1.3	24	0.12	10	0.11	460	<8
HKTN081	2.4	18	21	1.4	13	0.11	9	0.08	380	<8
HKTN082	2.4	21	23	1.2	17	0.09	10	0.10	420	<8
HKTN161	2.1	23	27	2.0	24	0.08	9	0.10	440	9
HKTN162	2.1	20	25	1.6	20	0.09	10	0.08	460	10
HKTN321	2.1	18	26	1.4	18	0.08	8	0.09	460	<8
HKTN322	1.9	15	30	1.7	21	0.08	8	0.04	570	<8
HKTN641	1.4	22	33	2.1	84	0.08	8	0.08	610	9
HKTN642	0.9	16	24	2.1	54	0.07	5	0.07	1300	<8
					South Transect					
HKTS011	2.5	16	23	0.72	57	0.11	10	0.10	400	<8
HKTS011X	2.6	22	24	0.79	59	0.11	10	0.04	400	<8
HKTS012	2.6	18	23	0.64	68	0.11	11	0.10	390	<8
HKTS021	2.5	20	25	1.1	34	0.11	9	0.10	420	<8
HKTS022	2.1	15	25	1.7	40	0.11	8	0.08	480	<8
HKTS041	2.6	18	22	0.97	20	0.09	10	0.08	490	<8
HKTS042	2.7	19	24	0.54	11	0.07	12	0.09	370	<8
HKTS081	2.3	18	30	0.90	290	0.10	11	0.16	460	<8
HKTS082	2.3	21	30	0.79	250	0.09	12	0.11	410	<8
HKTS161	2.1	18	31	1.5	260	0.09	10	0.07	540	<8
HKTS162	2.2	24	31	1.3	240	0.09	10	0.11	570	<8
HKTS321	2.4	18	31	0.68	42	0.08	13	0.12	360	<8
HKTS322	2.2	17	32	1.0	41	0.07	11	0.10	320	<8
HKTS641	1.7	15	19	1.9	23	0.06	7	0.03	610	<8
HKTS642	1.7	19	20	1.6	22	0.07	7	0.04	790	<8

Table A1.--Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barbell and transect sampling designs (continued).

Sample ID	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
				Barbell Sampling Design	
H11111	0.18	78	16	<2	430
H11121	0.21	61	11	<2	580
H11211	0.29	81	15	<2	780
H11211X	0.25	81	15	<2	790
H11221	0.19	69	14	<2	600
H12111	0.20	60	10	<2	880
H12112	0.22	68	11	<2	1500
H12112X	0.21	71	11	<2	1400
H12121	0.17	52	9	<2	710
H12211	0.19	63	11	<2	630
H12212	0.14	43	8	<2	490
H12221	0.15	47	9	<2	560
H21111	0.22	62	11	<2	460
H21112	0.23	64	12	<2	540
H21121	0.28	82	16	<2	250
H21211	0.33	91	14	<2	190
H21211X	0.31	90	15	<2	200
H21212	0.29	83	14	<2	140
H21221	0.27	75	12	<2	510
H22111	0.28	88	15	<2	270
H22121	0.28	92	15	2	380
H22211	0.28	89	15	2	390
H22212	0.29	92	16	2	360
H22221	0.27	88	15	<2	270
				East Transect	
HKTE011	0.34	100	19	2	360
HKTE011	0.30	93	19	2	730
HKTE012	0.32	100	20	3	290
HKTE012X	0.32	100	20	3	290
HKTE021	0.31	97	19	2	380
HKTE022	0.33	99	19	2	630
HKTE042	0.35	100	21	3	300
HKTE081	0.27	88	16	2	590
HKTE082	0.31	100	18	2	720
HKTE082X	0.31	100	18	2	720
HKTE161	0.31	95	15	<2	560
HKTE162	0.28	83	14	<2	730
HKTE321	0.28	84	12	<2	640
HKTE321X	0.28	85	13	<2	660
HKTE322	0.28	81	12	<2	610
HKTE641	0.20	72	11	<2	440
HKTE642	0.20	77	12	<2	490

Table A1.--Listing of analytical data for ash yield and element concentrations in feather moss samples collected according to barball and transect sampling designs (continued).

Sample ID	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
					North Transect
HKTN011	0.32	98	19	2	880
HKTN012	0.31	95	20	2	890
HKTN021	0.27	85	14	<2	570
HKTN022	0.32	97	18	2	420
HKTN041	0.27	90	18	2	760
HKTN042	0.32	97	18	2	610
HKTN081	0.27	89	18	2	620
HKTN082	0.31	92	19	2	760
HKTN161	0.24	83	16	2	880
HKTN162	0.28	89	16	<2	960
HKTN321	0.26	77	17	2	400
HKTN322	0.23	73	14	<2	590
HKTN641	0.21	60	10	<2	610
HKTN642	0.14	43	7	<2	510
					South Transect
HKTS011	0.34	100	20	3	410
HKTS011X	0.33	100	21	3	450
HKTS012	0.34	110	21	3	360
HKTS021	0.30	88	19	2	260
HKTS022	0.23	80	16	<2	480
HKTS041	0.31	96	20	3	470
HKTS042	0.36	110	22	3	190
HKTS081	0.36	110	17	2	300
HKTS082	0.37	110	17	2	310
HKTS161	0.30	94	15	<2	550
HKTS162	0.31	93	16	2	480
HKTS321	0.36	110	18	2	210
HKTS322	0.32	98	15	<2	210
HKTS641	0.20	63	12	<2	470
HKTS642	0.22	63	12	<2	560

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barbell and transect sampling designs.

Sample ID	Latitude	Longitude	Ash, %	Al, %	As, ppm	Ba, ppm	Ca, %	Ce, ppm	Co, ppm	Cr, ppm
					Barbell Sampling Design					
P11111	604528	1503023	2.97	0.61	<0.05	620	18	<8	7	15
P11121	604503	1503022	3.90	0.54	<0.05	320	15	9	6	16
P11121X	604503	1503022	3.87	0.55	<0.05	340	16	<8	6	15
P11211	604359	1503640	3.99	1.1	<0.05	350	17	<8	8	27
P11211X	604359	1503640	4.00	1.0	<0.05	240	16	<8	7	26
P11212	604359	1503640	3.45	0.59	<0.05	400	10	<8	6	16
P11221	604354	1503608	2.92	0.58	<0.05	780	16	<8	7	17
P12111	604422	1500426	3.33	0.35	<0.05	480	12	<8	6	13
P12112	604422	1500426	4.11	0.24	<0.05	790	17	<8	5	7
P12121	604407	1500458	2.93	0.20	<0.05	310	13	<8	3	11
P12211	604257	1500849	4.18	0.60	<0.05	590	19	<8	7	13
P12212	604257	1500849	4.24	0.35	<0.05	380	20	<8	4	10
P12221	604317	1500752	3.65	0.67	<0.05	290	17	<8	5	15
P21111	601516	1511049	3.55	0.84	<0.05	410	16	<8	4	19
P21112	601516	1511049	4.08	0.36	<0.05	220	16	<8	4	10
P21121	601507	1511154	3.48	0.76	<0.05	280	14	<8	5	17
P21211	601720	1511459	4.26	1.1	<0.05	490	19	<8	9	16
P21212	601720	1511459	4.22	1.2	<0.05	480	18	<8	7	23
P21221	601700	1511420	3.94	1.4	<0.05	400	13	<8	7	31
P22111	595916	1512835	4.21	0.72	<0.05	250	16	<8	7	14
P22121	595908	1512720	3.66	0.25	<0.05	550	13	<8	4	10
P22211	595934	1512206	4.08	0.55	<0.05	300	16	<8	4	12
P22212	595934	1512206	3.78	0.33	<0.05	290	15	<8	5	8
P22221	595917	1512313	4.18	0.32	<0.05	290	17	<8	4	6
					East Transect					
PKTE011	604034	1512121	4.08	0.63	<0.05	200	14	<8	6	9
PKTE012	604034	1512121	3.73	0.45	<0.05	200	13	<8	6	15
PKTE012X	604034	1512121	3.70	0.80	<0.05	240	14	<8	6	16
PKTE021	604031	1512029	3.31	0.73	<0.05	590	15	<8	7	13
PKTE041	603949	1511845	3.50	0.31	<0.05	280	14	<8	5	8
PKTE042	603949	1511845	3.23	0.35	<0.05	360	13	<8	6	9
PKTE081	604041	1511220	3.28	0.30	<0.05	710	17	<8	6	10
PKTE161	603830	1510340	4.83	1.7	0.09	260	17	<8	7	36
PKTE161X	603830	1510340	4.73	1.6	0.09	320	17	9	8	35
PKTE162	603820	1510340	4.41	1.7	0.08	360	12	<8	8	39
PKTE321	603540	1504702	3.71	0.88	<0.05	280	14	<8	5	26
PKTE641	602723	1501550	3.92	0.61	<0.05	840	20	<8	7	18
PKTE642	602723	1501550	4.02	1.0	0.07	660	19	<8	6	26

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barbell and transect sampling designs (continued).

Sample ID	Latitude	Longitude	Ash, %	Al, %	As, ppm	Ba, ppm	Ca, %	Ce, ppm	Co, ppm	Cr, ppm
					North Transect					
PKTN.51	604053	1512228	2.02	0.93	<0.05	210	10	<8	6	26
PKTN.52	604053	1512228	2.36	1.2	<0.05	380	11	11	7	34
PKTN.53	604053	1512228	1.92	1.0	<0.05	480	9.2	<8	7	31
PKTN011	604112	1512137	2.92	0.25	<0.05	320	12	<8	6	13
PKTN012	604112	1512137	3.26	0.71	<0.05	320	14	<8	8	22
PKTN021	604118	1512106	3.76	1.6	0.07	270	11	11	8	26
PKTN041	604142	1511853	3.74	1.8	0.09	290	13	<8	9	33
PKTN042	604142	1511853	4.10	1.3	0.07	540	14	8	8	22
PKTN081	604241	1511338	3.17	0.32	<0.05	390	16	<8	5	12
PKTN161	604328	1510706	3.40	0.85	<0.05	440	13	<8	6	17
PKTN162	604328	1510706	3.44	0.45	<0.05	300	17	<8	4	10
PKTN321	604406	1504630	4.26	0.30	<0.05	420	16	<8	5	11
PKTN641	604158	1501028	4.31	0.65	<0.05	590	19	<8	6	13
PKTN642	604158	1501028	4.32	0.30	<0.05	280	20	<8	5	7
					South Transect					
PKTS011	603956	1512149	3.48	0.98	<0.05	550	16	<8	6	18
PKTS012	603956	1512149	3.55	0.52	<0.05	360	13	<8	8	11
PKTS021	603933	1512127	3.48	0.55	<0.05	320	12	<8	9	11
PKTS041	603858	1511943	3.25	0.36	<0.05	380	12	<8	4	11
PKTS042	603956	1512249	3.42	0.48	<0.05	340	15	<8	8	11
PKTS081	603525	1511949	3.58	0.31	<0.05	440	13	<8	5	9
PKTS161	603956	1512149	3.46	0.85	<0.05	290	13	<8	6	27
PKTS161X	603956	1512149	3.51	0.92	<0.05	250	13	<8	6	29
PKTS162	603252	1511253	3.22	2.0	0.07	420	11	<8	8	43
PKTS321	603956	1512149	3.73	2.7	0.10	620	12	12	13	49
PKTS641	602732	1515735	3.56	0.84	<0.05	480	15	<8	5	19
PKTS642	601516	1511049	4.08	0.38	<0.05	400	16	<8	4	9

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barbell and transect sampling designs (continued).

Sample ID	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, ppm	Mn, ppm	Na, %
					Barbell Sampling Design					
P11111	99	0.35	<8	0.02	15	7	<4	3.6	36000	0.26
P11121	91	0.31	<8	0.03	16	7	4	2.2	12000	0.33
P11121X	94	0.33	<8	0.03	16	8	<4	2.3	13000	0.33
P11211	68	0.55	<8	0.04	11	9	8	3.3	7800	0.59
P11211X	63	0.54	<8	0.04	11	8	7	3.2	7900	0.57
P11212	63	0.30	<8	0.02	20	6	<4	3.5	8900	0.41
P11221	87	0.32	<8	0.04	16	7	<4	2.7	35000	0.25
P12111	77	0.22	<8	0.04	18	5	<4	2.8	8300	0.17
P12112	64	0.13	<8	0.02	15	5	<4	2.8	7000	0.11
P12121	70	0.14	10	0.02	18	7	<4	2.5	14000	0.09
P12211	60	0.25	8	0.02	8.3	7	<4	2.6	8200	0.23
P12212	59	0.19	<8	0.02	13	8	<4	2.4	4800	0.13
P12221	49	0.36	<8	0.02	8.8	8	5	2.9	9200	0.29
P21111	73	0.46	<8	0.02	16	7	<4	2.0	6500	0.30
P21112	68	0.21	9	0.02	16	7	<4	2.2	7600	0.14
P21121	75	0.40	<8	0.02	13	7	<4	2.6	4400	0.35
P21211	68	0.58	<8	0.02	7.5	9	6	2.9	13000	0.40
P21212	57	0.59	9	0.02	6.7	8	7	3.4	10000	0.48
P21221	110	0.75	9	0.03	16	10	6	2.0	8000	0.49
P22111	58	0.36	9	0.04	13	7	<4	2.1	12000	0.45
P22121	96	0.15	<8	0.03	24	5	<4	3.1	11000	0.17
P22211	79	0.26	<8	0.03	13	6	6	2.6	15000	0.52
P22212	80	0.18	<8	0.03	13	4	<4	2.8	16000	0.19
P22221	65	0.15	<8	0.02	13	6	<4	2.2	9000	0.12
					East Transect					
PKTE011	110	0.30	13	0.05	19	7	<4	2.3	13000	0.72
PKTE012	76	0.40	10	0.03	16	8	4	3.1	12000	0.82
PKTE012X	80	0.44	9	0.03	16	8	4	3.2	12000	0.95
PKTE021	88	0.45	<8	0.03	15	7	<4	3.3	11000	0.47
PKTE041	110	0.19	9	0.01	21	5	<4	2.5	12000	0.20
PKTE042	110	0.20	<8	0.03	24	6	<4	3.1	8400	0.20
PKTE081	69	0.15	<8	0.02	16	7	<4	2.6	5500	0.40
PKTE161	77	0.86	10	0.03	11	9	8	2.8	7300	0.60
PKTE161X	83	0.82	<8	0.02	12	9	8	3.0	7400	0.60
PKTE162	83	0.94	<8	0.03	17	9	9	2.2	10000	0.67
PKTE321	57	0.51	9	0.03	15	7	7	3.1	14000	0.31
PKTE641	44	0.35	<8	0.01	12	7	5	2.3	11000	0.19
PKTE642	42	0.61	<8	0.02	11	10	10	2.4	5100	0.30

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barball and transect sampling designs (continued).

Sample ID	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, ppm	Mn, ppm	Na, %
					North Transect					
PKTN.51	130	0.54	11	0.02	20	7	5	2.9	24000	1.5
PKTN.52	82	0.69	<8	0.02	18	7	6	2.8	27000	1.3
PKTN.53	110	0.61	<8	0.04	18	7	4	2.7	27000	1.1
PKTN011	79	0.22	13	0.02	22	7	<4	2.7	15000	0.1
PKTN012	98	0.43	17	0.03	19	8	<4	2.1	23000	0.3
PKTN021	86	0.87	9	0.04	16	8	8	3.3	6600	1.7
PKTN041	75	0.94	14	0.03	13	10	7	3.0	13000	1.1
PKTN042	88	0.69	<8	0.02	16	8	6	2.5	12000	0.7
PKTN081	96	0.21	<8	0.02	19	6	<4	3.0	17000	0.4
PKTN161	91	0.37	15	0.03	18	8	<4	2.3	14000	0.4
PKTN162	81	0.23	8	0.02	18	6	<4	3.3	9100	0.2
PKTN321	79	0.18	10	0.02	15	7	<4	2.8	16000	0.1
PKTN641	59	0.28	8	0.02	8.1	7	<4	2.6	7400	0.2
PKTN642	57	0.16	<8	0.02	12	7	<4	2.3	5200	0.1
					South Transect					
PKTS011	100	0.53	<8	0.02	14	6	5	3.0	16000	0.8
PKTS012	100	0.31	<8	0.02	21	5	<4	2.3	10000	0.5
PKTS021	120	0.31	<8	0.03	21	6	<4	2.8	15000	0.6
PKTS041	91	0.20	<8	0.02	20	6	<4	3.5	6700	0.2
PKTS042	100	0.29	<8	0.02	18	5	<4	2.0	17000	0.4
PKTS081	77	0.17	<8	0.02	23	<4	<4	2.6	5000	0.1
PKTS161	97	0.49	<8	0.02	19	9	5	3.0	10000	0.3
PKTS161X	98	0.53	<8	0.02	19	8	5	3.1	10000	0.3
PKTS162	120	1.10	<8	0.04	14	10	10	3.0	16000	0.7
PKTS321	84	1.60	9	0.03	13	12	14	2.5	21000	0.8
PKTS641	75	0.45	<8	0.02	14	7	4	2.0	6500	0.3
PKTS642	67	0.21	<8	0.02	15	7	<4	2.2	6900	0.1

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barbell and transect sampling designs (continued).

Sample ID	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Sr, ppm	Th, ppm	Ti, %	V, ppm
					Barbell Sampling Design					
P11111	<8	20	4.5	<8	0.06	<4	890	11	0.02	6
P11121	<8	44	4.5	<8	0.08	<4	1200	<8	0.01	6
P11121X	9	45	4.7	<8	0.08	<4	1200	<8	0.02	7
P11211	<8	42	3.4	<8	0.06	<4	1400	<8	0.05	15
P11211X	<8	40	3.4	<8	0.06	<4	1300	<8	0.04	15
P11212	<8	52	4.8	<8	0.06	<4	1000	<8	0.01	7
P11221	<8	42	5.0	<8	0.05	<4	680	12	0.01	5
P12111	11	40	5.2	9	0.06	<4	670	<8	0.01	5
P12112	<8	39	4.0	<8	0.06	<4	810	<8	<0.01	<4
P12121	<8	33	5.2	<8	0.07	<4	630	<8	<0.01	<4
P12211	11	21	3.9	15	0.05	<4	1100	<8	0.02	6
P12212	<8	31	3.6	<8	0.06	<4	1700	<8	0.01	<4
P12221	<8	16	3.8	15	0.05	<4	1000	<8	0.03	9
P21111	<8	10	3.9	<8	0.06	<4	1200	<8	0.04	11
P21112	<8	16	4.4	<8	0.07	<4	1400	<8	0.01	<4
P21121	<8	24	4.7	<8	0.07	<4	1000	<8	0.03	10
P21211	<8	15	2.0	<8	0.06	<4	1800	<8	0.06	15
P21212	10	15	2.2	<8	0.07	<4	1500	<8	0.06	16
P21221	<8	21	4.1	<8	0.07	<4	790	<8	0.07	20
P22111	<8	16	3.5	<8	0.07	<4	1000	<8	0.03	9
P22121	14	22	6.3	<8	0.08	<4	750	11	<0.01	<4
P22211	<8	15	4.6	<8	0.10	<4	1000	<8	0.02	5
P22212	<8	15	4.3	<8	0.08	<4	980	<8	<0.01	<4
P22221	<8	17	3.7	<8	0.08	<4	1100	<8	0.01	<4
					East Transect					
PKTE011	<8	18	5.0	14	0.11	<4	850	<8	0.02	7
PKTE012	<8	35	4.7	17	0.09	<4	890	<8	0.02	10
PKTE012X	<8	31	4.7	19	0.09	<4	920	<8	0.02	11
PKTE021	8	40	4.3	14	0.06	<4	910	<8	0.02	11
PKTE041	<8	30	5.3	<8	0.08	<4	910	<8	0.01	<4
PKTE042	<8	66	5.9	<8	0.08	<4	790	<8	<0.01	<4
PKTE081	<8	10	4.8	<8	0.07	<4	900	<8	<0.01	<4
PKTE161	12	24	3.4	<8	0.07	<4	1100	<8	0.07	25
PKTE161X	17	26	3.6	<8	0.07	<4	1100	8	0.07	25
PKTE162	13	29	4.1	<8	0.08	<4	780	<8	0.06	27
PKTE321	11	22	4.4	<8	0.06	<4	940	10	0.04	13
PKTE641	10	10	2.9	<8	0.05	<4	1200	<8	0.03	9
PKTE642	<8	14	2.9	<8	0.05	<4	1100	<8	0.06	17

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barbell and transect sampling designs (continued).

Sample ID	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Sr, ppm	Th, ppm	Ti, %	V, ppm
					North Transect					
PKTN.51	<8	34	6.6	20	0.11	<4	550	11	0.02	15
PKTN.52	11	40	5.0	32	0.09	<4	510	15	0.04	18
PKTN.53	<8	50	6.3	18	0.08	<4	380	<8	0.03	15
PKTN011	12	22	6.8	<8	0.11	<4	640	10	0.01	<4
PKTN012	11	24	5.2	11	0.10	<4	1200	11	0.03	9
PKTN021	8	36	4.2	22	0.09	<4	590	<8	0.06	26
PKTN041	9	31	4.2	<8	0.08	<4	960	<8	0.08	26
PKTN042	9	30	4.5	<8	0.07	<4	1000	<8	0.03	19
PKTN081	11	26	6.0	<8	0.07	<4	720	11	<0.01	<4
PKTN161	<8	23	4.9	<8	0.07	<4	630	<8	0.03	9
PKTN162	<8	14	4.5	<8	0.07	<4	980	<8	0.02	5
PKTN321	<8	21	3.7	<8	0.08	<4	1000	<8	0.01	<4
PKTN641	<8	20	3.8	14	0.06	<4	1100	<8	0.02	6
PKTN642	<8	29	3.6	<8	0.06	<4	1600	<8	0.01	<4
					South Transect					
PKTS011	<8	59	4.4	18	0.07	<4	1100	<8	0.03	14
PKTS012	24	40	5.4	11	0.09	<4	790	18	0.01	9
PKTS021	9	41	5.2	8	0.10	<4	930	10	0.01	7
PKTS041	<8	17	4.9	<8	0.09	<4	920	<8	0.01	4
PKTS042	10	16	4.9	<8	0.08	<4	1200	8	0.01	6
PKTS081	<8	23	4.2	<8	0.09	<4	810	<8	0.01	<4
PKTS161	9	44	4.9	34	0.07	<4	950	<8	0.03	11
PKTS161X	8	44	5.0	33	0.07	<4	960	<8	0.03	12
PKTS162	<8	41	4.7	100	0.07	<4	770	<8	0.09	29
PKTS321	10	37	3.7	<8	0.07	5	460	<8	0.13	42
PKTS641	9	9	4.0	<8	0.07	<4	1200	<8	0.03	11
PKTS642	<8	17	4.3	<8	0.08	<4	1400	<8	0.02	<4

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barbell and transect sampling designs (continued).

Sample ID	W, ppm	Y, ppm	Zn, ppm
			Barbell Sampling Design
P11111	---	<4	2500
P11121	---	<4	1000
P11121X	---	<4	1000
P11211	---	<4	820
P11211X	<8	<4	840
P11212	---	<4	1000
P11221	---	<4	1400
P12111	---	<4	1100
P12112	---	<4	970
P12121	<8	<4	960
P12211	<8	<4	690
P12212	<8	<4	960
P12221	<8	<4	720
P21111	<8	<4	1300
P21112	9	<4	1500
P21121	<8	<4	650
P21211	---	<4	970
P21212	<8	<4	430
P21221	9	<4	1400
P22111	<8	<4	990
P22121	---	<4	1200
P22211	---	<4	1600
P22212	8	<4	1700
P22221	<8	<4	1400
			East Transect
PKTE011	<8	<4	1500
PKTE012	9	<4	1600
PKTE012X	10	<4	1600
PKTE021	---	<4	1100
PKTE041	9	<4	1700
PKTE042	---	<4	1300
PKTE081	<8	<4	1300
PKTE161	<8	<4	1400
PKTE161X	---	<4	1400
PKTE162	---	<4	1500
PKTE321	9	<4	1600
PKTE641	---	<4	770
PKTE642	<8	<4	860

Table A2.--Listing of analytical data for ash yield and element concentrations in white spruce samples collected according to barball and transect sampling designs (continued).

Sample ID	W, ppm	Y, ppm	Zn, ppm
North Transect			
PKTN.51	---	<4	950
PKTN.52	---	<4	710
PKTN.53	---	<4	900
PKTN011	<8	<4	1200
PKTN012	11	<4	2000
PKTN021	<8	<4	920
PKTN041	<8	<4	1500
PKTN042	---	<4	1300
PKTN081	---	<4	1600
PKTN161	11	<4	1900
PKTN162	8	<4	1500
PKTN321	9	<4	1700
PKTN641	<8	<4	690
PKTN642	<8	<4	920
South Transect			
PKTS011	---	<4	1200
PKTS012	---	<4	1200
PKTS021	---	<4	1300
PKTS041	<8	<4	1500
PKTS042	---	<4	1600
PKTS081	<8	<4	820
PKTS161	8	<4	1400
PKTS161X	<8	<4	1400
PKTS162	---	4	1100
PKTS321	---	6	1200
PKTS641	<8	<4	1300
PKTS642	8	<4	1500

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barbell and transect designs.

Sample ID	Latitude	Longitude	pH	Ash, %	Ag, ppm	Al, %	As, ppm	Ba, ppm	Ca, %	Ce, ppm
					Barbell Sampling Design					
S0111111	604528	1503023	3.6	26.4	<2	1.8	0.8	28	0.71	11
S0111211	604503	1503022	4.0	37.4	<2	2.4	1.1	39	1.1	11
S0112111	604359	1503640	4.1	26.6	<2	1.7	0.8	43	1.0	7
S0112121	604359	1503640	3.7	25.8	3	1.7	0.7	27	0.74	9
S0112122	604359	1503640	3.6	26.6	3	1.8	0.7	28	0.79	9
S0112211	604354	1503608	3.9	50.4	<2	3.4	1.2	50	1.3	16
S0121111	604422	1500426	4.8	25.4	<2	1.5	1.0	47	1.6	7
S0121121	604422	1500426	3.9	16.2	<2	1.0	0.5	18	0.86	5
S0121211	604407	1500458	3.8	17.0	<2	1.1	0.5	21	0.75	6
S0122111	604257	1500849	3.7	22.0	<2	1.5	0.6	28	1.0	8
S0122211	604257	1500848	3.9	23.2	<2	1.6	0.9	25	1.0	9
S0211111	601516	1511049	4.0	21.2	<2	1.5	0.4	25	1.3	6
S0211121	601516	1511049	4.5	39.8	<2	2.8	1.0	54	1.6	13
S0211122	601516	1511049	4.5	41.2	<2	2.9	1.0	55	1.6	13
S0211211	601507	1511154	4.6	24.6	<2	1.7	0.3	31	1.9	6
S0212111	601720	1511459	4.5	61.6	<2	5.1	0.9	45	2.4	19
S0212211	601659	1511420	4.1	53.6	<2	4.1	1.3	38	1.7	16
S0221111	595916	1512835	4.0	39.0	<2	2.6	0.5	30	1.3	12
S0221211	595907	1512720	3.6	36.6	<2	2.7	0.5	29	1.2	12
S0221212	595908	1512720	3.6	36.0	<2	2.6	0.5	29	1.2	11
S0222111	595934	1512206	3.8	17.4	<2	1.2	0.4	16	1.0	6
S0222121	595934	1512206	4.0	22.4	<2	1.2	0.4	24	1.1	5
S0222211	595917	1512312	4.1	47.2	<2	2.5	0.5	29	1.3	11
S0222212	595917	1512312	4.1	46.0	<2	2.4	0.5	28	1.2	9
					East Transect					
SOKTE011	604034	1512021	4.1	49.0	<2	3.6	0.7	43	1.6	13
SOKXE011	604038	1512021	4.1	47.2	<2	3.6	1.0	43	1.6	15
SOKTE012	604034	1512121	4.3	54.8	<2	4.1	1.1	48	1.8	17
SOKTE021	604031	1512024	4.1	40.6	<2	3.0	0.7	34	1.5	12
SOKTE041	603949	1511845	3.8	40.2	<2	2.8	1.0	34	1.2	15
SOKTE042	603949	1511845	4.1	38.6	<2	3.0	0.5	32	1.7	12
SOKTE081	604041	1511220	3.9	19.4	<2	1.4	0.5	26	1.2	7
SOKTE161	603830	1510340	4.6	28.0	<2	1.8	0.7	100	1.4	11
SOKTE162	603830	1510340	4.4	45.2	<2	3.2	0.9	100	1.5	17
SOKTE321	603540	1504702	4.5	36.8	<2	2.5	0.7	45	1.5	11
SOKTE641	602722	1501550	4.4	63.0	<2	4.6	1.8	51	2.0	21
SOKTE642	602722	1501550	4.1	41.4	<2	2.9	2.0	45	1.2	15

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barbell and transect designs (continued).

Sample ID	Latitude	Longitude	pH	Ash, %	Ag, ppm	Al, %	As, ppm	Ba, ppm	Ca, %	Ce, ppm
					North Transect					
SOKTN.51	604053	1512228	3.8	22.4	<2	1.8	0.6	22	0.91	6
SOKTN011	604113	1512137	4.1	40.8	<2	3.1	0.5	30	1.6	11
SOKTN012	604113	1512137	4.1	34.6	<2	2.6	0.5	30	1.6	9
SOKXN012	604113	1512137	4.1	33.6	<2	2.4	0.5	29	1.4	9
SOKTN021	604118	1512106	4.0	44.8	<2	3.4	0.6	33	1.6	15
SOKTN041	604142	1511853	4.9	65.8	<2	5.2	0.9	49	2.3	18
SOKTN042	604142	1511853	4.1	43.6	<2	3.3	0.6	35	1.7	12
SOKTN081	604242	1511338	4.1	36.2	<2	2.8	0.6	32	1.6	9
SOKTN161	604328	1510706	4.1	37.0	<2	2.9	0.7	32	1.6	12
SOKTN162	604328	1510706	4.6	36.0	<2	2.7	0.6	35	1.6	11
SOKTN321	604406	1504630	3.8	29.4	<2	1.8	0.8	32	0.87	1
SOKTN641	604257	1500849	3.7	22.0	<2	1.5	0.6	28	1.0	8
SOKTN642	604157	1501028	3.6	18.4	<2	1.3	0.5	19	0.63	5
					South Transect					
SOKTS011	603956	1512149	4.0	46.2	<2	3.4	1.2	36	1.5	14
SOKTS012	603956	1512149	4.2	52.0	<2	3.9	1.3	39	1.7	16
SOKTS021	603933	1512127	4.3	56.6	<2	4.5	1.0	35	2.2	16
SOKTS041	603858	1511943	4.5	42.0	<2	3.4	0.5	32	2.0	9
SOKTS042	603858	1511943	4.1	41.4	<2	3.3	0.5	28	1.9	11
SOKTS081	603525	1511949	4.0	31.0	<2	2.3	0.8	19	0.8	11
SOKTS161	603252	1511253	3.9	40.2	<2	3.2	1.9	37	1.3	11
SOKXS161	603252	1511253	3.9	38.4	<2	3.1	1.9	36	1.3	11
SOKTS162	603252	1511253	3.8	26.6	<2	1.9	1.0	34	1.2	9
SOKTS321	602732	1505735	4.5	47.8	<2	3.9	0.9	40	2.0	13
SOKTS641	601516	1511049	4.0	21.2	<2	1.5	0.4	25	1.3	6
SOKXS641	601516	1511049	4.0	21.4	<2	1.6	0.4	26	1.3	7
SOKTS642	601516	1511049	4.5	39.8	<2	2.8	1.0	54	1.6	13

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barbell and transect designs (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
					Barbell Sampling Design					
S0111111	3	16	10	0.85	4	0.26	0.36	5	4	0.24
S0111211	4	20	13	1.1	5	0.18	0.44	7	6	0.35
S0112111	4	21	13	0.77	<4	0.28	0.39	6	4	0.28
S0112121	3	15	11	0.75	4	0.18	0.45	5	4	0.26
S0112122	3	19	12	0.79	4	0.20	0.37	5	4	0.27
S0112211	5	31	13	1.4	8	0.16	0.67	10	8	0.46
S0121111	4	19	12	0.73	5	0.32	0.37	5	4	0.32
S0121121	2	13	11	0.53	<4	0.24	0.24	3	3	0.22
S0121211	2	10	11	0.54	<4	0.18	0.31	4	3	0.20
S0122111	3	35	12	0.76	<4	0.20	0.29	5	3	0.23
S0122211	5	14	10	0.76	<4	0.24	0.28	5	4	0.25
S0211111	5	9	12	0.71	<4	0.14	0.30	5	3	0.30
S0211121	7	42	15	1.3	7	0.16	0.52	9	7	0.47
S0211122	8	16	14	1.4	8	0.16	0.53	9	6	0.50
S0211211	7	11	13	0.83	4	0.16	0.30	5	3	0.39
S0212111	10	34	22	2.6	12	0.10	0.65	11	10	0.94
S0212211	7	26	17	2.1	10	0.12	0.61	10	8	0.66
S0221111	5	14	10	1.3	6	0.14	0.53	7	6	0.42
S0221211	5	17	10	1.4	6	0.20	0.54	7	6	0.40
S0221212	5	10	10	1.4	6	0.24	0.53	7	6	0.38
S0222111	2	9	9	0.61	<4	0.26	0.30	3	2	0.26
S0222121	3	10	11	0.56	<4	0.26	0.28	4	3	0.24
S0222211	5	13	15	1.2	7	0.16	0.46	6	6	0.42
S0222212	4	15	14	1.1	6	0.14	0.44	6	6	0.39
					East Transect					
SOKTE011	6	23	13	1.5	9	0.22	0.59	9	8	0.57
SOKXE011	6	21	15	1.5	9	0.20	0.58	8	8	0.56
SOKTE012	7	41	17	1.7	10	0.20	0.65	10	8	0.62
SOKTE021	6	27	16	1.4	6	0.22	0.52	7	6	0.52
SOKTE041	4	20	11	1.1	7	0.14	0.53	8	6	0.39
SOKTE042	6	15	16	1.3	7	0.44	0.48	6	6	0.54
SOKTE081	4	14	12	0.65	<4	0.26	0.26	5	3	0.31
SOKTE161	6	15	16	0.82	5	0.20	0.43	6	4	0.34
SOKTE162	9	23	15	1.3	9	0.16	0.64	10	8	0.48
SOKTE321	5	20	12	1.1	7	0.10	0.50	7	6	0.40
SOKTE641	8	38	19	2.2	12	0.16	0.77	13	11	0.66
SOKTE642	8	29	17	1.5	7	0.16	0.51	9	10	0.50

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barbell and transect designs (continued).

Sample ID	Co, ppm	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %
					North Transect					
SOKTN.51	4	19	17	0.89	<4	0.16	0.27	4	3	0.29
SOKTN011	6	17	15	1.4	6	0.12	0.45	7	5	0.56
SOKTN012	6	13	17	1.2	6	0.28	0.35	5	5	0.46
SOKXN012	5	16	17	1.1	6	0.12	0.36	6	4	0.41
SOKTN021	6	18	14	1.4	8	0.14	0.54	9	7	0.57
SOKTN041	8	23	16	2.0	13	0.14	0.80	11	11	0.86
SOKTN042	5	15	13	1.3	8	0.16	0.51	7	7	0.53
SOKTN081	5	17	15	1.3	8	0.26	0.44	6	6	0.49
SOKTN161	5	17	14	1.3	7	0.18	0.45	7	6	0.48
SOKTN162	5	15	13	1.1	6	0.16	0.49	7	6	0.47
SOKTN321	3	34	10	0.78	5	0.28	0.40	6	4	0.25
SOKTN641	3	35	12	0.76	<4	0.20	0.29	5	3	0.23
SOKTN642	3	12	10	0.66	<4	0.16	0.28	5	3	0.20
					South Transect					
SOKTS011	7	21	16	1.6	8	0.24	0.54	8	7	0.54
SOKTS012	6	21	15	1.7	9	0.20	0.61	10	8	0.60
SOKTS021	9	29	21	2.0	10	0.14	0.60	9	9	0.76
SOKTS041	8	23	20	1.6	8	0.24	0.53	7	6	0.63
SOKTS042	7	19	19	1.6	7	0.22	0.48	7	6	0.63
SOKTS081	3	16	15	0.85	6	0.12	0.32	6	4	0.27
SOKTS161	6	19	14	1.6	8	0.20	0.46	7	8	0.48
SOKXS161	5	19	15	1.6	8	0.22	0.44	7	7	0.46
SOKTS162	4	15	11	0.94	5		0.31	5	5	0.33
SOKTS321	8	17	16	1.9	9	0.18	0.56	8	7	0.60
SOKTS641	5	9	12	0.71	<4	0.14	0.30	5	3	0.30
SOKXS641	5	16	11	0.75	<4	0.16	0.31	5	3	0.31
SOKTS642	7	42	15	1.3	7	0.16	0.52	9	7	0.47

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barbell and transect designs (continued).

Sample ID	Mn, ppm	Na, %	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Se, ppm	Sr, ppm
					Barbell Sampling Design					
S0111111	18	0.60	5	6	0.15	4	0.08	4	0.20	93
S0111211	54	0.83	6	8	0.13	4	0.11	5	0.20	130
S0112111	120	0.58	6	9	0.14	6	0.12	3	0.30	110
S0112121	30	0.58	5	6	0.16	<4	0.12	3	0.10	87
S0112122	30	0.59	5	9	0.17	5	0.14	3	0.20	95
S0112211	38	1.2	9	12	0.13	5	0.07	7	0.20	170
S0121111	350	0.51	<4	10	0.15	11	0.13	3	0.20	130
S0121121	48	0.35	<4	8	0.13	10	0.17	2	0.20	72
S0121211	38	0.39	4	5	0.17	12	0.12	3	0.20	72
S0122111	30	0.52	6	12	0.11	10	0.13	3	0.20	100
S0122211	18	0.53	<4	6	0.14	7	0.12	4	0.30	110
S0211111	46	0.53	<4	6	0.11	6	0.12	3	0.20	140
S0211121	180	0.99	8	15	0.17	6	0.10	5	0.20	190
S0211122	180	1.0	8	8	0.17	4	0.09	5	0.30	190
S0211211	67	0.58	<4	7	0.14	<4	0.16	3	0.40	170
S0212111	55	1.6	11	14	0.14	<4	0.08	9	0.20	270
S0212211	49	1.4	10	11	0.12	<4	0.08	8	0.20	190
S0221111	47	0.98	9	6	0.13	5	0.10	6	0.20	130
S0221211	43	1.0	10	7	0.15	4	0.11	6	0.20	130
S0221212	42	0.96	7	5	0.15	4	0.12	6	0.20	120
S0222111	64	0.41	<4	4	0.14	29	0.14	3	0.10	79
S0222121	69	0.41	<4	4	0.13	<4	0.14	2	0.10	92
S0222211	98	0.86	5	5	0.13	<4	0.11	5	0.10	130
S0222212	96	0.82	5	5	0.13	<4	0.11	5	0.10	120
					East Transect					
SOKTE011	52	1.2	9	10	0.09	16	0.09	6	0.20	180
SOKXE011	52	1.2	8	9	0.09	17	0.10	6	0.10	180
SOKTE012	66	1.4	9	15	0.10	18	0.09	7	0.20	200
SOKTE021	65	1.0	6	12	0.11	15	0.10	5	0.30	150
SOKTE041	41	0.94	5	8	0.11	<4	0.10	5	0.30	140
SOKTE042	78	0.99	5	8	0.12	4	0.12	5	0.20	150
SOKTE081	41	0.45	5	7	0.13	<4	0.18	2	0.20	120
SOKTE161	120	0.63	7	8	0.15	8	0.16	4	0.20	140
SOKTE162	100	1.1	9	9	0.17	9	0.10	6	0.10	170
SOKTE321	160	0.83	7	9	0.13	8	0.10	5	0.10	150
SOKTE641	53	1.6	14	14	0.11	6	0.06	9	0.30	230
SOKTE642	75	0.92	8	13	0.13	10	0.08	6	0.30	150

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barbell and transect designs (continued).

Sample ID	Mn, ppm	Na, %	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Se, ppm	Sr, ppm
					North Transect					
SOKTN.51	44	0.59	<4	10	0.10	23	0.16	3	0.30	87
SOKTN011	59	1.1	7	8	0.10	13	0.12	5	0.20	140
SOKTN012	83	0.87	5	8	0.11	12	0.15	4	0.20	130
SOKXN012	81	0.84	7	8	0.11	14	0.16	4	0.20	120
SOKTN021	54	1.2	8	8	0.10	10	0.10	6	0.10	160
SOKTN041	210	1.8	8	8	0.10	6	0.06	8	0.10	270
SOKTN042	74	1.1	7	6	0.09	<4	0.10	5	0.20	170
SOKTN081	170	0.92	6	7	0.13	5	0.11	5	0.10	140
SOKTN161	78	0.95	6	8	0.11	<4	0.10	5	0.10	140
SOKTN162	79	0.94	6	6	0.13	5	0.11	5	0.10	160
SOKTN321	20	0.65	7	13	0.12	5	0.12	4	0.20	110
SOKTN641	30	0.52	6	12	0.11	10	0.13	3	0.20	100
SOKTN642	16	0.45	4	5	0.13	11	0.08	3	0.20	73
					South Transect					
SOKTS011	63	1.1	8	10	0.11	22	0.11	6	0.20	160
SOKTS012	64	1.3	11	9	0.11	15	0.09	7	0.20	200
SOKTS021	86	1.5	9	13	0.12	11	0.09	7	0.20	200
SOKTS041	94	1.2	9	10	0.12	8	0.11	6	0.10	170
SOKTS042	78	1.1	7	9	0.12	10	0.10	6	0.20	150
SOKTS081	20	0.62	6	7	0.10	5	0.19	4	0.50	100
SOKTS161	48	0.98	7	8	0.13	24	0.09	5	0.30	170
SOKXS161	47	0.94	7	8	0.14	25	0.10	5	0.20	160
SOKTS162	73	0.61	5	7	0.13	73	0.13	4	0.20	130
SOKTS321	240	1.3	8	7	0.17	4	0.08	7	0.20	200
SOKTS641	46	0.53	<4	6	0.11	6	0.12	3	0.20	140
SOKXS641	46	0.55	5	9	0.11	4	0.11	3	0.10	140
SOKTS642	180	0.99	8	15	0.17	6	0.10	5	0.20	190

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barball and transect designs (continued).

Sample ID	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
					Barbell Sampling Design
S0111111	0.11	30	4	<1	29
S0111211	0.14	39	6	<1	43
S0112111	0.09	26	4	<1	79
S0112121	0.10	27	4	<1	44
S0112122	0.10	28	4	<1	43
S0112211	0.20	51	7	<1	32
S0121111	0.09	25	4	<1	140
S0121121	0.06	19	3	<1	38
S0121211	0.07	19	3	<1	30
S0122111	0.09	24	4	<1	33
S0122211	0.10	27	4	<1	19
S0211111	0.08	22	4	<1	50
S0211121	0.15	40	7	<1	88
S0211122	0.17	42	7	<1	89
S0211211	0.08	27	5	<1	22
S0212111	0.26	74	10	1	38
S0212211	0.24	62	9	1	44
S0221111	0.17	39	8	1	39
S0221211	0.18	39	8	1	36
S0221212	0.18	38	8	1	35
S0222111	0.07	18	3	<1	50
S0222121	0.06	19	3	<1	63
S0222211	0.14	37	7	<1	47
S0222212	0.14	36	6	<1	47
					East Transect
SOKTE011	0.18	49	7	<1	38
SOKXE011	0.18	48	7	<1	40
SOKTE012	0.19	56	8	1	56
SOKTE021	0.15	45	7	<1	53
SOKTE041	0.15	43	6	<1	42
SOKTE042	0.14	45	7	<1	61
SOKTE081	0.07	22	4	<1	64
SOKTE161	0.10	26	5	<1	95
SOKTE162	0.17	43	7	<1	57
SOKTE321	0.13	38	6	<1	75
SOKTE641	0.28	65	11	1	33
SOKTE642	0.16	47	6	<1	28

Table A3.--Listing of analytical data for pH, ash yield, and element concentrations in samples of O-horizon soils collected according to barbell and transect designs (continued).

Sample ID	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
					North Transect
SOKTN.51	0.09	27	4	<1	54
SOKTN011	0.15	46	7	1	62
SOKTN012	0.13	42	7	<1	130
SOKXN012	0.12	36	6	<1	120
SOKTN021	0.18	48	7	<1	43
SOKTN041	0.25	65	10	1	60
SOKTN042	0.16	46	7	<1	63
SOKTN081	0.13	43	7	<1	58
SOKTN161	0.15	44	7	<1	86
SOKTN162	0.14	38	6	<1	89
SOKTN321	0.10	28	4	<1	34
SOKTN641	0.09	24	4	<1	33
SOKTN642	0.08	21	3	<1	18
					South Transect
SOKTS011	0.17	51	7	1	51
SOKTS012	0.20	55	8	1	43
SOKTS021	0.20	64	9	1	51
SOKTS041	0.15	51	8	1	72
SOKTS042	0.16	51	8	<1	64
SOKTS081	0.12	25	5	<1	19
SOKTS161	0.15	48	5	<1	52
SOKXS161	0.15	46	5	<1	52
SOKTS162	0.10	30	4	<1	46
SOKTS321	0.19	54	8	<1	82
SOKTS641	0.08	22	4	<1	50
SOKXS641	0.08	23	4	<1	51
SOKTS642	0.15	40	7	<1	88

Table A4.--Listing of analytical data for pH and element concentrations in samples of B-horizon soils collected according to transect sampling designs.

Sample ID	Latitude	Longitude	pH	Al, %	As, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm	Co, ppm
					East Transect					
SBKTE011	604034	1512121	5.3	7.7	4.3	500	1	2.5	24	10
SBKTE012	604034	1512121	5.5	8.0	4.3	550	1	2.5	24	10
SBKTE021	604031	1512024	5.2	7.5	4.6	480	<1	2.5	21	8
SBKXE021	604031	1512024	5.3	7.5	4.1	480	<1	2.3	23	8
SBKTE041	603949	1511845	5.9	8.1	4.5	580	1	2.5	26	11
SBKTE042	603949	1511845	5.3	7.3	8.3	530	1	1.7	26	14
SBKTE081	604041	1511220	5.0	6.8	4.0	520	<1	2.2	24	6
SBKTE161	603830	1510340	5.6	7.1	11	500	1	1.6	25	18
SBKTE162	603830	1510340	5.5	6.7	6.3	530	<1	1.7	23	8
SBKTE321	603540	1504702	5.1	7.0	12	530	<1	1.6	24	14
SBKTE641	602723	1501550	5.6	7.2	9.6	560	1	1.6	33	11
SBKTE642	602723	1501550	5.8	7.4	9.3	570	1	1.6	28	13
					North Transect					
SBKTN.51	604053	1512228	4.6	7.6	6.4	530	<1	2.4	24	9
SBKTN011	604113	1512137	5.3	7.7	4.9	500	1	2.4	23	8
SBKTN012	604113	1512137	5.3	7.5	4.0	500	<1	2.6	22	9
SBKTN021	604118	1512106	5.6	8.2	4.1	560	1	2.4	30	13
SBKXN021	604118	1512106	5.8	8.4	4.2	550	1	2.3	30	12
SBKTN041	604142	1511853	5.3	7.6	4.6	530	<1	2.7	21	8
SBKTN042	604142	1511853	5.2	7.6	5.7	590	<1	2.5	23	14
SBKTN081	604242	1511338	5.3	7.7	5.2	520	1	2.2	22	10
SBKTN161	604328	1510706	5.4	7.7	12	530	1	1.6	27	17
SBKTN162	604328	1510706	5.3	2.7	6.4	130	<1	0.4	14	4
SBKTN321	604406	1504630	5.1	6.6	14	580	1	1.1	27	13
SBKXN321	604406	1504630	5.2	6.9	5.2	580	<1	2.0	27	8
SBKTN641	604158	1501028	5.2	7.1	12	530	1	1.4	27	12
SBKTN642	604158	1501028	5.1	7.1	11	500	1	1.4	29	11
					South Transect					
SBKTS011	603956	1512149	5.1	7.7	4.8	520	1	2.5	24	9
SBKTS012	603956	1512149	5.1	7.4	5.3	540	<1	2.3	26	8
SBKTS021	603933	1512127	5.1	6.6	8.3	370	<1	1.8	22	7
SBKTS041	603858	1511443	5.2	7.2	7.7	500	<1	1.9	23	10
SBKTS042	603858	1511443	5.7	8.1	5.1	530	1	2.1	28	10
SBKTS161	603252	1511253	5.3	7.5	10	490	1	1.5	22	18
SBKTS162	603252	1511253	5.6	8.5	8.2	460	1	1.6	26	13
SBKTS321	602732	1505735	5.2	6.8	5.1	570	<1	2.0	25	7
SBKTS641	601516	1511049	5.6	7.9	8.8	510	<1	1.9	25	12
SBKTS642	601516	1511049	5.7	7.8	6.2	540	<1	2.3	25	11

Table A4.--Listing of analytical data for pH and element concentrations in samples of B-horizon soils collected according to transect sampling designs (continued).

Sample ID	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm
					East Transect					
SBKTE011	30	18	3.7	18	0.10	0.86	15	16	0.92	590
SBKTE012	30	18	3.5	20	0.08	0.92	14	18	0.91	620
SBKTE021	29	20	3.4	18	0.12	0.80	14	15	0.83	490
SBKXE021	24	17	3.3	18	0.14	0.78	13	15	0.81	460
SBKTE041	26	20	3.5	19	0.08	0.97	15	20	1.0	830
SBKTE042	60	18	4.1	17	0.12	0.90	15	24	0.91	920
SBKTE081	31	9	2.9	18	0.10	0.94	10	17	0.95	560
SBKTE161	58	16	4.5	19	0.12	0.78	14	26	0.85	1000
SBKTE162	39	15	3.4	16	0.10	0.83	15	20	0.73	490
SBKTE321	51	13	4.6	19	0.08	0.77	14	24	0.72	1000
SBKTE641	65	13	3.9	20	0.02	0.95	18	34	0.98	550
SBKTE642	83	20	3.8	17	0.04	0.92	17	28	0.93	560
					North Transect					
SBKTN.51	20	19	4.1	20	0.04	0.92	14	15	0.96	730
SBKTN011	28	21	3.5	17	0.10	0.84	14	15	0.87	530
SBKTN012	28	16	3.3	18	0.10	0.85	14	16	0.91	550
SBKTN021	33	24	3.6	18	0.06	0.98	17	21	0.93	830
SBKXN021	27	24	3.5	20	0.06	0.98	17	22	0.96	800
SBKTN041	34	14	3.3	18	0.10	0.88	14	17	0.86	560
SBKTN042	30	17	4.0	20	0.10	0.95	14	18	0.90	1500
SBKTN081	31	17	3.6	19	0.10	0.85	14	18	0.92	620
SBKTN161	61	16	4.7	20	0.10	0.84	15	28	0.87	890
SBKTN162	24	6	2.3	10	0.08	0.11	8	2	0.13	150
SBKTN321	83	16	4.1	15	0.04	0.97	16	31	0.67	540
SBKXN321	43	12	2.7	18	0.04	0.98	17	21	0.80	520
SBKTN641	77	14	4.4	18	<0.02	0.85	16	32	0.80	520
SBKTN642	70	14	4.2	19	0.04	0.81	16	34	0.83	450
					South Transect					
SBKTS011	32	20	3.2	17	0.08	0.92	15	17	0.86	530
SBKTS012	25	14	3.0	18	0.08	0.91	14	18	0.83	510
SBKTS021	26	21	2.7	14	0.08	0.68	12	14	0.79	470
SBKTS041	46	19	3.9	17	0.14	0.84	14	20	0.84	690
SBKTS042	30	18	3.5	19	0.08	0.90	15	21	0.88	570
SBKTS161	48	15	4.9	19	0.08	0.74	14	23	0.70	1100
SBKTS162	40	12	4.4	19	0.12	0.70	14	23	0.76	800
SBKTS321	43	12	2.7	17	0.04	0.97	16	20	0.79	510
SBKTS641	36	14	4.1	19	0.02	0.74	15	26	0.75	560
SBKTS642	30	14	3.4	19	0.04	0.92	15	24	0.92	620

Table A4.--Listing of analytical data for pH and element concentrations in samples of B-horizon soils collected according to transect sampling designs (continued).

Sample ID	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Se, ppm	Sr, ppm
					East Transect					
SBKTE011	2.0	<4	11	7	0.10	9	0.05	9	0.6	380
SBKTE012	2.1	5	12	6	0.08	9	<0.05	9	0.6	390
SBKTE021	1.9	5	12	7	0.10	9	0.06	9	0.6	340
SBKXE021	1.9	4	12	6	0.10	8	0.06	9	0.7	320
SBKTE041	2.2	5	13	7	0.08	10	<0.05	10	0.7	370
SBKTE042	1.7	5	11	16	0.11	10	<0.05	11	0.7	250
SBKTE081	2.0	<4	24	6	0.09	<4	<0.05	10	0.5	310
SBKTE161	1.6	5	12	15	0.18	10	<0.05	10	0.9	220
SBKTE162	1.7	6	13	10	0.08	10	<0.05	9	0.5	250
SBKTE321	1.7	7	12	10	0.35	10	<0.05	10	0.5	230
SBKTE641	1.9	5	15	18	0.09	11	<0.05	12	0.5	220
SBKTE642	1.9	6	15	20	0.06	10	<0.05	13	0.4	240
					North Transect					
SBKTN.51	2.1	5	13	4	0.09	9	<0.05	9	0.6	380
SBKTN011	1.9	5	9	6	0.10	9	0.06	9	0.7	330
SBKTN012	2.1	5	11	6	0.10	11	<0.05	9	0.5	400
SBKTN021	2.1	6	15	9	0.08	11	<0.05	11	0.5	390
SBKXN021	2.2	5	15	9	0.08	11	<0.05	11	0.8	380
SBKTN041	2.1	6	10	6	0.09	11	<0.05	9	0.4	390
SBKTN042	2.1	5	13	5	0.16	9	<0.05	9	0.4	390
SBKTN081	1.9	5	11	7	0.13	10	<0.05	10	0.7	330
SBKTN161	1.7	4	12	17	0.20	9	<0.05	11	0.8	230
SBKTN162	0.1	<4	5	4	0.07	6	<0.05	4	0.4	52
SBKTN321	1.5	10	14	21	0.15	12	<0.05	9	0.4	180
SBKTN641	1.8	6	14	18	0.07	12	<0.05	11	0.3	220
SBKTN642	1.8	<4	13	21	0.05	10	<0.05	11	0.5	200
					South Transect					
SBKTS011	2.1	<4	12	7	0.08	9	<0.05	9	0.4	350
SBKTS012	2.1	4	12	6	0.08	9	<0.05	9	0.6	380
SBKTS021	1.5	<4	10	8	0.11	7	0.06	8	0.8	260
SBKTS041	1.8	<4	12	10	0.10	10	0.06	10	0.6	290
SBKTS042	2.0	4	14	8	0.08	9	<0.05	10	0.8	330
SBKTS161	1.5	7	10	11	0.14	12	<0.05	9	0.8	230
SBKTS162	1.6	4	12	10	0.11	8	<0.05	10	1.0	230
SBKTS321	2.1	12	13	7	0.16	8	<0.05	10	0.4	310
SBKXN321	2.1	6	13	8	0.15	10	<0.05	10	0.3	310
SBKTS641	1.7	6	14	10	0.19	9	<0.05	9	0.6	270
SBKTS642	2.1	4	13	9	0.21	8	<0.05	10	0.5	340

Table A4.--Listing of analytical data for pH and element concentrations in samples of B-horizon soils collected according to transect sampling designs (continued).

Sample ID	Th, ppm	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
					East Transect	
SBKTE011	<4	0.35	110	11	2	44
SBKTE012	<4	0.35	100	11	2	49
SBKTE021	<4	0.33	100	11	2	37
SBKXE021	<4	0.33	100	11	1	35
SBKTE041	4	0.36	100	12	2	47
SBKTE042	<4	0.38	130	11	2	59
SBKTE081	10	0.37	93	10	1	38
SBKTE161	5	0.39	140	10	1	51
SBKTE162	<4	0.36	110	11	1	40
SBKTE321	<4	0.40	150	10	1	54
SBKTE641	4	0.47	150	11	2	46
SBKTE642	<4	0.43	130	12	2	42
					North Transect	
SBKTN.51	<4	0.37	120	11	2	41
SBKTN011	<4	0.35	110	11	2	46
SBKTN012	<4	0.35	99	11	2	40
SBKTN021	<4	0.37	100	13	2	50
SBKXN021	<4	0.37	100	13	2	50
SBKTN041	<4	0.35	110	10	2	47
SBKTN042	<4	0.36	110	10	2	53
SBKTN081	<4	0.37	110	11	1	51
SBKTN161	4	0.39	140	10	1	59
SBKTN162	<4	0.20	88	4	<1	34
SBKTN321	5	0.35	120	9	1	48
SBKTN641	5	0.46	150	11	2	42
SBKTN642	5	0.43	140	11	2	44
					South Transect	
SBKTS011	<4	0.35	100	11	2	44
SBKTS012	<4	0.34	94	11	1	48
SBKTS021	<4	0.29	80	10	1	33
SBKTS041	<4	0.37	120	10	1	50
SBKTS042	4	0.37	110	12	2	45
SBKTS161	<4	0.37	140	10	1	48
SBKTS162	4	0.36	120	11	2	43
SBKTS321	<4	0.39	90	11	2	44
SBKXN321	<4	0.39	90	12	2	44
SBKTS641	<4	0.37	130	11	1	41
SBKTS642	<4	0.35	98	12	2	56

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs.

Sample ID	Latitude	Longitude	pH	Al, %	As, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm	Co, ppm
					Barbell Sampling Design					
SC111111	604528	1503023	5.9	6.9	9.9	650	1	1.4	37	14
SC111211	604503	1503023	5.7	7.0	11	620	1	1.5	35	13
SC112111	604359	1503640	5.3	6.9	11	590	1	1.4	37	13
SC112112	604359	1503640	5.7	7.7	10	620	1	1.5	44	14
SC112121	604359	1503640	5.5	7.3	10	650	1	1.4	34	13
SC112211	604354	1503608	5.3	6.8	10	620	1	1.5	31	12
SC112212	604354	1503608	5.5	7.0	9.4	610	1	1.5	33	12
SC121111	604422	1500426	5.5	6.8	10	570	1	1.4	31	12
SC121121	604422	1500426	5.4	6.5	9.1	620	1	1.0	28	13
SC121211	604407	1500458	5.5	6.9	9.9	530	1	1.3	27	11
SC122111	604257	1500849	5.2	6.9	12	570	1	1.4	33	13
SC122211	604257	1500848	5.5	7.4	11	590	1	1.4	39	16
SC122212	604257	1500848	5.6	7.1	11	570	1	1.4	38	15
SC211111	601516	1511049	5.5	7.5	7.1	550	1	2.0	28	12
SC211121	601516	1511049	5.5	7.3	5.5	570	<1	2.1	31	11
SC211211	601507	1511154	5.7	7.6	6.8	530	1	2.1	27	12
SC212111	601720	1511459	5.6	7.3	7.2	550	1	1.8	33	14
SC212211	601700	1511420	5.4	7.3	5.0	530	<1	2.2	26	11
SC212212	601659	1511420	5.5	7.5	4.8	520	<1	2.3	25	12
SC221111	595916	1512835	5.3	7.6	3.3	580	1	2.4	26	10
SC221211	595907	1512720	5.8	7.9	4.9	520	1	2.1	29	16
SC222111	595934	1512206	5.4	7.3	4.0	570	<1	2.1	27	11
SC222121	595934	1512206	5.4	7.3	2.2	530	<1	2.3	23	9
SC222211	595917	1512312	5.5	7.2	4.3	500	<1	1.8	30	15
					East Transect					
SCKTE011	604034	1512121	5.8	8.0	7.7	520	1	2.0	30	16
SCKTE012	604034	1512121	6.2	8.2	8.4	570	1	1.8	38	15
SCKTE021	604031	1512024	5.8	8.5	7.4	500	1	1.9	36	20
SCKTE041	603949	1511845	6.0	8.4	6.2	580	1	2.1	36	15
SCKTE042	603949	1511845	5.6	7.8	6.6	570	1	1.9	32	13
SCKTE081	604041	1511220	5.8	8.2	8.3	570	1	1.8	30	16
SCKTE161	603830	1510340	5.6	7.7	11	590	1	1.5	37	19
SCKTE162	603830	1510340	5.7	8.0	8.2	600	1	1.8	36	15
SCKTE321	603540	1504702	5.8	7.2	9.1	610	1	1.3	39	13
SCKTE641	602723	1501550	6.0	7.4	12	570	1	1.2	31	15
SCKXE641	602723	1501550	5.8	7.0	12	570	1	1.1	32	14
SCKTE642	602723	1501550	5.8	7.2	9.5	610	1	1.3	30	16

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs (continued).

Sample ID	Latitude	Longitude	pH	Al, %	As, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm	Co, ppm
					North Transect					
SCKTN.51	604053	1512228	5.2	7.8	4.3	550	1	2.1	25	15
SCKXN.51	604053	1512228	5.1	7.7	4.1	550	1	2.1	25	15
SCKTN011	604113	1512137	5.9	8.1	6.3	500	1	1.7	36	11
SCKXN011	604113	1512137	6.0	8.2	7.3	500	1	1.7	34	12
SCKTN012	604113	1512137	5.8	8.0	6.0	530	1	2.0	31	11
SCKTN021	604118	1512106	5.1	7.6	3.9	480	<1	2.5	21	8
SCKXN021	604118	1512106	5.4	7.9	3.7	480	<1	2.6	23	8
SCKTN041	604142	1511853	6.0	8.4	6.7	540	1	1.9	31	14
SCKTN042	604142	1511853	5.7	8.4	7.3	580	1	1.9	30	16
SCKTN081	604241	1511338	5.8	7.4	13	600	1	1.5	34	19
SCKTN161	604328	1510706	6.0	8.3	14	590	1	1.3	36	22
SCKTN162	604328	1510706	5.9	8.1	13	630	1	1.5	37	19
SCKTN321	604406	1504630	5.8	6.6	8.8	720	1	1.1	35	14
SCKTN641	604158	1501028	5.6	7.1	13	560	1	1.3	33	14
SCKTN642	604158	1501028	6.0	7.6	12	550	1	1.3	37	14
					South Transect					
SCKTS011	603956	1512149	5.7	8.4	4.3	540	1	2.5	31	13
SCKTS012	603956	1512149	5.8	8.2	6.3	560	1	2.1	32	13
SCKTS021	604031	1512024	5.2	5.5	12	370	<1	1.5	22	10
SCKTS041	603858	1511943	5.5	7.7	7.6	540	1	1.8	33	15
SCKTS042	603858	1511943	5.8	8.3	8.9	540	1	1.6	33	15
SCKTS081	603525	1511949	4.4	5.4	2.0	330	<1	1.8	19	5
SCKTS161	603252	1511253	6.0	7.8	8.8	550	1	1.7	32	17
SCTTS162	603252	1511253	5.9	7.9	7.8	520	1	1.7	35	12
SCKTS321	602732	1505735	5.8	7.5	5.9	550	<1	2.1	28	13
SCKTS641	601516	1511049	5.5	7.4	7.5	550	<1	2.0	29	15
SCKTS642	601516	1511049	6.0	7.9	6.6	590	1	2.2	34	14

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs (continued).

Sample ID	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm
					Barbell Sampling Design					
SC111111	78	21	3.5	15	0.04	1.0	20	28	0.94	640
SC111211	85	18	3.6	16	0.04	0.95	20	28	0.86	630
SC112111	85	17	3.5	14	0.04	0.95	20	28	0.89	630
SC112112	69	17	3.8	16	0.04	1.0	22	32	0.99	680
SC112121	72	18	3.6	17	0.04	1.1	18	31	0.92	630
SC112211	65	18	3.6	16	0.04	1.0	17	26	0.83	530
SC112212	66	18	3.4	17	0.02	1.0	18	28	0.82	490
SC121111	69	18	3.5	18	0.04	0.86	17	27	0.77	520
SC121121	77	18	3.6	14	0.04	1.1	15	34	1.1	620
SC121211	63	16	3.7	18	0.04	0.86	15	32	0.84	470
SC122111	73	17	4.2	19	<0.02	0.87	18	30	0.86	550
SC122211	78	17	3.8	17	0.02	0.96	20	31	0.97	590
SC122212	78	18	3.5	15	0.04	0.9	20	30	0.92	550
SC211111	56	16	3.5	17	0.02	0.91	17	25	0.93	620
SC211121	44	15	3.2	17	0.02	0.98	18	22	0.95	680
SC211211	53	22	3.6	15	0.02	0.86	17	23	0.99	640
SC212111	53	26	3.6	16	0.02	0.87	18	24	1.0	780
SC212211	33	18	3.5	18	0.02	0.88	15	19	0.98	670
SC212212	41	19	3.6	17	0.04	0.9	15	20	1.0	690
SC221111	29	15	3.1	18	0.04	1.0	16	20	0.88	720
SC221211	46	18	3.5	16	0.08	0.87	17	21	0.85	1000
SC222111	49	14	3.2	17	---	1.1	16	20	0.92	830
SC222121	34	16	2.8	17	0.04	0.97	14	17	0.83	930
SC222211	41	20	3.3	17	0.06	0.89	17	21	0.88	960
					East Transect					
SCKTE011	55	23	4.0	18	0.08	0.9	18	25	0.94	870
SCKTE012	55	29	4.1	19	0.06	0.91	19	28	1.0	740
SCKTE021	46	29	4.2	19	0.10	0.86	18	25	0.89	1100
SCKTE041	46	23	3.8	19	0.08	0.98	18	27	1.1	960
SCKTE042	58	23	3.9	18	0.06	0.98	18	24	0.91	790
SCKTE081	69	21	4.2	19	0.04	0.97	17	29	0.92	780
SCKTE161	93	26	4.1	15	0.04	0.93	20	30	1.0	870
SCKTE162	58	21	3.8	19	0.06	0.95	20	28	0.99	830
SCKTE321	76	23	3.5	15	0.04	0.97	20	30	1.0	690
SCKTE641	96	21	4.0	16	0.04	0.95	18	38	1.2	550
SCKXE641	92	21	4.1	15	<0.02	0.92	18	35	1.1	560
SCKTE642	110	26	3.8	15	<0.02	1.0	18	31	1.2	660

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs (continued).

Sample ID	Cr, ppm	Cu, ppm	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm
					North Transect					
SCKTN.51	48	21	3.6	16	0.06	1.0	15	21	1.0	710
SCKXN.51	47	21	3.6	16	0.04	1.0	15	21	1.0	700
SCKTN011	44	27	4.0	19	0.06	0.87	18	26	0.80	600
SCKXN011	45	27	4.1	20	0.06	0.88	17	26	0.86	630
SCKTN012	35	21	3.9	20	0.06	0.93	17	22	0.83	610
SCKTN021	27	15	3.3	18	0.08	0.80	14	15	0.77	510
SCKXN021	22	16	3.3	19	0.18	0.80	13	16	0.85	520
SCKTN041	48	23	4.1	19	0.10	0.86	17	26	0.94	780
SCKTN042	46	22	4.0	19	0.08	0.93	16	27	0.94	1100
SCKTN081	71	23	4.5	17	0.06	0.96	19	31	0.96	1000
SCKTN161	74	28	4.5	17	0.06	0.92	19	37	0.98	730
SCKTN162	81	27	4.5	19	0.02	0.97	19	32	0.95	800
SCKTN321	77	19	2.9	13	0.04	1.3	18	32	0.80	430
SCKTN641	76	19	4.3	16	0.02	0.88	18	31	0.93	590
SCKTN642	84	20	4.4	18	0.04	0.87	19	36	0.98	560
					South Transect					
SCKTS011	35	23	3.7	18	0.06	0.98	18	21	0.98	650
SCKTS012	40	22	3.7	19	0.06	0.94	18	25	0.93	750
SCKTS021	25	21	2.2	12	0.06	0.64	12	14	0.65	610
SCKTS041	43	24	3.8	18	0.08	0.90	18	24	0.86	890
SCKTS042	52	25	3.9	17	0.08	0.86	18	29	0.92	640
SCKTS081	14	23	1.2	13	0.04	0.64	10	11	0.68	360
SCKTS161	78	29	3.8	14	0.04	0.89	18	30	1.0	930
SCTTS162	48	20	3.7	17	0.06	0.79	19	28	0.85	670
SCKTS321	49	16	3.4	18	0.02	0.91	17	21	0.91	830
SCKTS641	52	19	3.8	17	0.02	0.89	16	25	1.1	710
SCKTS642	47	18	3.4	18	0.02	1.0	19	27	1.0	980

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs (continued).

Sample ID	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Se, ppm	Sr, ppm
					Barbell Sampling Design					
SC111111	2.0	6	18	27	0.04	11	<0.05	12	0.4	230
SC111211	1.9	5	16	25	0.07	11	<0.05	12	0.6	230
SC112111	1.9	15	16	24	0.07	9	<0.05	12	0.5	230
SC112112	2.0	4	21	25	0.08	11	<0.05	13	0.5	240
SC112121	1.9	<4	16	25	0.06	11	<0.05	12	0.4	210
SC112211	1.8	5	17	20	0.06	11	<0.05	11	0.5	230
SC112212	1.8	5	15	21	0.05	9	<0.05	12	0.5	220
SC121111	1.9	5	14	20	0.05	12	<0.05	11	0.6	210
SC121121	1.8	<4	14	31	0.08	8	<0.05	11	0.4	210
SC121211	1.8	4	12	19	0.10	9	<0.05	11	0.5	220
SC122111	1.8	6	17	24	0.05	12	<0.05	12	0.4	210
SC122211	2.1	<4	18	31	0.04	11	<0.05	13	0.4	220
SC122212	1.9	5	17	30	0.05	11	<0.05	13	0.4	210
SC211111	1.9	5	14	16	0.14	8	<0.05	10	0.5	290
SC211121	2.1	5	16	12	0.13	8	<0.05	10	0.4	340
SC211211	1.9	6	14	16	0.10	8	<0.05	12	0.5	280
SC212111	1.9	5	17	20	0.07	9	<0.05	12	0.4	250
SC212211	2.0	5	12	10	0.07	9	<0.05	10	0.5	300
SC212212	2.0	4	13	10	0.07	14	<0.05	11	0.5	300
SC221111	2.2	6	14	7	0.11	9	<0.05	10	0.3	390
SC221211	2.0	5	15	11	0.13	8	<0.05	11	0.5	280
SC222111	2.2	<4	13	12	0.11	10	<0.05	10	0.3	300
SC222121	2.1	<4	12	6	0.10	8	<0.05	9	0.3	340
SC222211	1.9	5	15	12	0.11	9	<0.05	11	0.5	250
					East Transect					
SCKTE011	1.8	12	16	14	0.10	11	<0.05	12	0.8	290
SCKTE012	1.9	6	18	19	0.08	10	<0.05	14	0.8	250
SCKTE021	1.8	5	18	14	0.10	9	<0.05	13	1.1	270
SCKTE041	2.1	6	17	17	0.09	12	<0.05	12	0.6	330
SCKTE042	1.9	6	16	15	0.09	11	<0.05	13	0.7	270
SCKTE081	1.9	5	14	18	0.07	13	<0.05	13	0.7	240
SCKTE161	1.8	6	15	31	0.09	10	<0.05	14	0.7	220
SCKTE162	2.0	4	17	22	0.07	11	<0.05	13	0.7	270
SCKTE321	2.0	5	16	30	0.07	9	<0.05	13	0.5	230
SCKTE641	1.9	4	16	33	0.06	8	<0.05	14	0.4	210
SCKXE641	1.8	6	15	32	0.06	12	<0.05	13	0.3	210
SCKTE642	1.9	6	14	30	0.06	8	<0.05	14	0.3	240

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs (continued).

Sample ID	Na, %	Nb, ppm	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Total S, %	Sc, ppm	Se, ppm	Sr, ppm
					North Transect					
SCKTN.51	2.0	5	13	11	0.07	13	<0.05	11	0.7	330
SCKXN.51	2.0	6	12	12	0.07	12	<0.05	11	0.5	330
SCKTN011	1.8	6	17	12	0.07	10	<0.05	13	0.9	230
SCKXN011	1.8	5	18	12	0.07	10	<0.05	13	1	230
SCKTN012	2.0	7	16	9	0.09	10	<0.05	11	0.9	330
SCKTN021	2.0	5	11	6	0.09	10	.05	8	0.4	370
SCKXN021	2.0	<4	11	6	0.09	7	<0.05	9	0.6	370
SCKTN041	1.8	<4	17	17	0.08	7	<0.05	13	1.2	240
SCKTN042	1.9	6	13	15	0.13	10	<0.05	12	0.8	290
SCKTN081	1.7	6	18	25	0.13	11	<0.05	13	0.7	220
SCKTN161	1.6	6	17	33	0.09	12	<0.05	14	0.9	190
SCKTN162	1.8	7	20	30	0.06	13	<0.05	14	0.6	220
SCKTN321	1.8	<4	14	35	0.13	11	<0.05	9	0.3	190
SCKTN641	1.8	5	18	26	0.15	9	<0.05	14	0.4	200
SCKTN642	1.8	5	18	30	0.05	12	<0.05	14	0.5	200
					South Transect					
SCKTS011	2.2	5	15	9	0.08	11	<0.05	11	0.8	400
SCKTS012	2.0	5	15	13	0.08	10	<0.05	12	0.8	310
SCKTS021	1.4	<4	11	8	0.09	8	<0.05	7	0.6	220
SCKTS041	1.9	5	19	14	0.09	10	<0.05	11	0.9	280
SCKTS042	1.8	6	17	21	0.08	10	<0.05	12	0.8	230
SCKTS081	1.5	<4	9	4	0.07	5	0.12	8	0.3	250
SCKTS161	1.8	6	15	26	0.07	10	<0.05	13	0.6	240
SCTTS162	1.8	6	17	16	0.07	9	<0.05	12	0.9	240
SCKTS321	2.2	4	15	12	0.10	9	<0.05	12	0.5	280
SCKTS641	2.0	4	13	19	0.13	9	<0.05	11	0.5	280
SCKTS642	2.2	6	16	16	0.11	9	<0.05	11	0.4	350

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs (continued).

Sample ID	Th, ppm	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
				Barbell Sampling Design		
SC111111	<4	0.42	120	12	2	58
SC111211	4	0.41	120	13	2	58
SC112111	5	0.40	120	13	2	62
SC112112	5	0.44	130	14	2	100
SC112121	5	0.40	120	11	2	65
SC112211	4	0.41	120	11	2	49
SC112212	<4	0.40	120	11	2	46
SC121111	5	0.43	130	11	2	56
SC121121	<4	0.36	110	11	1	63
SC121211	5	0.42	130	10	1	46
SC122111	5	0.46	140	12	2	47
SC122211	5	0.41	120	14	2	62
SC122212	4	0.40	120	13	2	57
SC211111	<4	0.37	110	11	2	48
SC211121	4	0.37	98	12	2	60
SC211211	<4	0.37	110	13	2	51
SC212111	<4	0.39	110	13	2	56
SC212211	<4	0.36	110	12	2	50
SC212212	<4	0.37	110	12	2	50
SC221111	<4	0.37	88	13	2	50
SC221211	<4	0.37	100	14	2	55
SC222111	<4	0.37	100	12	2	60
SC222121	<4	0.33	86	11	2	52
SC222211	<4	0.36	100	13	2	59
				East Transect		
SCKTE011	5	0.40	130	13	2	60
SCKTE012	5	0.43	130	15	2	68
SCKTE021	5	0.41	140	15	2	54
SCKTE041	4	0.39	120	13	2	65
SCKTE042	<4	0.43	130	14	2	53
SCKTE081	<4	0.45	140	13	2	69
SCKTE161	6	0.43	130	13	2	75
SCKTE162	5	0.42	120	14	2	63
SCKTE321	6	0.42	120	13	2	70
SCKTE641	5	0.45	140	11	2	66
SCKXE641	<4	0.45	140	11	2	67
SCKTE642	5	0.44	130	12	2	55

Table A5.--Listing of analytical data for pH and element concentrations in samples of C-horizon soils collected according to barbell and transect sampling designs (continued).

Sample ID	Th, ppm	Ti, %	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
					North Transect	
SCKTN.51	<4	0.38	110	12	2	46
SCKXN.51	<4	0.37	110	12	2	46
SCKTN011	4	0.42	130	15	2	43
SCKXN011	4	0.42	130	15	2	45
SCKTN012	<4	0.40	120	13	2	44
SCKTN021	<4	0.32	99	10	1	41
SCKXN021	<4	0.32	99	10	1	44
SCKTN041	5	0.39	130	14	2	57
SCKTN042	4	0.41	130	12	2	88
SCKTN081	5	0.43	140	13	2	88
SCKTN161	6	0.42	130	12	2	73
SCKTN162	6	0.44	140	13	2	85
SCKTN321	5	0.29	91	9	1	51
SCKTN641	5	0.44	130	13	2	53
SCKTN642	5	0.43	130	14	2	55
					South Transect	
SCKTS011	<4	0.38	110	15	2	51
SCKTS012	4	0.40	120	14	2	72
SCKTS021	<4	0.26	64	9	1	36
SCKTS041	<4	0.39	120	14	2	63
SCKTS042	5	0.39	120	13	2	59
SCKTS081	<4	0.22	51	8	1	27
SCKTS161	<4	0.39	120	13	2	65
SCTTS162	<4	0.38	120	13	2	55
SCKTS321	<4	0.40	110	14	2	45
SCKTS641	<4	0.40	120	11	2	56
SCKTS642	4	0.38	100	12	2	80

Table A6.--Listing for analytical data for ash content and element concentrations in ash of elderberry samples collected in and near the Kenai National Wildlife Refuge.

[Total S, As, Hg, and Se determined on the dry plant material; ELDER1 corresponds with site KTN.5, near the industrial complex; ELDER2 corresponds with site KTN32, 32km east of the industrial complex]

Sample ID	Latitude	Longitude	Total, S%	Ash, %	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %
ELDER1a	604053	1512228	0.48	10.6	0.22	4.40	0.26	23.	2.8	3.3
ELDER2b	604406	1504630	0.28	13.8	0.06	9.50	0.09	18.	2.7	1.8

	P, %	Ti, %	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm
ELDER1a	3.8	0.01	6800	210	<4	<8	2	7	32	<8
ELDER2b	3.0	<0.01	740	410	<4	<8	<2	5	39	<8

	La, ppm	Li, ppm	Mo, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V ppm
ELDER1	5	11	<4	<8	4	<8	<4	260	<8	<4
ELDER2	5	<4	13	10	<4	<8	<4	630	<8	<4

	W, ppm	Y, ppm	YB, ppm	ZN, ppm	As, ppm	Hg, ppm	Se, ppm
ELDER1	<8	<4	<2	340	<0.05	0.07	<0.05
ELDER2	<8	<4	<2	400	<0.05	0.06	<0.05

Table A7.--Listing for analytical data for ash content and element concentrations in ash for the age study of white spruce taken near the Kenai Industrial area.

[Total S, As, Hg, and Se determined on the dry plant material; KTN.53-5 is a sample of 3-to-5 year-old twigs; KTN.51-2 is a sample of 1-to-2 year-old twigs from the same tree near the industrial complex; The remaining three samples are from 1-to-2 year-old twigs of from three separate trees near the industrial complex]

Sample ID	Latitude	Longitude	Total S, %	Ash, %	Al, %	Ca, %	Fe, %	K, %	Mg, %
KTK.53-5	604053	1512228	0.06	1.99	1.4	11	0.67	16	1.4
KTN.51-2	604053	1512228	0.08	2.21	0.37	7.8	0.23	25	1.9
PKTN.51	604053	1512228	0.11	2.02	0.93	10	0.54	20	2.9
PKTN.52	604053	1512228	0.09	2.36	1.2	11	0.69	18	2.8
PKTN.53	604053	1512228	0.08	1.92	1.0	9.2	0.61	18	2.7

	Na, %	P, %	Ti, %	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
KTK.53-5	0.63	4.8	0.04	21000	200	<4	<8	8	36	120
KTN.51-2	0.18	6.3	0.01	17000	390	<4	<8	6	13	120
PKTN.51	1.5	6.6	0.02	24000	210	<4	<8	6	26	130
PKTN.52	1.3	5.0	0.04	27000	380	<4	11	7	34	82
PKTN.53	1.1	6.3	0.03	27000	480	<4	<8	7	31	110

	Ga, ppm	La, ppm	Li, ppm	Mo, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm
KTK.53-5	10	7	7	<4	9	44	20	<4	590
KTN.51-2	<8	5	<4	<4	<8	31	<8	<4	360
PKTN.51	11	7	5	<4	<8	34	20	<4	550
KTN.52	<8	7	6	<4	11	40	32	<4	510
PKTN.53	<8	7	4	<4	<8	50	18	<4	380

	Th, ppm	V , ppm	W, ppm	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Hg, ppm	Se, ppm
KTK.53-5	10	16	<8	<4	<2	1400	<0.05	0.03	<0.05
KTN.51-2	<8	<4	<8	<4	<2	1200	<0.05	0.01	<0.05
PKTN.51	11	15	<8	<4	<2	950	<0.05	0.02	<0.05
PKTN.52	15	18	<8	<4	<2	710	<0.05	0.02	<0.05
PKTN.53	<8	15	<8	<4	<2	900	<0.05	0.04	<0.05

Table A8.--Extraction anion data on selected soil samples.

[All determinations done by ion chromatography on a 1:5 (sample:water) extraction of soil, and reported as ppm in the extracting solution.]

SAMPLE ID	Chloride	Sulfate	Nitrate
SCKTE011	1	1	<0.5
SCKTE021	2	1	<0.5
SCKTE041	1	1	<0.5
SCKTE081	2	3	<0.5
SCKTE161	1	2	<0.5
SCKTE321	1	1	<0.5
SCKTN.51	2	<1	4.0
SCKTN161	1	<1	<0.5
SCKTS011	2	1	<0.5
SCKTS021	2	2	0.6
SCKTS041	1	1	<0.5
SCKTS081	4	4	5.0
SCKTS161	1	1	<0.5
SCKTS321	1	1	<0.5
SCKTS641	1	<1	<0.5
SOKTE011	14	13	<0.5
SOKTE021	23	35	<0.5
SOKTE041	28	25	<0.5
SOKTE081	24	30	<0.5
SOKTE161	30	35	2.0
SOKTE321	47	28	<0.5
SOKTN.51	15	23	55
SOKTN161	20	24	<0.5
SOKTS011	15	17	1.0
SOKTS021	11	14	1.0
SOKTS041	70	43	1.0
SOKTS081	10	14	6.0
SOKTS161	13	9	<0.5
SOKTS321	12	18	<0.5
SOKTS641	18	33	<0.5