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ELEMENT CONCENTRATIONS AND TRENDS FOR MOSS, LICHEN, AND SURFACE SOILS IN AND NEAR DENALI NATIONAL PARK AND PRESERVE, ALASKA

by

J.G. Crock*, L.P. Gough*, D.R. Mangis**,
K.L. Curry*, D.L. Fey*, P.L. Hageman*, and E.P. Welsch*

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*U.S. Geological Survey, DFC, Box 25046, MS 973, Denver, CO 80225
**National Park Service, Air Quality Division, Box 25287, Denver, CO 80225

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EXECUTIVE SUMMARY

Investigations in and near Denali National Park and Preserve (DENA), Alaska, had as their major objectives: (1) establishment of baseline information on selected native vegetation and the organic-rich Oa soil horizon of the study area; and, (2) definition of current element areal trends, if any, of the area, possibly resulting from anthropogenic influences such as power-plant emissions. These objectives were accomplished by establishing two generally east-to-west traverses (The Control and Stampede Traverses), one north-to-south Traverse (the Nenana River Traverse), and twelve additional sites at various strategic places in or near DENA. Traverse sample localities were positioned at geometric intervals starting near the existing Golden Valley Electric Association (GVEA) power-plant located in Healy. At each locality, samples were collected of Hylocomium splendens (Hedw.) BSG (feather moss, whole plant, including rhizoids), Peltigera aphthosa (L.) Willd. (lichen, whole plant), and the Oa soil horizon. Picea glauca (Moench) Voss. (white spruce, twigs and needles), was also collected at selected sites. All materials were analyzed for their major and trace total element concentrations.

This report is the result of a cooperative study between the National Park Service (NPS) and the U. S. Geological Survey (USGS). A product of this study will be providing the information so that an assessment of the potential for any effects to the biological resources of DENA from air pollutants to be emitted from the proposed Healy Clean Coal Project (HCCP) power-plant can be made.

1. Biogeochemical baseline and areal trends were assessed using an ANOVA/traverse study design. Baseline information was calculated as the observed range using the collective values for each of the three sampled media for sites beyond 6 km from the GVEA.

2. Moss samples possessed a higher and more variable ash yield than lichen samples. Samples of both moss and lichen had higher and more variable ash yield along the Stampede and Nenana traverses than along the Control Traverse. All samples were washed, and loose, extraneous dust was removed. Very little overt contamination was observed; however, ash yield versus concentrations of Ti, Sc, and Al indicate that deeply imbedded, difficult to remove, dust contamination was present. We conclude, however, that the contamination would only dilute the relative concentration of environmentally important metals, not enhance their concentrations. In addition, important inverse ash yield versus distance trends occur for moss, lichen and soil on nearly all traverses, the only exception being for soil along the Control Traverse.

3. Among-site variability for element concentrations in moss and soil is large, and is small for lichen, for nearly every element along every Traverse.

4. Among-sample, within-site element concentration variability also appears large for moss and small for lichen (soil within-site variability was not measured). This is particularly true for samples collected within 6 km of GVEA.

5. In general, element concentration levels follow the progression: lichen < moss < soil. Except for total sulfur levels, the concentrations of most elements were several times greater in moss than in lichen.

6. Most elements show their highest concentrations close-in to the GVEA/Nenana River area and by far their smallest concentrations beyond about 6 km from GVEA (but not necessarily the Nenana River). For those elements showing concentration values at or near the detection limit for the analytical method used, most occur beyond the 6 km range.

7. Plant samples from the Control Traverse have the lowest element concentration levels; inverse concentration versus distance trends are thought to result from the influence of airborne dust originating from the Nenana River alluvial plain. This Traverse appears to be well outside the potential influence of the present GVEA facility.

8. Plant samples from the Stampede Traverse have the highest overall element concentration levels in all three sample media; however, these higher concentration levels do not necessarily translate into stronger concentration versus distance trends. Some of these concentration levels appear elevated when compared to levels cited in the general cryptogram literature and the Traverse trends indicate that the GVEA facility, or the Healy area in general, or both, are probable sources for some elements.

9. Plant samples from the Nenana Traverse have intermediate concentration levels when compared to the Control and Stampede levels and the trends appear influenced by GVEA, or the Healy area in general, or both.

10. We discuss the relative importance of the levels of environmentally important elements in both moss and lichen tissue by comparing the data from this study with values from the literature. In general, levels of As, Cr, Cu, Mn, Ni, V, and the rare earth elements were high in moss tissue. Levels of Mn and total S were somewhat elevated in lichen tissue. Moss tissue was found to be somewhat low in concentrations of Cd, total S, and Zn, whereas lichen samples were generally low in Cd, Pb, and Zn. The concentrations of most all of the other elements analyzed for were close to published values including values for Pb in moss and As, Cr, Cu, Ni, and V in lichen.

11. Concentrations of the environmentally important elements (including total S) in Oa-horizon soils were found to be close to published values. We found no unusually high concentrations of any of the elements, including the rare-earth elements. Many of the element concentration versus distance trends observed for both moss and lichen were paralleled in the soil. This is to be expected if the soil organic matter is assumed to serve as a sink for the elements that are being transmitted through the atmosphere.

12. The coal being burned at the GVEA is relatively homogeneous and is low in total S and many of the potentially toxic metals. A true mass-balance study was not performed. Analysis of composite coal and fly ash samples, however, show that the amount of most elements, including Hg, As, V, Co, Cr, and Cu, lost to the atmosphere during coal combustion does not appear great. Total S, Ni, Pb, and Zn (and Cd by implication of the very similar chemistry and its geochemical association, although Cd was below the limits of detection of the ICP-AES method) are being released in the flue gases.

13. White spruce proved to be nonconclusive in this study. In general, it was sampled only occasionally; however, from the relatively complete sampling along the Nenana Traverse, very little interpretable information was obtained. Only Cu proved to be above the baseline calculated for Wrangell-Saint Elias National Preserve, Alaska, (WSE) and the remaining elements fell well within the WSE ranges. White spruce showed greater variance for within plot samples than with distance, indicating a large local variance and thus it has little utility in defining distance trends.

INTRODUCTION

BACKGROUND

This study provides information that will assist in evaluating the potential impact of the proposed 50 MW Healy Clean Coal Project (HCCP) power-plant on the biological resources of Denali National Park and Preserve (DENA) by establishing background information and areal biogeochemical trends for selected native vegetation and the organic-rich Oa soil horizon. Construction of the HCCP power-plant is proposed to begin in April 1993 and be completed June, 1996. It will be located adjacent to an existing coal-fired power-plant, the Golden Valley Electric Association (GVEA) Healy Unit #1 (25 MW), that has been operating since 1967. Both power-plants will be approximately 4 miles (6.5 km) from the northeastern border of DENA. The proposed HCCP plant will burn coal from throughout Alaska during the first year of operation to test the clean coal technology as proposed by the Alaska Industrial Development and Export Authority for support through the Clean Coal Technology Program of the U.S. Department of Energy.

Chemical emissions during the first-year test period can only be estimated, due to the different coal sources which will be used. After the first year, HCCP will burn coal mined from the same source as the GVEA plant (the nearby Poker Flats mine owned by Usibelli Coal Mine, Inc.). The projected annual emissions from the HCCP plant, using coal from the Poker Flats mine, are 243 tons per year (TPY) of sulfur dioxide, 988 TPY of nitrogen oxides, and 56 TPY of particulate matter (AIDEA, 1992). These values are the test results of pilot studies of the proposed new technologies that are to be included as a part of the HCCP using coal from the Poker Flats mine.

The NPS is concerned that emissions resulting from the proposed HCCP plant could negatively effect the biological resources in DENA. Preliminary studies conducted by the NPS and the USGS in October 1990 indicated that emissions from the existing GVEA power-plant may be affecting the chemistry of selected lichen and moss species; notably, an increase in concentrations of the rare earth elements (REE). The number of samples collected in the 1990 pilot study was not sufficient to clearly delineate patterns of elemental accumulation. Further research was needed to evaluate the response of vascular and non-vascular plant species and associated fauna of DENA to airborne contaminants emitted from coal-fired power-plants. This study, however, only addresses the assessment of potential impacts to non-vascular species (lichens and mosses) by establishing current areal trends and baseline information.

Uses of Mosses and Lichens as Biomonitors

Vegetation and organic-rich soils have been used successfully to assess the areal extent of industrial emissions [for example, Folkeson (1981), Godbeer and others (1981), Gough and Erdman (1977), LeBlanc and de Sloover (1970), Markert and Weckert (1989), Onianwa (1988), Pilegaard (1987), Severson and others (1992) and Thomas and others (1984)]. Folkeson (1981) used the moss Pleurozium schreberi to monitor heavy metal contamination resulting from peat-fired power facilities in Finland. Increases in Ca, Cu, Pb, V, and Zn, and a decrease in Mn were observed in moss downwind from the facilities. This trend in Mn was attributed, in part, to an increase in the sulfur dioxide (SO_2) levels in the plume gases close to these facilities. The authors theorized that the solubility (and the phyto-availability) of Mn decreased as soil pH decreased, presumably from the increased levels of SO_2. Godbeer and others (1981) used cleaned Sphagnum moss enclosed in fine mesh envelopes placed on stakes. The moss served as a bioaccumulator material 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. Gough and Erdman (1977) used a soil lichen, Parmelia chlorochroa, to delineate the effect of a coal-fired power-plant in eastern Wyoming. They found that ash yield, Li, Se, and Sr showed strong ($p < 0.01$) negative linear trends with distance from the power-plant. An additional ten elements showed a less significant response ($p < 0.05$) with distance. LeBlanc 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. Markert and Weckert (1989) sampled Polytrichum formosum (moss) seasonally over three years, and showed strong seasonal variations in its metal content. The authors proposed that to obtain comparable results, samples must be taken at the same time of year. They also proposed that moss would be an effective global monitoring medium for air pollution. In Greenland, Pilegaard (1987) used Hylocomium splendens (feather moss) to delineate the mineralization seen in the country rock, the Ilimaussaq mafic intrusion. Trends in heavy metals in this moss mirrored those observed in the substrate's geochemistry. Heavy metal concentrations in top soil, litter (the 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. Severson and others (1992) used the A horizon of weakly-developed soils and three different vegetation species, including H. splendens, to investigate the possibility of anthropogenic influences on five small islands in the Wattenmeer National Park and Preserve, Germany. They established baseline ranges for these media in this area and showed anthropogenic additions of Hg and Pb in the surface soils. 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 contamination levels in higher vegetation.

Lichens are often overlooked members of the plant community, nevertheless they nevertheless play a very important role in the ecosystem. At high elevations they stabilize fragile tundra soil. They are the pioneers of plant succession in disturbed environments. Lichens provide homes for invertebrates (Rhoades, 1988), and they participate in mineral cycling by releasing organic compounds when they decompose. Lichens are a good source of carbohydrates and are eaten by mites, insects, and gastropods, as well as deer, caribou, and other vertebrates (Nieboer and others, 1978). Additionally, they are an important component of the biodiversity of natural ecosystems.

Physiography, Climate, and Vegetation

A detailed discussion of the physiography, climate, and vegetation is given by Gough and others (1988c). In general, the study area is dominated by the mountains of the Alaska Range. This landscape is broken by the presence of broad alluvial fan complexes within wide river valleys covered with glacial outwash and eolian deposits. There are also lowlands containing many small lakes scattered in the glacial till. The area has a cold and dry continental climate; extremes in temperature are the rule. The vegetation is characterized by interior white spruce - birch forest with well-developed bogs and muskegs. Associated with these forests is an abundant shrub, lichen, and moss understory growth. The upland areas tend to be dominated by permafrost and tundra vegetation.

Geology

The geology of the Healy Quadrangle is summarized by Csejtey and others (1986). The USGS has also completed an in-depth geochemical reconnaissance survey of the Healy Quadrangle (under the Alaska Mineral Resource Assessment Program); results are presented in Cox and others (1989), King and others (1989), Light and others (1989), and Light and others (1990).

The study area is underlain by a wide variety of sedimentary, volcanic, and igneous rocks ranging in age from Precambrian to Recent. The area also has a complex metamorphic history. Most of the older formations have undergone at least some degree of metamorphism. There are numerous thrust faults throughout the area.

As is true of much of Alaskan geology, there is a complex history in the rocks of the Healy area. In general, the river valleys (Nenana River and Healy and Dry Creeks) are predominantly undifferentiated Quaternary and Tertiary surficial deposits. These include glacial deposits of several ages, lake deposits, and landslide debris, the latter being very common in the Nenana River valley. All of these deposits consist mainly of unconsolidated material ranging in size from huge boulders to very fine clays.

The Sugar Loaf Mountain, Mount Healy, Mount Margaret, and Mount Wright areas, also called the Primrose Ridge, consist of a Precambrian and early Paleozoic pelitic and quartzose schist sequence. This entire area is faulted and has undergone intense deformation. South of Primrose Ridge, the area is dominated by the Tertiary Cantwell Formation, consisting of two predominant units: (1) an upper volcanic unit, as seen in the area to the south of Healy at Mount Fellows; and (2) a lower sedimentary unit consisting of conglomerate, sandstone, arkose, siltstone, argillite, shale and a few thin coal beds. The sedimentary sequence is riddled with numerous igneous intrusions. The entire formation may exceed 3,000 m in thickness and is the dominant unit in the study area.

The coals of the Healy Quadrangle are predominantly associated with the Upper Oligocene to Late Upper Pliocene formations, with the greatest number and thickest coals in the Healy Creek and Suntrana Formations. Coal seams range from 5 cm to over 18 m in thickness and range in apparent rank from lignite A to subbituminous B coal (Affolter and others, 1980). The coal-bearing formations have been folded and faulted into a series of smaller basins, with low to moderate dips. The coal at the Poker Flats mine is associated with the Eocene to Miocene coal-bearing rocks, undivided, as described by Csejtey and others (1986).

Soils

Soils have developed over geological materials that vary from very shallow to very deep residual, glacial, or eolian deposits. The field notes, presented as a whole elsewhere, define the depths, color, and texture of the major soil horizons. Gough and others (1988c) discuss Alaskan surficial material types, weathering characteristics, and soil geochemistry. In this study, we are only interested in the organic-rich Oa horizon (usually 3-15 cm thick and about 3-4 cm below the surface), the soil layer between the vegetation mat above and the A0 mineralized layer below.

POLLUTANTS OF CONCERN AND SENSITIVE BIOLOGICAL RECEPTORS

The air pollutants of particular concern for biological resources of DENA that are commonly produced in the operation of coal-fired power-plants include sulfur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (precursors of ozone), and toxic metals (e.g., As, Se, and Hg) occurring as particulate matter and gases. Following is a brief discussion of some of the ecological effects of selected pollutants.

Sulfur Dioxide

Sulfur dioxide was probably one of the earliest recognized air pollutants. This gas enters vascular plants through the stomata. Under humid conditions, SO_2 can even stimulate stomatal opening, thereby allowing greater entry of other gaseous pollutants that are often associated with it. Also, conditions that usually enhance stomatal opening, i.e., high humidity and high light intensity, are the same ones that increase sulfur dioxide absorption in laboratory experiments (Ziegler, 1975). Sulfate accumulates in plants exposed to SO_2, and the accumulation increases with their photosynthetic activity. At low doses, transpiration increases because the stomata have been stimulated to open. At higher doses, however, the stomata collapse and transpiration is reduced. In broadleaf plants, chlorophyll is decomposed and visible injury in the form of interveinal or marginal chlorosis/necrosis results (Mudd, 1975; Jacobsen and Hill, 1970). Conifer needles become dry, brown, and brittle. Biochemical effects of SO_2 include reduction in carbon dioxide (CO_2) uptake with a resulting decrease in photosynthesis, decreased metabolism, decrease in the protein content of leaves, enzyme inactivation (Mudd, 1975), decrease in DNA synthesis in higher plants, and a reduction in terpene production in conifers (Ziegler, 1975).

The structural characteristics of lichens and bryophytes make them particularly susceptible to the effects of air pollution. Lichens trap particulates and accumulate sulfur and heavy metals. For this reason, they are often used as biomonitors. Because they are adapted to absorb moisture, they consequently absorb ambient pollutants (Rhoades, 1988). Lichens are almost entirely dependent on the atmosphere for their nutrients and moisture. In addition, unlike vascular plants which are able to close their stomata at night, lichens exchange gases with the atmosphere continuously. Sulfur dioxide interrupts the lichen's photosynthetic process. Because of their low metabolic rate, they have a limited ability to respond to abrupt environmental changes (Anderson and Treshow, 1984).

Sensitive species of lichen grow poorly or are missing from areas with high atmospheric sulfur concentrations. Treshow and Anderson (1989) showed all epiphytic lichens absent from an area with mean annual ambient air levels of 170 ug/m^3 (0.06 parts per million (ppm)) SO_2. Sensitive species were severely depleted above 60 ug/m^3 (0.02 ppm), and effects were measurable as low as 30 ug/m^3 (0.01 ppm) of SO_2 . McCune (1988) showed that the variation in lichen community composition and cover were correlated with mean annual ambient air SO_2 levels. A mean annual concentration of 30 ug/m^3 (0.01 ppm) of SO_2 may injure sensitive individual species of _Usnea_, _Lobaria_, _Ramalina_, and _Cladonia_. Other lichen species may be even more sensitive to sulfur oxides. LeBlanc and de Sloover (1970) showed that _Cladonia fimbriata_, _Lecidea nylanderi_, _Ramalina americana_, _Rinodina papilata_, and _Xanthoria fallax_ were present only when the annual average of SO_2 was less than 13-26 ug/m^3. Lichens growing on acid substrates are more sensitive to SO_2 than those growing on basic ones. Anderson and Treshow (1984) mentioned that a correlation between the concentration of atmospheric SO_2 and tree bark acidity can exist. The number of epiphytic lichens declined as the pH of the tree bark decreased.

Nitrogen Dioxide

The greatest man-made source of nitrogen oxides is the high-temperature combustion of fossil fuels. During combustion, some of the nitrogen in the air and fuel is oxidized to nitrogen oxide (NO) and nitrogen dioxide (NO_2). Through photochemical reactions involving the absorption of sunlight and interactions with hydrocarbons and oxygen, atmospheric NO is converted to NO_2, and some NO_2 is consumed in the production of ozone (Taylor and others, 1975).

Nitrogen oxide and NO_2 are phytotoxic. Concentrations exceeding 100 parts per billion (ppb) (hourly average) over many days have been shown to negatively affect sensitive plant species. Nitrogen dioxide reacts with water in the leaves to form nitrous and nitric acids. When the acids exceed a certain threshold, the tissues of the leaf are injured. Characteristic visual symptoms include brown or black spots--especially on the margins of the leaves--associated with necrosis, and an overall waxy appearance. Injury is exacerbated under moist conditions. Nitrogen oxide has been shown to reduce CO_2 absorption and photosynthesis, while NO_2 causes growth depression, increases leaf drop and reduces yield (Taylor and others, 1975).

Nitrogen addition through atmospheric NO_x deposition can have a profound effect on ecosystems in two ways. First, it has been shown that the addition of atmospheric NO_x acts as a fertilizer to plants (Van Cleve and Oliver, 1982; Ekwebelam and Reid, 1984). Zeevaart (1976) documented the addition of atmospheric nitrogen to fumigated plants by measuring the increase in protein content of the leaves. Growth stimulation is a common response of broad-leaf and conifer trees and herbaceous plants to small amounts of NO_2 (Okano and others, 1986, 1988, 1989). New growth that occurs too early in the season could enhance sensitivity to an early spring frost (Freer-Smith and Mansfield, 1987). Alternatively, unnatural fertilization causes plants to grow later into the fall. Plants are also, therefore, more susceptible to frost damage in the winter.

Second, the spatial distribution of nitrogen significantly influences vegetation community structure (Robertson and others, 1988). In a study of secondary succession, it was shown that plant biomass and height significantly increased and species diversity significantly decreased with added nitrogen (Tilman, 1987). Initial species abundance did not make a difference in terms of interspecies competition. Nitrogen addition led to a period of transitional dominance by certain species.

Toxic Elements

The interaction between elements and biological systems is determined by the inherent properties of the elements, particularly the chemical reactivity, solubility, and interactions with other inorganic and organic molecules (Lepp, 1981a,b). Determining the total concentration of an element is usually, but not always, relatively simple since each element of the periodic table can be detected in biological and abiotic samples with varying degrees of precision using different analytical techniques. Separating anthropogenic accumulation of elements in tissues from natural concentrations of the same elements and determining levels of thresholds for injury are difficult due to the natural variability of elements in ecosystems. Sufficient replication of individuals at a site and sites within a study area are important for determining gradients from point or regional sources of potentially toxic elements.

The physical, chemical, and biological properties of mosses and lichens that facilitate the uptake of sulfur also allow the uptake of atmospheric heavy metals. Particles are trapped on the rough plant surface and transported into the thalli through ion-exchange and intercellular uptake (Puckett, 1988). Zinc, Cd, and F have been found to cause chlorosis and reduce photosynthesis in several lichen species (Nash, 1971; 1975).

Lichens and mosses are able to accumulate metals to a far greater level than is necessary for their physiological needs. The metals remain in the plant throughout its lifetime, and accumulate in the surrounding soil when the plant dies and decays. Once in the soil (either due to plant decay or dry deposition), metals can have a profound impact on soil microorganisms. Heavy metals have been shown to decrease the decomposition rate of litter by fungi (Inman and Parker, 1978; Tyler, 1984), and fluoride has been shown to be toxic to litter-decomposing woodlice (Beyer and others, 1987). Over time, a decrease in decomposition will reduce the availability of macronutrients to vascular plants. Heavy metals also decrease the rate of starch decomposition by microorganisms and decrease soil respiration (Ebregt and Boldewijn, 1977). Earthworms, an important food source for small mammals and birds, have been shown to accumulate heavy metals in their tissues (Van Hook, 1974). The accumulation of metals in the soil also makes them available for uptake by vascular plants in toxic quantities. Many studies have shown that the deposition of toxic elements into an ecosystem results in the movement of the elements into biological components of the ecosystem (Lepp, 1981a and b).

Lichens have been established as biomonitors of metal deposition (Nash and Wirth, 1988) and can help distinguish between airborne metals and those occurring naturally in the soil. Species differ in their uptake of these elements. Methods developed for determination of toxic element effects on biological systems have typically been designed to detect spatial and/or temporal trends in the accumulation of metals in plants and their subsequent movement through trophic levels.

DENALI BIOMONITORING RESEARCH PLAN

This study focuses on the use of lichens and mosses as both passive and active biomonitors of the proposed HCCP facility. Peltigera aphthosa and Hylocomium splendens, lichen and moss species found in DENA, and the two primary non-vascular target species for elemental analyses, have been used as bioindicators of metal accumulation in previous studies. By analyzing thallus tissue it is possible to map the spatial distribution of the zone of influence of some point source of airborne sulfur or metals. The use of radiating traverses in the assessment of spatial trends is a more economical way of measuring zones of influence if general trends are desired rather than a detailed biogeochemical map. The measurement of metal levels in lichens and mosses, coupled with an examination of the geochemistry of local organic-rich soils and coals to be burned, assists in the process of evaluating the potential impact of the new HCCP plant by identifying both the background geochemistry of natural materials and the patterns of accumulation of elements for comparing future levels of exposure under the operation of the HCCP.

METHODS

STUDY DESIGN

A technique commonly used to define the minimum region of influence of a point source is discussed in detail by Gough and others (1986), and involves the determination of elemental concentration trends in vegetation with respect to distance from an emission source. An inverse linear relationship between element concentration in soil and vegetation with distance from an emission source is frequently found near fossil-fuel power-plants and refineries or other types of processing facilities. Typically, the concentration trends of selected trace metals, such as V from fuel oil or S from coal, can be measured in native vegetation. Because differences in emission-source-related trace-element concentrations may be found among different plant species (due to differences in longevity, absorptive surfaces, metabolism, growth-form, habitat, and microenvironment) more than one potentially sensitive species was sampled.

REGRESSION ANALYSIS

Variations of element concentrations in two cryptogam species (lichens and mosses, or more generally, vegetation without an internal vascular system), relative to distance from GVEA, were examined by linear regression. A leastsquares equation was used for the regression model and the prediction equation takes the form:

$$\underline{X} = \underline{a} + \underline{b} \log_{10} \underline{D}$$

where $\underline{X}$ is the concentration of the element in the receptor material, $\underline{D}$ is the distance from GVEA, and $\underline{a}$ and $\underline{b}$ are, respectively, the regression constant and regression coefficient. The statistical significance of each regression was determined by analysis-of-variance (ANOVA) procedures. Coefficients of determination between element concentration and log distance estimate the proportions of the total variance in concentration that is associated with distance from GVEA. Large coefficients of determination are strong arguments for associating an emission source with element accumulation in vegetation or soil. The correlation coefficient ($\underline{r}$) is not used as an indication of statistical significance because the values for distance were selected and cannot be considered as random, independent variables. Finally, the covariation between logarithms of element content in plant samples among the sample locations along each of the traverses was estimated by the product-moment correlation coefficient.

FIELD SAMPLING AND SAMPLE PREPARATION

Site Selection

The field sampling was completed September 6-16, 1991 with three field crews composed of both USGS and NPS personnel.

The study area is shown in Figure 1 and the actual location of the sampling sites in Figure 2. Sampling sites for this study were selected to be as similar to one another as possible with regard to soil, vegetation, geology, slope, and aspect. Variations observed in element content of plants or soils, therefore, could be attributed more confidently to some contamination point source rather than site-related influences. Plant and soil samples were collected in close proximity to each other (less than 3 m apart).

The general design consists of three traverses which were delineated on topographic maps of the Healy area before visiting the actual site. These traverses were: (1) the Nenana River Traverse which originated at the GVEA and progressed south; (2) the Stampede Traverse which originated at the GVEA and progressed northwest; and, (3) the Northern Control Traverse which originated at the Nenana River 18 km north of the GVEA and progressed west. The increased intensity of sampling close to GVEA, relative to standard geometric sampling, provides increased resolution of analyses near the plant (Figure 2). The traverses and sampling densities are summarized in Table 1.

The Nenana River Traverse sampling sites were located at approximately 0.0, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 25.0, 40.0 and 80.0 km. The Traverse continued south and included the Riley Creek drainage with alternate sites along the Nenana River, depending on access. The Stampede Traverse followed Panguingue Creek and the Stampede Trail and had sampling sites located at approximately 0.5, 1.0, 1.5, 2.0, 4.0, 6.0, 8.0, 14.0, 16.0 and 32.0 km.

Three other sites, in addition to the above Traverse sites, were established near meteorological or ambient pollutant monitoring equipment at each of the sites. One site (Denali monitoring site) is on the northern boundary of DENA, approximately 6 km south of the GVEA plant. The second monitoring site (Healy monitoring site) is approximately 1 km west of GVEA. A third site was located near the DENA Headquarters.

Additional sites were located at nine positions near the base of Healy Mountain and the Dry Creek drainage. These nine sites are designated as Radial Arc sites in Table 1. Although not in the original design, several of the Stampede and Radial Arc sites formed a Traverse which we later called the Dry Creek Traverse. This Traverse consists of samples from the Stampede Trail Site 0.5, Meteorologic Site 001, and Radial Arc Sites 002, 003, 004, 005, and 006. These sites comprise a Traverse that progresses from the GVEA southwest along Dry Creek at the base of Mount Healy.

Sites consisted of conifer stands, dominated by white spruce, with a canopy cover of between 30-60% (moderately dense). Sites were further stratified according to the Viereck vegetation classification system (Viereck and others, 1986) as determined by field crews. Sites were characterized by a moderate understory of mixed shrubs and a dense ground cover of mosses (<u>Hylocomium</u>/<u>Pleurozium</u>/<u>Polytrichum</u>) with scattered clumps of <u>Cladina</u> and <u>Peltigera</u>. This ground cover type (moss/lichen) was often found under spruce tree canopies.

All sites were marked (numbered locator tree), mapped, and geographical coordinates recorded. Sites were identified and recorded on USGS 15 minute topographical maps (1:63,300). Photographs were taken of each site. Sites were at least 200 m (if possible) from roads or railroads and at least 50 m from lakes or meadows.

<u>Sampling Plots At Each Site</u>

At each sampling site along the traverses, two or three permanent elemental monitoring plots (See Table 1.) were established by marking one dominant white spruce (plot locator tree) with a steel band, flagging, and an aluminum tag. The locator tree was usually a prominent feature of the site, making relocation possible. It became the focal point for each of the two or three sampling plots. The plots were within 200 m of each other (with a minimum of 50 meters between plots); distance and direction between plots were randomly selected within reasonable constraints of movement within the spruce stands. The dominant tree was tagged and mapped and served as focal point for the plot. Diameter at breast height (dbh), bole characteristics (beetles, lightning scars, overall health, etc.), and canopy condition (percent live crown; foliage discoloration) were recorded for each tree.

Any additional plot characteristics such as slope, elevation, aspect, and canopy closure thought to influence the structure of the lichen or vascular plant communities, were recorded. The presence or absence of vascular species was recorded to aid in the Viereck vegetation classification of each plot. This information was entered on the field sheets, as shown in Figure 3. All samples were labeled with coded field numbers. Coding is described in the "Explanation of Appendices".

Vegetation Collection

At each sampling plot within a site, approximately 200 g dry weight (dw) of feather moss and 200 g dw of Peltigera aphthosa lichen were collected. Distance and azimuth from the plot locator tree to the point where the samples were collected was recorded. The moss samples were usually thick, uniform mats and included the stratified old material as well as young material. Attached organic detritus and extraneous vegetation was removed as much as possible in the field. Lichen samples were collected from the forest floor, where the lichen was found in small colonies intermingled with various mosses, low-lying shrubs such as blueberries, or other lichens. Samples of the feather moss and lichen were composites of several clumps or mats within 10 m of the dominant white spruce tree of each plot. Needles and twigs (terminal 15 cm) were collected from the dominant white spruce of each plot. A composite sample of several low branches was made by clipping with stainless steel sheers. All vegetation samples were labeled with coded sample numbers, placed in Hubco cloth bags, allowed to air dry at camp, and then mailed to the USGS Denver laboratories.

Oa-Horizon Soil Collection

At one of the three sampling plots per site, living vegetation was removed from the soil surface and a 50 cm-diameter circle was cut into the top 10-15 cm of soil with a tiling shovel. The organic-rich Oa-horizon was then separated from the mineral soil using a knife or trowel. The Oa material was then disaggregated into a plastic bucket. This procedure was repeated at two additional places within the plot and the soil from these three places were mixed in the bucket. A homogenized portion was then placed in a water-resistant paper bag and labeled with coded sample numbers. The samples were mailed to the U.S. Geological Survey laboratories in Denver, Colorado.

LABORATORY METHODS

At the Denver laboratories, the samples of moss and lichen were washed by suspending the entire sample in plastic buckets filled with tap water. Foreign material was removed after careful visual inspection, and excess water was removed by hand squeezing. The material was then transferred to colanders and rinsed at least twice with demineralized water. The washed samples were then dried in a forced air oven at ambient room temperature. The white spruce samples were not washed, but were dried as received from the field in the same fashion as the mosses and lichens.

Once dry, the plant samples were ground to pass 10 mesh (2 mm) with a standard Wiley mill. Each plant sample was divided, with one part ashed at 450^{o}C over a 24 hr period, and the other part left unashed. Analytical procedures followed established Q/A and Q/C policies used in the USGS laboratories (Arbogast, 1990) and included the analysis of duplicate samples of the same material and the analysis of proposed in-house standard lichen, moss, and white spruce materials. These in-house standards do not give information about the accuracy of the results, but do show method precision. A separate in-progress study will determine if these materials prove to be homogeneous, and whether in fact can be used as standards. All samples and analytical duplicates (randomly chosen for 10% replication) of a given media were randomly ordered, and then divided into lots of 38 samples. Each lot had randomly inserted two samples of the appropriate proposed in-house standard.

Soil samples were dried under forced air at ambient temperature. All of the dry samples were disaggregated using a mechanical ceramic mortar and pestle and then sieved to minus 10 mesh (2 mm). Sample splits of the Oa-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 (percent ash) was calculated. Percent ash or ash yield equals (weight of ash)/(dry-weight sample weight ashed) * 100. Both the raw and the ashed material were used for analysis, depending on the method of analysis.

Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES)

Splits of the ashed vegetation and soil samples were analyzed simultaneously for 38 elements using ICP-AES. Each 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 1% (V\V) nitric acid. 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 2. The relative standard deviation (RSD) for replicate determinations of most elements is five percent or less.

Continuous-flow, Hydride-generation Atomic Absorption (HGAAS)

Arsenic and selenium in the vegetation and soils were determined by HGAAS (Crock and Lichte, 1982; Sanzolone and Chao, 1987). A 1.000 g unashed plant or soil 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 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 2. The RSD for the determination of both elements was about ten percent.

Miscellaneous Determinations

Mercury in soil and plants was determined using an automated continuous-flow, cold-vapor atomic absorption spectroscopic method (Kennedy and Crock, 1987). An unashed 0.100 g soil or a 0.200 g plant sample was digested with nitric acid and sodium dichromate in an open-glass test tube 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.

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, 1985, 1987). Limits of determination are given in Table 2 for both Hg and total S.

RESULTS

All the analytical results, as determined, for the samples, duplicates, and in-house standards are given in Appendix Tables A1-A5. For the RESULTS discussion, the analytical duplicates were averaged, and the average used for the statistical calculations.

All the analytical data for the feather moss samples are given in Appendix Table A1. The analytical results converted to a dry-weight basis for the Radial Arc Sites are given in Table 3, the Northern Control Traverse Sites in Table 4, the Meteorologic Sites in Table 5, the Nenana River Traverse Sites in Table 6, the Stampede Trail Traverse Sites in Table 7, and the in-house standard feather moss in Table 8. For all the samples, concentrations of Ag, Au, Bi, Eu, Ho, Sn, Ta, and U were below their respective limits of determination as given in Table 2. In general, the results for the in-house standard feather moss look to be precise, with Se, La, and Pb having the highest RSD.

All analytical data for P. aphthosa lichen samples are given in Appendix Table A2. The analytical results converted to a dry-weight basis for the Radial Arc Sites are given in Table 9, the Northern Control Traverse Sites in Table 10, the Meteorologic Sites in Table 11, the Nenana River Traverse Sites in Table 12, the Stampede Trail Traverse Sites in Table 13, and the in-house standard P. aphthosa lichen in Table 14. For all the samples, Au, Bi, Eu. Ho, Nb, Sn, Ta, and U were below their respective limits of determination as given in Table 2. Only two samples showed detectable Ag and only one sample detectable Be. The results for the in-house lichen standard look precise, with Ga, La, Pb, Se, Nd, Y having the highest RSDs of concern.

All analytical data for the Oa-horizon soil samples are given in Appendix Table A3. All analytical results converted to a dry-weight basis for these soils are given in Table 15. For all the samples, Au, Bi, Ho, Sn, Ta, and U were below their respective limits of determination as given in Table 2. Only two soils showed detectable Ag and Eu.

All analytical data for the white spruce samples are given in Appendix Table A4. The analytical results converted to a dry-weight basis for all the samples are given in Table 16. For all the samples, Ag, Au, Be, Bi, Eu, Ho, Nb, Sc, Sn, Ta, U, Y, and Yb were below their respective limits of determination as given in Table 2. Only one sample showed detectable Mo. All values for the in-house standard white spruce are acceptable, except for Se.

All analytical data for the miscellaneous lichen samples are given in Appendix A5. Due to the difficulty in finding sufficient sample mass for the Usnea sample, and one sample of Cladina, percent ash and ICP-AES methods were not performed. Of note is the elevated volatile element content of the Usnea sample as compared to the other lichens analyzed from the study area. This is especially true for total S and Hg.

ELEMENTAL CONCENTRATION BASELINE

Baseline information for the vegetation species and the Oa soils was calculated as the observed range, dry-weight basis, for those samples thought to be beyond the influence of the GVEA. Examination of element concentrations versus distance from the GVEA for the various traverses (See Figures 4-5 as examples.) shows that beyond about 6 km an inflection point is reached. The collective values beyond this point were used as a "working" or "observed" baseline range (Figures 4, 5). Therefore, the samples of the various media from Radial Arc Sites 003, 004, 005, 006, and 007, Control Traverse Sites 7.5, 008, and 016, Nenana River Traverse Sites 008, 016, 025, and 040, and Stampede Trail Traverse Sites 008, 014, 016, 025, and 032 were used to tabulate an observed baseline range for each of the media. This range was simply the range of observed values for this selected suite of samples.

Baselines for the elemental content and ash yield of feather moss are given in Table 17. Also listed are the calculated baseline ranges for elements in feather moss from the Kenai National Wildlife Range (KNWR), Alaska (Severson and others, 1990). By comparison, most trace elements from this study are similar; they are higher, however, for Ce, Cr, Cu, La, Li, Nd, Ni, and As and lower for percent ash yield and Al. Also listed are unpublished results for a baseline study for the Wrangell-Saint Elias Wilderness Area (WSE), Alaska. This study was completed by the same NPS and USGS personnel using the same field and laboratory methods. The WSE study area is more geographically and geomorphologically similar to this study site, both being heavily influenced by a major river valley with its intermittent dust storms and lower precipitation as when compared to the Kenai Peninsula. The REE (Ce and La) ranges for this study appear to be higher than the WSE study. This may indicate a localized REE influence in this study area. Total S, Mn, Pb, and Zn also show a slightly larger high-end for the baseline range. This may indicate an anthropogenic influence an the mosses.

An observed baseline for the elemental content and ash yield for P. aphthosa for this study area is given in Table 18. Also listed are the observed baseline ranges for the lichen from the WSE. For most elements there is good agreement between the two studies with a few exceptions. The REE appear elevated in this study area lichen, similar to the mosses. Total S, Mn, Pb, and Zn also show a larger high-end for the baseline range. This may also indicate an anthropogenic influence an the lichen.

An observed baseline for the elemental content and ash yield for white spruce for this study area is given in Table 19. Also listed are the baseline ranges for KNWR and WSE. There is good agreement between all three studies, except for Cu which is highest in this study.

An observed baseline for the elemental content and ash yield for the Oa-horizon soils for this study is given in Table 20. Also listed are the baseline ranges for KNWR and WSE. In general there is good agreement between the three studies with several exceptions. These exceptions include Ce, Nd, and La, indicating a possible REE enriched source for this study area's soils. This enrichment is also noticed when this study area's soil samples are compared to the geometric means listed for surficial materials of Alaska (Gough and others, 1988c) given in Table 21. The REE content of this study area's soils does fall within the baseline range of Gough and others (1988c); however, other elements in this study area's soils tend to be elevated include Ba, Mn, Be, Cr, and Th. These elements also fall within the range for Alaskan surficial materials, but do tend to be elevated when compared to the reported geometric means.

SPATIAL ELEMENT CONCENTRATION VARIABILITY

The total variance in the elemental concentration of sampled materials was partitioned among three sources: (1) distance away from the GVEA power-plant, or the Nenana River (Northern Control Traverse); (2) among plots within a site; and, (3) procedural or laboratory error.

Distance, plot, and procedural variance for elemental concentrations and ash yield for P. aphthosa lichen are presented in Tables 22 and 23. In general the analyses proved to be precise when the elemental concentrations were well above (usually >10 times) the respective limits of determination (possible exceptions being Ba, Mg, and Ca). The imprecise determinations may be due to the occurrence of an insoluble phase in the ash of the lichens. This may be a sulfate or an oxide (total S is more imprecise for the lichens than the mosses). The majority of the remaining variance lies in the distance factor. As with the mosses, the volatile elements in the lichens show a greater amount of variation in the within-site variation.

Distance, site, and procedural variance for elemental concentrations and ash yield for feather moss are presented in Tables 24 and 25. In general, when the elemental concentrations were well above the limit of determination, procedural variance was below about 3% (Tables 24 and 25). This indicates that the analyses were precise. Procedural variance was not listed for the Dry Creek Traverse because there were no randomly-chosen duplicates in the group of samples selected for that Traverse. The majority of the variation for most of the elements was associated with distance. The noticeable exceptions are Hg, total S, and Se. The majority of the variance is associated with plots within sites.

Because of study design economy, replicate soil samples were not collected at each site: therefore, an ANOVA for the Oa-horizon soils was not performed.

Distance, plot, and procedural variance for elemental concentrations and ash yield for white spruce for the Nenana River Traverse is presented in Table 26. In contrast to the moss and lichen, the variance was not primarily associated with the distance factor. When the element was sufficiently above the detection limit, procedural variation was small. For most elements, the within-site variation was large, thus demonstrating the limited usefulness of white spruce to monitor possible contamination. Because of insufficient spruce materials from sites along the other traverses, no ANOVA was performed.

TRAVERSE TRENDS

Ash Yield

Highly variable ash yield data for plant tissue used in biomonitoring studies is always troublesome because of the implication that one may be measuring differences in the deposition and entrapment of airborne particles. We have found this to be of particular concern in semi-arid environments (Gough and Erdman, 1977; Jackson and others, 1985; Gough and others, 1988a) but not so important in mesic environments (Gough and others, 1988b; Severson and others, 1990). Many studies have shown fallout-derived particles deeply imbedded in intertwined lichen tissue that were difficult or impossible to remove by standard cleaning procedures.

Samples of moss and lichen were washed, as detailed in the "Laboratory Methods" section. The rinse water was always observed to be clear following the third treatment and no debris was observed either on the bottom of the container or suspended in the water. Neither material was collected contiguous to the soil surface and we feel confident that nearly all of the loose extraneous attached material was removed through the washing process. The moss grows in dense, tangled mats which add vertically to their mass with each growing season. It is possible that entrapped extraneous material in the moss mat was not removed. The growth habit of the lichen, which has a smooth upper surface, however, makes the attachment of airborne particles difficult.

The large and small variability in ash yield for moss and lichen, respectively, can be seen in Figure 6. Ash yield ranged from <4 to 42 percent for moss and <2 to 7.5 percent for lichen. Several methods can be used to assess the relative degree of contamination originating from soil that might contribute to this variability: (1) assess the absolute concentration of resistate, biologically non-functioning elements, such as Ti and Sc, and (2) examine the relation between the concentration of these elements and ash yield.

Table 17 gives the observed range of values for element concentrations in _H. splendens_ measured in three separate studies in Alaska. In general, concentrations of Ti, Sc, Al, and other non-biological elements are higher in the moss from the WSE area than from either KNWR or DENA. (It should be noted that the WSE and KNWR materials were collected in exactly the same manner as the DENA material; Kenai material, however, was not washed.) None of these concentrations is excessively high when compared to the general literature for the concentration of these elements in plant materials (Ebens and Shacklette, 1982; Gough and Erdman, 1983). The Ti and Sc data for _P. aphthosa_ are also considered in the low range of observed concentrations for lichens in general (Gough and others, 1988a,b). These concentration data do not, by themselves, suggest soil contamination as the cause of the variable ash yield.

Figure 14 shows the plots of ash yield versus the concentration of Ti, Sc, and Al in moss tissue from samples collected along the three major traverses. The slopes are positive and the r^2 values indicate that these relations are strong for all nine trends. The same relations for the lichen material follow:

Coefficients of determination for relations between concentrations of Ti, Sc, and Al in *P. aphthosa* and ash yield along the three major study traverses.

Traverse:	Element:	r^2
Control	Titanium	0.81
	Scandium	0.85
	Aluminum	0.90
Stampede	Titanium	0.94
	Scandium	0.79
	Aluminum	0.94
Nenana	Titanium	0.83
	Scandium	0.88
	Aluminum	0.96

The relations for lichen tissue are not quite as strong as for moss but are, nevertheless, very important. These data indicate that the highly variable ash yield values, especially in moss, are probably the result of deeply entrapped soil particles. Although a concern, the presence of soil is of minor importance in this study, except that soil serves to "dilute" the concentration of most elements, such as the heavy metals. This is because ash-forming minerals, like quartz and feldspar, are composed of the major elements such as Ca, Fe, Mg, Si, and Ti, and not the trace elements, which are of more environmental concern. Therefore, entrapped soil particles should serve to cause an under-estimation of the presence of environmentally important trace elements - not an exaggeration or over-estimation.

The Control Traverse was incorporated into the overall study design in order to (1) factor out any observed GVEA influence, and (2) assess the potential influence of the Nenana River as a source of natural "contamination". Braided streams in Alaska, with their broad alluvial plains and extensive bars, are source areas for wind-blown dust.

Elemental Concentrations

The data in Figures 6-13, and the Appendix Tables A1-A4 that list the element concentration data by site, show that, in general, the Control samples have the lowest element concentrations for moss, lichen, and soil (exceptions include concentrations of Mn, total S, and Zn, as well as the major elements such as Mg and P). For example, concentrations were low along the Control Traverse for Al, As, Cr, Ni, Se, and V (as well as ash yield) in all three sample media, and for Ca, Cu, Fe, La, Pb, and Y for moss and soil (but not lichen). By far, the highest element concentrations were observed along the Stampede Traverse and "intermediate" concentration levels were recorded from the Nenana Traverse samples.

The Stampede Traverse crosses the sideslope of the Nenana River and an upland pediment which is a part of the Alaska Range. The Nenana River has eroded through the pediment in much the same manner as it has through various metamorphic and sedimentary deposits of the Alaska Range.

The Nenana River Traverse is basically in the Nenana River valley . The bottom of the valley is filled with glacial material deposits mixed with sideslope alluvial fans. The origin of these fans are determined by the upslope geological materials. Distance from GVEA may not be the only variable contributing to the trends observed in the data. Other variables, such as changes in mineral soil and geology may be important.

The data from all three traverses show that:

1. The Control Traverse has the lowest element concentration levels; inverse concentration versus distance trends are thought to result from the influence of airborne dust originating from the Nenana River alluvial plain. This Traverse appears to be outside the measurable potential influence of the present GVEA facility.

2. The Stampede Traverse has the highest overall element concentration levels in all three sample media; however, these higher concentration levels do not necessarily translate into stronger concentration versus distance trends. Some of these concentration levels appear elevated when compared to the general cryptogram literature (see the "Element Concentration Levels" section below) and the Traverse trends indicate that the GVEA facility, or the Healy area in general, or both are probable sources for some elements.

3. The Nenana Traverse has intermediate concentration levels when compared to the Control and Stampede levels. Unlike either the Control or the Stampede Traverses, sample sites beyond about 8 km from GVEA along the Nenana Traverse are located within a somewhat confined, narrow valley. Winds in this valley blow both north and south and air pollution (haze) from the Healy area is commonly observed to "slosh" up and down the valley along the east boundary of DENA (DENA personnel, personal communication, 1991). We are unsure why this Traverse has element concentrations that are less than the Stampede values; however, like the Stampede Traverse, the element concentrations and trends appear influenced by GVEA and the Healy area.

Relations between distance from GVEA, or the Nenana River, and element concentrations (and ash yield) in moss, lichen, and Oa soil, for each of the three major traverses are presented in Table 27. Only those elements are given that either (1) show strong inverse relations, or (2) show few or no inverse relations but are of environmental importance. Linear regression prediction equations are listed only for those relations that have a calculated coefficient of determination ($\underline{r}^2$) that is >0.50. This means that greater than 50 percent of the total variation in the data for a particular element along the distance gradient can be explained by the concentration/distance relation. We do not test the significance of $\underline{r}$ for reasons given in the "Regression Analysis" section.

The relations expressed in Table 27 are graphically presented in Figures 6-14. The scatter plots range from showing no trends (i.e., Mn and Zn) to showing very strong inverse relations (i.e., La and Pb). In examining these plots certain tendencies are apparent:

1. Among-site variability appears large for both moss and soil, and small for lichen, for nearly every element along every Traverse (the ANOVA in Tables 22-26 also shows this).

2. Among-sample, within-site variability (in other words, among replicate samples at a site) also appears large for moss and small for lichen (soil within-site variability was not measured).

3. In general, element concentration levels follow the progression: lichen < moss < soil. Concentrations of most elements were several times greater in moss than in lichen; sulfur concentrations were similar for moss and lichen.

4. Certain sites show consistently unusual or highly variable data (e.g., data for ash yield and As at the 0.52 and 2.41 km sites on the Stampede Traverse, Figures 4 and 11, respectively).

5. The majority of elements (Appendix Tables A1-A5; Figs. 6-14) show their highest concentrations close-in to the GVEA/Nenana River area and by far their smallest concentrations beyond about 6 km from GVEA (but not necessarily the Nenana River). For those elements showing concentration values at or near the detection limit for the analytical method used, most occur beyond the 6 km range.

6. Important trends for ash yield occur for moss, lichen and soil on nearly all traverses, the only exception being for soil along the Control Traverse.

ELEMENT CONCENTRATION LEVELS

Table 17 lists the observed baseline values for moss from the DENA, WSE, and KNWR studies in Alaska. Observed baseline is defined for this study as that range of concentrations in samples collected beyond 6 km from GVEA (see "Baseline Calculation" section). The following discussion focuses on the more important heavy metals, non-metals, and metalloids, and compares our observed baseline concentrations with literature values for moss, and to a lesser extent, lichen. Comparisons are made using reported element concentrations specifically for _Hylocomium splendens_ from Scandinavia (Ruhling and Tyler, 1984; Ruhling and others, 1987) and northern Germany (Severson and others, 1992) and with the general lichen literature but not specifically for _Peltigera aphthosa_ (Gough and others, 1988a,b). Assessments of relative toxicity to plants, animals, and humans comes primarily from Gough and others (1979).

Arsenic

A major source of atmospheric As is coal combustion. Arsenic is also extensively used in pesticides and wood preservatives and, depending on its form, is considered to be moderately toxic to plants and highly toxic to mammals. In general As concentrations in moss, along the three major traverses were <2 ppm; however, two extremely high values were recorded: 6.2 ppm (0.50 km site, Stampede Traverse) and 5.6 ppm (7.5 km site, Control Traverse). These samples were re-examined and the values appear precise. Concentrations >1.4 ppm were reported to be high for moss in Sweden; a range of 0.07 - 0.6 ppm has been reported as typical for northern Germany (Severson and others, 1992). It appears, therefore, that As levels in mosses from this study are comparatively elevated when all the data from Tables 3-7 are considered (Twenty-six samples are <0.6 ppm As.).

Arsenic concentrations in lichen were commonly <0.5 ppm. These values do not appear unusual and are in line with literature values.

Cadmium

Cadmium is a component of anthropogenic atmospheric emissions, mainly from fossil fuel combustion and waste incineration. Cadmium phytotoxicity is moderate; however, in mammals it tends to accumulate in the liver and kidneys and its toxicity can be very high over time. Levels of Cd in DENA moss approach levels reported as characteristic of areas in Sweden contaminated by airborne metals. However, our analytical method has a relatively high detection limit of approximately 0.2 ppm (dry-weight basis); most of our data fall below this value. We can make no conclusions about Cd Traverse trends. Like moss, Cd concentrations in lichen tissue were low, most being at or near the detection limit.

Chromium

Although industrial iron and steel mills are the major contributor of anthropogenic Cr in the atmosphere, fossil fuel combustion does contribute to the overall atmospheric Cr burden. Chromium toxicity depends on its oxidation state, Cr(VI) being much more toxic than the environmentally most common Cr(III) form. Chromium levels in DENA moss are comparatively quite high. Figure 10 gives the Cr plots for the three traverses and values >15 ppm are common for the Stampede and Nenana traverses. Values >6 ppm are common along the Control Traverse. Chromium concentrations in moss from KNWR and WSE are similar to the DENA values and are also high. Swedish authors report that concentrations >10 - 12 ppm are considered indicative of airborne contamination. Except for a few samples collected along the Stampede Traverse, the Cr levels in lichen are not unusual, especially when compared to the results of the WSE study (Table 18).

Copper

In general, Cu is only of concern locally near specialized industrial sources. Although Cu is an essential element, elevated Cu levels are highly toxic to microorganisms (bacteria, algae, and fungi) and only moderately toxic to mammals. One very high value of 61 ppm was found in moss at the 0.25 km site on the Nenana Traverse and several values >25 ppm were found along the Stampede Traverse. These values are high compared to those given in the literature. The Swedish authors report areas with >16 ppm as influenced by airborne sources, and in Germany a value of 14 ppm was reported as high. The Cu values in lichen do not appear to be unusual.

Lanthanum

Except under unusual industrial conditions, La and the rare earth elements (REE) are not considered to be of much environmental importance and their toxicity to living organisms is moderate to very low. Geochemical reports have shown that coal from the Healy, Alaska area may be enriched in La and REE when compared to coals from other U.S. sources (Affolter and others, 1980). Figure 9 shows the plots for La and Table 27 gives the regression equations for these relations. Very strong trends were observed for both moss and lichen along all three traverses. Although not presented, trends for Ce and Nd were also strong (see Appendix Tables A1-A4). Levels of Yb and other REE were mostly at or below the detection limit. Cryptogam REE concentrations rarely appear in the literature, but our data appear to be higher than any values that we have seen by a factor of two or three.

Lead

Lead originates from numerous diverse industrial sources but has been most frequently associated with contamination near roadways where use of leaded fuels has been a problem. Lead is a common airborne metal and is known to be transported great distances in the atmosphere. Lead can be extremely phytotoxic. Its toxicity to mammals is considered moderate but cumulative. Literature from Scandinavia identifies values >60-80 ppm in moss as heavily contaminated. A value of 20 ppm was reported as high from Germany. Figure 6 shows very strong inverse trends for Pb in moss along all three traverses with values >5 ppm are common from sites close to GVEA. Concentrations of Pb in moss may be associated with GVEA or wind-blown dust from the Nenana River. The total concentration of lead in sampled mosses and lichens is not considered high, however. Lead levels in lichen are particularly low compared to published values.

Nickel

The major source of Ni in the atmosphere is fossil fuel combustion and the ferrous metal industry. Nickel is considered very toxic to plants but only minimally toxic to animals and humans. The Scandinavian literature identifies as contaminated those areas with Ni concentrations in mosses exceeding 10-14 ppm. The Scandinavians note an important decrease in Ni concentrations from the late 1960's to the early 1980's, and attribute this to a concurrent decrease in industrial emissions. Much of the Ni in moss data for the Stampede Traverse exceeded 10 ppm; Ni values for the Control and Nenana traverses were commonly >5 ppm. Table 27 gives the regression equations for Ni in moss and lichen, and, along with Figure 11, these data show strong inverse concentration/distance trends (soil trends were generally not important).

Sulfur

Sources of atmospheric sulfur are both biogenic and anthropogenic. The concentration of total S in plant materials has been used extensively to define the impact of point-sources of atmospheric emissions, particularly fossil fuel power-plants, where both positive and negative relations are noted between S concentration and distance from the source. By itself S is not particularly toxic but it can be an indicator of acid deposition, which is toxic. Total S concentrations in this study never exceeded 0.15% in moss and 0.17% in lichen. These values are low and do not represent gross contamination. Figure 7 and Table 27 show that, except for S in lichen along the Control Traverse, few trends for this element are observed.

Vanadium

The most common source of V in the environment is the combustion of oil and to a lesser extent coal. Although moderately toxic to plants, V is one of the least toxic metals to animals and humans. Vanadium is considered a good "tracer" element for evaluating the zones of influence for the emission of metals from power-plants. In general, the Alaska moss samples were higher in V than values reported for both Scandinavia and Germany. In Scandinavia, values above 14 ppm have been identified as defining areas that are industrially impacted and in

Germany concentrations >6 ppm were rare. In this study, values >10 ppm are common in moss along all three traverses and values >20 ppm were common in samples collected within 2 km of GVEA along the Stampede Traverse. Atmospheric V is readily absorbed by moss. The strong inverse trends observed for V (Table 27; Figure 12) may be from power-plant emissions or from some available fraction that is associated with soil. The V concentrations found in lichen (generally <5 ppm) are not considered unusual.

<u>Zinc and Manganese</u>

Most Zn and Mn in the atmosphere is the result of emissions from base metal and voltaic-cell industries. Neither Zn nor Mn is considered an important metal originating from power-plants. Because both are essential micronutrients to all organisms, instances of toxicity occur only under rare occasions (e.g., gross over-fertilization). The scatter plots in Figure 9 and the data in Table 27 show that Zn and Mn in moss, lichen, and soil for all three traverses, display no pattern relative to distance from GVEA.

COAL AND FLY ASH

Twelve monthly samples of feedstock coal and fly ash from GVEA are to be analyzed for their trace, minor, and major elemental content by the USGS. Samples of the feedstock coal are taken by intercepting the finely powdered, dry coal immediately prior to its entering the firebox of the boiler. The fly ash is sampled from the bottom of the ash separators. To date, four sample pairs have been analyzed. These include pairs from September, October, and December 1991 and January 1992.

All analytical results for feedstock coal and fly ash from GVEA are presented in Table 28. The coal results are presented on both a dry-weight and ash-weight basis. The fly ash is given on the dry-weight basis. For both coal and fly ash, Ag, Au, Bi, Cd, Eu, Ho, Sn, Ta, and U were below their respective limits of determination as given in Table 2 for all samples.

The analytical results for the monthly samples show that the feedstock coal and the fly ash are similar from month to month, with most differences being less than a factor of two for most elements, except for Ni and Zn, which vary up to a factor of 5. The ash-weight basis results of the coal should be similar to the fly ash data if there are no losses due to element volatility. Some elements, including Ni, Pb, Zn, and total S, show a relative depletion in the fly ash when compared to the coal as calculated on an ash-weight basis. This indicates that these elements are being released into the atmosphere. Major-element content of the fly ash and the coal on an ash-weight basis suggest that the fly ash does represent the coal on the ash-weight basis. This is demonstrated by the Al, Fe, K, Na, and Ti concentrations. Elements thought classically to be volatilized from burning of coal are responding conservatively by not being lost. These include Hg, As, V, Cr, Cu, and Co. There is a relative enrichment of the alkaline earth and REE elements in the fly ash.

CONCLUSIONS

1. In order to assess the potential influence of a proposed expansion to the existing Golden Valley Electric Association Power-plant at Healy, Alaska on the air quality of Denali National Park and Preserve and its environs, samples of Hylocomium splendens (feather moss), Peltigera aphthosa (lichen), and Oa-horizon soil were collected at sites along three traverses, as well as from non-Traverse sites, and analyzed for their chemical element concentrations. Two of the three traverses, Stampede and Nenana, originated from GVEA and progressed northwest and south, respectively, for about 30 km. A Control Traverse originated at the Nenana River about 18 km north of GVEA and progressed west for about 20 km.

2. Ash yield of similar plant samples may indicate dust contamination. Moss samples possessed a higher and more variable ash yield than lichen samples. Samples of both moss and lichen had higher and more variable ash yield along the Stampede and Nenana traverses than along the Control Traverse. All samples were washed, and loose, extraneous dust was removed. Very little overt contamination was observed; however, ash yield versus concentrations of Ti, Sc, and Al indicate that deeply imbedded, difficult to remove, dust contamination was present. We conclude, however, that the contamination would only dilute the relative concentration of environmentally important metals, not enhance their concentrations. In addition, important inverse ash yield versus distance trends occur for moss, lichen and soil on nearly all traverses, the only exception being for soil along the Control Traverse.

3. Among-site variability for element concentrations in moss and soil is large, and is small for lichen, for nearly every element along every Traverse.

4. Among-sample, within-site element concentration variability also appears large for moss and small for lichen (soil within-site variability was not measured). This is particularly true for samples collected within 6 km of GVEA.

5. In general, element concentration levels follow the progression: lichen < moss < soil. Except for total sulfur levels, the concentrations of most elements were several times greater in moss than in lichen.

6. Most elements show their highest concentrations close-in to the GVEA/Nenana River area and by far their smallest concentrations beyond about 6 km from GVEA (but not necessarily the Nenana River). For those elements showing concentration values at or near the detection limit for the analytical method used, most occur beyond the 6 km range.

7. Plant samples from the Control Traverse have the lowest element concentration levels; inverse concentration versus distance trends are thought to result from the influence of airborne dust originating from the Nenana River alluvial plain. This Traverse appears to be well outside the potential influence of the present GVEA facility.

8. Plant samples from the Stampede Traverse have the highest overall element concentration levels in all three sample media; however, these higher concentration levels do not necessarily translate into stronger concentration versus distance trends. Some of these concentration levels appear elevated when compared to levels cited in the general cryptogram literature and the Traverse

trends indicate that the GVEA facility, or the Healy area in general, or both, are probable sources for some elements.

9. Plant samples from the Nenana Traverse have intermediate concentration levels when compared to the Control and Stampede levels and the trends appear influenced by GVEA, or the Healy area in general, or both.

10. We discuss the relative importance of the levels of environmentally important elements in both moss and lichen tissue by comparing the data from this study with values from the literature. In general, levels of As, Cr, Cu, Mn, Ni, V, and the rare earth elements were high in moss tissue. Levels of Mn and total S were somewhat elevated in lichen tissue. Moss tissue was found to be somewhat low in concentrations of Cd, total S, and Zn, whereas lichen samples were generally low in Cd, Pb, and Zn. The concentrations of most all of the other elements analyzed for were close to published values including values for Pb in moss and As, Cr, Cu, Ni, and V in lichen.

11. Concentrations of the environmentally important elements (including total S) in Oa-horizon soils were found to be close to published values. We found no unusually high concentrations of any of the elements, including the REE. Many of the element concentration versus distance trends observed for both moss and lichen were paralleled in the soil. This is to be expected if the soil organic matter is assumed to serve as a sink for the elements that are being transmitted through the atmosphere.

12. The coal being burned at the GVEA is relatively homogeneous and is low in total S and many of the potentially toxic metals. A true mass-balance study could not be performed; however, the amount of most elements, including Hg, As, V, Co, Cr, and Cu, lost to the atmosphere during coal combustion does not appear great. Total S, Ni, Pb, and Zn (and Cd by implication of the very similar chemistry and its geochemical association, although Cd was below the limits of detection of the ICP-AES method) are being released in the flue gases.

13. White spruce proved to be nonconclusive in this study. In general, it was sampled only occasionally; however, from the relatively complete sampling along the Nenana Traverse, very little interpretable information was obtained. Only Cu proved to be above the WSE baseline and the remaining elements fell well within the WSE ranges. White spruce showed greater variance for within plot samples than with distance, indicating a large local variance and thus it has little utility in defining distance trends.

ACKNOWLEDGEMENTS

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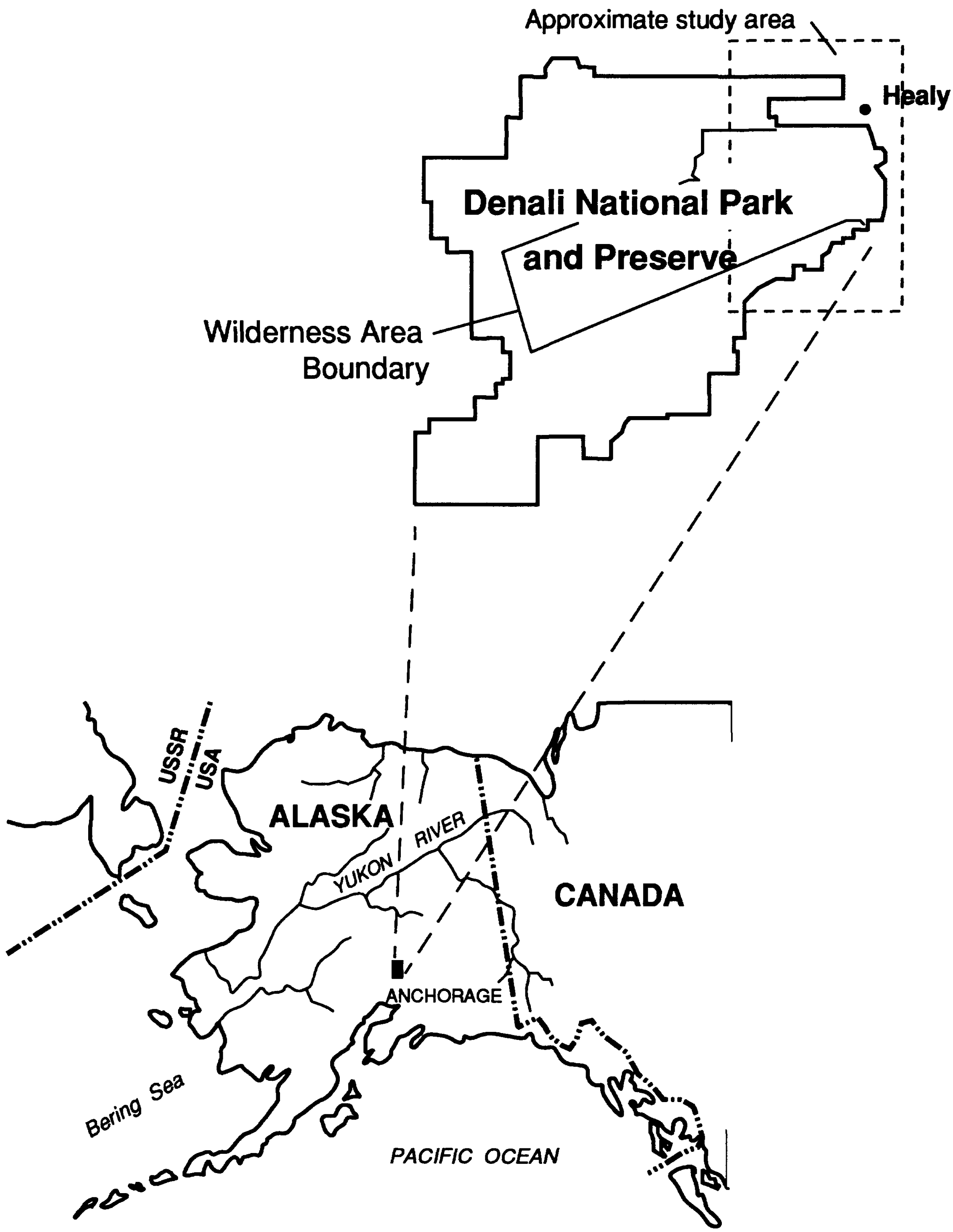

Figure 1. Index map showing location of Denali National Parkand Preserve and the surrounding area.

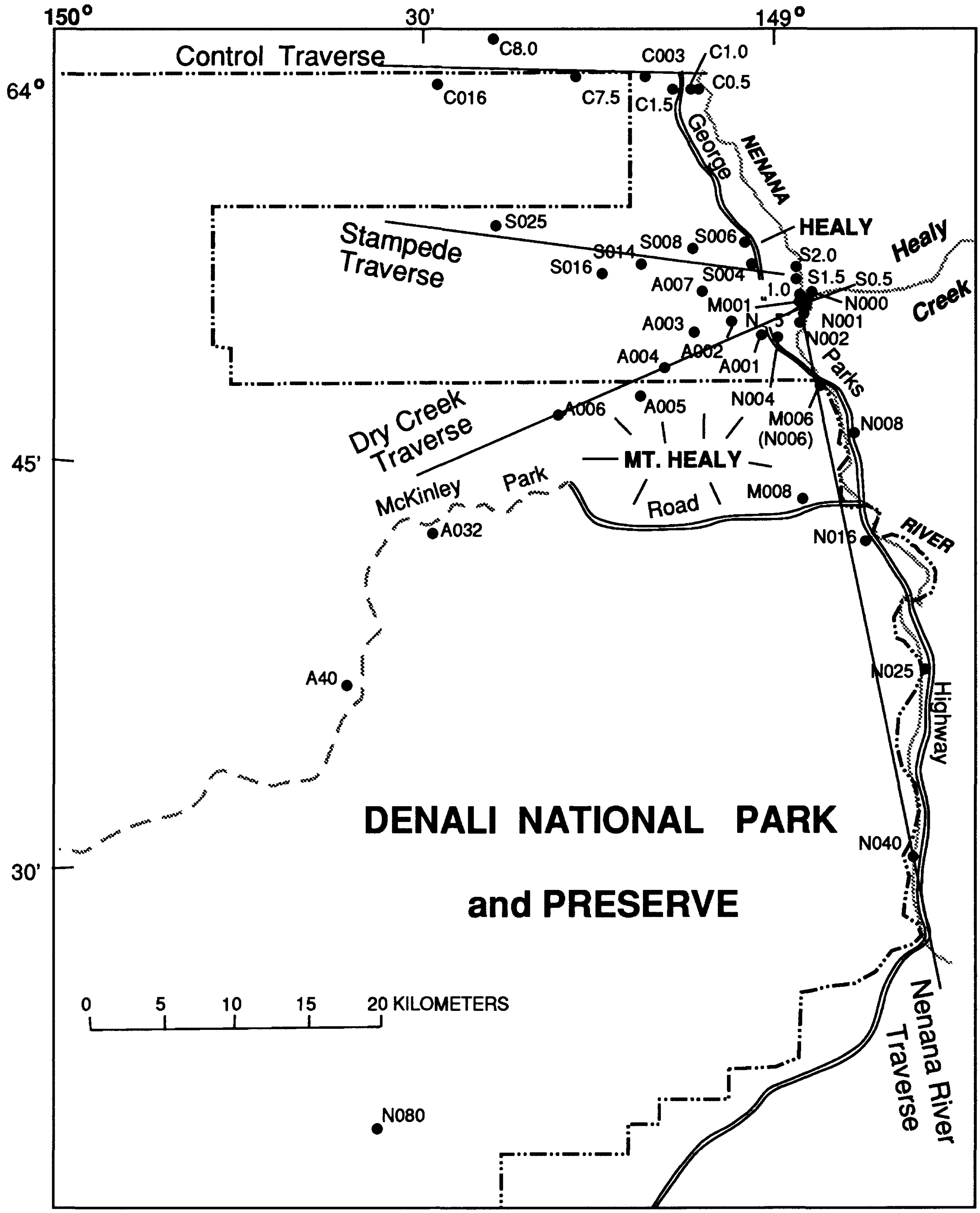

Figure 2. Location of sampling sites in and near the Denali National Park and Preserve

Sheet No._____

DENALI/HCCP PROJECT FIELD DATA SHEET

Date____ Collectors__________/__________ Site ID_____ Roll No.___ Pic. Nos._________

SITE LOCATION Lat_________Long________
Waypoint_______ (sketch of site)

Spruce A: ID_____ DBH_____ Sp._________
Height_________ Canopy Class_________

Moss Sample ID__________ Sp._________
Lichen Sample ID________ Sp._________

Spruce B: ID_____ DBH_____ Sp._________
Height_________ Canopy Class_________

Moss Sample ID__________ Sp._________
Lichen Sample ID________ Sp._________

Spruce C: ID_____ DBH_____ Sp._________
Height_________ Canopy Class_________

Moss Sample ID__________ Sp._________
Lichen Sample ID________ Sp._________

SOIL Sample ID________
Soil description (color; organic content; horizons, texture; moisture; etc.)

Top

Depth

of

horizons

Bottom

GENERAL COMMENTS (distance from human interference; weather; geomorphic/physiographic setting; vegetation community; wildlife disturbance/grazing; evidence of fire; etc.).

Sample ID code: AB001C1

A = moss, lichen, or soil (M, L, or S)

B = transect (S, Stampede; R, river; C, control

001 = site no. and distance from GVEA (0.5, 1.0, 1.5, 016, etc.)

C = Near spruce A, B, or C

1 = Analytical replicate (1, original; 2, anal. replicate); in the field this will always be 1.

Figure 3.--Denali/HCCP Project field data sheet

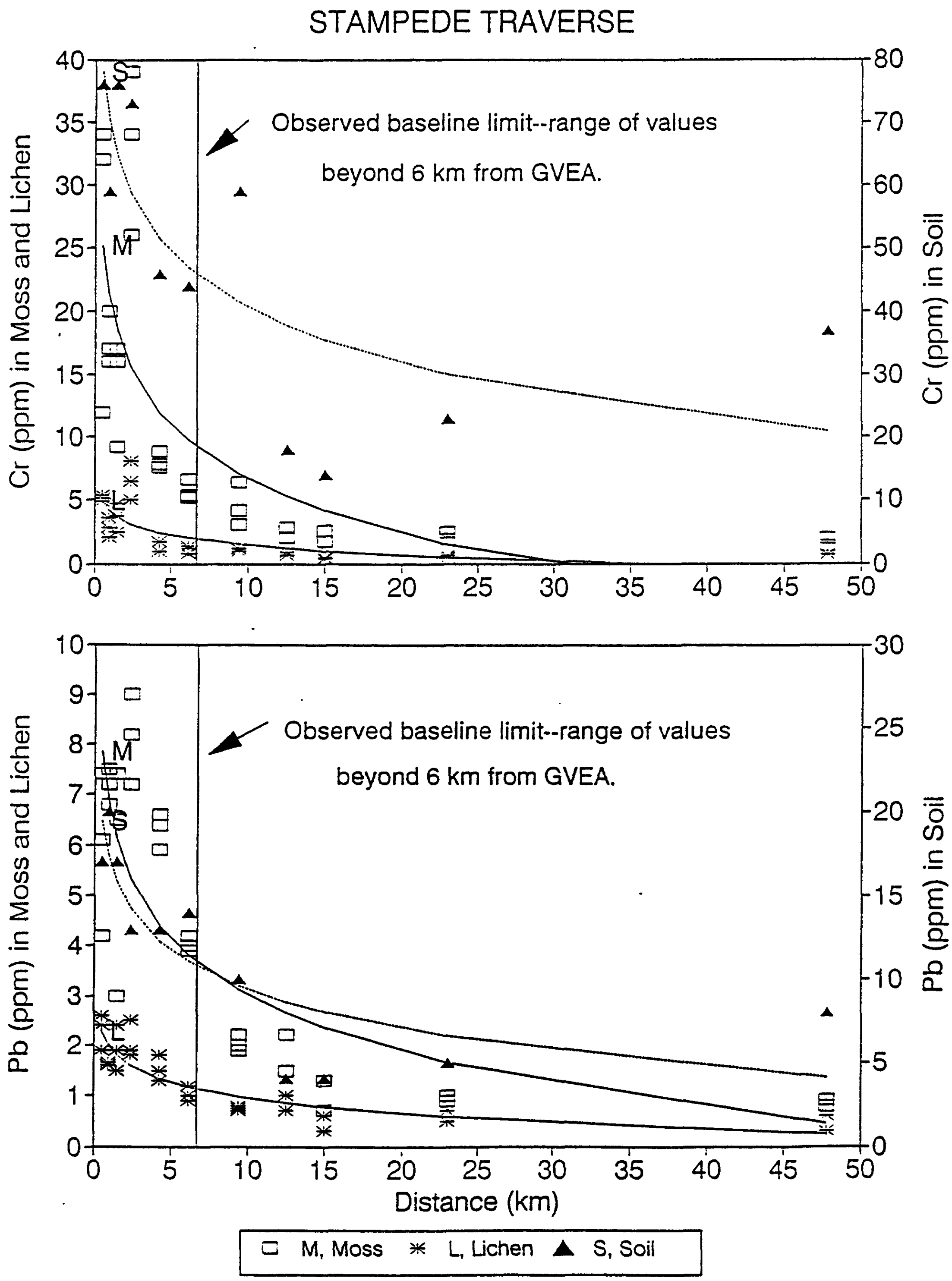

Figure 4. For this study, the observed baseline is defined as the range of element concentration values (dry weight base) for samples collected beyond 6 km from the Golden Valley Electric Association (GVEA) power plant along the Control, Stampede, and Nenana traverses (Tables 17, 18, and 20). As an example, this graph shows the observed baseline limit for chromium and lead in moss, lichen, and soil, along the Stampede traverse.

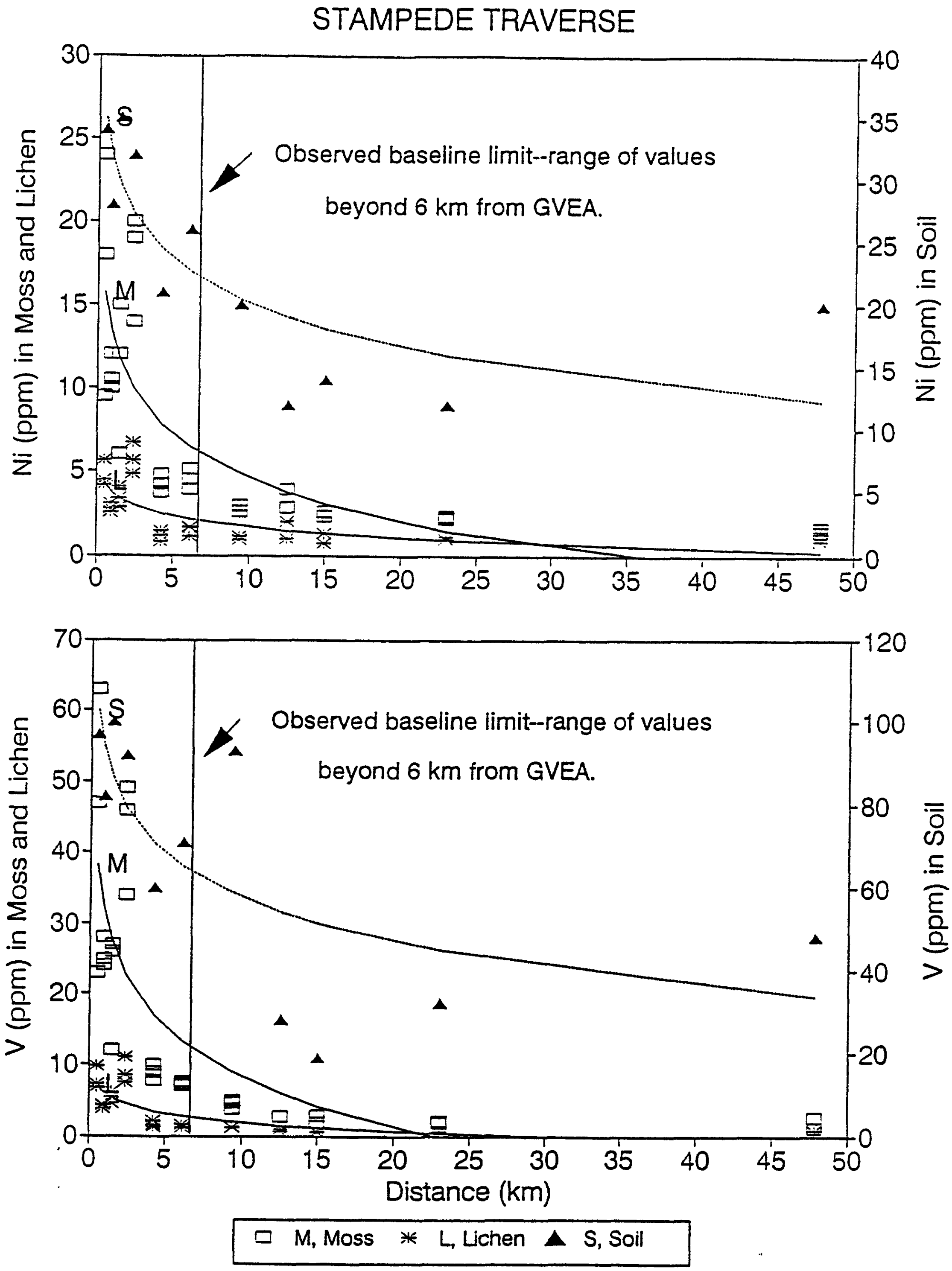

Figure 5. For this study, the observed baseline is defined as the range of element concentration values (dry weight base) for samples collected beyond 6 km from the Golden Valley Electric Association (GVEA) power plant along the Control, Stampede, and Nenana traverses (Tables 17, 18, and 20). As an example, this graph shows the observed baseline limit for nickel and vanadium in moss, lichen, and soil, along the Stampede traverse.

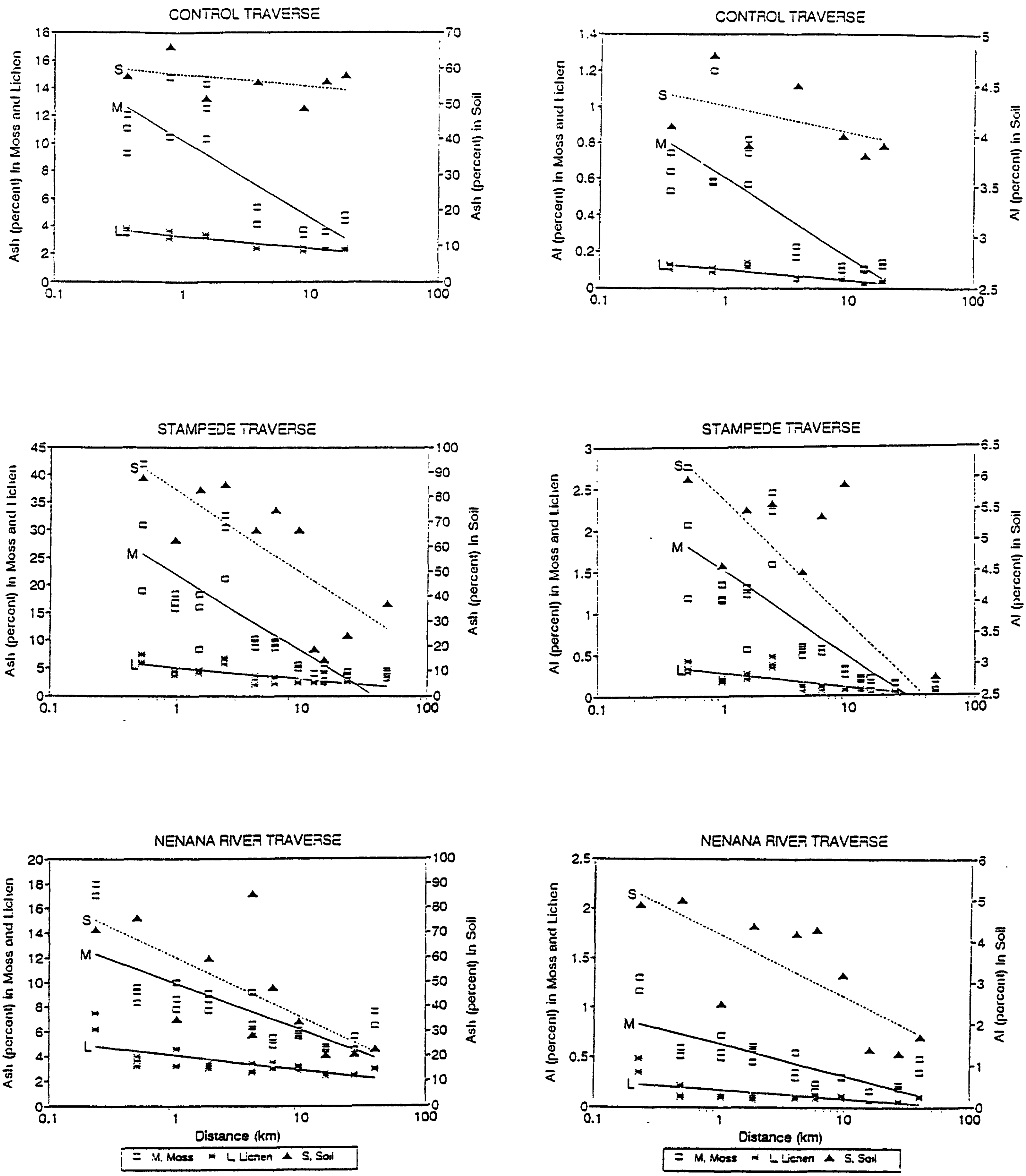

Figure 6. Regression trends for percent ash yield (ash) and aluminum (Al) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

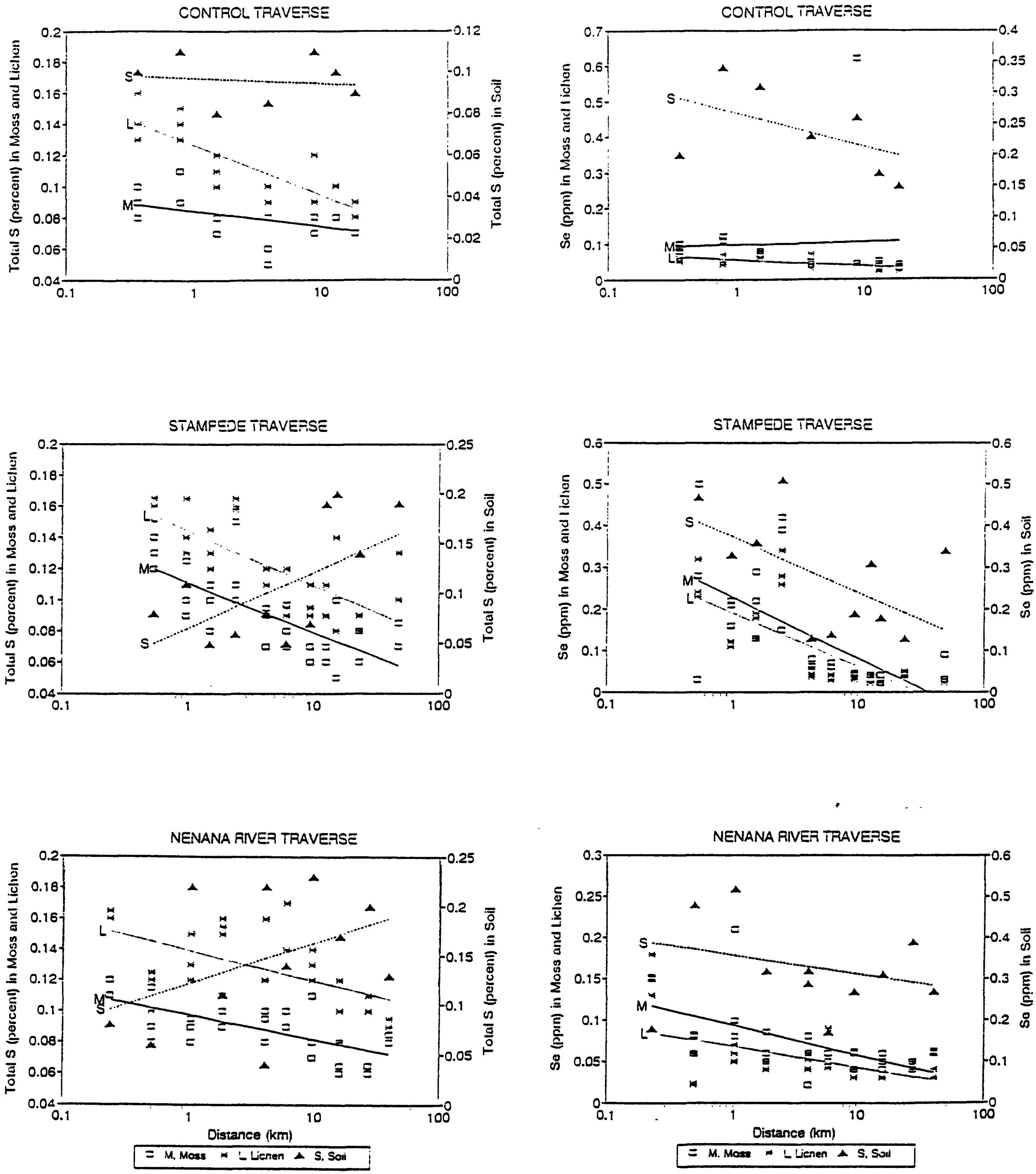

Figure 7. Regression trends for total sulfur (S) and selenium (Se) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

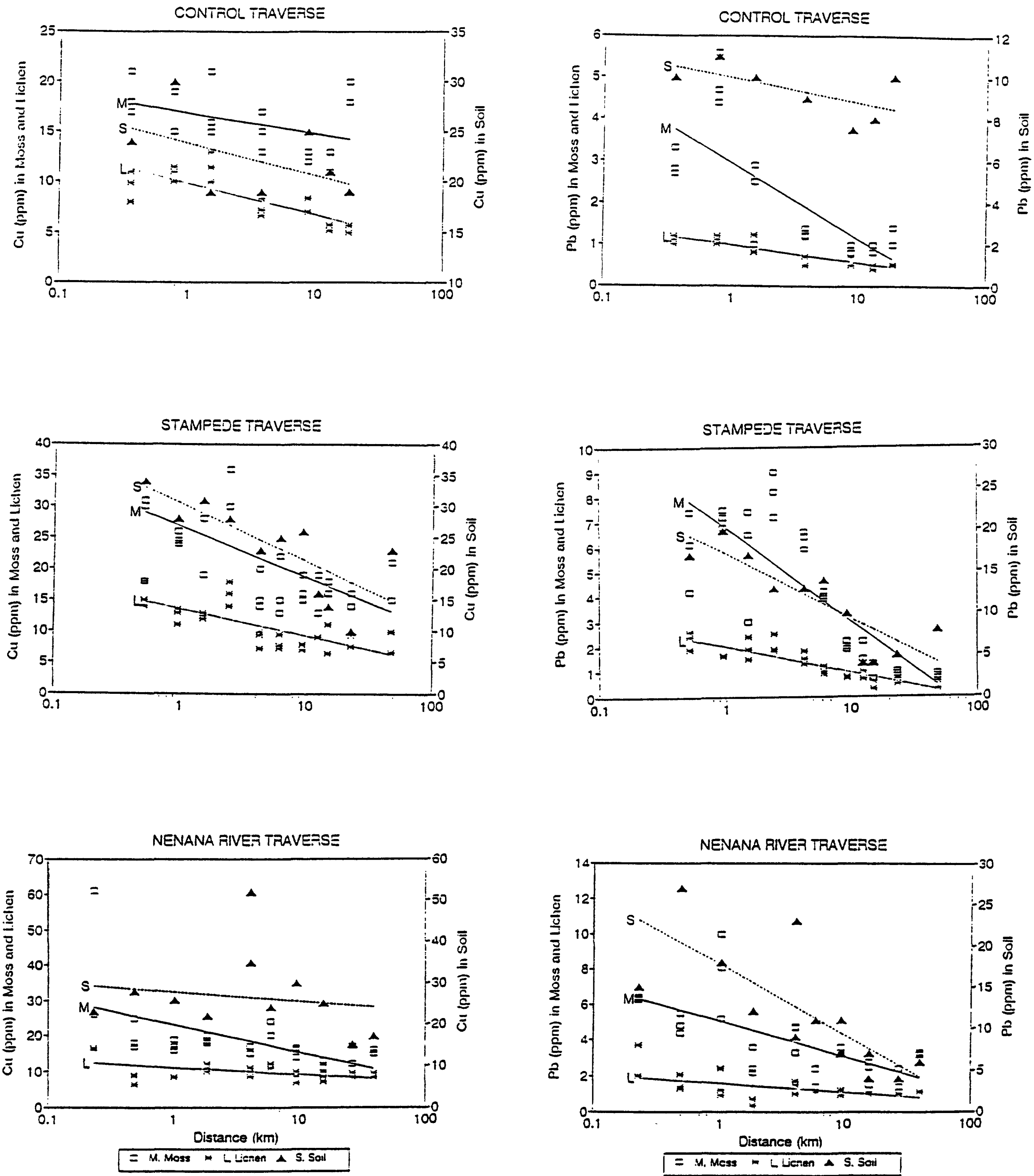

Figure 8. Regression trends for copper (Cu) and lead (Pb) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

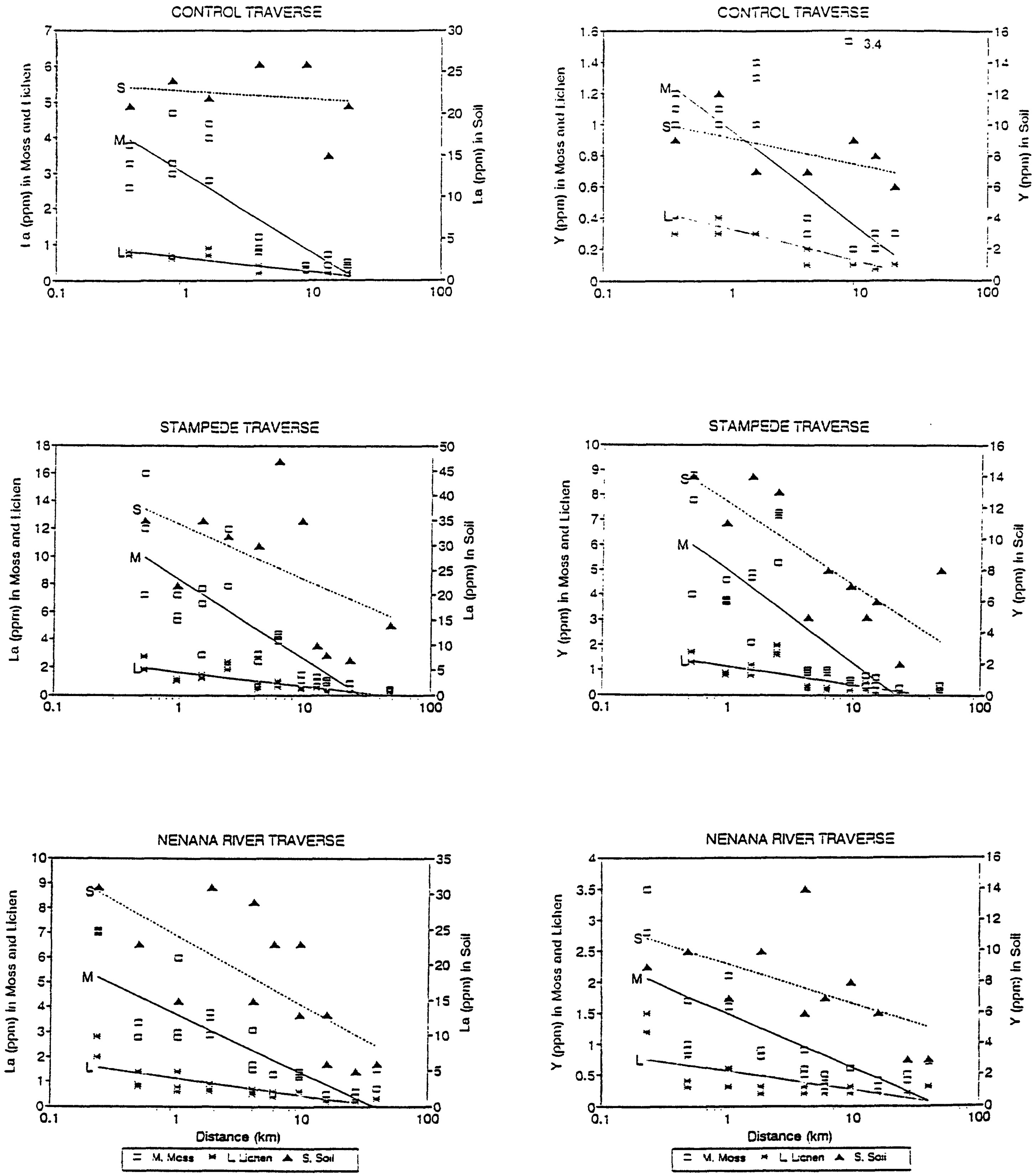

Figure 9. Regression trends for lanthanum (La) and yttrium (Y) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

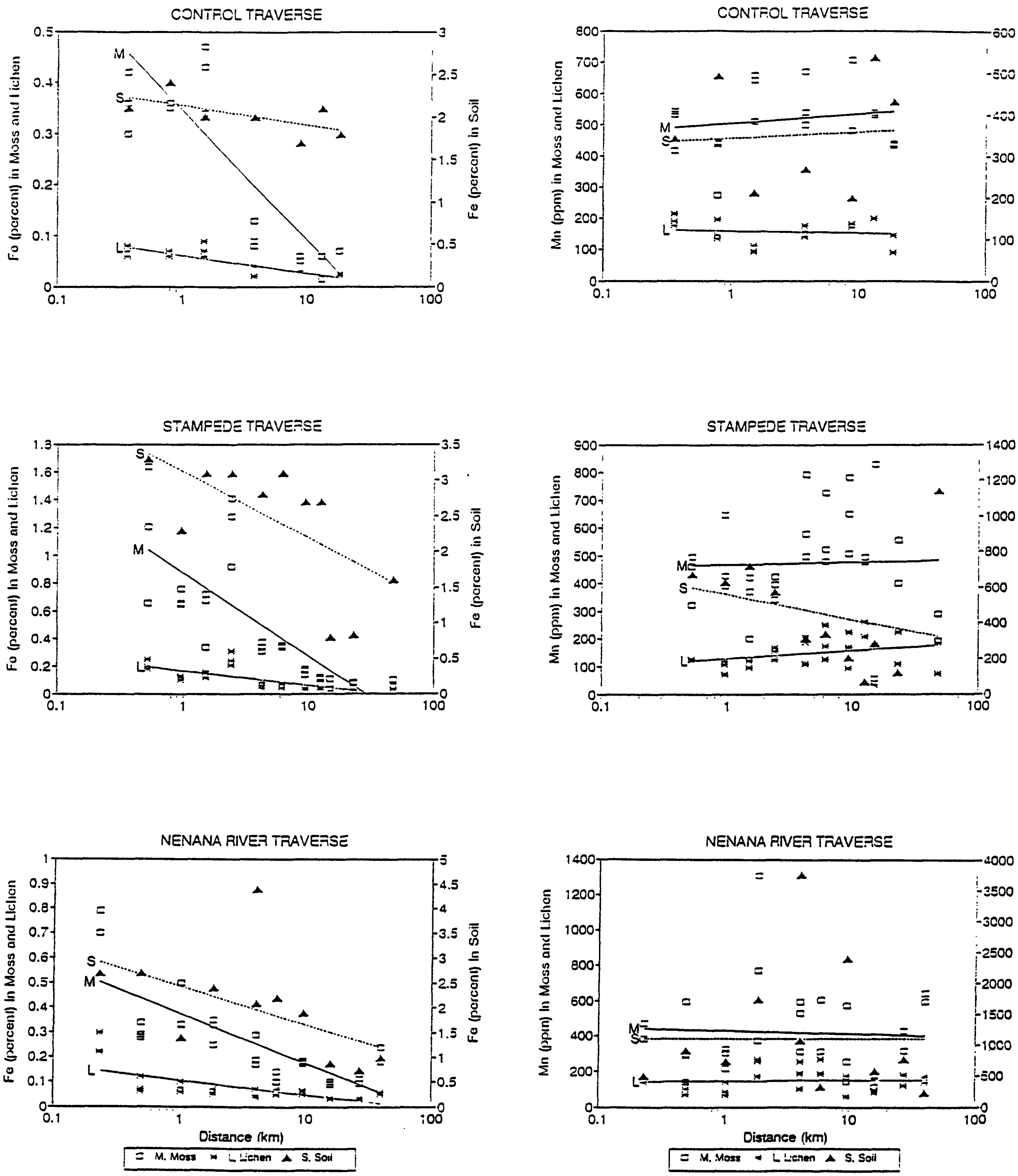

Figure 10. Regression trends for iron (Fe) and manganese (Mn) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

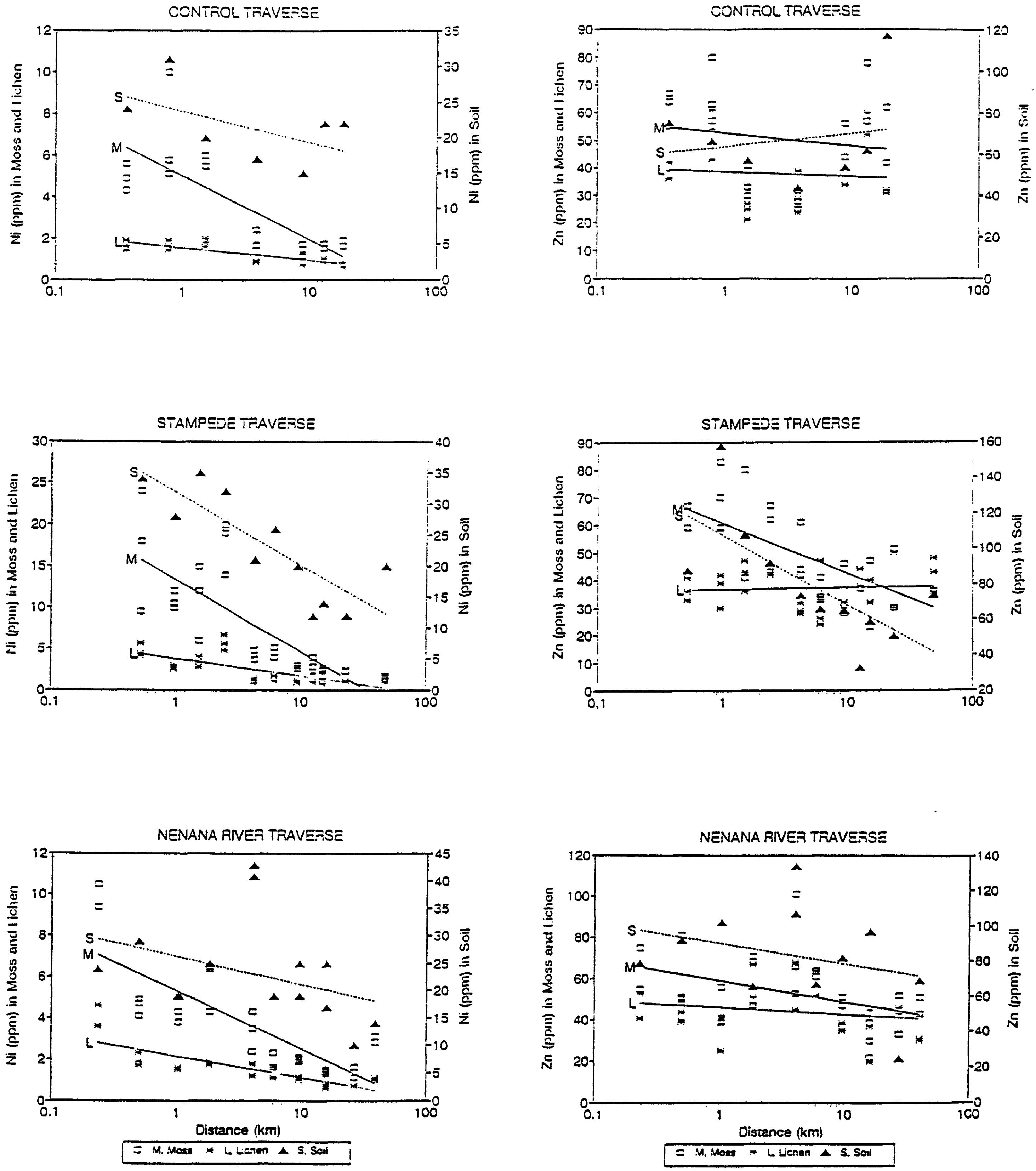

Figure 11. Regression trends for nickel (Ni) and zinc (Zn) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

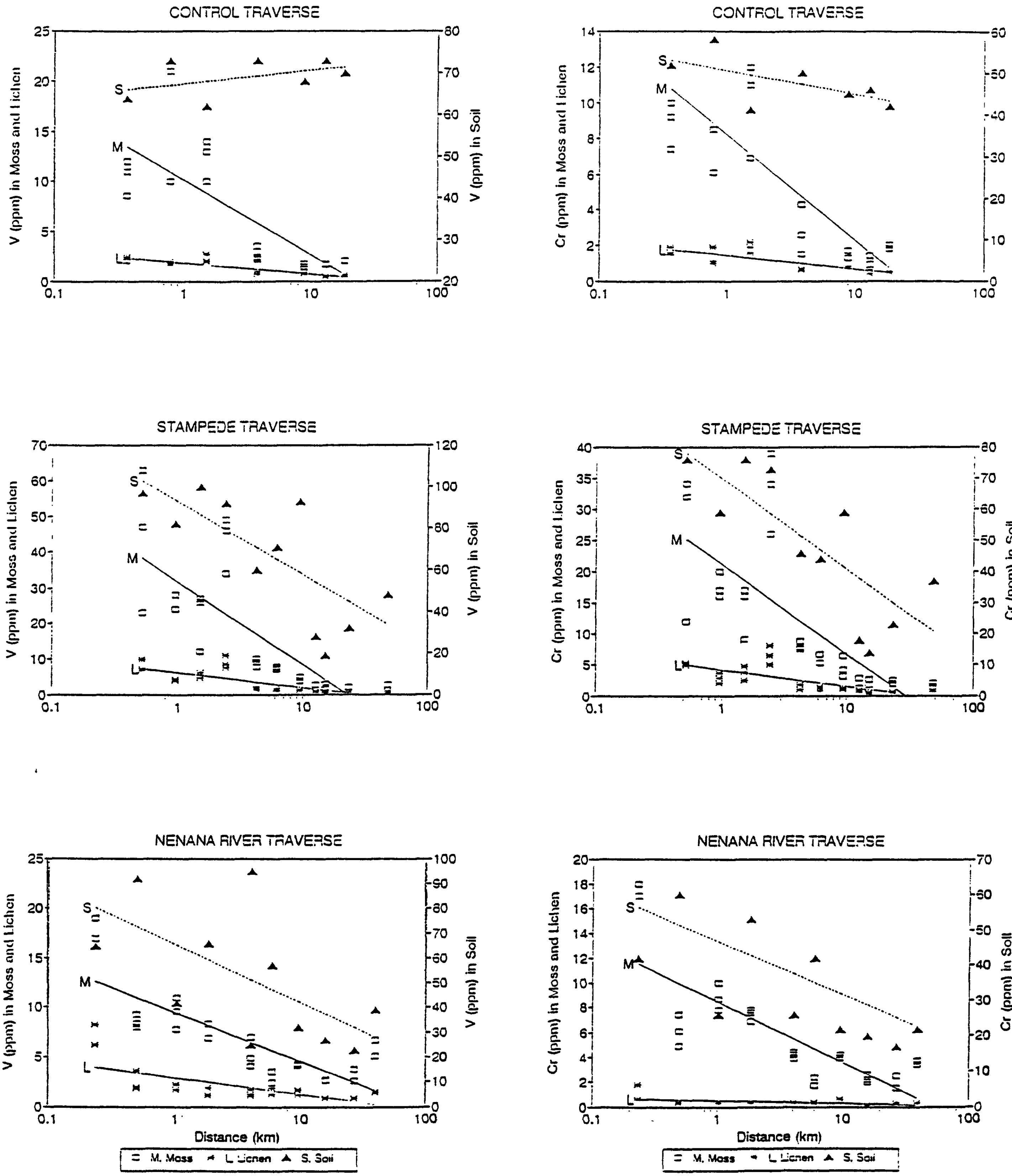

Figure 12. Regression trends for vanadium (V) and chromium (Cr) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

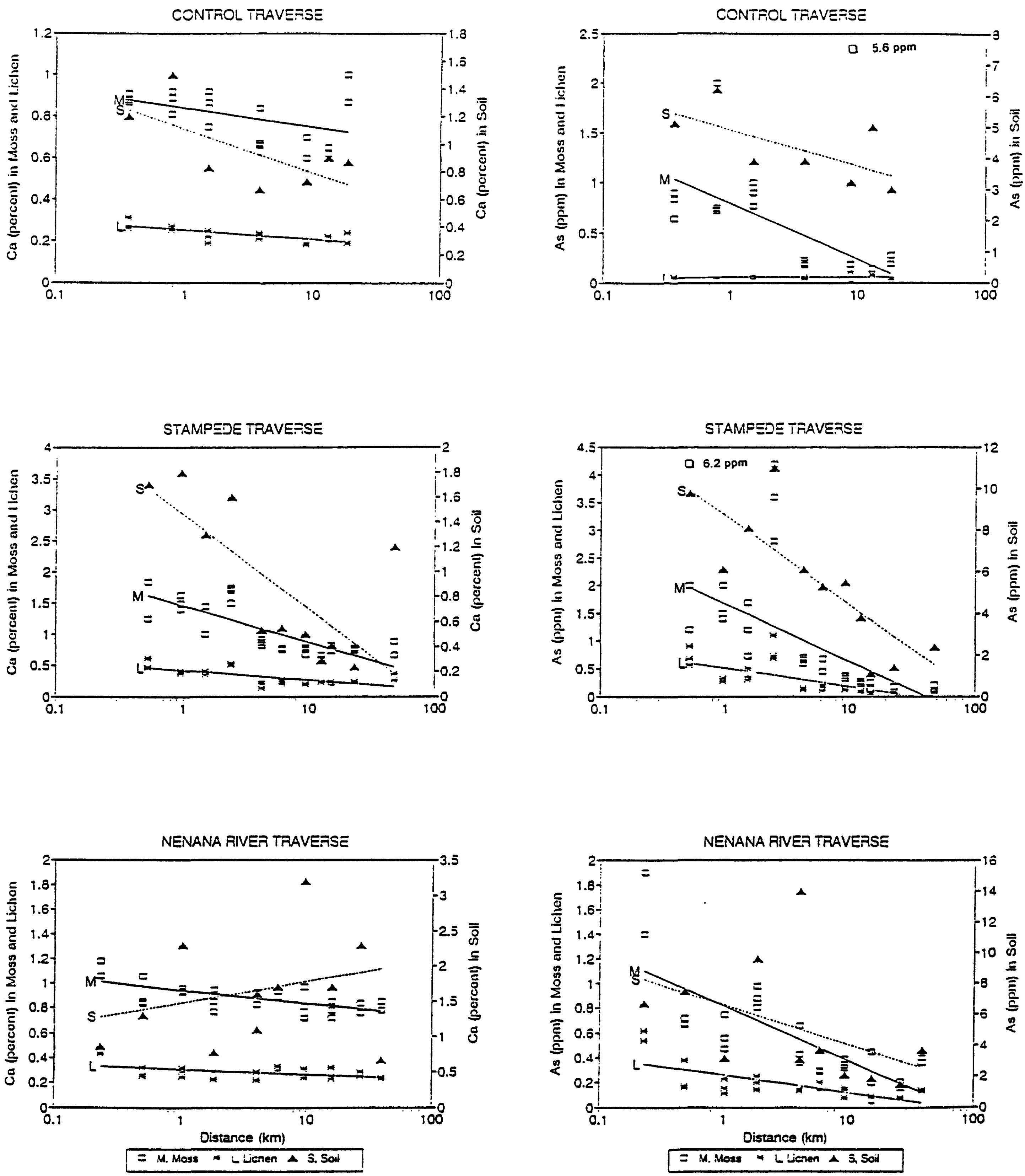

Figure 13. Regression trends for calcium (Ca) and arsenic (As) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hylocomium splendens (moss), Peltigera aphthosa (lichen), and O2-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression equations for trends with coefficients of determination > 0.50.

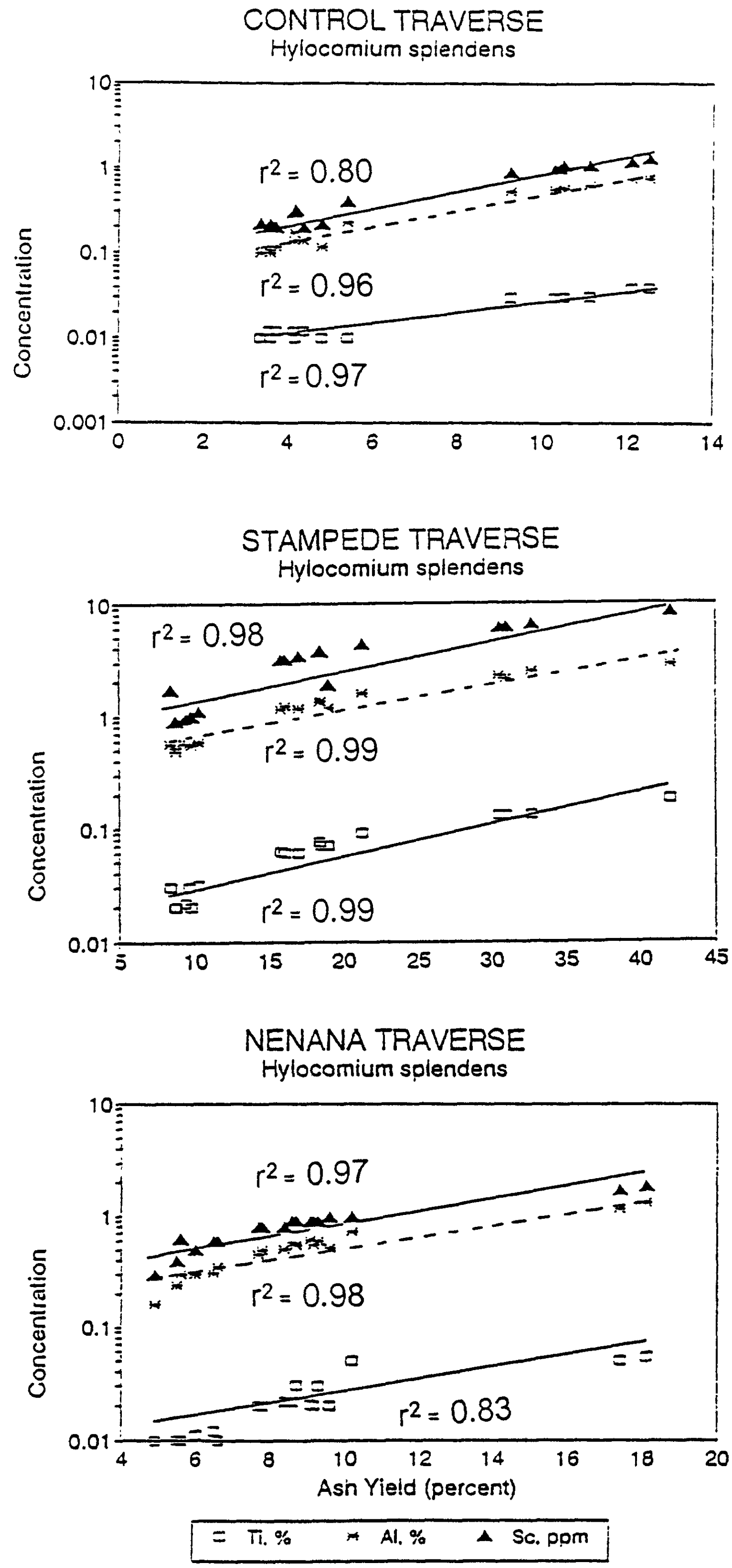

Figure 14. Relation between ash yield and moss tissue concentrations of Ti, Al, and Sc for samples collected along the Control, Stampede, and Nenana traverses. The coefficient of determination (r^2) of the relation is given for each regression.

Table 1. Traverses, distance of sites from GVEA, number of plots per site, and number of moss, lichen, and soil samples to be analyzed for elemental content at each site.

Traverse	Pre-planned Site Location (km)	Actual Measured Distance (km)	Plots, and Lichen or Moss Samples per site	Soil Samples Per Site
Stampede Trail	0.5	0.52	3	1
	1.0	0.95	3	1
	1.5	1.50	3	1
	2.0	2.41	3	1
	4.0	4.27	3	1
	6.0	6.11	3	1
	8.0	9.36	3	1
	14.0	12.5	2	1
	16.0	15.0	2	1
	25.0	23.0	2	1
	32.0	47.8	2 (29, total)	1
Nenana River	0.0	0.23	2	1
	0.5	0.49	3	1
	1.0	1.01	3	1
	2.0	1.84	3	1
	4.0	4.04	3	1
	8.0	9.55	3	1
	16.0	15.7	3	1
	25.0	26.8	2	1
	40.0	39.4	2	1
	80.0	67.8	2 (26, total)	1
Northern Control (distances from the Nenana River)	0.5	0.36	3	1
	1.0	0.78	3	1
	1.5	1.50	3	1
	3.0	3.80	3	1
	7.5	8.87	2	1
	8.0	13.2	2	1
	16.0	18.6	2 (18, total)	1
Radial Arc	001	4.79	2	1
	002	5.77	2	1
	003	8.87	2	1
	004	11.7	2	1
	005	13.9	2	1
	006	19.6	2	1
	007	7.86	2	1
	032	30.5	2	1
	040	41.8	2 (18, total)	1
Meteorologic Site	000	14.6	2	1
	001	0.90	2	1
	006	5.95	2 (6, total)	1

Table 2. Listing of approximate limits of determination for 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 (Values given are for 0.2 g soil sample)	Soil and Plant[2,3]	2.0 ppm	Ag, Cd, La, Li, Mo, Ni, Sc, Sr, V, Y, Zn
		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
		8.0 ppm	Au
		10 ppm	Bi, Sn
		40 ppm	Ta
		100 ppm	U
Continuous-flow cold vapor	Soil	0.02 ppm	Hg
	Plant[1]	0.01 ppm	
Combustion-IR	Soil Plant[1]	0.05%	S

[1] Determined on dry plant material.

[2] Determined on plant and soil 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 an ash-weight basis in Tables A1-A5. The data in Tables 3-20 has been converted to the dry-weight basis. Detection limits for the dry-weight basis concentrations will vary with the Ash Yield % of the individual sample.

Table 3.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Radial Arc sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
MA001A1	634945	1490138	0.58	0.92	0.29	0.48	0.20	0.07	0.13	0.02
MA001B1	634945	1490138	0.42	0.83	0.20	0.41	0.18	0.06	0.13	0.01
MA002A1	635023	1490346	0.29	0.88	0.15	0.37	0.18	0.06	0.14	0.01
MA002B1	635023	1490346	0.23	0.81	0.11	0.23	0.18	0.05	0.11	0.01
MA003A1	635004	1490727	0.45	0.69	0.26	0.38	0.18	0.08	0.12	0.01
MA003B1	635004	1490727	0.29	0.73	0.17	0.31	0.16	0.06	0.11	0.01
MA004A1	634854	1491006	0.62	0.61	0.42	0.54	0.20	0.08	0.15	0.01
MA004B1	634854	1491006	0.64	0.66	0.44	0.48	0.20	0.09	0.12	0.01
MA005A1	634802	1491202	0.33	0.65	0.19	0.40	0.17	0.06	0.14	0.01
MA005B1	634802	1491202	0.46	0.64	0.24	0.46	0.17	0.07	0.09	0.01
MA006A1	634706	1491851	0.68	0.83	0.24	0.45	0.18	0.06	0.10	0.01
MA006B1	634706	1491851	0.20	0.83	0.10	0.42	0.18	0.04	0.17	0.01
MA007A1	635158	1490638	0.50	0.77	0.27	0.37	0.20	0.10	0.12	0.02
MA007B1	635158	1490638	0.48	0.70	0.27	0.41	0.21	0.10	0.10	0.02
MA032A1	634256	1492900	0.50	0.76	0.35	0.28	0.22	0.12	0.08	0.02
MA032B1	634256	1492900	0.78	1.06	0.53	0.37	0.28	0.14	0.10	0.04
MA040A1	633640	1493514	0.36	0.93	0.25	0.27	0.21	0.09	0.11	0.02
MA040B1	633640	1493514	0.30	0.88	0.21	0.32	0.22	0.08	0.13	0.02
MN080A1	631839	1493323	0.49	0.72	0.23	0.38	0.19	0.17	0.11	0.02
MN080B1	631839	1493323	0.28	0.62	0.13	0.42	0.15	0.09	0.12	0.01

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
MA001A1	743	84	<0.2	<0.3	6.5	2.0	13	17	2.2	3.8
MA001B1	828	52	<0.1	<0.3	4.5	1.2	5.3	13	1.3	2.8
MA002A1	1057	88	<0.1	<0.2	2.8	1.1	4.1	12	1.2	1.7
MA002B1	616	66	<0.1	<0.2	2.1	0.9	2.0	18	1.0	1.2
MA003A1	416	69	<0.1	<0.3	6.9	1.4	3.7	14	1.4	4.1
MA003B1	299	53	<0.1	<0.2	3.9	1.1	3.3	21	0.6	2.2
MA004A1	157	77	<0.2	<0.4	9.5	2.3	7.0	17	1.7	5.5
MA004B1	182	88	<0.2	<0.4	18	2.5	6.2	13	2.0	10.
MA005A1	272	54	<0.1	<0.2	3.8	1.2	3.9	18	1.2	2.1
MA005B1	110	62	<0.1	<0.3	6.4	1.6	3.7	13	1.3	3.7
MA006A1	560	109	<0.2	<0.5	10	1.1	4.7	13	2.2	5.5
MA006B1	727	52	<0.1	<0.2	2.9	0.5	2.8	25	1.0	1.6
MA007A1	1275	128	<0.2	<0.3	3.1	1.7	6.7	13	1.7	1.9
MA007B1	340	103	<0.2	<0.3	3.3	1.4	6.0	13	1.4	1.8
MA032A1	240	125	<0.2	<0.3	2.9	1.9	9.5	12	1.0	1.9
MA032B1	491	227	<0.2	<0.5	4.4	2.5	16	18	1.3	2.5
MA040A1	114	79	<0.1	<0.3	3.4	1.4	3.4	19	0.7	1.8
MA040B1	126	70	<0.1	<0.3	2.4	0.6	4.3	16	0.6	1.3
MN080A1	491	67	<0.2	<0.3	1.8	0.8	3.3	15	1.5	0.8
MN080B1	326	40	<0.1	<0.2	1.1	0.5	1.9	10	0.5	0.5

Table 3.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Radial Arc sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

ROW ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
MA001A1	1.8	0.8	<0.7	3.5	5.2	2.1	0.8	54	1.7	6.4
MA001B1	1.3	1.3	<0.5	2.1	3.8	1.7	0.6	46	1.3	4.7
MA002A1	1.2	1.3	<0.5	1.5	3.2	1.9	0.5	52	1.2	3.7
MA002B1	1.0	2.0	<0.4	1.2	2.4	1.9	0.4	52	0.5	3.0
MA003A1	1.6	1.8	<0.6	3.8	3.1	2.6	0.7	48	1.4	5.1
MA003B1	1.1	1.7	<0.5	2.1	2.3	2.2	0.5	49	0.6	3.3
MA004A1	2.3	0.7	<0.7	4.8	6.3	4.7	0.9	43	2.2	6.3
MA004B1	2.1	1.0	<0.8	8.2	5.6	3.7	1.0	44	2.8	6.4
MA005A1	1.2	1.9	<0.5	2.1	3.1	2.3	0.5	44	0.6	3.6
MA005B1	1.7	1.9	<0.5	3.1	3.3	1.9	0.7	41	1.3	5.3
MA006A1	2.2	1.1	<0.9	4.7	4.8	3.0	1.1	55	2.2	7.3
MA006B1	1.0	1.3	<0.4	1.5	2.4	1.9	0.4	52	0.5	2.7
MA007A1	2.0	0.9	<0.7	1.9	3.7	1.9	0.9	48	1.7	8.3
MA007B1	1.7	1.6	<0.6	1.7	3.8	1.6	0.7	54	<0.6	7.4
MA032A1	3.1	1.0	<0.8	2.3	6.0	1.9	1.0	48	<0.8	12
MA032B1	5.0	0.9	<1.0	2.8	9.5	3.8	1.3	63	<1.0	20
MA040A1	1.4	1.4	<0.6	2.1	2.1	1.4	0.7	71	<0.6	5.6
MA040B1	1.3	2.1	<0.5	1.5	2.0	1.3	0.6	82	<0.5	4.9
MN080A1	1.5	1.5	<0.6	0.8	1.5	0.8	0.6	59	<0.6	5.1
MN080B1	0.5	1.0	<0.4	1.0	1.8	1.0	0.4	48	<0.4	3.2

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
MA001A1	0.8	<0.2	82	0.60	0.04	0.09	8.35	0.11
MA001B1	0.6	<0.1	70	0.48	0.07	0.10	6.37	0.10
MA002A1	0.5	<0.1	65	0.26	0.04	0.07	5.87	0.08
MA002B1	0.6	<0.1	57	0.25	0.04	0.07	4.74	0.06
MA003A1	0.7	<0.1	32	0.47	0.05	0.06	6.94	0.06
MA003B1	0.5	<0.1	42	0.40	0.04	0.08	5.65	0.08
MA004A1	0.9	<0.2	51	1.2	<0.03	0.07	8.70	0.08
MA004B1	1.0	<0.2	46	1.1	0.03	0.09	10.1	0.10
MA005A1	0.5	<0.1	34	0.35	<0.03	0.08	5.93	0.09
MA005B1	0.7	<0.1	29	0.67	0.05	0.06	6.48	0.08
MA006A1	0.7	<0.2	81	0.46	0.06	0.08	11.2	0.09
MA006B1	0.3	<0.1	73	0.18	0.03	0.08	5.19	0.08
MA007A1	0.9	<0.2	64	0.44	0.05	0.09	8.50	0.07
MA007B1	1.5	<0.2	29	0.52	0.04	0.06	7.39	0.07
MA032A1	1.0	<0.2	45	0.59	0.09	0.07	9.59	0.07
MA032B1	2.5	<0.3	47	0.95	0.14	0.13	12.6	0.07
MA040A1	1.5	0.2	41	0.43	0.03	0.07	7.14	0.09
MA040B1	1.3	<0.1	33	0.34	0.04	0.07	6.32	0.08
MN080A1	0.8	<0.2	35	0.24	0.05	0.06	7.55	0.09
MN080B1	0.5	<0.1	30	0.13	0.04	0.06	5.17	0.07

Table 4.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Control Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
MC0.5A1	635935	1490701	0.53	0.88	0.30	0.26	0.22	0.11	0.10	0.03
MC0.5B1	635935	1490701	0.64	0.91	0.36	0.36	0.22	0.13	0.11	0.03
MC0.5C1	635935	1490701	0.74	0.87	0.42	0.36	0.24	0.16	0.10	0.04
MC1.0A1	635936	1490735	0.59	0.81	0.35	0.33	0.23	0.14	0.10	0.03
MC1.0B1	635936	1490735	1.2	0.92	0.67	0.50	0.30	0.15	0.13	0.05
MC1.0C1	635936	1490735	0.58	0.89	0.36	0.35	0.24	0.13	0.09	0.03
MC1.5A1	635935	1490836	0.74	0.89	0.43	0.41	0.21	0.15	0.11	0.04
MC1.5B1	635935	1490836	0.82	0.92	0.47	0.37	0.24	0.17	0.10	0.05
MC1.5C1	635935	1490836	0.57	0.75	0.34	0.34	0.22	0.12	0.12	0.03
MC3.0A1	635950	1491135	0.22	0.85	0.12	0.29	0.21	0.06	0.14	0.01
MC3.0A2	635950	1491135	0.24	0.82	0.13	0.31	0.21	0.06	0.14	0.01
MC3.0B1	635950	1491135	0.14	0.66	0.08	0.35	0.16	0.04	0.12	0.01
MC3.0C1	635950	1491135	0.17	0.67	0.09	0.25	0.16	0.05	0.09	0.01
MC7.5A1	635950	1491753	0.12	0.70	0.06	0.22	0.18	0.04	0.12	0.01
MC7.5B1	635950	1491753	0.10	0.60	0.05	0.20	0.15	0.04	0.12	0.01
MC008A1	640111	1492416	0.11	0.60	0.06	0.21	0.17	0.05	0.11	0.01
MC008B1	640111	1492416	0.10	0.65	0.06	0.21	0.18	0.05	0.11	0.01
MC016A1	635934	1492905	0.14	0.87	0.07	0.15	0.17	0.05	0.10	0.01
MC016B1	635934	1492905	0.12	1.0	0.07	0.23	0.18	0.05	0.14	0.01

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
MC0.5A1	417	121	<0.2	<0.4	4.5	1.9	7.4	21	1.9	2.6
MC0.5B1	533	155	<0.2	<0.4	6.1	2.2	9.2	17	2.2	3.3
MC0.5C1	544	157	<0.2	<0.5	6.5	2.5	10	18	2.4	3.8
MC1.0A1	437	135	<0.2	<0.4	6.2	2.1	8.5	15	2.1	3.3
MC1.0B1	444	222	0.3	<0.6	8.4	3.9	16	19	3.0	4.7
MC1.0C1	273	126	<0.2	<0.4	5.3	2.1	6.1	15	1.1	3.0
MC1.5A1	512	163	<0.3	<0.6	8.0	2.5	11	16	2.5	4.4
MC1.5B1	643	186	<0.3	<0.6	7.3	2.9	12	21	2.9	4.0
MC1.5C1	659	134	<0.2	<0.4	5.2	2.1	6.9	15	2.1	2.8
MC3.0A1	693	49	<0.1	0.2	2.0	1.1	3.2	17	1.1	1.1
MC3.0A2	659	39	<0.1	<0.2	2.4	1.1	5.4	17	1.1	1.3
MC3.0B1	538	38	<0.1	0.2	1.2	0.4	2.6	13	0.8	0.8
MC3.0C1	500	26	<0.1	<0.2	1.5	0.4	1.5	15	0.4	0.9
MC7.5A1	482	35	<0.1	<0.2	1.0	0.4	1.7	13	0.7	0.4
MC7.5B1	706	19	<0.1	0.1	0.8	0.3	1.3	12	0.7	0.3
MC008A1	532	13	<0.1	0.7	1.0	0.8	0.9	11	0.4	0.7
MC008B1	538	18	<0.1	0.3	0.8	0.7	1.4	13	0.4	0.4
MC016A1	436	15	<0.1	0.3	0.9	0.4	1.8	18	0.4	0.4
MC016B1	436	18	<0.1	0.2	1.0	0.5	2.0	20	0.5	0.5

Table 4.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Control Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
MC0.5A1	2.1	1.9	<0.7	2.5	4.3	2.8	0.9	59	0.9	8.6
MC0.5B1	2.4	1.1	<0.9	3.2	4.9	2.7	1.1	59	1.1	11
MC0.5C1	2.8	1.2	1.0	4.0	5.6	3.3	1.2	62	1.2	12
MC1.0A1	2.3	1.0	<0.8	2.7	5.1	4.7	1.0	58	0.9	10
MC1.0B1	6.1	0.7	<1.2	4.9	10	5.6	3.0	84	3.0	21
MC1.0C1	2.2	0.8	<0.8	2.5	5.8	4.4	1.1	67	0.8	10
MC1.5A1	2.8	1.0	<1.0	3.9	5.5	2.5	1.3	62	1.3	13
MC1.5B1	3.3	1.3	<1.1	3.9	6.0	2.9	1.4	71	1.4	14
MC1.5C1	2.3	1.0	<0.8	2.9	5.5	1.0	1.0	55	1.0	10
MC3.0A1	1.1	1.5	<0.4	1.2	2.2	1.3	0.4	59	0.5	3.4
MC3.0A2	1.1	1.5	<0.4	1.2	2.5	1.5	0.4	60	0.5	3.6
MC3.0B1	0.4	1.1	<0.3	0.8	1.6	1.2	0.3	46	<0.3	2.2
MC3.0C1	0.4	1.6	<0.3	1.0	1.6	1.2	0.3	46	0.4	2.4
MC7.5A1	0.4	2.8	<0.3	0.7	1.6	1.0	0.2	45	<0.3	1.7
MC7.5B1	0.3	2.2	<0.3	0.3	1.1	0.8	0.2	37	0.3	1.4
MC008A1	0.4	2.0	<0.8	0.7	1.5	0.8	0.2	43	0.4	1.7
MC008B1	0.4	2.4	<0.3	0.7	1.7	1.0	0.2	47	<0.3	1.6
MC016A1	0.4	2.6	<0.4	0.9	1.9	1.4	0.2	52	0.4	2.1
MC016B1	0.5	2.1	<0.4	0.5	1.6	1.0	0.2	62	<0.4	2.0

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
MC0.5A1	1.0	<0.2	55	0.64	0.08	0.07	9.27	0.08
MC0.5B1	1.1	<0.2	64	0.84	0.09	0.08	11.1	0.09
MC0.5C1	1.2	<0.2	67	0.90	0.10	0.08	12.1	0.10
MC1.0A1	1.0	<0.2	63	0.75	0.11	0.06	10.4	0.11
MC1.0B1	3.4	0.3	80	2.0	0.11	0.08	14.8	0.09
MC1.0C1	1.1	<0.2	57	0.72	0.11	0.06	10.5	0.09
MC1.5A1	1.3	<0.3	39	0.90	0.09	0.08	12.5	0.07
MC1.5B1	1.4	<0.3	33	1.0	0.08	0.11	14.3	0.07
MC1.5C1	1.0	<0.2	30	0.77	0.07	0.06	10.3	0.08
MC3.0A1	0.4	<0.1	28	0.22	0.05	0.06	5.33	0.08
MC3.0A2	0.5	<0.1	29	0.25	0.05	0.07	5.49	0.08
MC3.0B1	0.3	<0.1	25	0.20	0.04	0.04	4.14	0.06
MC3.0C1	0.3	<0.1	32	0.18	0.04	0.07	4.17	0.05
MC7.5A1	0.2	<0.1	56	0.18	0.04	0.07	3.71	0.07
MC7.5B1	0.2	<0.1	44	5.6	0.62	0.06	3.36	0.08
MC008A1	0.3	<0.1	78	0.14	0.05	0.07	3.55	0.10
MC008B1	0.2	<0.1	57	0.14	0.04	0.08	3.59	0.08
MC016A1	0.3	<0.1	42	0.28	0.03	0.06	4.36	0.07
MC016B1	0.3	<0.1	62	0.19	0.04	0.09	4.79	0.07

Table 5.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Meteorological sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
MM000A1	634326	1485804	0.17	0.72	0.10	0.33	0.16	0.06	0.13	<0.01
MM000B1	634326	1485804	0.14	0.71	0.08	0.31	0.15	0.05	0.12	<0.01
MM001A1	635117	1485808	0.44	1.1	0.26	0.37	0.20	0.08	0.16	0.02
MM001B1	635117	1485808	0.41	0.83	0.23	0.33	0.21	0.08	0.14	0.02
MM006A1	634808	1485654	0.16	0.89	0.10	0.33	0.16	0.05	0.13	0.01
MM006B1	634808	1485654	0.24	0.94	0.14	0.27	0.20	0.07	0.15	0.01

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
MM000A1	576	21	<0.1	1.0	1.2	0.5	2.5	12	0.5	0.5
MM000B1	488	30	<0.1	0.4	0.9	0.4	2.7	13	0.4	0.4
MM001A1	335	90	<0.2	0.6	3.6	2.1	7.4	19	0.8	2.1
MM001B1	488	82	<0.2	0.4	3.3	1.6	5.6	23	0.8	2.0
MM006A1	311	40	<0.1	<0.2	1.4	0.5	1.7	20	0.5	0.5
MM006B1	609	28	<0.1	0.2	2.4	1.1	2.4	24	1.1	1.3

Sample ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
MM000A1	1.0	1.6	<0.4	0.5	2.5	1.5	0.3	44	<0.4	2.8
MM000B1	0.4	1.3	<0.4	0.4	2.1	1.4	0.3	44	<0.4	2.7
MM001A1	1.6	0.6	<0.7	2.2	5.1	2.5	0.8	74	0.8	7.7
MM001B1	1.5	0.8	<0.6	1.5	4.4	2.5	0.8	67	0.6	7.0
MM006A1	0.5	1.1	<0.4	1.0	1.6	1.4	0.3	54	<0.4	2.4
MM006B1	1.1	1.8	<0.4	1.2	2.3	2.4	0.4	61	0.6	3.5

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
MM000A1	0.5	<0.1	39	0.19	0.07	0.05	4.80	0.08
MM000B1	0.4	<0.1	35	0.19	0.05	0.05	4.44	0.08
MM001A1	0.8	<0.2	63	0.45	0.09	0.13	8.18	0.10
MM001B1	0.8	<0.2	52	0.41	0.08	0.07	7.50	0.10
MM006A1	0.3	<0.1	64	0.29	0.05	0.11	4.93	0.09
MM006B1	0.5	<0.1	61	0.30	0.06	0.13	5.54	0.10

Table 6.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
MN000A1	635120	1485638	1.34	1.06	0.80	0.58	0.30	0.19	0.15	0.06
MN000A2	635120	1485638	1.28	1.09	0.77	0.60	0.30	0.17	0.15	0.05
MN000B1	635120	1485638	1.17	1.18	0.70	0.56	0.30	0.16	0.17	0.05
MN0.5A1	635109	1485729	0.52	1.06	0.29	0.41	0.24	0.11	0.19	0.02
MN0.5B1	635109	1485729	0.51	0.84	0.29	0.29	0.18	0.09	0.12	0.02
MN0.5C1	635109	1485729	0.60	0.85	0.34	0.42	0.21	0.11	0.14	0.03
MN001A1	635047	1485652	0.55	0.96	0.33	0.32	0.20	0.09	0.10	0.03
MN001B1	635047	1485652	0.50	0.94	0.33	0.42	0.20	0.08	0.12	0.02
MN001C1	635047	1485652	0.72	0.94	0.50	0.42	0.23	0.10	0.13	0.05
MN002A1	635028	1485804	0.45	0.85	0.25	0.35	0.24	0.08	0.12	0.02
MN002B1	635028	1485804	0.61	0.77	0.35	0.33	0.23	0.11	0.11	0.02
MN002C1	635028	1485804	0.57	0.94	0.32	0.30	0.26	0.09	0.09	0.02
MN002C2	635028	1485804	0.60	0.96	0.34	0.32	0.26	0.10	0.10	0.02
MN004A1	634942	1490013	0.55	0.92	0.29	0.44	0.24	0.13	0.16	0.02
MN004B1	634942	1490013	0.35	0.93	0.19	0.32	0.21	0.07	0.12	0.01
MN004C1	634942	1490013	0.30	0.83	0.17	0.30	0.19	0.07	0.11	0.01
MM006A1	634808	1485654	0.16	0.89	0.10	0.33	0.16	0.05	0.13	0.01
MM006B1	634808	1485654	0.24	0.94	0.14	0.27	0.20	0.07	0.15	0.01
MN008A1	634619	1485407	0.31	0.97	0.18	0.27	0.19	0.07	0.08	0.01
MN008B1	634619	1485407	0.30	0.72	0.18	0.24	0.18	0.07	0.08	0.01
MN008C1	634619	1485407	0.30	0.81	0.18	0.22	0.18	0.07	0.08	0.01
MN016A1	634258	1485335	0.16	0.85	0.10	0.21	0.20	0.06	0.09	0.01
MN016B1	634258	1485335	0.17	0.72	0.09	0.22	0.15	0.06	0.10	0.01
MN016C1	634258	1485335	0.16	0.78	0.10	0.17	0.16	0.06	0.07	0.01
MN025A1	633741	1484720	0.17	0.75	0.09	0.22	0.15	0.07	0.08	0.01
MN025A2	633741	1484720	0.20	0.76	0.10	0.23	0.16	0.07	0.08	0.01
MN025B1	633741	1484720	0.22	0.84	0.13	0.26	0.16	0.08	0.10	0.01
MN040A1	633030	1484901	0.47	0.82	0.23	0.26	0.19	0.15	0.10	0.02
MN040A2	633030	1484901	0.51	0.88	0.26	0.28	0.21	0.16	0.11	0.02
MN040B1	633030	1484901	0.35	0.78	0.18	0.31	0.19	0.12	0.12	0.02

Table 6.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
MN000A1	465	335	<0.4	<0.7	13	4.1	17	26	3.7	7.4
MN000A2	487	264	<0.4	<0.7	12	4.1	18	26	3.5	6.5
MN000B1	383	313	<0.4	<0.7	13	3.8	17	61	3.5	7.1
MN0.5A1	597	154	<0.2	0.4	4.5	1.9	7.4	25	1.9	2.8
MN0.5B1	294	126	<0.2	<0.3	5.0	1.8	4.9	18	1.7	2.8
MN0.5C1	140	140	<0.2	<0.4	5.7	1.9	6.1	17	0.9	3.4
MN001A1	217	104	<0.2	<0.4	5.7	1.8	8.7	19	1.7	3.0
MN001B1	328	94	<0.2	<0.3	4.8	1.6	7.8	16	1.6	2.8
MN001C1	306	173	<0.2	<0.4	11	2.2	10.0	17	2.0	6.0
MN002A1	1310	93	<0.2	<0.3	4.9	2.1	6.9	18	1.6	2.9
MN002B1	773	127	<0.2	<0.4	6.5	3.3	7.6	18	1.9	3.6
MN002C1	375	111	<0.2	0.4	6.4	2.2	7.4	20	1.7	3.7
MN002C2	377	123	<0.2	0.4	6.8	2.4	8.1	19	1.8	3.9
MN004A1	313	101	<0.2	<0.4	5.2	2.2	4.4	17	1.8	3.1
MN004B1	531	64	<0.1	<0.3	3.0	1.3	4.2	15	1.3	1.7
MN004C1	596	72	<0.1	<0.2	2.8	1.3	3.9	17	1.2	1.5
MM006A1	311	40	<0.1	<0.2	1.4	0.5	1.7	20	0.5	0.5
MM006B1	609	28	<0.1	0.2	2.4	1.1	2.4	24	1.1	1.3
MN008A1	143	52	<0.1	<0.3	2.3	1.3	4.2	14	0.7	1.4
MN008B1	256	48	<0.1	<0.2	2.4	1.1	4.0	16	1.1	1.2
MN008C1	577	58	<0.1	<0.2	2.4	1.2	3.9	16	1.2	1.3
MN016A1	179	47	<0.1	0.3	0.9	0.5	2.6	13	0.5	0.5
MN016B1	179	22	<0.1	0.3	0.9	0.5	2.0	9	0.5	0.5
MN016C1	110	46	<0.1	0.2	1.0	0.5	2.2	11	0.4	0.5
MN025A1	318	49	<0.2	0.3	0.4	0.4	1.7	17	0.4	0.4
MN025A2	320	52	<0.1	0.2	1.1	0.5	1.3	17	0.5	0.5
MN025B1	432	79	<0.1	<0.2	1.2	0.6	2.5	12	0.6	0.6
MN040A1	586	82	<0.2	<0.3	2.1	0.7	3.6	16	1.5	1.5
MN040A2	622	88	<0.2	<0.3	2.3	0.8	3.8	15	1.6	1.6
MN040B1	648	78	<0.1	0.3	1.6	1.3	3.4	16	1.3	0.7

Table 6.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
MN000A1	4.8	0.7	<1.5	6.3	12	6.5	1.9	99	3.7	20
MN000A2	4.8	0.9	<1.4	6.0	9.5	6.2	1.8	99	3.5	19
MN000B1	4.4	0.9	<1.4	5.4	9.4	6.3	1.7	104	1.7	17
MN0.5A1	2.0	1.0	<0.8	2.6	4.9	4.4	1.0	83	1.0	8.4
MN0.5B1	1.9	0.8	<0.7	2.5	4.1	4.8	0.8	66	0.8	8.0
MN0.5C1	2.2	0.9	<0.8	3.2	4.7	5.5	0.9	66	0.9	9.3
MN001A1	1.8	1.7	<0.7	2.6	4.3	8.1	0.9	84	0.8	9.6
MN001B1	1.6	1.8	<0.6	2.7	3.8	5.2	0.8	74	0.8	7.8
MN001C1	2.2	2.0	1.0	4.7	5.0	10	1.0	79	1.0	11
MN002A1	1.5	1.9	<0.6	2.7	4.3	2.2	0.8	56	1.5	6.9
MN002B1	2.0	1.8	<0.7	3.4	6.5	2.4	0.9	57	0.9	8.4
MN002C1	2.1	1.7	<0.6	3.3	6.1	3.2	0.9	65	1.7	8.0
MN002C2	2.3	1.8	0.7	3.4	6.9	4.0	0.9	66	1.8	8.6
MN004A1	1.9	0.9	<0.7	2.6	4.3	4.7	0.9	67	0.8	7.0
MN004B1	1.3	1.7	<0.5	1.7	3.5	4.7	0.6	60	0.7	4.9
MN004C1	1.2	1.7	<0.5	1.7	2.4	3.3	0.5	51	0.6	4.1
MM006A1	0.5	1.1	<0.4	1.0	1.6	1.4	0.3	54	<0.4	2.4
MM006B1	1.1	1.8	<0.4	1.2	2.3	2.4	0.4	61	0.6	3.5
MN008A1	1.3	1.5	<0.5	1.3	2.1	3.6	0.6	63	<0.5	4.3
MN008B1	1.1	1.7	<0.5	1.2	2.0	3.2	0.6	48	0.5	4.1
MN008C1	1.2	1.5	<0.4	1.2	1.9	3.3	0.6	50	<0.5	4.2
MN016A1	0.5	2.2	<0.3	0.9	1.5	2.5	0.3	57	<0.4	2.7
MN016B1	0.5	1.6	<0.4	0.9	1.4	1.5	0.3	45	<0.4	2.6
MN016C1	0.5	2.0	<0.4	0.5	1.3	2.8	0.3	50	<0.4	2.7
MN025A1	0.4	1.7	<0.4	0.4	1.1	1.5	0.3	49	<0.4	2.4
MN025A2	0.5	1.6	<0.4	1.0	1.1	1.3	0.3	52	<0.5	2.9
MN025B1	0.6	1.5	<0.5	0.6	1.6	2.4	0.4	54	<0.4	3.7
MN040A1	1.5	0.7	<0.6	1.6	3.3	3.1	0.7	57	<0.6	6.4
MN040A2	1.6	1.6	<0.6	1.7	3.0	3.3	0.8	61	<0.6	7.0
MN040B1	1.3	1.3	<0.5	1.3	2.8	3.3	0.6	51	<0.5	5.1

Table 6.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
MN000A1	3.7	<0.4	60	1.7	0.16	<0.03	18.6	0.11
MN000A2	1.8	0.4	51	2.0	0.14	<0.03	17.6	0.11
MN000B1	3.5	<0.4	75	1.4	0.15	0.08	17.4	0.12
MN0.5A1	1.0	<0.2	81	0.72	0.08	0.08	9.63	0.11
MN0.5B1	1.7	<0.2	50	0.67	0.08	0.08	8.40	0.09
MN0.5C1	0.9	<0.2	51	0.67	0.06	0.09	9.33	0.08
MN001A1	1.7	<0.2	56	0.56	0.21	0.06	8.70	0.09
MN001B1	1.6	<0.2	39	0.47	0.08	0.06	7.81	0.08
MN001C1	2.1	<0.2	41	0.75	0.10	0.06	10.2	0.09
MN002A1	0.8	<0.2	71	0.81	0.05	0.09	7.71	0.10
MN002B1	0.9	<0.2	47	0.88	0.06	0.09	9.09	0.11
MN002C1	0.9	<0.2	68	1.0	0.09	0.10	8.53	0.09
MN002C2	0.9	<0.2	69	0.96	0.08	0.09	8.76	0.09
MN004A1	0.9	<0.2	101	0.66	0.08	0.06	9.20	0.09
MN004B1	0.6	<0.1	66	0.43	0.06	0.10	6.64	0.10
MN004C1	0.5	<0.1	53	0.36	<0.03	0.06	5.96	0.08
MM006A1	0.3	<0.1	64	0.29	0.05	0.11	4.93	0.09
MM006B1	0.5	<0.1	61	0.30	0.06	0.13	5.54	0.10
MN008A1	0.6	<0.1	51	0.34	0.06	0.07	6.48	0.10
MN008B1	0.6	<0.1	37	0.32	0.04	0.04	5.57	0.08
MN008C1	0.6	<0.1	47	0.39	0.06	0.07	5.77	0.07
MN016A1	0.3	<0.1	39	0.20	0.04	0.06	4.72	0.06
MN016B1	0.4	<0.1	22	0.45	0.05	0.05	4.48	0.06
MN016C1	0.4	<0.1	30	0.20	0.06	0.04	4.57	0.08
MN025A1	0.4	<0.1	33	0.15	0.04	0.05	4.41	0.06
MN025A2	0.4	<0.1	33	0.17	0.04	0.07	4.77	0.07
MN025B1	0.5	<0.1	52	0.21	0.05	0.08	5.61	0.06
MN040A1	0.7	<0.2	44	0.35	0.06	<0.03	7.42	0.08
MN040A2	0.8	0.2	43	0.37	0.06	<0.03	7.97	0.08
MN040B1	0.7	<0.1	51	0.44	0.06	0.09	6.48	0.08

Table 7.--Chemical analyses for <u>Hylocomium splendens</u> (feather moss) samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
MS0.5A1	635123	1485739	2.77	1.85	1.64	0.80	0.63	0.55	0.11	0.18
MS0.5B1	635123	1485739	2.08	1.83	1.21	0.62	0.50	0.34	0.13	0.13
MS0.5C1	635123	1485739	1.18	1.25	0.66	0.55	0.32	0.23	0.13	0.07
MS1.0A1	635138	1485757	1.17	1.63	0.66	0.49	0.32	0.17	0.19	0.06
MS1.0B1	635138	1485757	1.15	1.39	0.65	0.43	0.28	0.16	0.10	0.06
MS1.0C1	635138	1485757	1.35	1.49	0.76	0.41	0.31	0.18	0.11	0.07
MS1.5A1	635156	1485816	0.56	1.01	0.34	0.38	0.19	0.08	0.12	0.03
MS1.5B1	635156	1485816	1.35	1.47	0.73	0.49	0.30	0.17	0.12	0.08
MS1.5B2	635156	1485816	1.27	1.43	0.70	0.47	0.29	0.16	0.12	0.07
MS1.5C1	635156	1485816	1.22	1.43	0.68	0.37	0.29	0.15	0.11	0.06
MS1.5C2	635156	1485816	1.22	1.44	0.67	0.37	0.29	0.14	0.12	0.06
MS2.0A1	635230	1485818	2.23	1.74	1.28	0.67	0.46	0.34	0.12	0.13
MS2.0B1	635230	1485818	2.45	1.70	1.41	0.65	0.49	0.36	0.11	0.13
MS2.0C1	635230	1485818	1.58	1.49	0.92	0.45	0.36	0.23	0.10	0.09
MS004A1	635239	1490122	0.56	0.82	0.34	0.28	0.19	0.11	0.08	0.03
MS004B1	635239	1490122	0.59	0.92	0.38	0.33	0.22	0.11	0.12	0.03
MS004C1	635239	1490122	0.48	0.87	0.31	0.27	0.20	0.11	0.11	0.02
MS006A1	635328	1490242	0.57	0.74	0.35	0.29	0.19	0.10	0.10	0.02
MS006A2	635328	1490242	0.58	0.75	0.36	0.28	0.19	0.09	0.10	0.02
MS006B1	635328	1490242	0.57	0.77	0.35	0.29	0.22	0.12	0.12	0.02
MS006C1	635328	1490242	0.52	0.76	0.34	0.29	0.20	0.10	0.10	0.02
MS008A1	635328	1490720	0.31	0.78	0.17	0.22	0.16	0.06	0.09	0.01
MS008B1	635328	1490720	0.25	0.75	0.14	0.28	0.18	0.06	0.15	0.01
MS008C1	635328	1490720	0.30	0.65	0.17	0.18	0.16	0.07	0.09	0.01
MS008C2	635328	1490720	0.34	0.71	0.19	0.20	0.18	0.08	0.10	0.01
MS014A1	635244	1491158	0.19	0.60	0.11	0.18	0.15	0.05	0.10	0.01
MS014B1	635244	1491158	0.21	0.66	0.12	0.24	0.15	0.05	0.12	0.01
MS016A1	635225	1491513	0.21	0.73	0.11	0.23	0.19	0.05	0.13	<0.01
MS016B1	635225	1491513	0.11	0.82	0.07	0.15	0.19	0.03	0.09	<0.01
MS025A1	635411	1492415	0.14	0.77	0.07	0.20	0.16	0.05	0.11	<0.01
MS025A2	635411	1492415	0.13	0.69	0.07	0.19	0.15	0.05	0.10	<0.01
MS025B1	635411	1492415	0.15	0.77	0.08	0.24	0.19	0.05	0.14	<0.01
MS032A1	640414	1494727	0.18	0.66	0.10	0.29	0.16	0.07	0.13	0.01
MS032B1	640414	1494727	0.06	0.88	0.05	0.20	0.19	0.03	0.13	<0.01

Table 7.--Chemical analyses for *Hylocomium splendens* (feather moss) samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
MS0.5A1	462	714	<0.8	<1.7	29	9.7	32	31	8.4	16
MS0.5B1	496	620	<0.6	<1.2	21	7.4	34	30	3.1	12
MS0.5C1	323	285	<0.4	<0.8	13	3.8	12	18	1.9	7.2
MS1.0A1	391	374	<0.3	<0.7	10	3.9	17	24	1.7	5.4
MS1.0B1	427	379	0.3	<0.6	10	3.6	16	24	3.2	5.7
MS1.0C1	646	443	0.4	<0.7	13	4.4	20	26	3.7	7.2
MS1.5A1	201	126	0.2	<0.3	5.2	2.3	9.2	19	1.7	2.9
MS1.5B1	414	470	0.4	<0.8	14	5.1	14	49	3.8	8.1
MS1.5B2	430	465	0.4	<0.7	13	4.5	20	48	1.8	7.2
MS1.5C1	373	454	0.3	<0.7	11	4.5	19	28	3.2	6.3
MS1.5C2	368	240	0.3	<0.6	13	4.5	14	29	3.2	6.9
MS2.0A1	397	640	0.6	<1.2	22	7.3	34	30	6.1	12
MS2.0B1	425	654	0.7	<1.3	23	8.5	39	36	6.5	12
MS2.0C1	341	511	0.4	<0.9	14	6.2	26	30	4.3	7.9
MS004A1	497	127	<0.2	<0.4	5.6	2.0	8.8	14	2.0	3.0
MS004B1	793	144	<0.2	<0.4	5.5	2.2	7.8	20	2.1	2.9
MS004C1	578	114	<0.2	<0.4	4.4	1.8	7.6	15	1.8	2.4
MS006A1	476	124	<0.2	<0.4	8.0	1.9	4.9	13	1.9	4.7
MS006A2	481	123	<0.2	<0.4	7.5	2.8	7.3	13	1.9	3.9
MS006B1	520	128	<0.2	<0.4	7.5	2.2	5.4	15	2.0	4.2
MS006C1	725	87	<0.2	<0.4	7.1	1.8	5.2	22	1.8	3.9
MS008A1	781	67	<0.1	<0.2	2.7	1.1	4.2	16	1.1	1.5
MS008B1	650	65	<0.1	0.4	1.9	1.0	3.1	19	1.0	1.1
MS008C1	499	70	<0.1	0.3	2.7	1.1	4.3	15	1.1	1.5
MS008C2	512	77	<0.1	0.2	2.9	1.2	7.1	16	1.2	1.6
MS014A1	478	40	<0.1	0.2	1.6	0.9	2.8	13	0.8	1.0
MS014B1	494	30	0.1	0.3	2.4	1.6	2.1	19	0.8	1.3
MS016A1	828	16	<0.1	0.2	1.8	1.5	2.6	16	1.0	1.1
MS016B1	56	28	0.1	0.2	1.4	0.4	1.7	18	0.3	0.9
MS025A1	425	18	<0.1	0.2	0.9	0.8	1.9	15	0.4	0.8
MS025A2	384	13	<0.1	0.2	1.1	0.8	1.9	14	0.4	0.8
MS025B1	556	22	<0.1	0.2	1.2	0.9	2.5	16	0.4	0.9
MS032A1	290	36	<0.1	0.3	1.1	0.4	2.0	15	0.4	0.4
MS032B1	191	18	<0.1	0.2	0.4	0.8	1.4	21	0.4	0.3

Table 7.--Chemical analyses for Hylocomium splendens (feather moss) samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
MS0.5A1	13	<1.7	<3.4	14	24	4.2	8.4	172	8.4	63
MS0.5B1	9.3	1.2	2.5	11	18	7.4	6.2	167	3.1	47
MS0.5C1	4.9	<0.8	<1.5	6.1	9.5	6.1	1.9	110	1.5	23
MS1.0A1	4.8	1.2	1.4	5.1	10	7.5	3.4	163	1.7	24
MS1.0B1	4.6	1.0	<1.3	5.9	10	6.8	3.2	141	1.6	24
MS1.0C1	5.4	0.9	1.7	7.0	12	7.2	3.7	149	3.7	28
MS1.5A1	2.1	0.8	<0.7	2.8	6.0	3.0	1.7	92	0.8	12
MS1.5B1	5.5	0.9	<1.5	7.1	15	7.1	3.8	150	3.8	28
MS1.5B2	5.0	0.7	<1.4	6.6	15	5.9	3.6	145	1.8	27
MS1.5C1	4.9	1.5	1.5	5.8	12	7.1	3.2	144	1.6	26
MS1.5C2	4.8	1.0	<1.2	5.9	12	7.8	3.2	147	1.6	26
MS2.0A1	9.8	1.2	<2.4	10	19	8.2	6.1	174	6.1	46
MS2.0B1	10	1.6	<2.6	12	20	7.2	6.5	173	6.5	49
MS2.0C1	6.6	1.1	1.7	7.2	14	9.0	4.3	147	2.1	34
MS004A1	2.1	1.0	<0.8	2.9	4.2	6.6	1.0	54	1.0	8.9
MS004B1	2.3	1.0	<0.8	2.8	4.8	6.4	1.0	62	1.0	10
MS004C1	1.8	1.8	<0.7	2.3	3.7	5.9	0.9	54	0.8	7.8
MS006A1	2.0	1.9	<0.8	3.2	4.6	4.2	1.0	53	1.0	7.7
MS006A2	2.2	1.9	<0.8	3.3	4.5	4.3	0.9	53	0.9	7.8
MS006B1	2.0	2.0	<0.8	3.3	5.1	3.9	1.0	56	0.9	7.3
MS006C1	1.8	0.9	<0.7	3.5	3.9	4.0	0.9	54	1.8	7.1
MS008A1	1.2	1.5	<0.5	1.6	2.9	2.2	0.6	50	0.6	4.7
MS008B1	1.0	1.5	<0.4	1.2	2.9	2.0	0.5	50	0.5	3.7
MS008C1	1.1	2.2	<0.4	1.5	2.4	1.9	0.5	45	0.5	4.5
MS008C2	1.3	2.4	<0.5	1.6	2.7	1.9	0.6	48	0.6	5.3
MS014A1	0.8	2.2	<0.3	0.9	2.8	1.5	0.3	39	0.4	2.7
MS014B1	0.8	1.7	<0.3	1.2	3.9	2.2	0.4	45	0.4	2.8
MS016A1	1.0	2.1	<0.4	1.2	2.3	1.3	0.3	48	0.5	2.9
MS016B1	0.4	2.2	<0.3	1.2	2.6	0.7	0.2	56	<0.3	1.8
MS025A1	0.4	2.8	<0.3	0.8	2.2	0.9	0.2	54	0.4	2.0
MS025A2	0.4	2.5	<0.3	0.4	2.2	1.1	0.2	50	<0.3	1.9
MS025B1	0.4	2.3	<0.3	0.9	2.3	0.9	0.2	56	0.4	2.2
MS032A1	0.9	1.9	<0.4	0.4	1.4	0.9	0.3	48	<0.4	2.6
MS032B1	0.3	2.2	<0.3	0.4	1.7	0.8	<0.2	60	<0.3	1.1

Table 7.--Chemical analyses for *Hylocomium splendens* (feather moss) samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
MS0.5A1	8.8	<0.8	67	6.2	0.50	0.08	42.0	0.14
MS0.5B1	7.8	0.6	59	0.12	0.03	0.08	31.0	0.14
MS0.5C1	4.0	0.4	42	2.0	0.28	0.06	19.0	0.12
MS1.0A1	3.7	0.5	83	1.5	0.21	0.10	17.0	0.12
MS1.0B1	3.8	0.5	70	1.4	0.16	0.08	15.8	0.09
MS1.0C1	4.6	0.6	59	2.0	0.22	0.08	18.5	0.10
MS1.5A1	2.1	0.2	41	0.73	0.13	0.06	8.39	0.08
MS1.5B1	4.9	0.6	81	0.66	0.25	0.08	18.8	0.10
MS1.5B2	4.5	0.5	75	1.8	0.20	0.08	17.9	0.10
MS1.5C1	5.0	0.3	57	1.7	0.30	0.09	16.2	0.09
MS1.5C2	4.8	0.3	56	1.7	0.28	0.09	16.0	0.11
MS2.0A1	7.3	0.6	67	3.6	0.42	0.09	30.5	0.15
MS2.0B1	7.2	0.7	62	4.2	0.39	0.09	32.7	0.11
MS2.0C1	5.3	0.4	62	2.8	0.15	0.08	21.3	0.10
MS004A1	1.0	<0.2	42	0.66	0.08	0.06	9.74	0.07
MS004B1	1.0	<0.2	44	0.71	0.06	0.10	10.3	0.09
MS004C1	0.9	<0.2	61	0.59	0.06	0.08	8.76	0.09
MS006A1	0.9	<0.2	34	0.71	0.06	0.07	9.53	0.09
MS006A2	0.9	<0.2	35	0.67	0.07	0.05	9.44	0.09
MS006B1	1.0	<0.2	33	0.69	0.07	0.05	9.81	0.08
MS006C1	0.9	<0.2	41	0.45	0.06	0.05	8.73	0.07
MS008A1	0.6	<0.1	46	0.38	0.04	0.07	5.58	0.06
MS008B1	0.5	<0.1	46	0.23	0.04	0.09	5.00	0.07
MS008C1	0.5	<0.1	26	0.35	0.05	0.07	5.40	0.06
MS008C2	0.6	<0.1	30	0.32	0.04	0.05	5.95	0.06
MS014A1	0.4	<0.1	37	0.27	0.04	0.07	3.98	0.07
MS014B1	0.8	<0.1	37	0.23	0.03	0.07	4.12	0.06
MS016A1	0.4	<0.1	47	0.25	0.04	0.10	4.87	0.10
MS016B1	0.7	0.1	23	0.14	<0.03	0.04	3.72	0.05
MS025A1	0.3	<0.1	31	0.18	0.04	0.05	3.86	0.06
MS025A2	0.3	<0.1	29	0.20	0.05	0.04	3.84	0.07
MS025B1	0.3	<0.1	51	0.17	0.04	0.07	4.28	0.08
MS032A1	0.4	<0.1	35	0.20	0.09	0.05	4.40	0.08
MS032B1	0.2	<0.1	36	0.10	0.03	0.05	3.98	0.07

Table 8.--Chemical analyses for Hylocomium splendens (feather moss) Standard (dry-weight basis).

Sample ID	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %	Mn, ppm	Ba, ppm
STD	1.1	1.1	0.59	0.34	0.34	0.36	0.08	0.07	385	102
STD	1.0	1.1	0.54	0.33	0.33	0.33	0.08	0.06	359	95
STD	1.1	1.1	0.56	0.33	0.33	0.33	0.08	0.07	381	95
STD	1.1	1.1	0.57	0.33	0.35	0.35	0.08	0.07	377	96
STD	1.0	1.1	0.53	0.32	0.32	0.31	0.08	0.06	386	93
STD	0.94	1.0	0.50	0.31	0.30	0.30	0.08	0.06	367	90

Sample ID	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm	Mo, ppm
STD	<0.3	<0.6	4.7	3.1	13	9.9	3.0	3.0	1.5	<0.6
STD	<0.3	<0.6	3.9	2.9	9	9.5	2.8	2.8	1.4	<0.6
STD	<0.3	<0.5	4.1	2.9	9	10	2.7	2.7	1.4	<0.5
STD	<0.3	<0.6	4.1	3.0	11	9.5	2.9	1.5	1.5	<0.6
STD	<0.3	<0.5	3.7	2.7	12	9.8	2.7	2.7	1.3	<0.5
STD	<0.3	<0.5	3.8	2.6	11	9.4	2.6	2.6	1.3	<0.5

Sample ID	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
STD	<1	3.0	7.6	3.7	3.0	91	<1	19	1.5	<0.3
STD	<1	2.8	7.0	1.4	2.8	90	<1	18	1.4	<0.3
STD	<1	2.7	8.7	3.0	2.7	91	<1	18	1.4	<0.3
STD	<1	2.9	7.1	1.5	2.9	93	<1	19	1.5	<0.3
STD	<1	2.7	6.8	2.9	2.7	88	<1	17	1.3	<0.3
STD	<1	2.7	6.6	3.1	2.6	85	<1	17	1.3	<0.3

Sample ID	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
STD	37	0.28	0.85	0.07	14.8	0.07
STD	36	0.32	0.83	0.08	13.8	0.06
STD	41	0.29	1.6	0.08	13.6	0.06
STD	35	0.31	0.69	0.08	14.5	0.06
STD	33	0.34	1.0	0.08	13.3	0.06
STD	34	0.29	0.94	0.07	13.1	0.07

Table 9.--Chemical analyses for Peltigera aphthosa samples from the Radial Arc sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
LA001A1	634945	1490138	0.08	0.38	0.05	0.54	0.10	0.02	0.16	<0.01
LA001B1	634945	1490138	0.07	0.24	0.03	0.49	0.08	0.02	0.14	<0.01
LA002A1	635023	1490346	0.06	0.29	0.03	0.48	0.08	0.02	0.22	<0.01
LA002B1	635023	1490346	0.08	0.28	0.04	0.46	0.09	0.02	0.21	<0.01
LA003A1	635004	1490727	0.07	0.22	0.04	0.30	0.06	0.02	0.13	<0.01
LA003B1	635004	1490727	0.10	0.28	0.07	0.54	0.09	0.02	0.12	<0.01
LA004A1	634854	1491006	0.23	0.33	0.16	0.42	0.10	0.03	0.10	<0.01
LA004B1	634854	1491006	0.24	0.66	0.19	0.95	0.20	0.04	0.24	0.01
LA005A1	634802	1491202	0.13	0.25	0.07	0.43	0.09	0.02	0.13	<0.01
LA005B1	634802	1491202	0.09	0.28	0.05	0.54	0.09	0.02	0.14	<0.01
LA006A1	634706	1491851	0.11	0.25	0.05	0.48	0.09	0.02	0.14	<0.01
LA006B1	634706	1491851	0.07	0.28	0.04	0.38	0.09	0.02	0.21	<0.01
LA006B2	634706	1491851	0.07	0.30	0.04	0.46	0.10	0.02	0.21	<0.01
LA007A1	635158	1490638	0.10	0.25	0.05	0.37	0.08	0.02	0.13	<0.01
LA007B1	635158	1490638	0.11	0.23	0.06	0.41	0.08	0.03	0.14	0.01
LA032A1	634256	1492900	0.15	0.25	0.10	0.46	0.10	0.04	0.11	0.01
LA032B1	634256	1492900	0.13	0.24	0.09	0.54	0.09	0.03	0.12	0.01
LA040A1	633640	1493514	0.10	0.28	0.06	0.47	0.08	0.03	0.11	0.01
LA040B1	633640	1493514	0.06	0.29	0.05	0.41	0.10	0.02	0.15	<0.01
LN080A1	631839	1493323	0.14	0.27	0.06	0.50	0.09	0.05	0.15	<0.01
LN080B1	631839	1493323	0.13	0.33	0.06	0.63	0.09	0.05	0.17	<0.01

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
LA001A1	191	19	0.2	1.0	0.3	1.2	11	0.3	0.6	0.3
LA001B1	286	16	0.2	1.1	0.3	0.8	8.8	0.5	0.6	0.3
LA002A1	280	16	0.2	0.7	0.3	1.0	10	0.6	0.3	0.2
LA002B1	371	24	0.2	0.8	0.6	1.0	9.0	0.6	0.6	0.3
LA003A1	132	12	<0.1	0.9	0.3	1.0	9.1	<0.2	0.7	0.2
LA003B1	315	18	<0.1	2.1	0.6	1.0	7.9	0.3	1.2	0.3
LA004A1	122	33	0.3	4.7	1.3	2.8	11	0.5	2.4	0.9
LA004B1	248	49	0.3	7.3	2.0	3.6	18	0.7	4.1	0.7
LA005A1	257	23	0.2	2.0	0.8	1.6	9.9	0.7	1.1	0.3
LA005B1	182	21	0.2	1.4	0.6	0.9	8.7	0.6	0.8	0.6
LA006A1	255	15	0.1	1.4	0.6	1.0	10	0.6	0.7	0.6
LA006B1	493	10	0.2	0.6	0.3	1.0	9.3	0.3	0.6	0.3
LA006B2	494	18	0.2	1.0	0.3	0.8	10	0.6	0.6	0.3
LA007A1	248	17	0.2	1.2	0.5	1.4	8.3	0.3	0.2	0.5
LA007B1	252	27	0.2	1.1	0.3	1.1	9.4	0.6	0.6	0.6
LA032A1	147	37	0.4	1.2	0.8	2.2	8.5	0.4	0.8	1.0
LA032B1	127	40	0.2	1.2	0.7	2.7	10	0.7	0.7	0.8
LA040A1	53	19	0.2	1.2	0.3	1.5	5.9	0.3	0.7	0.3
LA040B1	70	16	0.2	0.9	0.3	1.0	6.7	0.3	0.6	0.3
LN080A1	171	21	0.2	0.4	0.3	0.8	12	0.4	0.4	0.4
LN080B1	148	41	0.3	0.7	0.4	0.7	8.2	0.4	0.3	0.4

Table 9.--Chemical analyses for Peltigera aphthosa samples from the Radial Arc sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mo, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
LA001A1	0.3	0. 8	1.9	0.9	<0.2	23	0.3	1.1	0.3	<0.1
LA001B1	0.2	0. 6	1.3	0.7	0.1	15	0.2	0.9	0.2	<0.1
LA002A1	0.3	0. 6	1.3	0.9	<0.1	18	0.3	0.9	0.2	<0.1
LA002B1	0.3	0. 7	1.4	1.2	0.2	16	0.3	1.2	0.2	<0.1
LA003A1	0.3	0. 6	1.2	0.8	<0.1	15	0.3	1.0	0.2	<0.1
LA003B1	0.3	1. 0	1.2	1.1	0.2	17	0.3	1.3	0.3	<0.1
LA004A1	<0.2	2. 2	3.2	2.3	0.4	21	1.0	2.4	0.5	<0.1
LA004B1	0.4	3. 5	5.9	3.3	0.4	38	1.5	2.8	0.7	<0.2
LA005A1	0.2	0. 7	2.1	1.3	0.2	16	<0.3	1.5	0.3	<0.1
LA005B1	0.3	0. 8	2.8	0.8	0.2	16	0.3	1.1	0.3	<0.1
LA006A1	0.2	0. 7	1.8	0.8	0.2	17	0.3	1.4	0.2	<0.1
LA006B1	0.3	0. 6	1.3	0.7	<0.1	19	0.3	1.0	0.2	<0.1
LA006B2	0.3	0. 6	1.3	0.7	<0.1	19	0.3	1.0	0.2	<0.1
LA007A1	0.2	0. 6	1.3	0.6	0.2	16	0.3	1.8	0.3	<0.1
LA007B1	0.6	0. 6	1.2	0.8	0.3	16	<0.2	1.9	0.3	<0.1
LA032A1	0.4	0. 8	2.3	0.8	0.4	16	<0.3	3.9	0.8	<0.1
LA032B1	0.3	0. 8	2.0	0.7	0.3	16	<0.3	3.3	0.7	<0.1
LA040A1	0.3	0. 7	0.9	0.6	0.2	21	<0.2	1.6	0.6	0.1
LA040B1	0.3	0. 6	0.7	0.6	0.2	24	<0.2	1.1	0.3	<0.1
LN080A1	0.4	0.7	1.2	0.8	0.1	21	<0.3	1.6	0.4	<0.1
LN080B1	0.4	0.7	0.7	0.7	0.2	27	<0.3	1.6	0.4	<0.1

Sample ID	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
LA001A1	48	0.09	<0.03	0.04	3.19	0.13
LA001B1	44	0.12	0.04	0.06	2.60	0.11
LA002A1	51	0.11	0.05	0.06	3.01	0.12
LA002B1	56	0.11	0.04	0.05	3.09	0.11
LA003A1	38	0.13	0.03	0.08	2.53	0.13
LA003B1	38	0.16	0.03	0.06	3.15	0.10
LA004A1	52	0.38	0.04	0.07	4.70	0.13
LA004B1	95	0.24	0.03	0.09	7.29	0.14
LA005A1	49	0.21	0.03	0.05	3.30	0.12
LA005B1	54	0.16	<0.03	0.05	2.99	0.13
LA006A1	53	0.15	0.06	0.08	2.97	0.14
LA006B1	46	0.10	0.04	0.10	2.90	0.13
LA006B2	53	0.11	0.04	0.05	3.09	0.14
LA007A1	40	0.19	0.05	0.10	2.67	0.09
LA007B1	38	0.21	0.06	0.06	2.93	0.10
LA032A1	42	0.18	0.06	0.05	3.86	0.10
LA032B1	31	0.26	0.07	0.03	3.63	0.11
LA040A1	32	0.15	0.04	0.06	2.94	0.12
LA040B1	27	0.14	<0.03	0.10	2.91	0.10
LN080A1	36	0.13	0.03	0.04	3.57	0.14
LN080B1	41	0.13	0.06	0.06	3.71	0.11

Table 10.--Chemical analyses for Peltigera aphthosa samples from the Control Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca,%	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
LC0.5A1	635935	1490701	0.10	0.27	0.06	0.59	0.09	0.03	0.13	0.01
LC0.5B1	635935	1490701	0.12	0.26	0.07	0.47	0.09	0.03	0.16	0.01
LC0.5C1	635935	1490701	0.13	0.31	0.08	0.53	0.10	0.03	0.13	0.01
LC1.0A1	635936	1490735	0.09	0.25	0.06	0.40	0.09	0.03	0.13	<0.01
LC1.0B1	635936	1490735	0.11	0.27	0.07	0.43	0.10	0.03	0.18	<0.01
LC1.0C1	635936	1490735	0.09	0.27	0.06	0.61	0.09	0.03	0.13	<0.01
LC1.5A1	635935	1490836	0.14	0.25	0.09	0.51	0.08	0.03	0.14	0.01
LC1.5B1	635935	1490836	0.11	0.22	0.06	0.44	0.08	0.03	0.13	0.01
LC1.5C1	635935	1490836	0.12	0.19	0.07	0.41	0.08	0.03	0.14	0.01
LC3.0A1	635950	1491135	0.06	0.23	0.04	0.31	0.07	0.02	0.16	<0.01
LC3.0B1	635950	1491135	0.04	0.24	0.02	0.34	0.08	0.02	0.20	<0.01
LC3.0C1	635950	1491135	0.04	0.21	0.02	0.36	0.08	0.01	0.19	<0.01
LC7.5A1	635950	1491753	0.05	0.18	0.03	0.37	0.07	0.02	0.25	<0.01
LC7.5A2	635950	1491753	0.05	0.17	0.03	0.36	0.07	0.02	0.23	<0.01
LC7.5B1	635950	1491753	0.04	0.19	0.03	0.22	0.06	0.02	0.17	<0.01
LC008A1	640111	1492416	0.02	0.22	0.01	0.18	0.08	0.01	0.20	<0.01
LC008B1	640111	1492416	0.03	0.21	0.02	0.53	0.09	0.02	0.26	<0.01
LC008B2	640111	1492416	0.03	0.19	0.02	0.50	0.09	0.02	0.24	<0.01
LC016A1	635934	1492905	0.04	0.24	0.02	0.40	0.08	0.01	0.18	<0.01
LC016B1	635934	1492905	0.03	0.19	0.02	0.43	0.06	0.01	0.19	<0.01

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
LC0.5A1	214	19	0.3	1.2	0.7	1.6	9.9	0.3	0.7	0.3
LC0.5B1	190	22	0.2	1.2	0.4	1.9	8.0	0.3	0.7	0.5
LC0.5C1	176	11	0.3	1.4	0.8	1.5	11	0.4	0.8	0.5
LC1.0A1	195	19	0.3	1.0	0.3	1.0	11	0.3	0.6	0.3
LC1.0B1	145	25	0.3	1.0	0.4	1.9	10	0.3	0.7	0.5
LC1.0C1	135	23	0.3	1.0	0.3	1.1	11	0.3	0.7	0.3
LC1.5A1	113	31	0.2	1.6	0.7	2.2	11	0.3	0.9	0.8
LC1.5B1	95	26	0.2	1.4	0.7	1.9	13	0.3	0.7	0.3
LC1.5C1	93	28	0.2	1.1	0.6	1.6	10	0.3	0.7	0.6
LC3.0A1	158	18	0.1	0.7	0.5	0.7	6.7	0.2	0.4	0.2
LC3.0B1	142	15	0.2	0.5	0.2	0.6	8.4	0.5	0.2	0.3
LC3.0C1	177	15	0.1	0.5	0.2	0.6	7.2	0.2	0.2	0.3
LC7.5A1	176	9	0.2	0.5	0.3	0.8	7.2	0.2	0.3	0.2
LC7.5A2	166	15	0.1	0.5	0.2	0.9	6.7	0.2	0.2	0.2
LC7.5B1	181	11	0.1	0.4	0.2	0.7	8.4	0.2	0.2	0.3
LC008A1	200	10	0.2	0.2	0.2	0.4	5.2	0.2	0.2	0.1
LC008B1	202	16	0.2	<0.5	0.2	0.5	6.0	<0.5	<0.2	<0.3
LC008B2	194	15	0.2	0.5	0.2	0.7	5.5	0.2	0.2	0.3
LC016A1	145	13	0.2	0.5	0.2	0.5	5.7	0.2	0.2	0.3
LC016B1	91	9	0.1	0.2	0.2	0.5	5.0	0.2	0.1	0.3

Table 10.--Chemical analyses for Peltigera aphthosa samples from the Control Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample Id	Mo, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
LC0.5A1	0.3	0.7	1.4	1.2	0.2	18	<0.3	1.8	0.3	<0.1
LC0.5B1	0.3	0.7	1.6	1.1	0.3	17	<0.3	2.2	0.4	<0.1
LC0.5C1	0.3	1.0	1.9	1.0	0.3	20	0.3	2.4	0.4	<0.1
LC1.0A1	0.3	0.6	1.4	1.1	0.2	17	<0.3	1.6	0.3	<0.1
LC1.0B1	0.3	0.4	1.9	1.0	0.3	20	0.3	2.0	0.4	<0.1
LC1.0C1	0.3	0.7	1.6	1.2	0.2	20	0.3	1.8	0.3	<0.1
LC1.5A1	0.3	1.0	2.0	1.2	0.3	18	0.3	2.7	0.7	0.1
LC1.5B1	0.2	1.0	1.6	0.8	0.2	16	0.3	2.0	0.3	<0.1
LC1.5C1	0.3	0.8	1.8	0.8	0.3	15	0.3	2.1	0.3	<0.1
LC3.0A1	0.2	0.2	0.9	0.7	0.1	17	<0.2	1.0	0.2	<0.1
LC3.0B1	0.2	0.5	0.8	0.7	<0.1	17	<0.2	0.7	0.1	<0.1
LC3.0C1	0.2	0.2	0.8	0.5	<0.1	14	<0.2	0.7	0.1	<0.1
LC7.5A1	0.3	0.3	1.4	0.7	<0.1	11	<0.2	0.9	0.2	<0.1
LC7.5A2	0.2	0.2	1.3	0.7	0.1	11	<0.2	0.8	0.1	<0.1
LC7.5B1	0.4	0.2	0.7	0.5	<0.1	12	<0.2	0.7	0.1	<0.1
LC008A1	0.2	0.2	0.8	0.4	<0.1	15	<0.2	0.4	<0.1	<0.1
LC008B1	0.2	<0.5	1.0	0.4	<0.2	14	<0.5	0.5	<0.2	<0.1
LC008B2	0.2	0.2	1.1	0.6	<0.1	13	<0.2	0.5	<0.1	<0.1
LC016A1	0.2	0.5	0.8	0.5	<0.1	14	<0.2	0.6	0.1	<0.1
LC016B1	0.2	0.2	0.6	0.5	<0.1	12	<0.2	0.5	0.1	<0.1

Sample ID	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
LC0.5A1	39	0.15	0.05	0.05	3.29	0.13
LC0.5B1	36	0.22	0.05	0.06	3.65	0.14
LC0.5C1	42	0.22	0.06	0.06	3.82	0.16
LC1.0A1	43	0.15	0.04	0.05	3.09	0.14
LC1.0B1	54	0.18	0.05	0.05	3.62	0.15
LC1.0C1	61	0.18	0.07	0.05	3.37	0.13
LC1.5A1	27	0.23	0.06	0.07	3.41	0.10
LC1.5B1	25	0.19	0.06	0.04	3.41	0.12
LC1.5C1	21	0.21	0.08	0.04	3.19	0.11
LC3.0A1	24	0.09	0.07	0.04	2.39	0.09
LC3.0B1	29	0.08	0.04	0.05	2.41	0.09
LC3.0C1	39	0.11	0.03	0.06	2.39	0.10
LC7.5A1	35	0.08	<0.03	N.D.	2.48	0.09
LC7.5A2	34	0.09	0.05	N.D.	2.40	0.08
LC7.5B1	34	0.07	0.04	0.11	2.15	0.12
LC008A1	52	0.05	<0.03	0.08	2.15	0.10
LC008B1	62	0.08	<0.03	0.10	2.40	0.09
LC008B2	58	0.06	<0.03	0.05	2.40	0.11
LC016A1	31	0.08	0.04	0.03	2.38	0.09
LC016B1	32	0.08	<0.03	0.05	2.27	0.08

N.D., Not determined due to insufficient sample.

Table 11.--Chemical analyses for <u>Peltigera aphthosa</u> samples from the Meteorological sampling sites, Denali National Park and preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca,%	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
LM000A1	634326	1485804	0.06	0.22	0.04	0.70	0.08	0.03	0.22	<0.01
LM000B1	634326	1485804	0.07	0.22	0.04	0.62	0.08	0.03	0.26	<0.01
LM001A1	635117	1485808	0.18	0.31	0.10	0.65	0.09	0.04	0.26	0.01
LM001A2	635117	1485808	0.18	0.31	0.11	0.60	0.10	0.04	0.26	0.01
LM001B1	635117	1485808	0.08	0.25	0.05	0.46	0.09	0.02	0.15	<0.01
LM006A1	634808	1485654	0.08	0.30	0.05	0.40	0.08	0.02	0.14	<0.01
LM006B1	634808	1485654	0.12	0.33	0.07	0.46	0.10	0.03	0.19	<0.01

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
LM000A1	213	23	0.9	0.6	0.2	0.9	8.2	0.3	0.3	0.3
LM000B1	251	27	0.7	0.7	0.3	1.1	6.2	0.7	0.3	0.3
LM001A1	73	32	0.2	1.8	0.9	2.6	9.1	0.4	1.0	0.9
LM001A2	73	42	0.2	1.5	0.9	2.4	9.0	0.4	0.9	0.9
LM001B1	150	27	0.2	0.9	0.6	1.2	7.8	0.3	0.6	0.3
LM006A1	189	15	0.2	0.9	0.3	1.3	11	0.3	0.6	0.3
LM006B1	269	10	<0.1	1.8	0.7	1.7	12	0.4	0.4	0.7

Sample ID	Mo, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
LM000A1	0.3	<0.3	1.3	0.8	<0.1	13	<0.3	1.2	0.2	<0.1
LM000B1	0.3	0.3	1.4	0.8	<0.1	13	<0.3	1.3	0.2	<0.1
LM001A1	0.4	1.1	2.1	1.3	0.4	22	0.3	3.2	0.4	<0.1
LM001A2	0.3	1.2	2.1	1.2	0.4	22	0.4	3.3	0.4	<0.1
LM001B1	0.3	0.3	1.2	0.8	0.2	19	<0.2	1.5	0.3	<0.1
LM006A1	0.2	0.6	1.1	1.1	0.2	18	<0.2	1.3	0.2	<0.1
LM006B1	<0.1	1.1	1.6	1.1	0.3	22	0.4	1.9	0.4	<0.1

Sample ID	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
LM000A1	33	0.10	0.05	0.06	3.04	0.08
LM000B1	42	0.08	0.08	0.07	3.26	0.10
LM001A1	36	0.27	0.04	0.06	4.31	0.13
LM001A2	36	0.27	0.06	0.06	4.28	0.14
LM001B1	29	0.10	<0.03	0.09	2.88	0.10
LM006A1	52	0.13	0.04	0.10	3.05	0.14
LM006B1	64	0.20	0.09	0.17	3.54	0.17

Table 12.--Chemical analyses for <u>Peltigera aphthosa</u> samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca,%	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
LN000A1	635120	1485638	0.35	0.43	0.22	0.62	0.14	0.04	0.19	0.01
LN000B1	635120	1485638	0.49	0.43	0.30	0.72	0.15	0.06	0.19	0.02
LN0.5A1	635109	1485729	0.10	0.32	0.06	0.47	0.10	0.02	0.31	<0.01
LN0.5B1	635109	1485729	0.12	0.25	0.07	0.49	0.08	0.03	0.19	0.01
LN0.5C1	635109	1485729	0.22	0.27	0.12	0.40	0.10	0.04	0.11	0.01
LN001A1	635047	1485652	0.09	0.29	0.06	0.41	0.09	0.02	0.13	<0.01
LN001B1	635047	1485652	0.11	0.30	0.07	0.52	0.08	0.02	0.16	<0.01
LN001B2	635047	1485652	0.12	0.34	0.08	0.50	0.09	0.03	0.19	<0.01
LN001C1	635047	1485652	0.13	0.25	0.10	0.55	0.08	0.02	0.13	0.01
LN002A1	635028	1485804	0.12	0.23	0.07	0.58	0.09	0.03	0.14	<0.01
LN002B1	635028	1485804	0.07	0.22	0.05	0.54	0.09	0.02	0.16	<0.01
LN002C1	635028	1485804	0.09	0.29	0.05	0.54	0.10	0.02	0.17	<0.01
LN004A1	634942	1490013	0.09	0.28	0.05	0.36	0.09	0.02	0.16	<0.01
LN004B1	634942	1490013	0.11	0.29	0.07	0.48	0.09	0.02	0.15	<0.01
LN004C1	634942	1490013	0.08	0.22	0.04	0.32	0.07	0.02	0.15	<0.01
LM006A1	634808	1485654	0.08	0.30	0.05	0.40	0.08	0.02	0.14	<0.01
LM006B1	634808	1485654	0.12	0.33	0.07	0.46	0.10	0.03	0.19	<0.01
LN008A1	634619	1485407	0.08	0.31	0.05	0.31	0.08	0.02	0.11	<0.01
LN008B1	634619	1485407	0.11	0.27	0.06	0.48	0.10	0.03	0.10	<0.01
LN008C1	634619	1485407	0.12	0.24	0.06	0.45	0.09	0.03	0.10	0.01
LN016A1	634258	1485335	0.05	0.25	0.03	0.47	0.09	0.02	0.15	<0.01
LN016B1	634258	1485335	0.05	0.23	0.03	0.47	0.08	0.02	0.15	<0.01
LN016C1	634258	1485335	0.05	0.32	0.03	0.37	0.09	0.02	0.13	<0.01
LN025A1	633741	1484720	0.06	0.28	0.03	0.33	0.08	0.03	0.12	<0.01
LN025B1	633741	1484720	0.05	0.25	0.03	0.36	0.07	0.02	0.15	<0.01
LN040A1	633030	1484901	0.11	0.23	0.05	0.34	0.08	0.04	0.12	0.01
LN040B1	633030	1484901	0.10	0.24	0.05	0.51	0.09	0.04	0.18	<0.01

Table 12.--Chemical analyses for <u>Peltigera</u> <u>aphthosa</u> samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
LN000A1	137	17	0.3	3.4	1.6	5.2	16	0.6	2.0	1.4
LN000B1	157	28	0.4	6.4	2.3	5.2	16	1.8	2.8	2.0
LN0.5A1	139	17	0.3	1.4	0.7	1.7	8.8	0.4	0.8	0.4
LN0.5B1	101	13	0.3	1.8	0.7	1.3	9.1	0.3	0.9	0.3
LN0.5C1	72	21	0.4	2.5	0.9	3.1	6.4	0.4	1.4	0.8
LN001A1	67	9	0.3	1.2	0.3	1.4	17	0.3	0.6	0.3
LN001B1	128	12	0.2	1.4	0.7	1.8	8.6	0.3	0.8	0.3
LN001B2	153	18	0.2	1.4	0.8	2.1	9.2	0.3	0.8	0.4
LN001C1	83	16	0.2	2.4	0.7	1.7	7.4	0.3	1.4	0.3
LN002A1	272	16	0.1	1.5	0.7	1.5	10	0.3	0.9	0.3
LN002B1	260	18	0.2	0.7	0.3	0.8	11	0.3	0.6	0.2
LN002C1	172	12	0.3	1.1	0.6	1.2	12	0.3	0.7	0.3
LN004A1	101	18	0.2	0.9	0.6	1.3	8.7	0.3	0.6	0.3
LN004B1	189	19	<0.1	1.1	0.7	1.7	11	0.3	0.7	0.3
LN004C1	255	15	0.1	0.5	0.5	1.1	10	0.3	0.5	0.3
LM006A1	189	15	0.2	0.9	0.3	1.3	11	0.3	0.6	0.3
LM006B1	269	10	<0.1	1.8	0.7	1.7	12	0.4	0.4	0.7
LN008A1	59	13	0.1	0.8	0.6	1.1	9.8	0.3	0.6	0.2
LN008B1	175	23	<0.1	1.0	0.6	1.0	8.6	0.3	0.6	0.3
LN008C1	149	19	<0.1	1.1	0.6	1.5	6.7	0.6	0.6	0.3
LN016A1	97	11	0.3	0.3	0.2	0.7	7.1	<0.2	0.2	0.2
LN016B1	76	23	0.2	0.5	0.2	0.7	7.3	0.2	0.2	0.2
LN016C1	84	13	0.3	0.3	0.3	0.7	8.5	0.2	0.2	0.2
LN025A1	180	16	0.3	0.2	0.3	0.6	9.6	0.3	0.2	0.2
LN025B1	119	18	0.1	0.5	0.2	0.7	8.4	0.3	0.2	0.2
LN040A1	137	20	0.2	0.6	0.3	0.6	8.3	0.3	0.3	0.3
LN040B1	169	20	0.2	0.6	0.3	0.7	9.6	0.3	0.3	0.3

Table 12.--Chemical analyses for Peltigera aphthosa samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mo, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
LN000A1	0.6	1.9	3.6	2.0~	0.6	37	0.6	6.2	1.2	<0.1
LN000B1	<0.3	1.5	4.6	3.7	0.8	40	<0.6	8.2	1.5	<0.2
LN0.5A1	0.3	0.8	1.9	1.3	0.2	24	0.4	1.8	0.4	<0.1
LN0.5B1	0.3	0.7	1.7	1.4	0.3	20	<0.3	2.0	0.3	<0.1
LN0.5C1	0.4	1.2	2.3	2.1	0.4	22	0.3	3.6	0.8	<0.1
LN001A1	0.6	1.1	1.5	0.9	0.2	23	0.3	1.7	0.3	<0.1
LN001B1	0.3	0.7	1.5	1.1	0.2	23	<0.3	2.2	0.3	<0.1
LN001B2	0.4	0.4	1.6	1.3	0.3	27	<0.3	2.3	0.4	<0.1
LN001C1	0.6	1.1	1.6	2.4	0.3	21	0.3	2.2	0.6	<0.1
LN002A1	0.3	0.8	1.9	0.7	0.3	16	0.3	1.9	0.3	<0.1
LN002B1	0.3	0.3	1.8	0.3	0.2	15	<0.2	1.1	0.2	<0.1
LN002C1	0.3	0.7	1.7	0.7	0.2	20	0.3	1.2	0.3	<0.1
LN004A1	0.2	0.6	1.7	1.5	0.2	19	0.3	1.3	0.3	<0.1
LN004B1	0.2	0.7	1.8	1.7	0.2	22	<0.3	1.7	0.3	<0.1
LN004C1	0.3	0.6	1.2	1.0	0.1	14	0.3	1.1	0.2	<0.1
LM006A1	0.2	0.6	1.1	1.1	0.2	18	<0.2	1.3	0.2	<0.1
LM006B1	<0.1	1.1	1.6	1.1	0.3	22	0.4	1.9	0.4	<0.1
LN008A1	0.3	0.6	1.0	1.2	0.1	20	<0.2	1.2	0.2	<0.1
LN008B1	0.3	0.6	1.1	0.9	0.2	16	<0.3	1.6	0.3	<0.1
LN008C1	0.3	0.7	1.1	1.2	0.2	16	0.3	1.7	0.3	<0.1
LN016A1	0.2	0.2	0.7	1.1	<0.1	16	<0.2	0.8	0.2	<0.1
LN016B1	0.5	0.5	0.8	1.0	<0.1	16	<0.2	0.8	0.2	<0.1
LN016C1	0.3	0.3	0.6	1.0	<0.1	19	<0.2	0.9	0.2	<0.1
LN025A1	0.3	0.3	0.7	1.0	<0.1	18	<0.2	0.9	0.2	<0.1
LN025B1	0.3	0.5	0.7	1.0	<0.1	17	0.2	0.8	0.2	<0.1
LN040A1	0.3	0.3	1.0	1.1	0.2	16	<0.2	1.5	0.3	<0.1
LN040B1	0.2	0.3	1.1	1.1	0.2	16	<0.2	1.4	0.3	<0.1

Table 12.--Chemical analyses for Peltigera aphthosa samples from the Nenana River Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
LN000A1	41	0.54	0.13	0.13	6.22	0.16
LN000B1	53	0.62	0.18	<0.01	7.47	0.16
LN0.5A1	44	0.17	0.06	0.10	3.65	0.12
LN0.5B1	39	0.16	<0.03	0.12	3.25	0.12
LN0.5C1	40	0.38	<0.03	0.14	4.02	0.10
LN001A1	41	0.11	0.05	0.08	3.18	0.12
LN001B1	38	0.16	0.07	0.08	3.45	0.16
LN001B2	38	0.15	0.05	0.12	3.82	0.14
LN001C1	25	0.23	0.07	0.04	3.21	0.13
LN002A1	48	0.25	0.05	0.08	3.44	0.16
LN002B1	51	0.14	0.04	0.06	3.02	0.15
LN002C1	67	0.20	0.05	0.06	3.19	0.15
LN004A1	67	0.15	0.05	0.10	2.80	0.12
LN004B1	68	0.15	0.06	0.08	3.44	0.16
LN004C1	45	0.15	0.04	0.06	2.66	0.12
LM006A1	52	0.13	0.04	0.10	3.05	0.14
LM006B1	64	0.20	0.09	0.17	3.54	0.17
LN008A1	39	0.08	0.04	0.12	2.80	0.13
LN008B1	38	0.14	0.03	0.04	3.18	0.14
LN008C1	35	0.16	0.04	0.05	3.18	0.12
LN016A1	45	<0.05	0.03	0.07	2.63	0.10
LN016B1	20	0.09	0.05	0.04	2.36	0.08
LN016C1	37	0.09	0.03	0.05	2.64	0.12
LN025A1	46	0.09	0.04	0.05	2.53	0.10
LN025B1	43	0.08	0.05	0.06	2.54	0.11
LN040A1	31	0.14	0.04	0.05	2.85	0.09
LN040B1	30	0.13	0.03	0.08	3.01	0.09

Table 13.--Chemical analyses for <u>Peltigera aphthosa</u> samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca,%	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
LS0.5A1	635123	1485739	0.42	0.61	0.25	0.54	0.16	0.07	0.13	0.02
LS0.5B1	635123	1485739	0.29	0.47	0.18	0.57	0.13	0.05	0.14	0.01
LS0.5C1	635123	1485739	0.33	0.46	0.20	0.53	0.13	0.05	0.15	0.01
LS1.0A1	635138	1485757	0.19	0.43	0.12	0.53	0.11	0.03	0.18	0.01
LS1.0A2	635138	1485757	0.19	0.41	0.12	0.52	0.11	0.03	0.17	0.01
LS1.0B1	635138	1485757	0.16	0.37	0.10	0.42	0.10	0.03	0.12	0.01
LS1.0C1	635138	1485757	0.21	0.39	0.13	0.53	0.11	0.03	0.18	0.01
LS1.5A1	635156	1485816	0.24	0.40	0.15	0.42	0.11	0.03	0.13	0.01
LS1.5B1	635156	1485816	0.20	0.35	0.12	0.53	0.10	0.03	0.16	0.01
LS1.5C1	635156	1485816	0.27	0.41	0.16	0.41	0.11	0.04	0.15	0.01
LS2.0A1	635230	1485818	0.38	0.53	0.24	0.56	0.15	0.05	0.12	0.02
LS2.0B1	635230	1485818	0.47	0.50	0.31	0.58	0.16	0.05	0.12	0.02
LS2.0C1	635230	1485818	0.34	0.52	0.21	0.40	0.13	0.04	0.10	0.02
LS004A1	635239	1490122	0.10	0.20	0.06	0.50	0.07	0.02	0.10	0.01
LS004B1	635239	1490122	0.13	0.24	0.08	0.52	0.09	0.03	0.14	0.01
LS004C1	635239	1490122	0.06	0.12	0.04	0.22	0.04	0.01	0.08	<0.01
LS004C2	635239	1490122	0.07	0.13	0.05	0.35	0.05	0.02	0.09	<0.01
LS006A1	635328	1490242	0.06	0.20	0.04	0.41	0.07	0.02	0.18	<0.01
LS006A2	635328	1490242	0.07	0.22	0.05	0.44	0.08	0.02	0.21	<0.01
LS006B1	635328	1490242	0.11	0.23	0.07	0.42	0.09	0.03	0.18	<0.01
LS006C1	635328	1490242	0.10	0.27	0.07	0.51	0.10	0.03	0.16	<0.01
LS008A1	635328	1490720	0.07	0.19	0.04	0.29	0.07	0.02	0.14	<0.01
LS008B1	635328	1490720	0.06	0.17	0.03	0.30	0.06	0.02	0.15	<0.01
LS008B2	635328	1490720	0.07	0.21	0.04	0.43	0.07	0.02	0.19	<0.01
LS008C1	635328	1490720	0.07	0.20	0.04	0.41	0.07	0.03	0.17	<0.01
LS008C2	635328	1490720	0.06	0.18	0.04	0.30	0.06	0.02	0.13	<0.01
LS014A1	635244	1491158	0.07	0.22	0.04	0.31	0.07	0.02	0.14	<0.01
LS014B1	635244	1491158	0.05	0.22	0.03	0.40	0.07	0.02	0.20	<0.01
LS016A1	635225	1491513	0.03	0.18	0.02	0.30	0.07	0.01	0.15	<0.01
LS016B1	635225	1491513	0.03	0.23	0.02	0.42	0.08	0.01	0.19	<0.01
LS025A1	635411	1492415	0.04	0.22	0.02	0.48	0.07	0.02	0.22	<0.01
LS025B1	635411	1492415	0.03	0.24	0.02	0.47	0.09	0.01	0.37	<0.01
LS032A1	640414	1494727	0.05	0.26	0.03	0.37	0.08	0.02	0.17	<0.01
LS032B1	640414	1494727	0.04	0.36	0.03	0.50	0.10	0.02	0.13	<0.01

Table 13.--Chemical analyses for Peltigera aphthosa samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
LS0.5A1	120	58	0.8	5.0	2.2	4.9	18	1.5	2.8	1.8
LS0.5B1	125	25	0.5	3.5	1.5	5.1	14	1.1	1.8	1.2
LS0.5C1	127	43	0.5	3.3	1.6	5.4	15	1.2	1.9	1.4
LS1.0A1	75	12	0.4	2.2	1.1	2.7	11	0.9	1.1	0.9
LS1.0A2	69	12	0.3	2.1	1.0	2.9	12	0.4	1.2	0.9
LS1.0B1	107	14	0.3	1.7	0.8	2.1	13	0.4	1.0	0.8
LS1.0C1	119	15	0.4	2.2	1.1	3.6	13	0.9	1.1	0.9
LS1.5A1	121	26	0.3	2.2	1.3	3.8	12	0.9	1.3	0.9
LS1.5B1	97	20	0.3	2.2	0.9	2.5	12	0.4	1.2	0.8
LS1.5C1	122	26	0.3	2.8	1.5	4.7	13	0.9	1.5	1.1
LS2.0A1	124	45	0.7	4.0	2.0	6.5	16	1.3	2.2	1.7
LS2.0B1	169	47	0.6	4.7	2.8	8.1	18	1.7	2.4	2.2
LS2.0C1	156	38	0.5	3.4	1.9	5.0	14	1.2	1.9	1.4
LS004A1	188	25	0.2	1.0	0.6	1.7	9.4	0.3	0.6	0.3
LS004B1	206	19	<0.2	1.6	0.4	1.7	9.9	0.4	0.8	0.4
LS004C1	98	12	0.2	0.7	0.4	1.1	7.0	0.2	0.4	0.2
LS004C2	111	15	0.2	0.9	0.4	0.9	7.4	0.2	0.5	0.2
LS006A1	167	17	0.2	1.1	0.5	0.8	7.2	0.3	0.6	0.3
LS006A2	182	16	0.2	1.1	0.6	0.9	7.2	0.3	0.7	0.3
LS006B1	125	25	0.1	1.9	0.8	1.2	7.7	0.3	0.9	0.3
LS006C1	250	25	0.3	1.7	0.7	1.4	9.5	0.3	1.0	0.3
LS008A1	95	16	0.2	0.6	0.5	1.1	7.8	0.2	0.5	0.2
LS008B1	200	15	0.2	0.5	0.2	1.4	6.7	0.2	0.2	0.2
LS008B2	258	20	0.2	0.7	0.5	1.1	7.5	0.3	0.5	0.3
LS008C1	183	15	0.2	0.8	0.3	0.8	8.1	0.3	0.5	0.3
LS008C2	160	14	0.2	0.5	0.2	1.1	7.8	0.2	0.5	0.2
LS014A1	208	15	0.2	0.6	0.2	0.9	9.0	0.2	0.5	0.2
LS014B1	261	21	0.2	1.0	1.2	0.6	9.0	0.5	0.6	0.2
LS016A1	176	9	0.2	0.4	0.4	0.4	6.5	0.2	0.2	0.1
LS016B1	32	9	0.2	0.6	0.3	0.5	11	<0.2	0.3	0.2
LS025A1	108	16	0.2	0.5	0.3	0.5	9.3	0.2	0.2	0.2
LS025B1	226	22	0.1	0.3	0.3	0.6	7.6	0.2	0.2	0.1
LS032A1	185	18	0.2	0.2	0.3	0.6	6.6	0.3	0.2	0.2
LS032B1	73	16	0.2	0.3	0.3	0.7	9.9	<0.3	0.3	0.2

Table 13.--Chemical analyses for Peltigera aphthosa samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mo, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
LS0.5A1	0.7	2.7	5.6	2.4	0.8	52	0.8	9.8	1.7	0.2
LS0.5B1	0.5	1.7	4.1	1.9	0.6	41	<0.5	6.8	1.3	<0.1
LS0.5C1	0.5	1.8	4.4	2.6	0.6	39	0.6	7.3	1.3	<0.1
LS1.0A1	0.4	1.1	2.8	1.8	0.4	40	<0.4	4.3	0.9	0.1
LS1.0A2	0.4	1.2	2.7	1.4	0.4	38	0.4	4.2	0.9	<0.1
LS1.0B1	0.4	1.0	2.5	1.6	0.4	36	0.3	3.8	0.8	0.1
LS1.0C1	0.4	1.2	3.0	1.6	0.4	37	0.4	4.4	0.9	0.1
LS1.5A1	0.5	1.2	3.3	1.9	0.5	36	0.4	5.4	1.0	0.1
LS1.5B1	0.4	1.1	2.8	1.5	0.4	32	<0.3	4.5	0.8	0.1
LS1.5C1	0.5	1.3	4.0	2.4	0.9	37	<0.4	6.1	1.2	0.1
LS2.0A1	0.5	2.1	5.6	1.8	1.3	48	0.7	8.5	1.7	0.3
LS2.0B1	0.7	2.4	6.7	2.5	1.4	48	0.7	11	2.0	0.2
LS2.0C1	0.6	2.1	4.8	1.9	1.2	47	0.6	7.5	1.6	0.2
LS004A1	0.3	0.6	1.2	1.5	0.2	13	0.3	1.6	0.3	<0.1
LS004B1	0.4	0.7	1.4	1.8	0.3	17	<0.3	2.2	0.4	<0.1
LS004C1	0.2	0.2	0.8	1.2	0.1	8	<0.2	1.2	0.2	<0.1
LS004C2	0.2	0.4	0.9	1.4	0.2	9	<0.2	1.2	0.2	<0.1
LS006A1	0.2	0.6	1.1	0.8	0.1	13	<0.2	1.0	0.2	<0.1
LS006A2	0.3	0.6	1.1	1.0	0.1	15	0.3	1.1	0.3	<0.1
LS006B1	0.2	1.1	1.6	1.0	0.3	16	0.6	1.6	0.3	<0.1
LS006C1	0.3	1.1	1.6	1.2	0.2	19	0.3	1.6	0.3	<0.1
LS008A1	0.2	0.5	1.1	0.7	0.1	13	<0.2	1.2	0.2	<0.1
LS008B1	0.2	0.2	0.9	0.6	0.1	11	<0.2	1.1	0.2	<0.1
LS008B2	0.3	0.3	1.1	0.9	0.1	14	<0.2	1.2	0.2	<0.2
LS008C1	0.3	0.7	1.1	0.9	0.2	13	0.5	1.3	0.3	<0.1
LS008C2	0.5	0.7	1.1	0.6	0.1	11	0.5	1.1	0.2	<0.1
LS014A1	1.6	0.2	1.0	1.0	0.1	14	<0.2	0.9	0.2	<0.1
LS014B1	0.5	0.6	2.0	0.7	0.1	15	<0.2	0.7	0.5	<0.1
LS016A1	0.2	0.2	0.7	0.6	<0.1	12	<0.2	0.5	0.1	<0.1
LS016B1	0.6	0.5	1.3	0.3	<0.1	16	<0.2	0.6	0.3	<0.1
LS025A1	0.2	0.3	1.0	0.7	<0.1	15	<0.2	0.6	0.1	<0.1
LS025B1	0.3	<0.2	1.1	0.5	<0.1	17	<0.2	0.6	0.1	<0.1
LS032A1	0.3	0.3	0.9	0.6	<0.1	19	<0.2	0.8	0.2	<0.1
LS032B1	0.7	<0.3	1.5	0.3	<0.1	26	<0.3	0.8	0.3	<0.1

Table 13.--Chemical analyses for Peltigera aphthosa samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
LS0.5A1	41	0.91	0.32	0.09	7.50	0.16
LS0.5B1	33	0.57	0.24	0.07	5.70	0.16
LS0.5C1	36	0.68	0.23	0.08	6.04	0.15
LS1.0A1	40	0.34	0.12	0.08	4.39	0.16
LS1.0A2	39	0.33	0.12	N.D.	4.32	0.17
LS1.0B1	42	0.27	0.12	0.08	3.81	0.13
LS1.0C1	30	0.28	0.11	0.10	4.42	0.14
LS1.5A1	43	0.36	0.18	0.09	4.47	0.14
LS1.5B1	36	0.30	0.13	0.09	4.05	0.12
LS1.5C1	47	0.51	0.19	0.07	4.71	0.13
LS2.0A1	42	0.74	0.28	0.09	6.51	0.16
LS2.0B1	44	1.10	0.34	0.08	6.77	0.16
LS2.0C1	43	0.69	0.26	0.09	5.76	0.16
LS004A1	29	0.13	0.04	0.05	2.93	0.12
LS004B1	32	0.16	0.04	0.08	3.68	0.11
LS004C1	26	0.12	0.03	0.06	2.01	0.10
LS004C2	31	0.13	0.04	0.03	2.18	0.09
LS006A1	26	0.11	0.03	0.06	2.57	0.10
LS006A2	27	0.08	<0.03	0.12	2.76	0.09
LS006B1	24	0.17	0.04	0.04	3.21	0.09
LS006C1	47	0.21	0.04	0.05	3.38	0.12
LS008A1	29	0.12	0.03	0.06	2.43	0.11
LS008B1	28	0.14	0.04	0.08	2.30	0.09
LS008B2	32	0.10	<0.03	0.08	2.66	0.09
LS008C1	33	0.09	0.04	0.08	2.54	0.08
LS008C2	30	0.13	0.05	0.03	2.28	0.10
LS014A1	44	0.10	0.04	0.08	2.42	0.09
LS014B1	38	0.07	<0.03	0.07	2.37	0.11
LS016A1	32	0.07	<0.03	0.05	2.02	0.08
LS016B1	40	<0.05	<0.03	0.04	2.47	0.14
LS025A1	30	0.08	0.04	0.03	2.51	0.09
LS025B1	50	0.06	0.05	0.07	2.63	0.08
LS032A1	48	0.09	<0.03	0.05	2.65	0.10
LS032B1	43	0.14	0.03	0.04	3.30	0.13

N.D., Not determined due to insufficient sample.

Table 14.--Chemical analyses for Peltigera aphthosa standard samples (dry-weight basis).

Sample ID	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %	Mn, ppm	Ba, ppm
STD	0.30	0.33	0.17	0.51	0.13	0.10	0.11	0.01	127	32
STD	0.31	0.34	0.17	0.56	0.14	0.10	0.12	0.01	131	33
STD	0.40	0.40	0.22	0.64	0.16	0.13	0.13	0.02	152	40
STD	0.39	0.38	0.21	0.58	0.15	0.12	0.13	0.02	146	37
STD	0.33	0.33	0.18	0.49	0.14	0.10	0.11	0.01	132	32
STD	0.37	0.38	0.21	0.62	0.16	0.12	0.14	0.01	143	37

Sample ID	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm	Mo, ppm	Nd, ppm
STD	<0.2	1.4	1.1	2.9	6.6	0.6	0.6	0.6	<0.2	0.6
STD	<0.2	1.5	1.1	3.7	7.4	0.6	0.6	0.6	<0.2	0.6
STD	<0.2	2.1	1.3	4.6	8.0	1.3	1.3	0.7	<0.2	1.5
STD	<0.2	1.7	1.3	3.6	7.6	0.6	1.3	0.6	<0.2	1.3
STD	<0.2	2.0	1.1	3.8	7.2	1.1	0.6	0.6	<0.2	1.1
STD	<0.2	1.8	1.3	3.0	7.5	0.6	1.3	0.6	<0.2	1.3

Sample ID	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm	As, ppm
STD	2.4	1.1	0.6	27	<0.4	5.5	0.6	<0.1	25	0.21
STD	2.5	0.6	0.6	27	<0.5	5.7	0.6	<0.1	28	0.19
STD	3.1	1.3	0.7	34	<0.5	7.3	1.3	<0.1	30	0.22
STD	2.9	1.3	0.6	32	<0.5	7.0	0.6	<0.1	28	0.19
STD	2.5	<0.4	0.6	28	<0.4	6.0	0.6	<0.1	27	0.17
STD	2.9	0.6	0.6	32	<0.5	7.0	0.6	<0.1	29	0.25

Sample ID	Se, ppm	Hg, ppm	Ash, %	Total S, %
STD	0.47	0.08	5.53	0.09
STD	0.51	0.09	5.70	0.09
STD	1.30	0.07	6.63	0.09
STD	0.50	0.10	6.35	0.08
STD	0.74	0.07	5.52	0.08
STD	0.48	0.12	6.23	0.08

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Radial Arc Sites					
SA001A1	634945	1490138	4.4	0.90	2.6	1.5	0.39	0.36	0.11	0.12
SA002A1	635023	1490346	4.0	0.37	1.9	1.4	0.30	0.39	0.13	0.16
SA002A2	635023	1490346	4.1	0.37	1.9	1.3	0.30	0.39	0.13	0.15
SA003A1	635004	1490727	3.4	0.46	2.0	1.2	0.29	0.38	0.06	0.08
SA004A1	634854	1491006	6.0	0.32	4.0	2.2	0.55	0.57	0.07	0.13
SA005A1	634802	1491202	4.5	0.24	2.8	1.6	0.36	0.34	0.08	0.09
SA006A1	634706	1491851	4.3	0.30	1.6	1.5	0.24	0.22	0.05	0.09
SA007A1	635158	1490638	4.5	0.53	2.3	1.1	0.39	0.63	0.09	0.24
SA032A1	634256	1492900	5.1	1.1	2.7	1.0	0.65	0.78	0.10	0.32
SA040A1	633640	1493514	2.4	2.3	1.6	0.61	0.48	0.39	0.11	0.20
SN080A1	631839	1493323	4.2	0.58	1.7	0.92	0.45	0.81	0.16	0.28
SN080A2	631839	1493323	4.2	0.64	1.7	0.98	0.45	0.81	0.16	0.27
					Control Traverse Sites					
SC0.5A1	635935	1490701	4.1	1.2	2.1	1.2	0.58	0.75	0.08	0.20
SC1.0A1	640111	1492416	4.8	1.5	2.4	1.4	0.66	0.86	0.09	0.22
SC1.5A1	635934	1492905	3.9	0.83	2.0	0.98	0.49	0.62	0.09	0.18
SC3.0A1	635935	1490836	4.5	0.67	2.0	1.1	0.46	0.67	0.11	0.21
SC7.5A1	635950	1491753	4.0	0.73	1.7	1.0	0.40	0.54	0.12	0.19
SC7.5A2	635950	1491753	4.0	0.73	1.7	1.0	0.40	0.58	0.12	0.19
SC008A1	635936	1490735	3.8	0.90	2.1	0.85	0.55	0.68	0.10	0.21
SC016A1	635950	1491135	3.9	0.87	1.8	1.2	0.48	0.64	0.13	0.19
					Meteorological Sites					
SM000A1	634326	1485804	3.9	0.90	2.5	0.71	0.47	0.52	0.19	0.19
SM001A1	635117	1485808	4.7	1.2	2.7	1.2	0.64	0.79	0.11	0.26
SM006A1	634808	1485654	4.3	1.7	2.2	1.3	0.45	0.53	0.08	0.16
					Nenana River Transaect Sites					
SN000A1	635120	1485638	4.9	0.86	2.7	1.5	0.60	0.71	0.09	0.21
SN0.5A1	635109	1485729	5.0	1.3	2.7	1.3	0.76	0.99	0.11	0.25
SN001A1	635047	1485652	2.5	2.3	1.4	0.74	0.56	0.39	0.12	0.13
SN002A1	635028	1485804	4.4	0.78	2.4	1.3	0.60	0.72	0.11	0.21
SN004A1	634942	1490013	6.3	1.1	4.4	1.7	0.88	0.88	0.08	0.32
SN004A2	634942	1490013	6.3	1.1	4.4	1.7	0.86	0.86	0.09	0.33
SN004B1	634942	1490013	2.1	1.6	2.1	0.72	0.40	0.21	0.12	0.05
SM006A1	634808	1485654	4.3	1.7	2.2	1.3	0.45	0.53	0.08	0.16
SN008A1	634619	1485407	2.4	3.2	1.9	0.62	0.48	0.41	0.11	0.10
SN016A1	634258	1485335	1.4	1.7	0.87	0.35	0.41	0.27	0.13	0.07
SN025A1	633741	1484720	1.3	2.3	0.73	0.27	0.23	0.27	0.12	0.06
SN040A1	633030	1484901	1.7	0.67	1.0	0.39	0.30	0.30	0.09	0.10

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Stampede Trail Traverse					
SS0.5A1	635123	1485739	6.0	1.7	3.3	1.7	0.97	1.1	0.09	0.33
SS1.0A1	635138	1485757	4.6	1.7	2.3	1.1	0.69	0.76	0.11	0.23
SS1.5A1	635156	1485816	5.5	1.3	3.1	1.4	0.83	1.08	0.09	0.35
SS2.0A1	635230	1485818	5.6	1.6	3.1	1.5	0.92	1.2	0.08	0.30
SS004A1	635239	1490122	4.5	0.53	2.8	1.3	0.41	0.61	0.07	0.15
SS006A1	635328	1490242	5.4	0.54	3.1	1.5	0.51	0.75	0.11	0.20
SS008A1	635328	1490720	5.9	0.49	2.7	1.5	0.47	0.73	0.10	0.22
SS014A1	635244	1491158	1.5	0.29	2.7	0.38	0.15	0.17	0.13	0.05
SS014A2	635244	1491158	1.5	0.29	2.7	0.36	0.15	0.17	0.13	0.05
SS016A1	635225	1491513	1.2	0.41	0.80	0.39	0.17	0.13	0.14	0.03
SS025A1	635411	1492415	1.8	0.24	0.83	0.51	0.20	0.24	0.12	0.06
SS032A1	640414	1494727	2.8	1.2	1.6	0.70	0.44	0.40	0.18	0.17

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ag, ppm	As, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
					Radial Arc Sites					
SA001A1	1490	<1	5	288	0.9	<1	77	17	41	44
SA002A1	661	<1	4	485	0.9	<1	49	9	39	20
SA002A2	663	<1	4	486	0.9	<1	53	9	38	20
SA003A1	463	<1	9	361	0.9	<1	45	9	33	20
SA004A1	648	<2	9	579	1.7	<2	85	18	54	42
SA005A1	503	<1	6	463	1.1	<1	62	15	38	24
SA006A1	390	<1	<7	437	1.4	<1	63	7	36	16
SA007A1	262	<1	6	684	1.1	<1	44	10	46	28
SA032A1	357	<1	6	845	0.7	<1	38	12	84	35
SA040A1	644	<1	6	322	0.6	<1	24	7	24	14
SN080A1	370	<1	14	526	<0.6	<1	24	6	49	16
SN080A2	376	<1	13	538	0.6	<1	27	6	49	16
					Control Traverse Sites					
SC0.5A1	342	<1	6	695	1.2	<1	39	9	52	24
SC1.0A1	491	<1	13	663	1.3	<1	44	11	58	30
SC1.5A1	213	<1	5	619	1.0	<1	38	11	41	19
SC3.0A1	270	<1	6	674	1.1	<1	46	8	50	19
SC7.5A1	200	<1	5	634	1.0	<1	41	7	46	25
SC7.5A2	200	<1	5	633	1.0	<1	46	7	44	26
SC008A1	536	<1	6	620	0.6	<1	28	10	46	21
SC016A1	431	<1	<6	1690	0.6	<1	38	11	42	19
					Meteorological Sites					
SM000A1	762	1	5	714	1.0	3.3	38	16	47	67
SM001A1	716	<1	7	788	0.7	<1	43	12	53	24
SM006A1	325	<1	5	440	1.0	<1	42	11	42	24
					Nenana River Traverse Sites					
SN000A1	500	<1	7	701	0.7	<1	54	11	42	23
SN0.5A1	918	<2	8	918	0.8	<2	40	14	60	28
SN001A1	737	<1	4	200	0.7	1.0	28	7	26	26
SN002A1	1750	<1	12	662	1.2	<1	57	40	53	22
SN004A1	1051	<2	18	762	0.9	<2	58	23	88	53
SN004A2	1114	<2	17	763	1.7	<2	51	22	94	52
SN004B1	3757	<1	3	144	0.6	<1	25	26	26	35
SM006A1	325	<1	5	440	1.0	<1	42	11	42	24
SN008A1	2394	<1	3	120	0.3	<1	23	10	22	30
SN016A1	580	<1	4	130	0.2	1.5	10	5	20	25
SN025A1	770	<1	2	87	0.2	1.0	9	6	17	15
SN040A1	230	<1	5	159	0.2	1.2	11	6	22	17

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ag, ppm	As, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
					Stampede Trail Traverse Sites					
SS0.5A1	676	<2	9	1050	0.9	<2	62	16	76	34
SS1.0A1	631	<1	6	883	0.6	1.3	40	13	59	28
SS1.5A1	722	<2	17	913	0.8	<2	66	15	76	31
SS2.0A1	577	<2	8	836	0.8	<2	57	15	73	28
SS004A1	315	<1	7	489	0.7	<1	55	11	46	23
SS006A1	339	<2	8	618	1.5	<2	83	14	44	25
SS008A1	206	<1	7	733	1.3	<1	61	10	59	26
SS014A1	69	<1	4	106	0.4	<1	19	6	18	16
SS014A2	69	<1	5	46	0.4	0.4	17	6	18	16
SS016A1	286	<1	1	21	0.3	1.0	16	19	14	14
SS025A1	120	1	2	317	0.2	0.7	12	5	23	10
SS032A1	1140	<1	4	442	0.7	1.1	25	13	37	23

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Ga, ppm	La, ppm	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm
					Radial Arc Sites					
SA001A1	12	49	11	<1	4	40	42	10	9	76
SA002A1	11	27	12	<1	4	20	17	11	7	62
SA002A2	11	30	12	<1	3	23	17	11	8	62
SA003A1	8	25	12	<1	<2	19	17	11	6	51
SA004A1	14	47	20	<2	<3	37	37	20	10	55
SA005A1	11	34	16	<1	3	27	25	18	8	46
SA006A1	11	36	15	<1	<3	29	15	11	7	50
SA007A1	11	25	15	1	6	18	21	9	10	97
SA032A1	12	21	23	3	7	19	25	13	11	111
SA040A1	7	12	10	1	4	14	10	6	6	190
SN080A1	13	13	20	2	6	12	12	8	8	110
SN080A2	14	14	20	2	5	13	12	6	8	116
					Control Traverse Sites					
SC0.5A1	10	21	14	<1	5	19	24	10	9	122
SC1.0A1	12	24	17	<1	5	22	31	11	9	152
SC1.5A1	9	22	13	<1	4	18	20	10	8	108
SC3.0A1	12	26	14	<1	4	20	17	9	8	118
SC7.5A1	10	25	12	1	5	21	15	9	8	97
SC7.5A2	10	27	13	<1	4	24	16	6	8	97
SC008A1	9	15	15	<1	4	13	22	8	8	107
SC016A1	10	21	20	<1	5	17	22	10	8	99
					Meteorological Sites					
SM000A1	10	21	14	1	4	21	41	19	10	100
SM001A1	11	24	20	<1	6	21	26	13	10	122
SM006A1	11	23	16	<1	3	18	19	11	8	110
					Nenana River Traverse Sites					
SN000A1	12	31	16	<1	5	26	24	15	9	122
SN0.5A1	12	23	21	<2	6	18	29	27	10	153
SN001A1	7	15	10	1	4	15	19	18	5	144
SN002A1	11	31	15	<1	5	25	25	12	9	96
SN004A1	15	32	23	<2	6	29	41	25	14	123
SN004A2	15	27	23	<2	6	27	42	21	14	120
SN004B1	8	15	9	1	<1	13	43	9	4	90
SM006A1	11	23	16	<1	3	18	19	11	8	110
SN008A1	8	13	7	1	2	14	25	7	5	137
SN016A1	4	6	5	1	1	7	17	4	4	118
SN025A1	4	5	4	2	1	6	10	4	3	133
SN040A1	4	6	8	<1	2	6	14	6	4	60

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Ga, ppm	La, ppm	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm
					Stampede Trail Traverse Sites					
SS0.5A1	14	35	24	2	8	30	34	17	12	184
SS1.0A1	11	22	20	<1	5	20	28	20	10	227
SS1.5A1	12	35	25	<2	8	29	35	17	12	166
SS2.0A1	13	32	23	<2	6	27	32	13	12	150
SS004A1	11	30	16	<1	3	24	21	13	8	74
SS006A1	16	47	17	<2	4	35	26	14	10	90
SS008A1	16	35	18	<1	3	27	20	10	11	100
SS014A1	3	10	4	4	1	9	12	4	4	38
SS014A2	3	9	4	4	<1	8	12	4	3	36
SS016A1	3	8	4	1	1	8	14	4	3	50
SS025A1	4	7	6	1	<1	6	12	5	3	41
SS032A1	8	14	10	1	4	13	20	8	6	103

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
					Radial Arc Sites					
SA001A1	18	49	18	2	90	4.6	0.18	0.12	45.0	0.16
SA002A1	8	57	5	<1	79	3.8	0.17	0.13	44.1	0.10
SA002A2	8	57	5	<1	84	3.7	0.15	0.12	44.2	0.10
SA003A1	7	37	4	<1	83	4.1	0.11	0.14	46.3	0.11
SA004A1	16	60	7	<1	136	8.3	0.12	0.12	85.2	0.11
SA005A1	12	47	5	<1	96	6.0	0.12	0.11	56.5	0.11
SA006A1	12	46	3	<1	81	11	0.32	0.09	67.3	0.08
SA007A1	7	74	8	1	63	3.8	0.12	0.10	57.0	0.07
SA032A1	5	117	12	1	65	5.7	0.49	0.13	65.0	0.12
SA040A1	3	35	11	1	74	2.6	0.18	0.11	32.2	0.19
SN080A1	3	104	5	1	47	7.6	0.25	0.10	57.8	0.13
SN080A2	4	104	5	1	49	9.0	0.23	0.09	57.8	0.13
					Control Traverse Sites					
SC0.5A1	6	64	9	1	75	5.1	0.20	0.09	57.9	0.10
SC1.0A1	8	73	12	1	66	6.2	0.34	0.07	66.3	0.11
SC1.5A1	6	62	7	1	57	3.9	0.31	0.09	51.6	0.08
SC3.0A1	6	73	7	1	44	3.9	0.23	0.10	56.2	0.08
SC7.5A1	5	68	9	1	54	3.1	0.28	0.13	48.8	0.11
SC7.5A2	7	68	9	1	54	3.4	0.24	0.12	48.7	0.12
SC008A1	3	73	8	1	62	5.0	0.17	0.12	56.4	0.10
SC016A1	5	70	6	1	117	3.0	0.15	0.09	58.3	0.09
					Meteorological Sites					
SM000A1	5	71	17	1	71	3.8	0.48	0.12	47.6	0.10
SM001A1	7	86	9	1	79	6.9	0.31	0.08	71.6	0.07
SM006A1	6	57	7	<1	67	3.7	0.17	0.13	47.8	0.14
					Nenana River Traverse Sites					
SN000A1	11	65	9	1	79	6.7	0.18	0.08	71.5	0.08
SN0.5A1	7	92	10	1	92	7.5	0.48	0.07	76.5	0.06
SN001A1	5	42	7	1	102	3.2	0.52	0.14	35.1	0.22
SN002A1	11	66	10	1	66	9.6	0.32	0.18	60.2	0.11
SN004A1	10	96	14	2	131	14	0.29	0.28	87.6	<0.05
SN004A2	10	94	14	2	137	14	0.30	0.26	85.7	0.05
SN004B1	6	25	6	1	107	3.1	0.32	0.15	28.9	0.22
SM006A1	6	57	7	<1	67	3.7	0.17	0.13	47.8	0.14
SN008A1	4	32	8	1	82	2.1	0.27	0.11	34.2	0.23
SN016A1	2	27	6	<1	97	1.9	0.31	0.09	20.7	0.17
SN025A1	1	23	3	<1	25	1.5	0.39	0.08	20.8	0.20
SN040A1	2	39	3	<1	69	3.7	0.27	0.14	23.0	0.13

Table 15.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
					Stampede Trail Traverse Sites					
SS0.5A1	11	97	14	1	88	9.8	0.47	0.07	87.8	0.08
SS1.0A1	7	82	11	1	158	6.1	0.33	0.08	63.1	0.11
SS1.5A1	11	100	14	2	108	8.1	0.36	0.08	83.0	0.05
SS2.0A1	11	92	13	2	92	11	0.51	0.08	83.6	0.06
SS004A1	9	60	5	<1	74	6.1	0.13	0.11	67.0	0.08
SS006A1	10	71	8	<1	66	5.3	0.14	0.10	75.4	0.05
SS008A1	10	93	7	1	65	5.5	0.19	0.06	66.6	0.07
SS014A1	3	29	5	1	33	3.9	0.30	0.09	19.2	0.19
SS014A2	3	27	5	<1	33	3.7	0.32	0.09	19.2	0.19
SS016A1	2	19	6	<1	59	1.1	0.18	0.13	14.3	0.20
SS025A1	2	32	2	<1	51	1.4	0.13	0.13	24.4	0.14
SS032A1	4	48	8	1	74	2.4	0.34	0.10	36.8	0.19

Table 16.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Radial Arc Sites					
PA002B1	635023	1490346	<0.01	0.50	<0.01	0.35	0.10	<0.01	0.14	<0.01
PA003A1	635004	1490727	0.02	0.85	0.01	0.57	0.10	<0.01	0.10	<0.01
PA003A2	635004	1490727	0.02	0.81	0.02	0.50	0.10	<0.01	0.09	<0.01
PA003B1	635004	1490727	0.02	0.57	0.01	0.44	0.07	<0.01	0.09	<0.01
PA004A1	634854	1491006	0.03	1.0	0.02	0.44	0.08	<0.01	0.07	<0.01
PA004B1	634854	1491006	0.02	0.74	0.01	0.62	0.09	<0.01	0.12	<0.01
PA005A1	634802	1491202	0.01	0.57	0.01	0.51	0.08	<0.01	0.11	<0.01
PA005B1	634802	1491202	0.01	0.85	0.01	0.58	0.10	<0.01	0.10	<0.01
PA006A1	634706	1491851	0.01	0.68	0.01	0.37	0.07	<0.01	0.09	<0.01
PA006A2	634706	1491851	0.01	0.76	0.01	0.47	0.08	<0.01	0.10	<0.01
PA006B1	634706	1491851	<0.01	0.54	<0.01	0.54	0.09	<0.01	0.14	<0.01
PN080A1	631839	1493323	0.01	0.93	0.01	0.54	0.08	<0.01	0.14	<0.01
PN080B1	631839	1493323	0.01	0.54	0.01	0.38	0.09	<0.01	0.13	<0.01
					Control Traverse Sites					
PC3.0A1	635950	1491135	<0.01	0.40	<0.01	0.35	0.08	<0.01	0.15	<0.01
PC7.5A1	635950	1491753	<0.01	0.57	<0.01	0.36	0.08	<0.01	0.15	<0.01
PC7.5B1	635950	1491753	0.01	0.72	0.01	0.52	0.11	<0.01	0.18	<0.01
PC008A1	640111	1492416	<0.01	0.58	<0.01	0.43	0.09	<0.01	0.14	<0.01
PC008B1	640111	1492416	<0.01	0.63	<0.01	0.39	0.07	<0.01	0.14	<0.01
PC016B1	635934	1492905	<0.01	0.69	<0.01	0.62	0.07	<0.01	0.17	<0.01
					Meteorological Sites					
PM000A1	634326	1485804	0.01	1.2	0.01	0.47	0.09	<0.01	0.10	<0.01
PM000B1	634326	1485804	0.02	1.6	0.01	0.45	0.07	<0.01	0.09	<0.01
					Nenana River Traverse Sites					
PN0.5A1	635109	1485729	0.01	0.78	0.01	0.47	0.09	<0.01	0.12	<0.01
PN0.5C1	635109	1485729	<0.01	0.43	0.01	0.31	0.09	<0.01	0.12	<0.01
PN001A1	635047	1485652	<0.01	0.60	0.01	0.44	0.07	<0.01	0.10	<0.01
PN001B1	635047	1485652	<0.01	0.83	0.01	0.39	0.09	<0.01	0.12	<0.01
PN001B2	635047	1485652	0.01	0.91	0.01	0.47	0.09	<0.01	0.12	<0.01
PN001C1	635047	1485652	<0.01	0.65	0.01	0.38	0.08	<0.01	0.13	<0.01
PN002A1	635028	1485804	<0.01	0.51	0.01	0.55	0.08	<0.01	0.10	<0.01
PN002B1	635028	1485804	0.01	0.58	0.01	0.65	0.07	<0.01	0.11	<0.01
PN002C1	635028	1485804	<0.01	0.55	<0.01	0.48	0.10	<0.01	0.11	<0.01
PN004A1	634942	1490013	<0.01	0.79	0.01	0.59	0.09	<0.01	0.15	<0.01
PN004B1	634942	1490013	0.01	0.77	0.01	0.55	0.09	<0.01	0.11	<0.01
PN004C1	634942	1490013	0.01	0.73	0.01	0.40	0.10	<0.01	0.14	<0.01
PN004C2	634942	1490013	0.01	0.75	0.01	0.38	0.10	<0.01	0.14	<0.01
PN016B1	634258	1485335	0.01	0.51	0.01	0.54	0.07	<0.01	0.16	<0.01
PN016C1	634258	1485335	0.01	0.64	0.01	0.28	0.08	<0.01	0.11	<0.01
PN025A1	633741	1484720	0.01	0.95	0.01	0.45	0.08	<0.01	0.08	<0.01
PN025B1	633741	1484720	0.01	0.91	<0.01	0.41	0.07	<0.01	0.09	<0.01
PN040A1	633030	1484901	0.02	1.2	0.01	0.45	0.08	<0.01	0.11	<0.01
PN040B1	633030	1484901	0.01	0.92	0.01	0.44	0.12	<0.01	0.12	<0.01

Table 16.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Stampede Trail Traverse Sites					
PS032A1	640414	1494727	<0.01	0.67	<0.01	0.39	0.09	<0.01	0.17	<0.01
PS032B1	640414	1494727	<0.01	0.40	<0.01	0.31	0.08	<0.01	0.10	<0.01
					In-house Standard White Spruce					
STD			0.03	0.57	0.02	0.35	0.08	0.03	0.10	<0.01
STD			0.04	0.65	0.02	0.47	0.09	0.03	0.12	<0.01
STD			0.03	0.60	0.02	0.49	0.08	0.03	0.11	<0.01
STD			0.03	0.64	0.02	0.50	0.09	0.03	0.12	<0.01

Table 16.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
Radial Arc Sites										
PA002B1	347	35	<0.1	<0.3	0.2	0.3	2.3	0.6	<0.1	<0.1
PA003A1	356	53	<0.2	0.4	0.2	0.4	2.4	0.4	0.2	0.4
PA003A2	341	54	<0.2	0.3	0.2	0.8	2.3	0.4	0.2	0.4
PA003B1	295	60	<0.1	0.6	0.2	0.7	2.3	0.3	0.3	0.2
PA004A1	151	98	<0.2	0.4	0.4	0.3	2.3	<0.4	0.4	<0.2
PA004B1	175	39	<0.2	0.4	0.2	0.4	3.0	<0.3	0.2	0.2
PA005A1	220	27	<0.1	<0.2	0.2	0.6	2.7	<0.2	0.2	0.2
PA005B1	427	47	<0.2	<0.3	0.3	0.5	3.2	0.4	<0.2	0.3
PA006A1	338	41	<0.1	<0.3	0.3	0.3	2.6	0.3	<0.1	0.3
PA006A2	338	51	<0.2	<0.3	0.3	0.4	2.9	0.4	<0.2	0.3
PA006B1	571	21	<0.1	<0.3	0.2	0.3	2.9	0.6	<0.1	0.1
PN080A1	372	89	<0.2	<0.3	0.3	0.4	3.2	0.4	<0.2	0.2
PN080B1	792	38	<0.1	<0.3	0.2	0.3	3.5	0.8	<0.1	<0.1
Control Traverse Sites										
PC3.0A1	240	25	<0.1	<0.2	0.1	0.3	2.4	0.3	<0.1	<0.1
PC7.5A1	273	51	<0.1	<0.2	0.2	0.2	2.7	0.3	<0.1	<0.1
PC7.5B1	344	45	<0.1	<0.3	0.2	0.3	2.4	<0.3	<0.1	<0.1
PC008A1	289	43	<0.1	<0.2	0.2	0.2	3.8	0.3	<0.1	<0.1
PC008B1	393	24	<0.1	<0.2	0.1	0.2	2.4	0.6	<0.1	<0.1
PC016B1	401	88	<0.2	<0.3	0.3	0.3	2.0	0.4	<0.2	0.2
Meteorological Sites										
PM000A1	513	144	<0.2	<0.4	0.2	0.5	1.6	0.5	<0.2	<0.2
PM000B1	443	189	<0.2	<0.5	0.4	0.5	1.5	0.5	<0.2	<0.2
Nenana River Traverse Sites										
PN0.5A1	247	74	<0.2	<0.3	0.2	0.3	1.8	<0.3	<0.2	0.2
PN0.5C1	240	41	<0.1	<0.2	0.1	0.2	2.2	0.2	<0.1	0.1
PN001A1	113	50	<0.1	<0.3	0.2	0.3	2.9	<0.3	<0.1	0.3
PN001B1	357	116	<0.2	<0.3	0.3	0.3	2.9	0.3	<0.2	0.2
PN001B2	375	82	<0.2	<0.3	0.3	0.4	3.2	0.4	<0.2	<0.2
PN001C1	217	58	<0.1	<0.3	0.2	0.7	2.8	<0.3	<0.1	<0.1
PN002A1	312	27	<0.1	<0.3	0.1	0.3	2.4	0.3	<0.1	0.1
PN002B1	690	30	<0.2	<0.3	0.2	0.4	3.4	0.8	<0.2	<0.2
PN002C1	185	44	<0.1	<0.3	0.2	0.3	2.9	0.3	<0.1	0.2
PN004A1	130	67	<0.2	<0.3	0.2	0.3	3.3	<0.3	<0.2	<0.2
PN004B1	474	19	<0.2	<0.3	0.2	0.3	3.3	0.4	<0.2	0.2
PN004C1	404	40	<0.2	<0.3	0.2	0.4	3.4	0.4	<0.2	<0.2
PN004C2	361	36	<0.2	<0.3	0.2	0.3	3.3	0.4	<0.2	<0.2
PN016B1	119	66	<0.1	0.2	0.2	0.3	7.5	<0.2	<0.1	<0.1
PN016C1	406	41	<0.1	<0.2	0.2	0.3	2.6	0.6	<0.1	<0.1
PN025A1	210	78	<0.2	<0.3	0.2	0.4	2.2	<0.3	0.3	0.2
PN025B1	310	95	<0.2	<0.3	0.2	0.4	1.3	0.3	<0.2	0.4
PN040A1	302	48	<0.2	<0.4	0.2	0.5	2.5	<0.4	<0.2	0.3
PN040B1	379	109	<0.2	<0.4	0.3	0.4	2.1	0.4	<0.2	0.2

Table 16.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
					Stampede Trail Traverse Sites					
PS032A1	141	64	<0.1	<0.3	0.2	0.4	2.4	<0.3	<0.1	<0.1
PS032B1	102	33	<0.1	<0.2	0.1	0.2	1.9	<0.2	<0.1	<0.1
					In-house White Spruce Standard					
STD	441	27	0.3	<0.3	0.2	2.1	2.6	0.6	<0.1	0.2
STD	543	34	0.3	0.3	0.2	2.8	2.9	0.4	0.1	0.3
STD	492	30	0.3	<0.3	0.2	2.4	2.8	0.7	<0.1	0.2
STD	531	34	0.3	0.3	0.3	2.2	2.9	0.4	<0.1	0.3

Table 16.--Chemical analyses for *Picea glauca* (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample Id	Nd, ppm	Ni, ppm	Pb, ppm	Sr, ppm	Th, ppm	V, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm
					Radial Arc Sites					
PA002B1	0.2	2.4	<0.3	21	<0.3	<0.1	41	<0.05	<0.03	<0.02
PA003A1	0.8	1.1	<0.3	32	<0.3	0.2	69	<0.05	<0.03	0.03
PA003A2	0.4	1.1	<0.3	30	<0.3	0.3	66	<0.05	<0.03	0.03
PA003B1	0.3	0.6	<0.3	29	<0.3	0.2	75	<0.05	<0.03	0.02
PA004A1	1.2	1.7	<0.4	53	0.4	0.4	84	<0.05	<0.03	0.03
PA004B1	0.8	2.0	<0.3	43	<0.3	0.2	70	<0.05	<0.03	0.04
PA005A1	<0.2	3.0	<0.2	15	<0.2	0.2	60	<0.05	<0.03	0.03
PA005B1	0.4	1.3	<0.3	36	<0.3	0.2	74	<0.05	<0.03	0.02
PA006A1	0.3	1.4	<0.3	32	<0.3	<0.1	57	<0.05	<0.03	<0.02
PA006A2	0.3	1.6	<0.3	36	<0.3	<0.2	65	<0.05	<0.03	0.03
PA006B1	<0.3	1.7	<0.3	19	<0.3	<0.1	54	<0.05	<0.03	0.02
PN080A1	0.4	0.8	<0.3	85	<0.3	<0.2	93	<0.05	<0.03	0.03
PN080B1	0.3	1.3	<0.3	28	<0.4	<0.1	67	<0.05	<0.03	0.03
					Control Traverse Sites					
PC3.0A1	<0.2	0.9	<0.2	20	<0.2	<0.1	32	<0.05	<0.03	0.03
PC7.5A1	0.3	1.0	<0.2	24	<0.2	<0.1	39	0.33	<0.03	0.05
PC7.5B1	<0.3	1.1	<0.3	19	<0.3	<0.1	55	<0.05	<0.03	0.04
PC008A1	<0.2	1.0	<0.2	25	<0.2	<0.1	52	<0.05	<0.03	0.03
PC008B1	0.3	0.3	<0.2	17	<0.2	<0.1	42	<0.05	<0.03	0.02
PC016B1	0.3	1.7	<0.3	29	<0.2	<0.2	51	<0.05	<0.03	0.03
					Meteorological Sites					
PM000A1	0.9	0.5	<0.4	51	0.4	0.2	65	<0.05	<0.03	0.05
PM000B1	0.6	1.2	<0.5	59	<0.5	0.4	57	<0.05	<0.03	0.03
					Nenana River Traverse Sites					
PN0.5A1	0.4	0.9	<0.3	47	<0.3	<0.2	38	<0.05	<0.03	0.04
PN0.5C1	0.2	1.6	<0.2	26	<0.2	0.1	82	<0.05	<0.03	0.03
PN001A1	0.3	0.7	<0.3	47	<0.3	<0.1	63	0.10	<0.03	0.02
PN001B1	0.4	0.8	<0.3	41	<0.3	<0.2	34	0.65	<0.03	0.03
PN001B2	0.4	0.9	<0.3	43	<0.3	<0.2	35	<0.05	<0.03	<0.02
PN001C1	0.3	1.1	<0.3	34	0.3	<0.1	34	<0.05	<0.03	0.03
PN002A1	0.3	0.7	<0.3	16	<0.3	<0.1	41	<0.05	<0.03	0.03
PN002B1	<0.3	1.4	<0.3	20	<0.3	<0.2	51	<0.05	<0.03	0.02
PN002C1	0.3	1.8	<0.3	26	<0.3	<0.1	79	<0.05	<0.03	0.02
PN004A1	0.4	2.4	<0.3	46	<0.3	<0.2	75	<0.05	<0.03	0.03
PN004B1	0.7	1.9	<0.3	58	<0.3	0.2	62	<0.05	<0.03	0.04
PN004C1	0.4	1.5	<0.3	18	<0.3	<0.2	70	<0.05	<0.03	<0.02
PN004C2	0.4	1.4	<0.3	18	<0.3	<0.2	71	<0.05	<0.03	0.03
PN016B1	<0.2	0.6	<0.2	22	<0.2	<0.1	42	<0.05	<0.03	0.02
PN016C1	0.6	0.2	0.2	28	0.3	0.1	75	<0.05	<0.03	0.03
PN025A1	0.4	0.3	<0.3	62	<0.3	0.2	54	<0.05	<0.03	0.04
PN025B1	0.4	0.3	<0.3	41	<0.3	<0.2	78	<0.05	<0.03	0.05
PN040A1	1.0	1.0	0.5	40	<0.4	0.3	67	<0.05	<0.03	0.03
PN040B1	0.4	1.8	<0.4	48	<0.4	0.3	65	<0.05	<0.03	0.02

Table 16.--Chemical analyses for *Picea glauca* (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample Id	Nd, ppm	Ni, ppm	Pb, ppm	Sr, ppm	Th, ppm	V, ppm	Zn, ppm	As, ppm	Se, ppm	Hg, ppm
					Stampede Trail Traverse Sites					
PS032A1	0.4	0.7	<0.3	33	<0.3	<0.1	71	<0.05	<0.03	0.02
PS032B1	0.2	0.5	<0.2	26	<0.2	<0.1	55	<0.05	<0.03	0.04
					In-House White Spruce Standard					
STD	0.3	0.6	6.3	27	<0.3	0.6	44	<0.05	4.0	0.04
STD	<0.3	0.8	6.5	31	<0.3	0.7	54	<0.05	1.8	0.03
STD	0.4	0.7	7.7	30	<0.3	0.7	49	<0.05	3.5	0.04
STD	0.4	0.8	7.1	31	<0.3	0.7	53	<0.05	3.1	0.02

Table 16.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Ash, %	Total S, %
Radial Arc Sites		
PA002B1	3.15	0.08
PA003A1	4.05	0.05
PA003A2	3.88	0.07
PA003B1	3.14	0.07
PA004A1	4.44	0.06
PA004B1	3.90	0.09
PA005A1	3.02	0.07
PA005B1	3.88	0.09
PA006A1	3.38	0.08
PA006A2	3.63	0.08
PA006B1	3.17	0.09
PN080A1	3.88	0.08
PN080B1	3.17	0.09
Control Traverse Sites		
PC3.0A1	2.89	0.08
PC7.5A1	3.00	0.08
PC7.5B1	3.44	0.08
PC008A1	2.89	0.08
PC008B1	3.02	0.07
PC016B1	3.65	0.07
Meteorological Sites		
PM000A1	4.66	0.06
PM000B1	5.91	0.08
Nenana River Traverse Sites		
PN0.5A1	3.92	0.07
PN0.5C1	2.40	0.08
PN001A1	3.15	0.06
PN001B1	4.15	0.08
PN001B2	4.31	0.07
PN001C1	3.44	0.08
PN002A1	3.43	0.09
PN002B1	3.63	0.09
PN002C1	3.42	0.08
PN004A1	4.18	0.08
PN004B1	3.65	0.08
PN004C1	3.67	0.09
PN004C2	3.76	0.09
PN016B1	2.98	0.08
PN016C1	2.90	0.09
PN025A1	4.12	0.07
PN025B1	4.31	0.06
PN040A1	4.79	0.06
PN040B1	4.36	0.07

Table 16.--Chemical analyses for *Picea glauca* (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

Sample ID	Ash, %	Total S, %
Stampede Trail Traverse Sites		
PS032A1	3.53	0.08
PS032B1	2.38	0.08
In-house White Spruce Standard		
STD	3.15	0.07
STD	3.62	0.08
STD	3.52	0.07
STD	3.54	0.07

Table 17.--Observed baseline range for element concentrations and ash yield for Hylocomium splendens, Denali National Park and Preserve, Alaska (dry-weight basis). Data based on samples collected >6 Km from GVEA.

Variable, Unit of Measure	Denali Observed Baseline (n=45)			Kenai Peninsula, Alaska (Severson and others, 1990) Calculated Baseline (n=21)			Wrangell-Saint Elias, Alaska Observed Baseline (n=67)		
Al, %	0.064	-	0.78	0.11	-	1.2	0.38	-	3.5
Ca, %	0.60	-	1.1	0.35	-	1.3	0.53	-	2.0
Fe, %	0.048	-	0.53	0.060	-	0.53	0.19	-	1.8
K, %	0.15	-	0.54	0.30	-	0.56	0.22	-	0.63
Mg, %	0.15	-	0.28	0.085	-	0.31	0.16	-	0.99
Na, %	0.033	-	0.16	0.040	-	0.43	0.12	-	1.1
P, %	0.069	-	0.17	0.080	-	0.12	0.065	-	0.082
Ti, %	0.003	-	0.035	0.005	-	0.057	0.016	-	0.21
Mn, ppm	56	-	1300	190	-	1000	100	-	750
Ba, ppm	13	-	230	21	-	230	41	-	200
Cd, ppm	<0.1	-	0.7						
Ce, ppm	0.4	-	18	0.5	-	3.8	1.4	-	13
Co, ppm	0.4	-	2.5	0.4	-	2.7	1.3	-	10
Cr, ppm	0.9	-	16	1.4	-	8.1	3.9	-	38
Cu, ppm	9	-	25	3.0	-	6.9	5.5	-	23
Ga, ppm	0.3	-	2.2	0.4	-	2.2	0.9	-	7.9
La, ppm	0.3	-	10	0.6	-	2.6	0.6	-	7.5
Li, ppm	0.3	-	5.0	0.4	-	2.2	0.6	-	4.5
Mo, ppm	0.7	-	2.8				<0.3	-	1.6
Nd, ppm	0.4	-	8.2	0.5	-	3.3	0.6	-	7.5
Ni, ppm	1.1	-	9.5	1.0	-	3.7	2.5	-	25
Pb, ppm	0.7	-	4.7	0.6	-	7.0	<0.6	-	3.2
Sc, ppm	<0.2	-	1.3	0.2	-	1.9	0.6	-	7.9
Sr, ppm	37	-	82	18	-	110	41	-	250
Th, ppm	<0.3	-	2.8						
V, ppm	1.1	-	20	1.7	-	17	6.0	-	59
Y, ppm	0.2	-	2.5	0.3	-	2.9	0.6	-	7.5
Zn, ppm	22	-	81	16	-	77	24	-	60
As, ppm	0.1	-	5.6	0.05	-	0.36			
Se, ppm	<0.03	-	0.62	<0.03	-	0.18			
Hg, ppm	<0.02	-	0.13	0.04	-	0.17	0.04	-	0.12
Ash, %	3.36	-	12.6	3.39	-	16.3	6.46	-	39.5
Total S, %	0.05	-	0.10	0.05	-	0.10	0.05	-	0.08

Table 18.--Observed baseline range for element concentrations and ash yield for Peltigera aphthosa, Denali National Park and Preserve, Alaska (dry-weight basis). Data based on samples collected >6 Km from GVEA.

Variable, Unit of Measure	Denali Observed Baseline (n=45)	Wrangell-Saint Elias, Alaska Observed Baseline (n=67)
Al, %	0.022 - 0.24	0.19 - 0.72
Ca, %	0.17 - 0.66	0.27 - 0.66
Fe, %	0.014 - 0.19	0.10 - 0.41
K, %	0.18 - 0.95	0.49 - 0.76
Mg, %	0.058 - 0.20	0.11 - 0.25
Na, %	0.012 - 0.045	0.06 - 0.23
P, %	0.099 - 0.37	0.09 - 0.20
Ti, %	0.0003 - 0.0077	0.0073 - 0.040
Mn, ppm	32 - 490	50 - 290
Ba, ppm	9 - 49	19 - 60
Cd, ppm	<0.1 - 0.4	
Ce, ppm	<0.2 - 7.3	0.8 - 3.1
Co, ppm	0.2 - 2.0	0.6 - 2.4
Cr, ppm	0.4 - 3.6	1.6 - 6.7
Cu, ppm	5 - 18	5 - 11
Ga, ppm	<0.2 - 0.7	0.4 - 1.7
La, ppm	<0.1 - 4.1	0.6 - 2.0
Li, ppm	<0.1 - 1.0	0.4 - 1.2
Mo, ppm	<0.2 - 1.5	<0.2 - 0.9
Nd, ppm	<0.2 - 3.5	0.4 - 2.0
Ni, ppm	0.6 - 5.9	1.3 - 6.8
Pb, ppm	0.2 - 3.3	0.4 - 1.1
Sc, ppm	<0.1 - 0.4	0.4 - 1.5
Sr, ppm	11 - 38	19 - 53
Th, ppm	<0.2 - 1.5	
V, ppm	0.4 - 3.9	3.1 - 12
Y, ppm	<0.1 - 0.8	0.4 - 1.7
Zn, ppm	20 - 95	21 - 50
As, ppm	<0.05 - 0.38	
Se, ppm	<0.03 - 0.07	
Hg, ppm	<0.02 - 0.12	0.04 - 0.12
Ash, %	2.02 - 7.29	3.75 - 10.0
Total S, %	0.08 - 0.14	0.06 - 0.11

Table 19.--Observed baseline range for element concentrations and ash yield for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (dry-weight basis). Data based on samples collected >6 Km from GVEA.

Variable, Unit of Measure	Denali Observed Baseline (n=23)			Kenai Peninsula, Alaska (Severson and others, 1990) Calculated Baseline (n=21)			Wrangell-Saint Elias, Alaska Observed Baseline (n=67)		
Al, %	0.0002	-	0.027	0.0066	-	0.066	0.013	-	0.099
Ca, %	0.41	-	1.2	0.37	-	0.95	0.45	-	1.1
Fe, %	0.0026	-	0.020	0.0039	-	0.033	0.0054	-	0.059
K, %	0.28	-	0.62	0.30	-	0.87	0.26	-	0.77
Mg, %	0.069	-	0.12	0.068	-	0.15	0.063	-	0.13
Na, %	0.0006	-	0.0048	0.0030	-	0.034	0.0054	-	0.035
P, %	0.071	-	0.18	0.10	-	0.23	0.046	-	0.18
Ti, %	<0.0002	-	0.0009	<0.0002	-	0.0036	0.0005	-	0.0079
Mn, ppm	100	-	570	160	-	960	61	-	1100
Ba, ppm	21	-	110	7	-	29	7	-	130
Ce, ppm	<0.2	-	0.6	0.2	-	0.3	<0.2	-	0.4
Co, ppm	0.1	-	0.4	0.1	-	0.4	0.1	-	0.4
Cr, ppm	0.2	-	0.8	0.2	-	1.2	0.3	-	2.6
Cu, ppm	1.3	-	7.5	1.9	-	4.0	1.6	-	2.9
Ga, ppm	<0.2	-	0.6	0.1	-	0.4	<0.3	-	1.4
La, ppm	<0.1	-	0.4	0.2	-	0.4	<0.1	-	0.3
Li, ppm	<0.1	-	0.4	0.1	-	0.3	<0.1	-	0.8
Nd, ppm	<0.2	-	1.2	0.1	-	0.5			
Ni, ppm	0.2	-	3.0	0.4	-	2.3	0.3	-	1.8
Sr, ppm	15	-	62	18	-	84	18	-	77
V, ppm	<0.1	-	0.4	0.1	-	0.9	0.2	-	2.2
Zn, ppm	39	-	84	20	-	79	36	-	100
Hg, ppm	<0.02	-	0.05	<0.02	-	0.05	<0.02	-	0.07
Ash, %	2.38	-	4.79	2.95	-	4.81	2.48	-	5.52
Total S, %	0.05	-	0.09	0.05	-	0.09	<0.05	-	0.08

Table 20.--Observed baseline range for element concentrations and ash yield for Oa-Horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis). Data based on samples collected >6 Km from GVEA.

Variable, Unit of Measure	Denali Observed Baseline (n=21)	Kenai Peninsula, Alaska (Severson and others, 1990) Calculated Baseline (n=21)	Wrangell-Saint Elias, Alaska Observed Baseline (n=35)
Al, %	1.2 - 6.0	0.13 - 3.0	2.2 - 7.3
Ca, %	0.24 - 3.2	0.10 - 1.3	1.5 - 3.9
Fe, %	0.73 - 4.0	0.060 - 1.4	0.94 - 3.5
K, %	0.27 - 2.2	0.032 - 0.47	0.31 - 1.1
Mg, %	0.15 - 0.65	0.024 - 0.45	0.44 - 1.8
Na, %	0.13 - 0.78	0.043 - 1.0	0.68 - 2.4
P, %	0.053 - 0.18	0.019 - 0.095	0.045 - 0.10
Ti, %	0.034 - 0.33	0.007 - 0.18	0.081 - 0.43
Mn, ppm	69 - 2400	30 - 1000	150 - 1200
Ba, ppm	21 - 1700.	25 - 350	140 510
Be, ppm	0.2 - 1.7		
Cd, ppm	<0.4 - 1.7		
Ce, ppm	9 - 85	0.6 - 12	7.9 - 26
Co, ppm	5 - 19	0.3 - 6.0	4.7 - 22
Cr, ppm	14 - 85	1.2 - 21	15 - 67
Cu, ppm	10 - 42	1.3 - 11	18 - 52
Ga, ppm	3 - 16	0.3 - 8.4	4.2 - 15
La, ppm	5 - 47	0.4 - 7.5	4.7 - 16
Li, ppm	4 - 23	0.3 - 6.7	3.7 - 102
Mo, ppm	<0.5 - 4.2		
Nb, ppm	<0.8 - 7.2		
Nd, ppm	6 - 37	0.3 - 8.6	5.2 - 17
Ni, ppm	10 - 37	0.6 - 7.9	9.4 - 41
Pb, ppm	3.5 - 20	0.7 - 4.0	2.1 - 31
Sc, ppm	2.7 - 11	0.3 - 5.8	3.4 - 13
Sr, ppm	36 - 190	10 - 150	162 - 490
Th, ppm	1.5 - 16		
V, ppm	19 - 120	2.1 - 43	32 - 120
Y, ppm	2.2 - 12	0.3 - 7.1	4.7 - 15
Yb, ppm	<0.2 - 1.3		<0.5 - 1.8
Zn, ppm	25 - 140	4 - 47	13 - 240
As, ppm	1.1 - 11	0.3 - 1.5	<5 - 50
Se, ppm	0.11 - 0.49	0.09 - 0.40	
Hg, ppm	0.06 - 0.14	0.10 - 0.34	0.02 - 0.10
Ash, %	14.3 - 85.2	14.1 - 65.7	52.4 - 88.6
Total S, %	0.07 - 0.23	0.07 - 0.18	<0.05 - 1.55

Table 21. Baseline data for element concentrations in samples of surficial materials from Alaska (Gough and others, 1988c).

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 22.--Distance, plot, and procedural variance for element concentrations and ash yield for Peltigera aphthosa, Control Traverse and the Stampede Trail Traverse, Denali National Park and Preserve, Alaska ($\log_{10}$ dry-weight basis).

Variable, Unit of Measure	Control Traverse: Total Log10 Variance	Control Traverse: Percentage of Variance: Distance	Plot	Procedural	Stampede Trail Traverse: Total Log10 Variance	Stampede Trail Traverse: Percentage of Variance: Distance	Plot	Procedural
Al, %	0.0766	90.1	9.9	0.1	0.139	94.6	4.3	1.1
Ca, %	0.0056	70.6	19.5	9.9	0.0367	86.5	9.7	3.9
Fe, %	0.0794	91.1	8.8	0.1	0.140	94.7	4.0	1.3
K, %	0.0180	3.3	95.9	0.9	0.0112	26.3	0.0	73.7
Mg, %	0.0035	65.5	24.3	10.2	0.0202	75.0	18.2	6.8
Na, %	0.0235	82.3	17.2	0.6	0.0378	81.2	14.4	4.4
P, %	0.0111	65.2	29.3	5.6	0.0156	60.8	19.4	19.8
Ti, %	0.225	90.8	7.5	1.8	0.258	88.5	10.2	1.2
Mn, ppm	0.0149	72.3	26.1	1.6	0.0372	10.4	84.0	5.6
Ba, ppm	0.0282	67.0	0.0	33.0	0.0411	75.7	17.6	6.6
Cd, ppm	0.0279	64.8	25.5	9.7	0.0420	84.7	10.6	4.8
Ce, ppm	0.0707	79.4	19.6	1.0	0.146	91.5	3.3	5.2
Co, ppm	0.0472	74.2	25.7	0.1	0.116	78.9	9.2	11.2
Cr, ppm	0.0609	88.1	4.7	7.2	0.150	93.0	5.1	1.8
Cu, ppm	0.0171	86.1	10.7	3.2	0.0184	75.6	22.6	1.8
Ga, ppm	0.0267	14.9	0.0	85.1	0.104	84.2	4.2	11.6
La, ppm	0.0887	88.8	8.5	2.7	0.131	88.8	0.0	11.2
Li, ppm	0.0456	77.5	20.2	2.4	0.150	96.3	3.2	0.5
Mo, ppm	0.0072	25.6	73.7	0.7	0.0437	47.4	36.4	16.2
Nd, ppm	0.0725	68.7	0.0	31.3	0.127	77.3	13.4	9.4
Ni, ppm	0.0300	73.2	25.3	1.6	0.0887	87.2	11.0	1.8
Pb, ppm	0.0274	81.5	12.5	6.0	0.0721	86.5	0.6	12.4
Sc, ppm	0.0500	79.1	0.0	21.0	0.146	92.3	6.2	1.5
Sr, ppm	0.0074	77.8	18.1	4.1	0.0631	92.1	5.1	2.8
Th, ppm	0.0326	30.4	0.0	69.6	0.0437	53.1	43.2	3.7
V, ppm	0.0825	94.1	3.8	2.1	0.185	96.2	3.3	0.5
Y, ppm	0.0674	77.9	6.6	15.5	0.168	89.9	8.6	1.5
Yb, ppm	0.0291	21.9	0.0	78.1	0.0418	90.9	7.0	2.0
Zn, ppm	0.0206	84.4	13.9	1.7	0.0082	31.1	54.8	14.1
As, ppm	0.0504	90.3	0.6	9.0	0.149	91.8	3.7	4.5
Se, ppm	0.0225	45.0	0.0	55.0	0.153	96.8	0.6	2.7
Hg, ppm	0.181	66.2	21.3	12.5	0.177	11.7	0.0	88.3
Ash, %	0.0084	90.9	8.5	0.6	0.0296	87.2	9.9	2.9
Total S, %	0.0092	72.3	0.0	27.7	0.0117	67.3	20.5	12.2

Table 23.--Distance, plot, and procedural variance for element concentrations and ash yield for Peltigera aphthosa, Nenana River Traverse and the Dry Creek Traverse, Denali National Park and Preserve, Alaska (log_{10} dry-weight basis).

	Nenana River Traverse				Dry Creek Traverse			
Variable, Unit of Measure	Total Log10 Variance	Percentage of Variance			Total Log10 Variance	Percentage of Variance		
		Distance	Plot	Procedural		Distance	Plot	Procedural
Al, %	0.0574	83.5	13.6	2.9	0.0711	72.3	28.7	0.0
Ca, %	0.0062	52.7	28.3	19.5	0.0192	56.0	43.5	0.5
Fe, %	0.0637	85.3	11.5	3.3	0.0958	80.7	19.3	0.1
K, %	0.0089	46.8	51.4	1.8	0.0148	0.0	84.6	15.4
Mg, %	0.0059	66.6	0.0	33.4	0.0151	49.2	50.0	0.8
Na, %	0.0146	65.2	22.6	8.7	0.0396	73.6	26.3	0.1
P, %	0.0112	16.8	54.8	28.4	0.0179	7.1	92.6	0.4
Ti, %	0.0916	58.2	40.8	1.1	0.141	69.0	28.2	2.8
Mn, ppm	0.0372	35.0	56.8	8.2	0.0735	54.4	45.6	0.0
Ba, ppm	0.0143	0.1	0.0	99.9	0.0515	57.2	0.0	42.8
Cd, ppm	0.0227	54.0	41.6	4.3	0.0515	76.9	22.7	0.4
Ce, ppm	0.119	79.8	20.1	0.0	0.116	73.8	14.9	11.3
Co, ppm	0.0704	76.0	22.6	1.4	0.0898	64.2	35.6	0.2
Cr, ppm	0.0683	85.0	13.0	2.0	0.0842	83.1	15.6	1.2
Cu, ppm	0.0123	37.8	59.4	2.9	0.0135	61.6	35.3	3.1
Ga, ppm	0.0346	65.5	34.5	0.0	0.0675	60.0	0.0	40.0
La, ppm	0.110	91.1	8.0	0.9	0.0933	78.6	21.2	0.2
Li, ppm	0.0615	79.9	18.5	1.6	0.0843	55.1	43.3	1.6
Mo, ppm	0.0233	49.5	46.3	4.2	0.0223	51.8	44.0	4.2
Nd, ppm	0.0691	52.3	0.0	47.7	0.0865	54.7	44.8	0.5
Ni, ppm	0.0481	92.6	5.3	2.0	0.0613	77.6	22.1	0.3
Pb, ppm	0.0411	55.5	36.1	8.4	0.0467	74.7	24.7	0.5
Sc, ppm	0.0521	71.0	27.1	1.9	0.0801	66.1	33.7	0.2
Sr, ppm	0.0128	73.7	13.7	12.7	0.0290	78.5	21.3	0.2
Th, ppm	0.0153	84.4	9.2	6.4	0.0594	82.7	13.3	4.0
V, ppm	0.0643	85.7	14.3	0.1	0.107	84.4	15.4	0.2
Y, ppm	0.0645	80.4	18.1	1.5	0.0978	88.7	3.6	7.7
Yb, ppm	0.0119	82.2	9.6	8.2	0.0237	71.9	27.3	0.8
Zn, ppm	0.0159	47.0	53.0	0.0	0.0160	60.9	34.5	4.7
As, ppm	0.0617	71.8	27.6	0.6	0.0867	71.1	28.4	0.5
Se, ppm	0.0387	64.6	7.8	27.6	0.107	90.7	2.1	7.3
Hg, ppm	0.0808	43.3	37.5	19.2	0.0259	12.4	0.0	87.6
Ash, %	0.0128	87.9	4.5	7.7	0.0237	71.9	27.3	0.8
Total S, %	0.0084	67.5	12.4	20.1	0.0037	29.5	56.6	13.9

Table 24.--Distance, plot, and procedural variance for element concentrations and ash yield for Hylocomium splendens, Control Traverse and Stampede Trail Traverse, Denali National Park and Preserve, Alaska (log_{10} dry-weight basis).

	Control Traverse				Stampede Trail Traverse			
Variable, Unit of Measure	Total Log10 Variance	Percentage of Variance			Total Log10 Variance	Percentage of Variance		
		Distance	Plot	Procedural		Distance	Plot	Procedural
Al, %	0.156	92.7	7.1	0.2	0.205	91.5	8.3	0.2
Ca, %	0.0051	64.3	33.4	2.3	0.0273	89.6	8.8	1.5
Fe, %	0.171	94.5	5.4	0.1	0.204	93.8	6.1	0.1
K, %	0.0184	69.0	29.9	1.2	0.0366	84.8	14.4	0.8
Mg, %	0.0066	64.7	34.0	1.3	0.302	84.7	14.1	1.1
Na, %	0.0683	94.4	5.5	0.1	0.100	87.2	12.4	0.5
P, %	0.0049	0.0	99.9	0.1	0.0060	0.0	94.6	5.4
Ti, %	0.235	93.0	7.0	0.0	0.301	93.6	6.2	0.2
Mn, ppm	0.0101	34.5	59.2	2.4	0.045	2.7	96.7	0.5
Ba, ppm	0.211	94.5	3.4	2.1	0.318	92.9	3.9	3.2
Cd, ppm	0.0513	75.5	24.3	0.2	0.883	86.9	11.6	1.5
Ce, ppm	0.174	94.4	3.9	1.7	0.246	92.6	6.9	0.5
Co, ppm	0.140	84.4	15.5	0.0	0.150	86.0	13.7	0.3
Cr, ppm	0.175	84.7	0.2	15.1	0.203	92.3	1.6	6.0
Cu, ppm	0.0073	47.9	50.9	1.1	0.0263	56.4	42.7	0.9
Ga, ppm	0.118	82.4	17.5	0.1	0.152	83.6	9.4	7.0
La, ppm	0.198	94.7	3.9	1.4	0.227	93.9	2.6	0.5
Li, ppm	0.197	85.9	14.0	0.0	0.227	90.8	9.0	0.2
Mo, ppm	0.0318	79.3	20.7	0.0	0.0311	51.6	32.4	15.9
Nd, ppm	0.140	88.1	11.7	0.3	0.208	93.2	2.4	4.5
Ni, ppm	0.0924	89.9	8.6	1.5	0.139	91.6	8.1	0.3
Pb, ppm	0.0850	84.2	13.4	2.4	0.136	92.9	6.1	1.0
Sc, ppm	0.159	88.7	11.3	0.1	0.288	92.8	7.1	0.1
Sr, ppm	0.0081	56.9	42.1	1.0	0.0589	93.8	5.8	0.4
Th, ppm	0.0917	77.3	22.6	0.1	0.176	78.2	15.2	6.6
V, ppm	0.181	93.9	6.0	0.1	0.268	94.0	5.8	0.2
Y, ppm	0.139	86.0	13.9	0.1	0.277	94.7	5.2	0.1
Zn, ppm	0.0288	83.2	16.5	0.3	0.0223	46.7	50.9	2.4
As, ppm	0.202	44.7	54.6	0.8	0.242	82.4	29.5	8.0
Se, ppm	0.0899	28.3	71.7	0.0	0.158	62.9	35.0	2.1
Hg, ppm	0.0091	0.0	75.5	24.5	0.0136	24.9	36.7	38.4
Ash, %	0.0621	93.4	6.5	0.1	0.109	91.9	7.8	0.2
Total S, %	0.0069	38.9	61.1	0.0	0.0148	63.0	28.8	8.2

Table 25.--Distance, plot, and procedural variance for element concentrations and ash yield for Hylocomium spendens, Nenana River Traverse and the Dry Creek Traverse, Denali National Park and Preserve, Alaska (log_{10} dry-weight basis).

Variable, Unit of Measure	Nenana River Traverse: Total Log10 Variance	Nenana River Traverse: Percentage of Variance: Distance	Nenana River Traverse: Percentage of Variance: Plot	Nenana River Traverse: Percentage of Variance: Procedural	Dry Creek Traverse: Total Log10 Variance	Dry Creek Traverse: Percentage of Variance: Distance	Dry Creek Traverse: Percentage of Variance: Plot
Al, %	0.0757	92.0	7.1	0.9	0.117	73.6	26.4
Ca, %	0.0030	45.8	48.8	5.4	0.0258	87.3	12.7
Fe, %	0.0788	92.4	6.7	0.9	0.133	83.0	27.0
K, %	0.0194	80.7	18.0	1.3	0.0184	70.6	29.4
Mg, %	0.0078	78.7	18.8	2.5	0.0341	83.8	16.2
Na, %	0.0256	78.7	18.2	3.1	0.116	88.1	11.9
P, %	0.0134	68.4	30.0	1.6	0.0068	0.0	100.0
Ti, %	0.0706	86.1	12.8	1.1	0.250	85.6	14.4
Mn, ppm	0.0609	29.9	69.9	0.2	0.0732	73.2	26.8
Ba, ppm	0.0857	87.3	10.6	2.1	0.148	86.2	13.8
Cd, ppm	0.0243	84.6	13.5	1.9			
Ce, ppm	0.165	86.6	0.0	13.4	0.134	70.2	29.8
Co, ppm	0.0994	89.8	9.8	0.4	0.121	82.6	17.4
Cr, ppm	0.0973	95.1	3.1	1.9	0.134	81.1	18.5
Cu, ppm	0.0211	58.4	40.9	1.1	0.0169	10.2	89.8
Ga, ppm	0.0830	86.4	13.2	0.4	0.0855	47.6	52.4
La, ppm	0.168	88.7	10.9	0.4	0.132	70.1	29.9
Li, ppm	0.0975	92.6	7.1	0.4	0.125	83.0	27.0
Mo, ppm	0.0295	50.9	0.0	49.1	0.0313	61.9	38.1
Nd, ppm	0.109	87.0	0.0	13.0	0.122	70.1	29.6
Ni, ppm	0.0891	93.4	4.5	2.2	0.102	82.2	17.8
Pb, ppm	0.0536	76.8	19.9	3.3	0.0400	80.5	19.5
Sc, ppm	0.0613	91.9	7.5	0.6	0.172	72.5	27.5
Sr, ppm	0.0101	79.1	18.5	2.4	0.0462	93.2	6.8
Th, ppm	0.0841	88.8	10.8	0.4	0.131	32.4	67.6
V, ppm	0.0753	93.3	5.3	1.4	0.190	84.4	15.6
Y, ppm	0.0945	85.6	0.0	14.2	0.224	90.1	9.9
Zn, ppm	0.0203	47.7	49.5	2.8	0.0177	68.5	31.5
As, ppm	0.0894	88.8	10.0	1.2	0.210	0.0	100.0
Se, ppm	0.0398	58.5	39.6	1.9	0.137	17.4	82.6
Hg, ppm	0.177	46.9	51.4	1.7	0.0085	0.0	100.0
Ash, %	0.0310	91.8	7.0	1.1	0.0871	81.6	18.4
Total S, %	0.0075	63.8	28.8	7.4	0.0130	75.1	24.9

Table 26.--Distance, plot, and procedural variance for element concentrations and ash yield for Picea glauca (white spruce) twigs and needles, Nenana River Traverse, Denali National Park and Preserve, Alaska ($\log_{10}$ dry-weight basis).

		Nenana River Traverse		
		Percentage of Variance		
Variable, Unit of Measure	Total Log10 Variance	Distance	Plot	Procedural
Al, %	0.0781	36.7	31.0	32.3
Ca, %	0.0132	53.9	43.2	2.9
Fe, %	0.0173	25.2	72.6	2.2
K, %	0.0089	0.0	75.0	25.0
Mg, %	0.0049	0.0	98.5	1.5
Na, %	0.0345	93.2	6.5	0.3
P, %	0.0055	40.4	57.6	2.0
Ti, %	0.0057	37.9	60.5	1.7
Mn, ppm	0.0633	0.0	98.9	1.1
Ba, ppm	0.0462	27.0	59.0	14.0
Co, ppm	0.0176	24.4	75.1	0.5
Cr, ppm	0.0120	35.7	35.0	29.4
Cu, ppm	0.0232	41.6	56.2	2.2
Ga, ppm	0.0202	0.0	84.0	16.0
Li, ppm	0.0242	26.7	66.5	6.8
Nd, ppm	0.0219	4.1	95.5	0.4
Ni, ppm	0.0929	70.7	29.1	0.2
Sr, ppm	0.0358	19.6	80.3	0.2
V, ppm	0.0138	85.1	14.2	0.7
Zn, ppm	0.0190	5.3	93.9	0.8
Hg, ppm	0.0208	25.6	0.0	74.4
Ash, %	0.0057	37.9	60.5	1.7
Total S, %	0.0040	50.3	28.4	21.3

Table 27. Regression equations, for those relations with coefficients of determination > 0.50, for ash yield and selected element concentrations in plants and soils versus distance from the Golden Valley Electric Association power plant.

Variable	Traverse	Sample Medium	Regression Equation [1]	N[2]	CD[3]
Ash, %	Control	Moss	Ash = 10.2 - 5.6 Log D	18	0.67
		Lichen	Ash = 3.2 - .88 Log D	18	0.82
		Soil		7	0.14
	Stampede	Moss	Ash = 22 - 14 Log D	29	0.60
		Lichen	Ash = 5.0 - 2.0 Log D	29	0.54
		Soil	Ash = 82 - 33 Log D	11	0.56
	Nenana	Moss	Ash = 9.9 - 3.8 Log D	26	0.60
		Lichen	Ash = 4.0 - 1.2 Log D	26	0.50
		Soil	Ash = 60 - 24 Log D	11	0.52
Aluminum, %	Control	Moss	Al = 0.6 - 0.43 Log D	18	0.64
		Lichen	Al = 0.1 - 0.06 Log D	18	0.75
		Soil		7	0.18
	Stampede	Moss	Al = 1.5 - 1.0 Log D	29	0.61
		Lichen	Al = 0.27 - 0.17 Log D	29	0.59
		Soil		11	0.45
	Nenana	Moss	Al = 0.63 - 0.32 Log D	26	0.60
		Lichen		26	0.40
		Soil	Al = 4.2 - 1.5 Log D	11	0.57
Arsenic, ppm	Control	Moss		18	0.49
		Lichen		18	0.01
		Soil		7	0.42
	Stampede	Moss		29	0.32
		Lichen		29	0.46
		Soil	As = 8.7 - 4.3 Log D	11	0.65
	Nenana	Moss	As = 0.82 - 0.4 Log D	26	0.59
		Lichen	As = 0.26 - 0.14 Log D	26	0.50
		Soil		11	0.22
Calcium, %	Control	Moss		18	0.20
		Lichen	Ca = 0.25 - 0.04 Log D	18	0.55
		Soil		7	0.43
	Stampede	Moss	Ca = 1.4 - 0.59 Log D	29	0.66
		Lichen		29	0.48
		Soil	Ca = 1.4 - 0.76 Log D	11	0.55
	Nenana	Moss		26	0.44
		Lichen		26	0.26
		Soil		11	0.07
Chromium, ppm	Control	Moss	Cr = 8.2 - 5.9 Log D	18	0.62
		Lichen	Cr = 1.4 - 0.77 Log D	18	0.61
		Soil		7	0.34
	Stampede	Moss	Cr = 21 - 14 Log D	29	0.54
		Lichen	Cr = 4.2 - 2.7 Log D	29	0.53
		Soil	Cr = 70 - 29 Log D	11	0.62
	Nenana	Moss	Cr = 8.4 - 4.9 Log D	26	0.64
		Lichen	Cr = 2.3 - 1.3 Log D	26	0.56
		Soil		11	0.23

Copper, ppm	Control	Moss		18	0.17
		Lichen	Cu = 9.9 - 3.1 Log D	18	0.60
		Soil		7	0.22
	Stampede	Moss		29	0.33
		Lichen	Cu = 14 - 4.3 Log D	29	0.54
		Soil	Cu = 30 - 9.3 Log D	11	0.63
	Nenana	Moss		26	0.32
		Lichen		26	0.23
		Soil		11	0.03

Iron, %	Control	Moss	Fe = 0.34 - 0.25 Log D	18	0.65
		Lichen	Fe = 0.06 - 0.03 Log D	18	0.72
		Soil		7	0.41
	Stampede	Moss	Fe = 0.87 - 0.60 Log D	29	0.61
		Lichen	Fe = 0.17 - 0.11 Log D	29	0.56
		Soil		11	0.42
	Nenana	Moss	Fe = 0.38 - 0.20 Log D	26	0.62
		Lichen		26	0.45
		Soil		11	0.28

Lanthanum, ppm	Control	Moss	La = 3.0 - 2.2 Log D	18	0.72
		Lichen	La = 0.63 - 0.4 Log D	18	0.79
		Soil		7	0.03
	Stampede	Moss	La = 8.3 - 5.6 Log D	29	0.62
		Lichen	La = 1.6 - 1.0 Log D	29	0.63
		Soil		11	0.26
	Nenana	Moss	La = 3.7 - 2.4 Log D	26	0.70
		Lichen	La = 1.1 - 0.7 Log D	26	0.64
		Soil	La = 24 - 9.8 Log D	11	0.50

Lead, ppm	Control	Moss	Pb = 2.9 - 1.8 Log D	18	0.55
		Lichen	Pb = 0.97 - 0.42 Log D	18	0.79
		Soil		7	0.42
	Stampede	Moss	Pb = 6.8 - 3.8 Log D	29	0.64
		Lichen	Pb = 2.0 - 1.0 Log D	29	0.76
		Soil	Pb = 17 - 7.8 Log D	11	0.75
	Nenana	Moss		26	0.43
		Lichen		26	0.27
		Soil	Pb = 18 - 8.5 Log D	11	0.59

Manganese, ppm	Control	Moss		18	0.03
		Lichen		18	0.01
		Soil		7	0.01
	Stampede	Moss		29	0.01
		Lichen		29	0.08
		Soil		11	0.08
	Nenana	Moss		26	0.01
		Lichen		26	0.01
		Soil		11	0.01

Nickel, ppm	Control	Moss	Ni = 5.0 - 3.1 Log D	18	0.59
		Lichen	Ni = 1.5 - 0.61 Log D	18	0.63
		Soil		7	0.28
	Stampede	Moss	Ni = 13 - 8.7 Log D	29	0.60
		Lichen		29	0.49
		Soil	Ni = 32 - 11 Log D	11	0.69
	Nenana	Moss	Ni = 5.3 - 2.8 Log D	26	0.64
		Lichen	Ni = 2.1 - 1.0 Log D	26	0.64
		Soil		11	0.16

Selenium, ppm	Control	Moss		18	0.14
		Lichen		18	0.38
		Soil		7	0.24
	Stampede	Moss		29	0.41
		Lichen	Se = 0.19 - 0.13 Log D	29	0.53
		Soil		11	0.32
	Nenana	Moss		26	0.37
		Lichen		26	0.26
		Soil		11	0.08

Sulfur, % Total	Control	Moss		18	0.16
		Lichen	S = 0.13 - 0.03 Log D	18	0.68
		Soil		7	0.02
	Stampede	Moss	S = 0.11 - 0.03 Log D	29	0.51
		Lichen		29	0.49
		Soil		11	0.36
	Nenana	Moss		26	0.41
		Lichen		26	0.29
		Soil		11	0.19

Vanadium, ppm	Control	Moss	V = 10 - 7.5 Log D	18	0.62
		Lichen	V = 1.8 - 1.1 Log D	18	0.75
		Soil		7	0.18
	Stampede	Moss	V = 32 - 23 Log D	29	0.61
		Lichen	V = 6.0 - 4.2 Log D	29	0.59
		Soil	V = 93 - 35 Log D	11	0.54
	Nenana	Moss	V = 9.4 - 4.9 Log D	26	0.65
		Lichen		26	0.45
		Soil		11	0.41

Yttrium, ppm	Control	Moss	Y = 0.95 - 0.63 Log D	18	0.73
		Lichen	Y = 0.32 - 0.2 Log D	18	0.55
		Soil		7	0.29
	Stampede	Moss	Y = 12 - 5.3 Log D	29	0.63
		Lichen	Y = 1.1 - 0.74 Log D	29	0.55
		Soil	Y = 12 - 5.3 Log D	11	0.62
	Nenana	Moss	Y = 1.5 - 0.89 Log D	26	0.59
		Lichen		26	0.43
		Soil		11	0.36

Zinc, ppm	Control	Moss		18	0.02
		Lichen		18	0.01
		Soil		7	0.04
	Stampede	Moss		29	.045
		Lichen		29	0.01
		Soil		11	0.49
	Nenana	Moss		26	0.17
		Lichen		26	0.04
		Soil		11	0.10

[1] Log D is distance in kilometers.
[2] Number of samples.
[3] Coefficient of determination.

Table 28.--Chemical Analyses for the feedstock coal (both dry-weight and ash-weight basis) and fly ash from the Golden Valley Electric Association power plant.

Feedstock Coal, Dry-weight basis

Sample ID	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %	Mn, ppm
C-9/91	1.31	1.61	0.66	0.16	0.20	0.01	<0.01	0.05	91
C-10/91	2.30	1.50	0.64	0.37	0.25	0.05	0.01	0.07	101
C-12/91	1.37	1.50	0.54	0.17	0.21	0.03	<0.01	0.05	210
C-1/92	1.17	1.61	0.56	0.16	0.20	0.03	<0.01	0.04	121

Sample ID	Ba, ppm	Be, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm	Mo, ppm
C-9/91	394	0.4	8	4	22	38	3	5	5	1
C-10/91	414	0.7	17	5	44	48	6	9	10	2
C-12/91	165	0.5	9	4	27	23	4	5	5	2
C-1/92	214	0.3	6	3	25	16	3	3	4	1

Sample ID	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
C-9/91	1	5	57	10	3	189	1	31	4	0.4
C-10/91	2	9	39	17	6	186	2	53	9	0.9
C-12/91	1	5	12	6	3	195	1	30	4	0.5
C-1/92	1	4	10	4	3	214	<1	21	3	<0.3

Sample ID	Zn, ppm	As, ppm	Se, ppm	Hg, ppm	Ash, %	Total S, %
C-9/91	67	3.1	0.7	0.06	14.6	0.23
C-10/91	64	4.5	1.2	0.11	23.0	0.42
C-12/91	13	2.8	0.7	0.08	15.0	0.26
C-1/92	17	3.3	0.4	0.05	13.4	0.18

Table 28.--Chemical Analyses for the feedstock coal (both dry-weight and ash-weight basis) and fly ash from the Golden Valley Electric Association power plant (continued).

Feedstock Coal, Ash-weight basis

Sample ID	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %	Mn, ppm	As, ppm
C-9/91	9.0	11	4.5	1.1	1.4	0.1	0.03	0.36	620	30
C-10/91	10	6.5	2.8	1.6	1.1	0.2	0.03	0.30	440	30
C-12/91	9.1	10	3.6	1.1	1.4	0.2	0.02	0.33	1400	20
C-1/92	8.7	12	4.2	1.2	1.5	0.2	0.03	0.32	900	30

Sample ID	Ba, ppm	Be, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm	Mo, ppm
C-9/91	2700	3	58	26	150	260	21	34	35	9
C-10/91	1800	3	74	20	190	210	26	40	43	10
C-12/91	1100	3	59	28	180	150	24	32	31	10
C-1/92	1600	2	46	24	190	120	22	25	30	10

Sample ID	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
C-9/91	10	35	390	70	21	1300	10	210	30	3
C-10/91	10	40	170	74	24	810	10	230	37	4
C-12/91	9	35	78	43	21	1300	10	200	30	3
C-1/92	9	28	77	29	20	1600	<8	160	20	<2

Sample ID	Zn, ppm
C-9/91	460
C-10/91	280
C-12/91	86
C-1/92	130

Table 28.--Chemical Analyses for the feedstock coal (both dry-weight and ash-weight basis) and fly ash from the Golden Valley Electric Association power plant (continued).

Fly ash, Dry-weight basis

Sample ID	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %	Mn, ppm	As, ppm
A-9/91	9.7	19	5.3	0.94	2.1	0.2	0.05	0.51	1000	44
A-10/91	11	12	3.9	1.4	1.6	0.2	0.04	0.53	710	30
A-12/91	9.4	18	5.4	0.91	2.2	0.2	0.02	0.52	2500	20
A-1/92	8.4	22	6.0	0.90	2.4	0.2	0.02	0.42	1400	30

Sample ID	Ba, ppm	Be, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm	Mo, ppm
A-9/91	5500	4	91	38	160	190	30	52	36	10
A-10/91	3600	4	110	28	170	180	25	60	44	10
A-12/91	5000	4	86	43	150	150	20	50	29	10
A-1/92	6500	3	62	36	140	120	21	38	25	10

Sample ID	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
A-9/91	<8	49	89	39	29	2300	20	290	51	5
A-10/91	10	56	73	26	32	1400	21	310	60	6
A-12/91	8	46	88	20	29	2300	20	280	51	5
A-1/92	<8	35	94	20	22	2900	10	210	34	4

Sample ID	Zn, ppm	Hg, ppm	Total S, %
A-9/91	66	0.79	0.40
A-10/91	73	0.68	0.34
A-12/91	32	0.43	0.26
A-1/92	38	0.53	0.34

EXPLANATION OF APPENDIXES

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These five tables give the sample identification, location, and chemical composition as it as determined for the plants and soil samples collected in 1991 for the Denali National Park and Preserve study. The Sample ID's are keyed as follows:

First position: Sample medium: M - feather Moss; L - lichen; S - Oa soil horizon; P - white spruce; C - cladina lichen; or, U - usnea lichen.

Second position: Sampling site group: A - radial arc sites; C - control Traverse sites; M - meteorologic sites; N - Nenana River Traverse sites; or, S - Stampede Trail Traverse sites.

Third, fourth, and fifth position: Pre-planned distance in km from the GVEA for all sample sites, except for the radial arc sites. The radial arc sites 000 thru 007 were numbered sequentially as they were collected. Radial sites 032 and 040 do represent distance from the GVEA in km.

Sixth position: Composite sample from the separate plots at each sampling site (A, B, C).

Seventh position: Analytical splits made in the laboratory (1, 2).

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Table A1.-Chemical analyses for <u>Hylocomium splendens</u> (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Radial Arc Sites					
MA001A1	634945	1490138	6.9	11	3.5	5.8	2.4	0.87	1.6	0.20
MA001B1	634945	1490138	6.6	13	3.2	6.5	2.9	1.0	2.0	0.20
MA002A1	635023	1490346	4.9	15	2.5	6.3	3.1	0.94	2.3	0.20
MA002B1	635023	1490346	4.8	17	2.4	4.9	3.8	1.1	2.3	0.20
MA003A1	635004	1490727	6.5	10	3.7	5.5	2.6	1.2	1.8	0.20
MA003B1	635004	1490727	5.1	13	3.0	5.4	2.9	0.99	2.0	0.10
MA004A1	634854	1491006	7.1	7.0	4.8	6.2	2.3	0.95	1.7	0.10
MA004B1	634854	1491006	6.3	6.5	4.4	4.8	2.0	0.91	1.2	0.10
MA005A1	634802	1491202	5.5	11	3.2	6.7	2.9	0.97	2.3	0.10
MA005B1	634802	1491202	7.1	9.8	3.7	7.1	2.6	1.1	1.4	0.20
MA006A1	634706	1491851	6.1	7.4	2.1	4.0	1.6	0.51	0.93	0.10
MA006B1	634706	1491851	3.9	16	1.9	8.0	3.5	0.72	3.3	0.10
MA007A1	635158	1490638	5.9	9.1	3.2	4.4	2.3	1.2	1.4	0.29
MA007B1	635158	1490638	6.5	9.5	3.6	5.6	2.8	1.4	1.3	0.27
MA032A1	634256	1492900	5.2	7.9	3.6	2.9	2.3	1.2	0.88	0.24
MA032B1	634256	1492900	6.2	8.4	4.2	2.9	2.2	1.1	0.77	0.28
MA040A1	633640	1493514	5.1	13	3.5	3.8	3.0	1.2	1.5	0.34
MA040B1	633640	1493514	4.8	14	3.3	5.1	3.5	1.3	2.0	0.32
					Control Traverse Sites					
MC0.5A1	635935	1490701	5.7	9.5	3.2	2.8	2.4	1.2	1.1	0.27
MC0.5B1	635935	1490701	5.8	8.2	3.2	3.2	2.0	1.2	1.0	0.27
MC0.5C1	635935	1490701	6.1	7.2	3.5	3.0	2.0	1.3	0.83	0.32
MC1.0A1	635936	1490735	5.7	7.8	3.4	3.2	2.2	1.3	0.97	0.30
MC1.0B1	635936	1490735	8.2	6.2	4.5	3.4	2.0	0.98	0.86	0.37
MC1.0C1	635936	1490735	5.5	8.5	3.4	3.3	2.3	1.2	0.83	0.30
MC1.5A1	635935	1490836	5.9	7.1	3.4	3.3	1.7	1.2	0.88	0.33
MC1.5B1	635935	1490836	5.7	6.4	3.3	2.6	1.7	1.2	0.68	0.33
MC1.5C1	635935	1490836	5.5	7.3	3.3	3.3	2.1	1.2	1.2	0.31
MC3.0A1	635950	1491135	4.2	16	2.3	5.5	3.9	1.1	2.7	0.20
MC3.0A2	635950	1491135	4.3	15	2.3	5.6	3.9	1.1	2.6	0.20
MC3.0B1	635950	1491135	3.4	16	1.9	8.4	3.9	0.97	2.8	0.10
MC3.0C1	635950	1491135	4.0	16	2.1	5.9	3.9	1.2	2.2	0.20
MC7.5A1	635950	1491753	3.1	19	1.6	5.8	4.8	0.98	3.3	0.10
MC7.5B1	635950	1491753	3.0	18	1.5	6.1	4.4	1.1	3.5	0.10
MC008A1	640111	1492416	3.2	17	1.8	5.8	4.8	1.4	3.2	0.10
MC008B1	640111	1492416	2.8	18	1.6	5.8	5.0	1.3	3.2	0.10
MC016A1	635934	1492905	3.3	20	1.5	3.5	4.0	1.2	2.3	0.10
MC016B1	635934	1492905	2.6	21	1.4	4.9	3.7	1.0	2.9	0.10

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Meteorological Sites					
MM000A1	634326	1485804	3.6	15	2.0	6.8	3.3	1.2	2.7	0.10
MM000B1	634326	1485804	3.2	16	1.9	6.9	3.4	1.1	2.8	0.10
MM001A1	635117	1485808	5.4	13	3.2	4.5	2.5	0.95	2.0	0.23
MM001B1	635117	1485808	5.5	11	3.0	4.4	2.8	1.1	1.8	0.26
MM006A1	634808	1485654	3.2	18	2.0	6.6	3.3	0.92	2.6	0.10
MM006B1	634808	1485654	4.4	17	2.6	4.8	3.6	1.2	2.7	0.20
					Nenana River Traverse Sites					
MN000A1	635120	1485638	7.2	5.7	4.3	3.1	1.6	1.0	0.78	0.31
MN000A2	635120	1485638	7.3	6.2	4.4	3.4	1.7	0.97	0.87	0.31
MN000B1	635120	1485638	6.7	6.8	4.0	3.2	1.7	0.93	1.0	0.28
MN0.5A1	635109	1485729	5.4	11	3.0	4.3	2.5	1.1	2.0	0.24
MN0.5B1	635109	1485729	6.1	10	3.5	3.5	2.2	1.1	1.4	0.27
MN0.5C1	635109	1485729	6.4	9.1	3.6	4.5	2.3	1.2	1.5	0.28
MN001A1	635047	1485652	6.3	11	3.8	3.7	2.3	1.0	1.2	0.31
MN001B1	635047	1485652	6.4	12	4.2	5.4	2.6	1.0	1.6	0.30
MN001C1	635047	1485652	7.1	9.2	4.9	4.1	2.3	1.0	1.3	0.46
MN002A1	635028	1485804	5.8	11	3.3	4.5	3.1	1.1	1.6	0.23
MN002B1	635028	1485804	6.7	8.5	3.8	3.6	2.5	1.2	1.2	0.23
MN002C1	635028	1485804	6.7	11	3.8	3.5	3.0	1.0	1.1	0.22
MN002C2	635028	1485804	6.9	11	3.9	3.6	3.0	1.1	1.1	0.24
MN004A1	634942	1490013	6.0	10	3.1	4.8	2.6	1.4	1.7	0.22
MN004B1	634942	1490013	5.2	14	2.9	4.8	3.1	1.1	1.8	0.20
MN004C1	634942	1490013	5.1	14	2.8	5.0	3.2	1.1	1.9	0.20
MN008A1	634619	1485407	4.8	15	2.8	4.2	2.9	1.1	1.3	0.20
MN008B1	634619	1485407	5.3	13	3.3	4.3	3.3	1.3	1.4	0.22
MN008C1	634619	1485407	5.2	14	3.1	3.8	3.2	1.2	1.3	0.22
MN016A1	634258	1485335	3.3	18	2.1	4.5	4.2	1.3	1.9	0.20
MN016B1	634258	1485335	3.8	16	2.1	4.9	3.4	1.4	2.2	0.20
MN016C1	634258	1485335	3.6	17	2.2	3.7	3.5	1.3	1.5	0.20
MN025A1	633741	1484720	3.9	17	2.0	5.0	3.4	1.5	1.8	0.20
MN025A2	633741	1484720	4.1	16	2.1	4.8	3.3	1.5	1.7	0.20
MN025B1	633741	1484720	4.0	15	2.3	4.7	2.8	1.4	1.7	0.20
MN040A1	633030	1484901	6.3	11	3.1	3.5	2.6	2.0	1.4	0.28
MN040A2	633030	1484901	6.4	11	3.2	3.5	2.6	2.0	1.4	0.29
MN040B1	633030	1484901	5.4	12	2.8	4.8	2.9	1.8	1.8	0.24
MN080A1	631839	1493323	6.5	9.6	3.0	5.0	2.5	2.2	1.5	0.24
MN080B1	631839	1493323	5.4	12	2.5	8.1	2.9	1.8	2.4	0.20

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Stampede Trail Traverse Sites					
MS0.5A1	635123	1485739	6.6	4.4	3.9	1.9	1.5	1.3	0.27	0.44
MS0.5B1	635123	1485739	6.7	5.9	3.9	2.0	1.6	1.1	0.43	0.43
MS0.5C1	635123	1485739	6.2	6.6	3.5	2.9	1.7	1.2	0.66	0.37
MS1.0A1	635138	1485757	6.9	9.6	3.9	2.9	1.9	1.0	1.1	0.37
MS1.0B1	635138	1485757	7.3	8.8	4.1	2.7	1.8	0.99	0.66	0.38
MS1.0C1	635138	1485757	7.3	8.1	4.1	2.2	1.7	1.0	0.62	0.39
MS1.5A1	635156	1485816	6.7	12	4.0	4.5	2.3	0.90	1.4	0.33
MS1.5B1	635156	1485816	7.2	7.8	3.9	2.6	1.6	0.92	0.66	0.40
MS1.5B2	635156	1485816	7.1	8.0	3.9	2.6	1.6	0.89	0.67	0.38
MS1.5C1	635156	1485816	7.5	8.8	4.2	2.3	1.8	0.93	0.70	0.40
MS1.5C2	635156	1485816	7.6	9.0	4.2	2.3	1.8	0.90	0.72	0.40
MS2.0A1	635230	1485818	7.3	5.7	4.2	2.2	1.5	1.1	0.39	0.41
MS2.0B1	635230	1485818	7.5	5.2	4.3	2.0	1.5	1.1	0.33	0.40
MS2.0C1	635230	1485818	7.4	7.0	4.3	2.1	1.7	1.1	0.48	0.42
MS004A1	635239	1490122	5.8	8.4	3.5	2.9	1.9	1.1	0.83	0.26
MS004B1	635239	1490122	5.7	8.9	3.7	3.2	2.1	1.1	1.2	0.27
MS004C1	635239	1490122	5.5	9.9	3.5	3.1	2.3	1.2	1.3	0.23
MS006A1	635328	1490242	6.0	7.8	3.7	3.0	2.0	1.0	1.1	0.22
MS006A2	635328	1490242	6.1	7.9	3.8	3.0	2.0	1.0	1.1	0.22
MS006B1	635328	1490242	5.8	7.8	3.6	3.0	2.2	1.2	1.2	0.21
MS006C1	635328	1490242	6.0	8.7	3.9	3.3	2.3	1.2	1.2	0.24
MS008A1	635328	1490720	5.5	14	3.1	4.0	2.9	1.1	1.7	0.22
MS008B1	635328	1490720	4.9	15	2.8	5.6	3.6	1.3	2.9	0.20
MS008C1	635328	1490720	5.6	12	3.2	3.4	3.0	1.3	1.6	0.23
MS008C2	635328	1490720	5.7	12	3.2	3.4	3.0	1.3	1.6	0.24
MS014A1	635244	1491158	4.8	15	2.8	4.6	3.7	1.3	2.6	0.20
MS014B1	635244	1491158	5.0	16	2.8	5.9	3.7	1.2	2.9	0.20
MS016A1	635225	1491513	4.3	15	2.2	4.8	3.8	1.1	2.7	0.10
MS016B1	635225	1491513	3.0	22	1.9	4.1	5.0	0.88	2.3	0.09
MS025A1	635411	1492415	3.6	20	1.8	5.3	4.2	1.4	2.8	0.10
MS025A2	635411	1492415	3.5	18	1.9	5.0	3.9	1.3	2.6	0.10
MS025B1	635411	1492415	3.6	18	1.8	5.6	4.5	1.1	3.2	0.10
MS032A1	640414	1494727	4.2	15	2.2	6.6	3.7	1.6	2.9	0.20
MS032B1	640414	1494727	1.6	22	1.2	5.1	4.8	0.85	3.2	0.07
					In-house Standard Moss Sample					
STD			7.5	7.4	4.0	2.3	2.3	2.4	0.54	0.47
STD			7.5	7.8	3.9	2.4	2.4	2.4	0.58	0.46
STD			7.8	7.8	4.1	2.4	2.4	2.4	0.58	0.48
STD			7.6	7.5	3.9	2.3	2.4	2.4	0.54	0.46
STD			7.6	7.9	4.0	2.4	2.4	2.3	0.60	0.48
STD			7.2	7.6	3.8	2.4	2.3	2.3	0.61	0.45

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
					Radial Arc Sites					
MA001A1	8900	1000	<2	<4	78	24	150	200	24	45
MA001B1	13000	810	<2	<4	72	20	84	210	20	44
MA002A1	18000	1500	<2	<4	48	20	71	210	21	29
MA002B1	13000	1400	<2	<4	46	20	43	380	20	26
MA003A1	6000	1000	<2	<4	100	21	54	200	20	59
MA003B1	5300	930	<2	<4	69	20	60	370	10	39
MA004A1	1800	880	<2	<4	110	27	81	200	20	63
MA004B1	1800	870	<2	<4	180	25	62	130	20	99
MA005A1	4600	910	<2	<4	65	21	66	310	20	36
MA005B1	1700	960	<2	<4	100	26	58	200	20	57
MA006A1	5000	970	<2	<4	92	10	42	120	20	49
MA006B1	14000	1000	<2	<4	56	10	55	490	20	31
MA007A1	15000	1500	<2	<4	37	20	79	150	20	22
MA007B1	4600	1400	<2	<4	45	20	82	180	20	24
MA032A1	2500	1300	<2	<4	31	20	100	130	10	20
MA032B1	3900	1800	<2	<4	35	20	130	140	10	20
MA040A1	1600	1100	<2	<4	48	20	48	270	10	25
MA040B1	2000	1100	<2	<4	38	10	69	250	10	21
					Control Traverse Sites					
MC0.5A1	4500	1300	<2	<4	49	20	80	230	20	28
MC0.5B1	4800	1400	<2	<4	55	20	83	150	20	30
MC0.5C1	4500	1300	<2	<4	54	21	84	150	20	31
MC1.0A1	4200	1300	<2	<4	60	20	82	140	20	32
MC1.0B1	3000	1500	2	<4	57	26	110	130	20	32
MC1.0C1	2600	1200	<2	<4	50	20	58	140	10	29
MC1.5A1	4100	1300	<2	<4	64	20	91	130	20	35
MC1.5B1	4500	1300	<2	<4	51	20	90	150	20	28
MC1.5C1	6400	1300	<2	<4	50	20	67	150	20	27
MC3.0A1	13000	910	<2	4	38	21	60	310	20	20
MC3.0A2	12000	710	<2	<4	44	20	99	310	20	23
MC3.0B1	13000	910	<2	5	30	10	63	310	20	20
MC3.0C1	12000	630	<2	<4	37	10	37	350	10	21
MC7.5A1	13000	950	<2	<4	26	10	45	370	20	10
MC7.5B1	21000	580	<2	4	24	10	39	350	20	10
MC008A1	15000	360	<2	20	29	22	25	310	10	20
MC008B1	15000	490	<2	7	23	20	38	370	10	10
MC016A1	10000	340	<2	6	20	10	41	410	10	10
MC016B1	9100	370	<2	5	20	10	41	420	10	10

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
					Meteorological Sites					
MM000A1	12000	430	<2	20	24	10	51	250	10	10
MM000B1	11000	680	<2	10	20	10	61	290	10	10
MM001A1	4100	1100	<2	7	44	25	91	230	10	25
MM001B1	6500	1100	<2	5	44	21	75	310	10	26
MM006A1	6300	810	<2	<4	28	10	34	410	10	10
MM006B1	11000	500	<2	4	43	20	44	440	20	24
					Nenana River Traverse Sites					
MN000A1	2500	1800	<2	<4	69	22	93	140	20	40
MN000A2	2600	1500	<2	<4	66	23	100	140	20	37
MN000B1	2200	1800	<2	<4	76	22	96	350	20	41
MN0.5A1	6200	1600	<2	4	47	20	77	260	20	29
MN0.5B1	3500	1500	<2	<4	60	21	58	210	20	33
MN0.5C1	1500	1500	<2	<4	61	20	65	180	10	36
MN001A1	2500	1200	<2	<4	65	21	100	220	20	35
MN001B1	4200	1200	<2	<4	61	20	100	210	20	36
MN001C1	3000	1700	<2	<4	110	22	98	170	20	59
MN002A1	17000	1200	<2	<4	63	27	90	240	21	37
MN002B1	8500	1400	<2	<4	72	36	84	200	21	40
MN002C1	4400	1300	<2	5	75	26	87	230	20	43
MN002C2	4300	1400	<2	5	77	27	92	220	20	44
MN004A1	3400	1100	<2	<4	57	24	48	190	20	34
MN004B1	8000	970	<2	<4	45	20	63	230	20	26
MN004C1	10000	1200	<2	<4	47	21	66	280	20	25
MN008A1	2200	810	<2	<4	36	20	65	210	10	21
MN008B1	4600	870	<2	<4	43	20	72	290	20	22
MN008C1	10000	1000	<2	<4	42	20	67	270	20	23
MN016A1	3800	1000	<2	7	20	10	56	280	10	10
MN016B1	4000	490	<2	6	20	10	44	200	10	10
MN016C1	2400	1000	<2	5	21	10	47	250	9	10
MN025A1	7200	1100	<2	6	10	10	39	380	10	10
MN025A2	6700	1100	<2	5	24	10	28	360	10	10
MN025B1	7700	1400	<2	<4	22	10	45	220	10	10
MN040A1	7900	1100	<2	<4	28	10	48	220	20	20
MN040A2	7800	1100	<2	<4	29	10	48	190	20	20
MN040B1	10000	1200	<2	4	24	20	53	250	20	10
MN080A1	6500	890	<2	<4	24	10	43	200	20	10
MN080B1	6300	780	<2	<4	21	10	37	190	10	10

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm
					Stampede Trail Traverse Sites					
MS0.5A1	1100	1700	<2	<4	70	23	76	73	20	39
MS0.5B1	1600	2000	<2	<4	67	24	110	96	10	39
MS0.5C1	1700	1500	<2	<4	67	20	65	97	10	38
MS1.0A1	2300	2200	<2	<4	57	23	99	140	10	32
MS1.0B1	2700	2400	2	<4	63	23	100	150	20	36
MS1.0C1	3500	2400	2	<4	69	24	110	140	20	39
MS1.5A1	2400	1500	2	<4	62	27	110	230	20	34
MS1.5B1	2200	2500	2	<4	77	27	75	260	20	43
MS1.5B2	2400	2600	2	<4	70	25	110	270	10	40
MS1.5C1	2300	2800	2	<4	70	28	120	170	20	39
MS1.5C2	2300	1500	2	<4	79	28	87	180	20	43
MS2.0A1	1300	2100	2	<4	73	24	110	99	20	39
MS2.0B1	1300	2000	2	<4	69	26	120	110	20	38
MS2.0C1	1600	2400	2	<4	67	29	120	140	20	37
MS004A1	5100	1300	<2	<4	57	20	90	140	20	31
MS004B1	7700	1400	<2	<4	53	21	76	190	20	28
MS004C1	6600	1300	<2	<4	50	20	87	170	20	27
MS006A1	5000	1300	<2	<4	84	20	51	140	20	49
MS006A2	5100	1300	<2	<4	79	21	77	140	20	41
MS006B1	5300	1300	<2	<4	76	22	55	160	20	43
MS006C1	8300	1000	<2	<4	81	20	59	250	20	45
MS008A1	14000	1200	<2	<4	49	20	75	280	20	27
MS008B1	13000	1300	<2	7	38	20	62	380	20	22
MS008C1	9200	1300	<2	5	50	20	79	280	20	28
MS008C2	8600	1300	<2	4	49	20	120	270	20	27
MS014A1	12000	1000	<2	5	40	23	70	330	20	24
MS014B1	12000	730	2	6	57	39	52	470	20	31
MS016A1	17000	330	<2	5	37	30	53	320	21	22
MS016B1	1500	740	3	4	37	10	45	480	9	23
MS025A1	11000	470	<2	5	24	20	50	390	10	20
MS025A2	10000	330	<2	4	28	20	50	360	10	20
MS025B1	13000	510	<2	4	29	20	58	370	10	20
MS032A1	6600	810	<2	7	24	10	46	330	10	10
MS032B1	4800	460	<2	5	10	20	36	520	9	7
					In-house Standard Moss Sample					
STD	2600	690	<2	<4	32	21	89	67	20	20
STD	2600	690	<2	<4	28	21	63	69	20	20
STD	2800	700	<2	<4	30	21	64	74	20	20
STD	2600	660	<2	<4	28	21	79	66	20	10
STD	2900	700	<2	<4	28	20	89	74	20	20
STD	2800	690	<2	<4	29	20	82	72	20	20

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
					Radial Arc Sites					
MA001A1	22	10	<8	42	62	25	10	650	20	77
MA001B1	21	20	<8	33	60	27	10	720	20	74
MA002A1	20	22	<8	26	55	33	9	880	20	63
MA002B1	20	42	<8	26	51	41	8	1100	10	63
MA003A1	23	26	<8	54	44	37	10	690	20	74
MA003B1	20	30	<8	37	41	38	9	860	10	58
MA004A1	26	8	<8	55	72	54	10	490	25	72
MA004B1	21	10	<8	81	55	37	10	440	28	63
MA005A1	20	32	<8	35	53	38	9	750	10	61
MA005B1	26	29	<8	48	51	29	10	640	20	82
MA006A1	20	10	<8	42	43	27	10	490	20	65
MA006B1	20	25	<8	29	47	37	7	1000	10	51
MA007A1	24	10	<8	22	44	22	10	570	20	98
MA007B1	23	21	<8	23	51	21	10	730	<8	100
MA032A1	32	10	<8	24	62	20	10	500	<8	130
MA032B1	40	7	<8	22	75	30	10	500	<8	160
MA040A1	20	20	<8	30	30	20	10	1000	<8	79
MA040B1	20	33	<8	23	32	20	10	1300	<8	77
					Control Traverse Sites					
MC0.5A1	23	20	<8	27	46	30	10	640	10	93
MC0.5B1	22	10	<8	29	44	24	10	530	10	97
MC0.5C1	23	10	8	33	46	27	10	510	10	100
MC1.0A1	22	10	<8	26	49	45	10	560	9	99
MC1.0B1	41	5	<8	33	68	38	20	570	20	140
MC1.0C1	21	8	<8	24	55	42	10	640	8	97
MC1.5A1	23	8	<8	31	44	20	10	500	10	100
MC1.5B1	23	9	<8	27	42	20	10	500	10	100
MC1.5C1	22	10	<8	28	53	10	10	530	10	98
MC3.0A1	20	28	<8	23	42	24	8	1100	10	64
MC3.0A2	20	27	<8	21	46	27	8	1100	10	65
MC3.0B1	10	27	<8	20	38	29	6	1100	<8	52
MC3.0C1	10	39	<8	24	38	29	7	1100	10	58
MC7.5A1	10	76	<8	20	42	28	6	1200	<8	46
MC7.5B1	10	64	<8	10	32	23	5	1100	10	41
MC008A1	10	57	<8	20	42	22	6	1200	10	48
MC008B1	10	66	<8	20	48	27	6	1300	<8	45
MC016A1	10	59	<8	20	43	31	5	1200	8	48
MC016B1	10	43	<8	10	33	20	5	1300	<8	41

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
					Meteorological Sites					
MM000A1	20	34	<8	10	52	32	6	920	<8	59
MM000B1	10	29	<8	10	48	32	6	990	<8	61
MM001A1	20	8	<8	27	63	31	10	900	10	94
MM001B1	20	10	<8	20	59	33	10	900	8	93
MM006A1	10	22	<8	20	33	29	6	1100	<8	48
MM006B1	20	32	<8	22	42	44	8	1100	10	63
					Nenana River Traverse Sites					
MN000A1	26	4	<8	34	64	35	10	530	20	110
MN000A2	27	5	<8	34	54	35	10	560	20	110
MN000B1	25	5	<8	31	54	36	10	600	10	100
MN0.5A1	21	10	<8	27	51	46	10	860	10	87
MN0.5B1	22	10	<8	30	49	57	10	780	10	95
MN0.5C1	23	10	<8	34	50	59	10	710	10	100
MN001A1	21	20	<8	30	49	94	10	960	9	110
MN001B1	21	23	<8	35	49	67	10	950	10	100
MN001C1	22	20	10	46	49	100	10	770	10	110
MN002A1	20	25	<8	35	56	28	10	720	20	89
MN002B1	22	20	<8	37	71	26	10	630	10	92
MN002C1	25	20	<8	39	72	38	10	760	20	94
MN002C2	26	20	8	39	79	46	10	760	20	98
MN004A1	21	10	<8	28	47	51	10	730	9	76
MN004B1	20	26	<8	26	52	71	9	910	10	74
MN004C1	20	28	<8	28	41	55	9	860	10	69
MN008A1	20	23	<8	20	33	56	9	970	<8	66
MN008B1	20	30	<8	22	36	57	10	870	8	73
MN008C1	20	26	<8	21	33	57	10	870	<8	72
MN016A1	10	47	<8	20	32	52	6	1200	<8	57
MN016B1	10	36	<8	20	28	33	6	1000	<8	59
MN016C1	10	43	<8	10	29	62	7	1100	<8	59
MN025A1	10	38	<8	10	24	34	6	1100	<8	55
MN025A2	10	34	<8	20	24	27	6	1100	<8	60
MN025B1	10	27	<8	10	28	42	7	960	<8	65
MN040A1	20	10	<8	20	44	42	10	770	<8	86
MN040A2	20	20	<8	20	37	41	10	760	<8	88
MN040B1	20	20	<8	20	43	51	9	790	<8	79
MN080A1	20	20	<8	10	20	10	8	780	<8	78
MN080B1	10	20	<8	20	34	20	7	930	<8	62

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm
					Stampede Trail Traverse Sites					
MS0.5A1	30	<4	<8	34	56	10	20	410	20	150
MS0.5B1	30	4	8	36	59	24	20	540	10	150
MS0.5C1	26	<4	<8	32	50	32	10	580	8	120
MS1.0A1	28	7	8	30	60	44	20	960	10	140
MS1.0B1	29	6	<8	37	63	43	20	890	10	150
MS1.0C1	29	5	9	38	64	39	20	810	20	150
MS1.5A1	25	9	<8	33	72	36	20	1100	10	140
MS1.5B1	29	5	<8	38	81	38	20	800	20	150
MS1.5B2	28	4	<8	37	82	33	20	810	10	150
MS1.5C1	30	9	9	36	76	44	20	890	10	160
MS1.5C2	30	6	<8	37	77	49	20	920	10	160
MS2.0A1	32	4	<8	34	63	27	20	570	20	150
MS2.0B1	32	5	<8	36	62	22	20	530	20	150
MS2.0C1	31	5	8	34	66	42	20	690	10	160
MS004A1	22	10	<8	30	43	68	10	550	10	91
MS004B1	22	10	<8	27	47	62	10	600	10	99
MS004C1	20	20	<8	26	42	67	10	620	9	89
MS006A1	21	20	<8	34	48	44	10	560	10	81
MS006A2	23	20	<8	35	48	46	10	560	10	83
MS006B1	20	20	<8	34	52	40	10	570	10	75
MS006C1	21	10	<8	40	45	46	10	620	20	81
MS008A1	21	27	<8	29	51	40	10	900	10	85
MS008B1	20	30	<8	23	57	40	9	1000	10	74
MS008C1	21	41	<8	28	44	35	10	830	10	84
MS008C2	21	40	<8	26	46	32	10	810	10	89
MS014A1	20	56	<8	23	70	38	8	980	10	68
MS014B1	20	41	<8	29	95	54	9	1100	10	68
MS016A1	20	42	<8	24	47	26	7	990	10	60
MS016B1	10	59	<8	31	69	20	5	1500	<8	49
MS025A1	10	72	<8	20	57	24	6	1400	10	53
MS025A2	10	66	<8	10	56	28	6	1300	<8	50
MS025B1	10	54	<8	20	53	22	5	1300	9	52
MS032A1	20	42	<8	10	32	20	7	1100	<8	59
MS032B1	8	55	<8	10	43	20	<4	1500	<8	28
					In-house Standard Moss Sample					
STD	10	<4	<8	20	51	25	20	650	<8	130
STD	10	<4	<8	20	51	10	20	650	<8	130
STD	10	<4	<8	20	64	22	20	670	<8	130
STD	10	<4	<8	20	49	10	20	640	10	130
STD	10	<4	<8	20	51	22	20	660	<8	130
STD	10	<4	<8	20	50	24	20	650	<8	130

Table A1.-Chemical analyses for <u>Hylocomium splendens</u> (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
				Radial Arc Sites				
MA001A1	10	<2	980	0.60	0.04	0.09	8.35	0.11
MA001B1	10	<2	1100	0.48	0.07	0.10	6.37	0.10
MA002A1	9	<2	1100	0.26	0.04	0.07	5.87	0.08
MA002B1	8	<2	1200	0.25	0.04	0.07	4.74	0.06
MA003A1	10	<2	460	0.47	0.05	0.06	6.94	0.06
MA003B1	8	<2	750	0.40	0.04	0.08	5.65	0.08
MA004A1	10	<2	590	1.2	<0.03	0.07	8.70	0.08
MA004B1	10	<2	460	1.1	0.03	0.09	10.1	0.10
MA005A1	8	<2	650	0.35	<0.03	0.08	5.93	0.09
MA005B1	10	<2	450	0.67	0.05	0.06	6.48	0.08
MA006A1	6	<2	720	0.46	0.06	0.08	11.2	0.09
MA006B1	6	<2	1400	0.18	0.03	0.08	5.19	0.08
MA007A1	10	<2	710	0.44	0.05	0.09	8.50	0.07
MA007B1	20	<2	390	0.52	0.04	0.06	7.39	0.07
MA032A1	10	<2	470	0.59	0.09	0.07	9.59	0.07
MA032B1	20	<2	370	0.95	0.14	0.13	12.6	0.07
MA040A1	21	3	570	0.43	0.03	0.07	7.14	0.09
MA040B1	20	<2	520	0.34	0.04	0.07	6.32	0.08
				Control Traverse Sites				
MC0.5A1	10	<2	590	0.64	0.08	0.07	9.27	0.08
MC0.5B1	10	<2	580	0.84	0.09	0.08	11.1	0.09
MC0.5C1	10	<2	550	0.90	0.10	0.08	12.1	0.10
MC1.0A1	10	<2	610	0.75	0.11	0.06	10.4	0.11
MC1.0B1	23	2	540	2.0	0.11	0.08	14.8	0.09
MC1.0C1	10	<2	540	0.72	0.11	0.06	10.5	0.09
MC1.5A1	10	<2	310	0.90	0.09	0.08	12.5	0.07
MC1.5B1	10	<2	230	1.0	0.08	0.11	14.3	0.07
MC1.5C1	10	<2	290	0.77	0.07	0.06	10.3	0.08
MC3.0A1	9	<2	520	0.22	0.05	0.06	5.33	0.08
MC3.0A2	9	<2	520	0.25	0.05	0.07	5.49	0.08
MC3.0B1	8	<2	610	0.20	0.04	0.04	4.14	0.06
MC3.0C1	8	<2	760	0.18	0.04	0.07	4.17	0.05
MC7.5A1	6	<2	1500	0.18	0.04	0.07	3.71	0.07
MC7.5B1	6	<2	1300	5.6	0.62	0.06	3.36	0.08
MC008A1	7	<2	2200	0.14	0.05	0.07	3.55	0.10
MC008B1	6	<2	1600	0.14	0.04	0.08	3.59	0.08
MC016A1	7	<2	970	0.28	0.03	0.06	4.36	0.07
MC016B1	6	<2	1300	0.19	0.04	0.09	4.79	0.07

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
				Meteorological Sites				
MM000A1	10	<2	820	0.19	0.07	0.05	4.80	0.08
MM000B1	8	<2	780	0.19	0.05	0.05	4.44	0.08
MM001A1	10	<2	770	0.45	0.09	0.13	8.18	0.10
MM001B1	10	<2	690	0.41	0.08	0.07	7.50	0.10
MM006A1	6	<2	1300	0.29	0.05	0.11	4.93	0.09
MM006B1	9	<2	1100	0.30	0.06	0.13	5.54	0.10
				Nenana River Traverse Sites				
MN000A1	20	<2	320	1.7	0.16	<0.03	18.6	0.11
MN000A2	10	2	290	2.0	0.14	<0.03	17.6	0.11
MN000B1	20	<2	430	1.4	0.15	0.08	17.4	0.12
MN0.5A1	10	<2	840	0.72	0.08	0.08	9.60	0.11
MN0.5B1	20	<2	590	0.67	0.08	0.08	8.40	0.09
MN0.5C1	10	<2	550	0.67	0.06	0.09	9.33	0.08
MN001A1	20	<2	640	0.56	0.21	0.06	8.70	0.09
MN001B1	20	<2	500	0.47	0.08	0.06	7.81	0.08
MN001C1	21	<2	400	0.75	0.10	0.06	10.2	0.09
MN002A1	10	<2	920	0.81	0.05	0.09	7.71	0.10
MN002B1	10	<2	520	0.88	0.06	0.09	9.09	0.11
MN002C1	10	<2	800	1.0	0.09	0.10	8.53	0.09
MN002C2	10	<2	790	0.96	0.08	0.09	8.76	0.09
MN004A1	10	<2	1100	0.66	0.08	0.06	9.20	0.09
MN004B1	9	<2	1000	0.43	0.06	0.10	6.64	0.10
MN004C1	9	<2	890	0.36	<0.03	0.06	5.96	0.08
MN008A1	9	<2	790	0.34	0.06	0.07	6.48	0.10
MN008B1	10	<2	660	0.32	0.04	0.04	5.57	0.08
MN008C1	10	<2	810	0.39	0.06	0.07	5.77	0.07
MN016A1	7	<2	830	0.20	0.04	0.06	4.72	0.06
MN016B1	8	<2	500	0.45	0.05	0.05	4.48	0.06
MN016C1	8	<2	660	0.20	0.06	0.04	4.57	0.08
MN025A1	9	<2	740	0.15	0.04	0.05	4.41	0.06
MN025A2	8	<2	690	0.17	0.04	0.07	4.77	0.07
MN025B1	9	<2	920	0.21	0.05	0.08	5.61	0.06
MN040A1	10	<2	590	0.35	0.06	<0.03	7.42	0.08
MN040A2	10	2	540	0.37	0.06	<0.03	7.97	0.08
MN040B1	10	<2	780	0.44	0.06	0.09	6.48	0.08
MN080A1	10	<2	460	0.24	0.05	0.06	7.55	0.09
MN080B1	10	<2	580	0.13	0.04	0.06	5.17	0.07

Table A1.-Chemical analyses for Hylocomium splendens (feather moss) samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Y, ppm	Yb, ppm	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
				Stampede Trail Traverse Sites				
MS0.5A1	21	<2	160	6.2	0.50	0.08	42.0	0.14
MS0.5B1	25	2	190	0.12	0.03	0.08	31.0	0.14
MS0.5C1	21	2	220	2.0	0.28	0.06	19.0	0.12
MS1.0A1	22	3	490	1.5	0.21	0.10	17.0	0.12
MS1.0B1	24	3	440	1.4	0.16	0.08	15.8	0.09
MS1.0C1	25	3	320	2.0	0.22	0.08	18.5	0.10
MS1.5A1	25	2	490	0.73	0.13	0.06	8.39	0.08
MS1.5B1	26	3	430	0.66	0.25	0.08	18.8	0.10
MS1.5B2	25	3	420	1.8	0.20	0.08	17.9	0.10
MS1.5C1	31	2	350	1.7	0.30	0.09	16.2	0.09
MS1.5C2	30	2	350	1.7	0.28	0.09	16.0	0.11
MS2.0A1	24	2	220	3.6	0.42	0.09	30.5	0.15
MS2.0B1	22	2	190	4.2	0.39	0.09	32.7	0.11
MS2.0C1	25	2	290	2.8	0.15	0.08	21.3	0.10
MS004A1	10	<2	430	0.66	0.08	0.06	9.74	0.07
MS004B1	10	<2	430	0.71	0.06	0.10	10.3	0.09
MS004C1	10	<2	700	0.59	0.06	0.08	8.76	0.09
MS006A1	10	<2	360	0.71	0.06	0.07	9.53	0.09
MS006A2	10	<2	370	0.67	0.07	0.05	9.44	0.09
MS006B1	10	<2	340	0.69	0.07	0.05	9.81	0.08
MS006C1	10	<2	470	0.45	0.06	0.05	8.73	0.07
MS008A1	10	<2	820	0.38	0.04	0.07	5.58	0.06
MS008B1	9	<2	920	0.23	0.04	0.09	5.00	0.07
MS008C1	10	<2	480	0.35	0.05	0.07	5.40	0.06
MS008C2	10	<2	500	0.32	0.04	0.05	5.95	0.06
MS014A1	10	<2	940	0.27	0.04	0.07	3.98	0.07
MS014B1	20	<2	890	0.23	0.03	0.07	4.12	0.06
MS016A1	9	<2	970	0.25	0.04	0.10	4.87	0.10
MS016B1	20	2	620	0.14	<0.03	0.04	3.72	0.05
MS025A1	7	<2	800	0.18	0.04	0.05	3.86	0.06
MS025A2	7	<2	760	0.20	0.05	0.04	3.84	0.07
MS025B1	7	<2	1200	0.17	0.04	0.07	4.28	0.08
MS032A1	9	<2	800	0.20	0.09	0.05	4.40	0.08
MS032B1	6	<2	900	0.10	0.03	0.05	3.98	0.07
				In-house Standard Moss Sample				
STD	10	<2	250	0.28	0.85	0.07	14.8	0.07
STD	10	<2	260	0.32	0.83	0.08	13.8	0.06
STD	10	<2	300	0.29	1.6	0.08	13.6	0.06
STD	10	<2	240	0.31	0.69	0.08	14.5	0.06
STD	10	<2	250	0.34	1.0	0.08	13.3	0.06
STD	10	<2	260	0.29	0.94	0.07	13.1	0.07

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Radial Arc Sites					
LA001A1	634945	1490138	2.5	12	1.5	17	3.2	0.74	5.1	0.07
LA001B1	634945	1490138	2.7	9.3	1.3	19	2.9	0.82	5.4	0.07
LA002A1	635023	1490346	1.9	9.8	0.97	16	2.7	0.64	7.3	0.05
LA002B1	635023	1490346	2.7	8.9	1.4	15	3.0	0.75	6.9	0.08
LA003A1	635004	1490727	2.7	8.8	1.6	12	2.5	0.61	5.0	0.07
LA003B1	635004	1490727	3.3	8.8	2.1	17	2.7	0.72	3.7	0.10
LA004A1	634854	1491006	4.9	7.0	3.5	8.9	2.2	0.67	2.2	0.09
LA004B1	634854	1491006	3.3	9.0	2.6	13	2.8	0.61	3.3	0.08
LA005A1	634802	1491202	3.9	7.6	2.1	13	2.7	0.75	3.9	0.10
LA005B1	634802	1491202	3.1	9.2	1.7	18	3.1	0.71	4.8	0.07
LA006A1	634706	1491851	3.8	8.4	1.6	16	3.0	0.56	4.7	0.09
LA006B1	634706	1491851	2.5	9.8	1.3	13	3.2	0.63	7.4	0.04
LA006B2	634706	1491851	2.4	9.6	1.2	15	3.1	0.58	6.7	0.05
LA007A1	635158	1490638	3.8	9.2	2.0	14	3.0	0.91	4.7	0.10
LA007B1	635158	1490638	3.9	8.0	2.1	14	2.7	0.91	4.8	0.20
LA032A1	634256	1492900	3.8	6.5	2.6	12	2.6	0.94	2.8	0.20
LA032B1	634256	1492900	3.6	6.6	2.4	15	2.6	0.89	3.3	0.20
LA040A1	633640	1493514	3.3	9.4	2.2	16	2.7	0.87	3.9	0.23
LA040B1	633640	1493514	2.1	9.9	1.6	14	3.4	0.74	5.2	0.10
					Control Traverse Sites					
LC0.5A1	635935	1490701	3.0	8.3	1.9	18	2.6	0.83	4.1	0.20
LC0.5B1	635935	1490701	3.4	7.1	2.0	13	2.4	0.79	4.4	0.20
LC0.5C1	635935	1490701	3.4	8.0	2.1	14	2.7	0.85	3.5	0.20
LC1.0A1	635936	1490735	2.8	8.2	1.8	13	2.8	0.90	4.1	0.10
LC1.0B1	635936	1490735	3.0	7.5	1.9	12	2.8	0.79	5.1	0.10
LC1.0C1	635936	1490735	2.8	8.0	1.8	18	2.7	1.0	4.0	0.10
LC1.5A1	635935	1490836	4.1	7.3	2.5	15	2.3	0.94	4.1	0.22
LC1.5B1	635935	1490836	3.1	6.4	1.9	13	2.4	0.76	3.8	0.20
LC1.5C1	635935	1490836	3.7	6.1	2.3	13	2.4	0.84	4.5	0.20
LC3.0A1	635950	1491135	2.6	9.5	1.5	13	3.1	0.78	6.8	0.08
LC3.0B1	635950	1491135	1.5	9.8	0.86	14	3.4	0.64	8.2	0.03
LC3.0C1	635950	1491135	1.5	8.6	0.86	15	3.2	0.61	8.1	0.04
LC7.5A1	635950	1491753	2.2	7.1	1.2	15	2.9	0.84	10	0.02
LC7.5A2	635950	1491753	2.2	7.0	1.2	15	2.9	0.83	9.7	0.02
LC7.5B1	635950	1491753	2.0	9.0	1.2	10	3.0	0.78	8.0	0.06
LC008A1	640111	1492416	1.0	10	0.66	8.4	3.9	0.54	9.5	0.03
LC008B1	640111	1492416	1.3	8.6	0.85	22	3.9	0.76	11	0.03
LC008B2	640111	1492416	1.3	7.8	0.88	21	3.6	0.74	10	0.04
LC016A1	635934	1492905	1.5	10	0.84	17	3.3	0.59	7.7	0.04
LC016B1	635934	1492905	1.2	8.3	0.68	19	2.8	0.55	8.4	0.03

Table A2.--Chemical analyses for *Peltigera aphthosa* samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Meteorological Sites					
LM000A1	634326	1485804	2.1	7.1	1.2	23	2.5	1.1	7.1	0.05
LM000B1	634326	1485804	2.0	6.8	1.1	19	2.4	0.82	8.0	0.06
LM001A1	635117	1485808	4.2	7.3	2.4	15	2.2	0.84	6.0	0.20
LM001A2	635117	1485808	4.2	7.3	2.5	14	2.3	0.86	6.0	0.20
LM001B1	635117	1485808	2.9	8.7	1.7	16	3.0	0.75	5.2	0.10
LM006A1	634808	1485654	2.7	10	1.7	13	2.7	0.77	4.5	0.10
LM006B1	634808	1485654	3.3	9.2	1.9	13	2.8	0.71	5.3	0.10
					Nenana River Traverse Sites					
LN000A1	635120	1485638	5.7	6.9	3.5	10	2.2	0.71	3.0	0.23
LN000B1	635120	1485638	6.5	5.8	4.0	9.7	2.0	0.76	2.5	0.26
LN0.5A1	635109	1485729	2.7	8.7	1.7	13	2.7	0.61	8.6	0.04
LN0.5B1	635109	1485729	3.6	7.7	2.1	15	2.5	0.83	6.0	0.20
LN0.5C1	635109	1485729	5.4	6.8	3.1	10	2.4	0.95	2.8	0.23
LN001A1	635047	1485652	2.8	9.0	1.9	13	2.8	0.77	4.2	0.10
LN001B1	635047	1485652	3.1	8.8	2.1	15	2.3	0.70	4.7	0.10
LN001B2	635047	1485652	3.2	8.9	2.2	13	2.4	0.71	5.1	0.10
LN001C1	635047	1485652	4.0	7.9	3.1	17	2.5	0.75	4.1	0.21
LN002A1	635028	1485804	3.5	6.6	2.1	17	2.7	0.93	4.1	0.10
LN002B1	635028	1485804	2.4	7.4	1.5	18	3.1	0.69	5.2	0.08
LN002C1	635028	1485804	2.7	9.2	1.7	17	3.0	0.70	5.2	0.08
LN004A1	634942	1490013	3.2	10	1.9	13	3.1	0.85	5.6	0.10
LN004B1	634942	1490013	3.2	8.5	1.9	14	2.6	0.69	4.3	0.10
LN004C1	634942	1490013	2.9	8.4	1.5	12	2.8	0.65	5.8	0.07
LN008A1	634619	1485407	3.0	11	1.7	11	3.0	0.73	4.1	0.10
LN008B1	634619	1485407	3.6	8.4	2.0	15	3.1	0.82	3.1	0.10
LN008C1	634619	1485407	3.8	7.4	2.0	14	2.7	0.90	3.2	0.20
LN016A1	634258	1485335	2.0	9.5	1.2	18	3.3	0.90	5.6	0.05
LN016B1	634258	1485335	2.1	9.8	1.2	20	3.2	1.0	6.2	0.07
LN016C1	634258	1485335	2.0	12	1.2	14	3.3	0.93	4.8	0.07
LN025A1	633741	1484720	2.2	11	1.2	13	3.1	0.99	4.9	0.08
LN025B1	633741	1484720	1.9	9.7	1.0	14	2.9	0.83	5.9	0.05
LN040A1	633030	1484901	4.0	8.1	1.9	12	2.7	1.5	4.2	0.20
LN040B1	633030	1484901	3.3	7.9	1.6	17	2.9	1.3	6.0	0.10
LN080A1	631839	1493323	4.0	7.7	1.7	14	2.5	1.5	4.1	0.10
LN080B1	631839	1493323	3.4	8.9	1.5	17	2.4	1.3	4.5	0.10

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
				Stampede Trail Traverse Sites						
LS0.5A1	635123	1485739	5.6	8.1	3.4	7.2	2.1	0.96	1.8	0.30
LS0.5B1	635123	1485739	5.1	8.2	3.1	10	2.3	0.86	2.5	0.21
LS0.5C1	635123	1485739	5.5	7.6	3.3	8.8	2.1	0.90	2.5	0.23
LS1.0A1	635138	1485757	4.4	9.8	2.7	12	2.5	0.69	4.1	0.20
LS1.0A2	635138	1485757	4.4	9.5	2.8	12	2.5	0.68	3.9	0.21
LS1.0B1	635138	1485757	4.3	9.8	2.7	11	2.6	0.72	3.2	0.20
LS1.0C1	635138	1485757	4.8	8.9	2.9	12	2.5	0.76	4.0	0.21
LS1.5A1	635156	1485816	5.4	8.9	3.3	9.3	2.4	0.73	3.0	0.22
LS1.5B1	635156	1485816	4.9	8.7	3.0	13	2.5	0.73	3.9	0.22
LS1.5C1	635156	1485816	5.8	8.7	3.5	8.8	2.4	0.79	3.2	0.20
LS2.0A1	635230	1485818	5.8	8.1	3.7	8.6	2.3	0.76	1.8	0.28
LS2.0B1	635230	1485818	7.0	7.4	4.6	8.5	2.3	0.80	1.8	0.32
LS2.0C1	635230	1485818	5.9	9.0	3.6	7	2.2	0.75	1.7	0.27
LS004A1	635239	1490122	3.3	6.9	2.1	17	2.5	0.80	3.4	0.20
LS004B1	635239	1490122	3.4	6.5	2.2	14	2.4	0.77	3.9	0.20
LS004C1	635239	1490122	3.2	6.0	2.1	11	2.2	0.73	4.0	0.10
LS004C2	635239	1490122	3.2	6.1	2.2	16	2.2	0.75	4.2	0.10
LS006A1	635328	1490242	2.5	7.7	1.7	16	2.9	0.69	6.9	0.07
LS006A2	635328	1490242	2.5	7.8	1.7	16	2.9	0.70	7.5	0.05
LS006B1	635328	1490242	3.4	7.1	2.3	13	2.7	0.86	5.5	0.10
LS006C1	635328	1490242	3.1	8.1	2.0	15	3.1	0.96	4.8	0.10
LS008A1	635328	1490720	2.9	7.8	1.6	12	2.7	0.79	5.8	0.09
LS008B1	635328	1490720	2.6	7.3	1.5	13	2.5	0.82	6.4	0.10
LS008B2	635328	1490720	2.8	7.8	1.6	16	2.7	0.89	7.3	0.07
LS008C1	635328	1490720	2.9	7.9	1.7	16	2.7	1.0	6.5	0.10
LS008C2	635328	1490720	2.8	7.9	1.6	13	2.7	0.98	5.9	0.09
LS014A1	635244	1491158	2.7	9.2	1.5	13	2.9	0.96	5.9	0.10
LS014B1	635244	1491158	2.1	9.2	1.4	17	3.0	0.78	8.6	0.04
LS016A1	635225	1491513	1.5	8.9	0.82	15	3.3	0.73	7.5	0.03
LS016B1	635225	1491513	1.3	9.2	1.0	17	3.4	0.57	7.5	0.03
LS025A1	635411	1492415	1.5	8.9	0.82	19	2.9	0.68	8.6	0.03
LS025B1	635411	1492415	1.1	9.1	0.63	18	3.5	0.53	14	0.01
LS032A1	640414	1494727	1.9	10	1.1	14	3.0	0.70	6.4	0.07
LS032B1	640414	1494727	1.3	11	1.0	15	3.0	0.55	4.0	0.06
				In-house Standard Lichen-Sample						
STD			5.5	5.9	3.1	9.3	2.4	1.8	1.9	0.10
STD			5.4	6.0	3.0	9.9	2.5	1.7	2.1	0.20
STD			6.1	6.0	3.3	9.6	2.4	2.0	1.9	0.26
STD			6.1	6.0	3.3	9.2	2.4	1.9	2.1	0.30
STD			5.9	6.0	3.2	8.8	2.5	1.9	2.0	0.21
STD			5.9	6.1	3.3	10	2.5	1.9	2.20	0.24

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
Radial Arc Sites										
LA001A1	6000	600	7	31	10	39	340	10	20	8
LA001B1	11000	610	6	42	10	29	340	20	21	10
LA002A1	9300	520	5	24	10	34	340	20	10	8
LA002B1	12000	770	6	27	20	33	290	20	20	10
LA003A1	5200	490	<4	34	10	40	360	<8	29	9
LA003B1	10000	580	<4	67	20	31	250	10	37	10
LA004A1	2600	700	6	99	27	59	230	10	52	20
LA004B1	3400	670	4	100	27	50	250	10	56	10
LA005A1	7800	710	7	60	24	47	300	20	33	10
LA005B1	6100	690	5	46	20	29	290	20	27	20
LA006A1	8600	520	4	48	20	34	350	20	25	20
LA006B1	17000	330	7	20	10	33	320	10	21	9
LA006B2	16000	580	7	31	10	27	330	20	21	10
LA007A1	9300	620	6	46	20	52	310	10	10	20
LA007B1	8600	920	5	38	10	38	320	20	21	20
LA032A1	3800	970	10	30	20	57	220	10	20	26
LA032B1	3500	1100	6	33	20	73	280	20	20	23
LA040A1	1800	660	7	42	10	50	200	10	23	10
LA040B1	2400	540	6	30	10	35	230	9	20	10
Control Traverse Sites										
LC0.5A1	6500	580	9	36	20	47	300	10	20	10
LC0.5B1	5200	590	5	33	10	51	220	9	20	10
LC0.5C1	4600	300	9	37	20	39	280	10	22	10
LC1.0A1	6300	630	10	31	10	32	350	10	20	10
LC1.0B1	4000	680	9	28	10	51	280	8	20	10
LC1.0C1	4000	680	8	30	10	33	320	10	20	10
LC1.5A1	3300	900	6	46	21	65	330	10	26	20
LC1.5B1	2800	770	5	42	20	56	370	10	20	10
LC1.5C1	2900	880	7	35	20	49	310	9	22	20
LC3.0A1	6600	760	5	29	20	31	280	10	20	10
LC3.0B1	5900	640	8	21	10	24	350	20	9	8
LC3.0C1	7400	640	5	20	9	24	300	9	10	7
LC7.5A1	7100	380	6	23	10	33	290	8	10	9
LC7.5A2	6900	610	5	21	10	36	280	8	10	10
LC7.5B1	8400	520	5	20	10	31	390	10	10	8
LC008A1	9300	460	10	10	10	20	240	10	7	5
LC008B1	8400	670	10	<20	10	20	250	<20	<8	<8
LC008B2	8100	630	9	20	10	27	230	10	10	7
LC016A1	6100	550	8	20	10	21	240	10	8	8
LC016B1	4000	410	5	10	8	22	220	10	6	7

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
					Meteorological Sites					
LM000A1	7000	760	28	20	8	28	270	9	9	10
LM000B1	7700	840	21	20	10	33	190	20	9	10
LM001A1	1700	750	5	41	20	60	210	10	22	20
LM001A2	1700	990	5	35	20	57	210	10	22	20
LM001B1	5200	950	7	30	20	42	270	9	20	10
LM006A1	6200	490	5	29	10	43	350	10	20	10
LM006B1	7600	290	<4	51	20	48	350	10	10	20
					Nenana River Traverse Sites					
LN000A1	2200	270	4	54	25	84	260	10	32	22
LN000B1	2100	380	5	85	31	70	210	24	37	27
LN0.5A1	3800	470	7	38	20	47	240	10	21	10
LN0.5B1	3100	410	8	54	20	40	280	10	27	10
LN0.5C1	1800	530	10	62	22	76	160	10	35	20
LN001A1	2100	270	8	38	10	43	550	10	20	10
LN001B1	3700	360	6	39	20	53	250	10	22	10
LN001B2	4000	480	6	36	20	54	240	9	22	10
LN001C1	2600	510	6	75	22	53	230	10	42	10
LN002A1	7900	470	4	44	20	44	290	10	25	10
LN002B1	8600	590	5	22	10	27	350	10	20	8
LN002C1	5400	380	8	34	20	38	370	10	21	10
LN004A1	3600	650	8	33	21	48	310	10	20	10
LN004B1	5500	540	<4	33	20	48	310	10	20	10
LN004C1	9600	580	5	20	20	42	390	10	20	10
LN008A1	2100	470	5	30	20	38	350	10	20	9
LN008B1	5500	720	<4	31	20	32	270	10	20	10
LN008C1	4700	610	<4	35	20	48	210	20	20	10
LN016A1	3700	430	10	10	8	27	270	<8	7	8
LN016B1	3200	980	10	20	10	30	310	10	9	9
LN016C1	3200	500	10	10	10	28	320	8	7	8
LN025A1	7100	650	10	10	10	22	380	10	7	8
LN025B1	4700	690	5	20	9	26	330	10	6	8
LN040A1	4800	710	6	20	10	21	290	10	10	10
LN040B1	5600	650	5	20	10	23	320	10	10	10
LN080A1	4800	580	6	10	9	22	350	10	10	10
LN080B1	4000	1100	5	20	10	20	220	10	9	10

Table A2.--Chemical analyses for <u>Peltigera</u> <u>aphthosa</u> samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
					Stampede River Traverse Sites					
LS0.5A1	1600	780	10	66	29	65	240	20	37	24
LS0.5B1	2200	430	8	61	26	89	250	20	32	21
LS0.5C1	2100	710	8	55	26	89	250	20	32	23
LS1.0A1	1700	280	8	50	25	62	260	20	24	20
LS1.0A2	1600	270	7	49	24	67	270	10	28	20
LS1.0B1	2800	360	8	44	21	55	350	10	25	20
LS1.0C1	2700	330	8	49	24	81	290	20	24	20
LS1.5A1	2700	580	7	50	30	86	260	20	30	21
LS1.5B1	2400	500	8	53	23	62	290	10	30	20
LS1.5C1	2600	550	7	59	31	100	270	20	31	23
LS2.0A1	1900	690	10	62	31	100	250	20	34	26
LS2.0B1	2500	690	9	69	42	120	270	25	36	32
LS2.0C1	2700	660	8	59	33	86	240	21	33	25
LS004A1	6400	840	6	35	20	58	320	10	21	10
LS004B1	5600	530	<4	42	10	46	270	10	21	10
LS004C1	4900	600	8	36	20	56	350	10	20	10
LS004C2	5100	680	8	40	20	42	340	10	22	10
LS006A1	6500	680	7	44	20	32	280	10	25	10
LS006A2	6600	580	7	39	20	31	260	9	26	9
LS006B1	3900	770	4	59	25	37	240	10	28	10
LS006C1	7400	730	8	50	22	40	280	10	28	10
LS008A1	3900	650	10	26	20	47	320	10	20	10
LS008B1	8700	660	8	21	10	59	290	10	10	10
LS008B2	9700	770	8	26	20	41	280	10	20	10
LS008C1	7200	590	9	32	10	33	320	10	20	10
LS008C2	7000	630	8	22	10	46	340	8	20	10
LS014A1	8600	610	8	25	10	37	370	8	20	9
LS014B1	11000	900	10	42	52	26	380	20	23	8
LS016A1	8700	430	10	20	22	20	320	10	8	7
LS016B1	1300	380	7	25	10	21	450	<8	10	6
LS025A1	4300	640	8	20	10	20	370	8	9	7
LS025B1	8600	820	5	10	10	21	290	8	8	5
LS032A1	7000	670	8	9	10	22	250	10	9	7
LS032B1	2200	500	7	10	10	20	300	<8	8	7
					In-house Standard Lichen Sample					
STD	2300	570	<4	25	20	53	120	10	10	10
STD	2300	580	<4	27	20	64	130	10	10	10
STD	2300	610	<4	32	20	69	120	20	20	10
STD	2300	590	<4	26	20	56	120	10	20	10
STD	2400	580	<4	37	20	69	130	20	10	10
STD	2300	600	<4	29	20	48	120	10	20	10

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Mo, ppm	Nd,ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
					Radial Arc Sites					
LA001A1	10	24	58	28	<5	710	9	33	8	<2
LA001B1	10	22	48	25	5	560	9	34	9	<2
LA002A1	10	20	44	31	<4	610	9	29	6	<2
LA002B1	9	21	44	38	5	530	8	40	7	<2
LA003A1	10	24	48	30	<4	590	10	38	8	<2
LA003B1	8	31	39	36	6	540	10	41	8	<2
LA004A1	<4	46	68	48	9	440	21	52	10	<2
LA004B1	5	48	81	45	6	520	20	38	10	<2
LA005A1	6	21	65	39	7	470	<8	44	10	<2
LA005B1	9	27	92	26	5	520	10	37	9	<2
LA006A1	7	24	62	27	8	560	10	48	8	<2
LA006B1	10	20	43	24	<4	640	10	33	5	<2
LA006B2	10	20	43	24	<4	620	10	33	7	<2
LA007A1	8	22	47	23	9	600	10	67	10	<2
LA007B1	22	22	42	27	9	560	<8	66	10	<2
LA032A1	9	20	59	20	9	410	<8	100	20	<2
LA032B1	9	21	55	20	8	430	<8	92	20	<2
LA040A1	10	25	31	20	8	730	<8	55	21	2
LA040B1	10	20	23	20	5	820	<8	38	10	<2
					Control Traverse Sites					
LC0.5A1	10	20	41	36	7	540	<8	55	10	<2
LC0.5B1	8	20	45	31	7	460	<8	59	10	<2
LC0.5C1	9	27	49	27	7	530	9	62	10	<2
LC1.0A1	10	20	46	37	6	560	<8	52	10	<2
LC1.0B1	8	10	53	27	7	550	8	55	10	<2
LC1.0C1	10	20	48	35	6	580	10	52	10	<2
LC1.5A1	10	28	58	35	9	530	10	78	20	2
LC1.5B1	7	30	48	24	7	470	10	59	10	<2
LC1.5C1	8	25	57	24	8	470	10	67	10	<2
LC3.0A1	10	10	36	28	5	700	<8	42	9	<2
LC3.0B1	10	20	33	30	<4	700	<8	27	6	<2
LC3.0C1	10	9	33	20	<4	590	<8	27	5	<2
LC7.5A1	10	10	55	27	<4	450	<8	35	6	<2
LC7.5A2	10	10	53	29	4	450	<8	34	6	<2
LC7.5B1	20	10	32	25	<4	570	<8	34	6	<2
LC008A1	10	10	38	20	<4	710	<8	20	<4	<2
LC008B1	10	<20	41	20	<8	570	<20	20	<8	<4
LC008B2	10	10	44	24	<5	530	<10	24	<5	<2
LC016A1	10	20	35	20	<4	590	<8	25	6	<2
LC016B1	9	10	26	20	<4	540	<8	21	4	<2

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Mo, ppm	Nd,ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
					Meteorological Sites					
LM000A1	10	<9	43	27	<4	430	<9	38	7	<2
LM000B1	8	10	44	25	<4	400	<8	40	6	<2
LM001A1	9	25	48	29	9	510	8	75	10	<2
LM001A2	8	27	49	28	9	510	10	76	10	<2
LM001B1	10	10	42	27	6	650	<8	53	9	<2
LM006A1	7	20	36	36	5	590	<8	41	7	<2
LM006B1	<4	32	44	30	8	620	10	53	10	<2
					Nenana River Traverse Sites					
LN000A1	10	30	57	32	10	600	10	100	20	<2
LN000B1	<4	20	62	50	10	530	<8	110	20	<2
LN0.5A1	9	23	52	35	5	670	10	48	10	<2
LN0.5B1	9	20	52	44	8	610	<8	62	10	<2
LN0.5C1	9	29	56	52	10	540	8	90	20	<2
LN001A1	20	35	46	27	7	720	10	53	10	<2
LN001B1	10	20	43	32	7	680	<8	65	10	<2
LN001B2	10	10	43	35	7	700	<8	60	10	<2
LN001C1	20	35	51	75	9	660	8	69	20	<2
LN002A1	9	23	54	20	8	460	9	54	10	<2
LN002B1	10	10	61	10	5	500	<8	36	8	<2
LN002C1	10	23	53	23	5	640	9	39	9	<2
LN004A1	9	22	61	53	8	670	10	45	10	<2
LN004B1	7	20	51	50	6	650	<8	48	9	<2
LN004C1	10	21	44	38	4	530	10	41	8	<2
LN008A1	9	20	34	42	5	710	<8	42	8	<2
LN008B1	10	20	33	28	7	510	<8	50	9	<2
LN008C1	9	21	34	37	7	490	8	53	9	<2
LN016A1	9	9	25	41	<4	610	<8	32	6	<2
LN016B1	20	20	33	41	<6	660	<10	35	7	3
LN016C1	10	10	23	39	<4	730	<8	33	6	<2
LN025A1	10	10	26	40	<4	730	<8	34	7	<2
LN025B1	10	20	28	38	<4	660	8	32	7	<2
LN040A1	9	10	34	37	6	570	<8	52	10	<2
LN040B1	7	10	37	36	5	540	<8	45	9	<2
LN080A1	10	20	34	22	4	590	<8	46	10	<2
LN080B1	10	20	20	20	4	730	<8	42	10	<2

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Mo, ppm	Nd,ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	Th, ppm	V, ppm	Y, ppm	Yb, ppm
					Stampede Trail Traverse Sites					
LS0.5A1	9	36	75	32	10	690	10	130	22	2
LS0.5B1	9	30	71	33	10	720	<8	120	22	<2
LS0.5C1	8	30	72	43	10	650	10	120	22	<2
LS1.0A1	10	25	63	40	10	910	<8	97	20	2
LS1.0A2	10	27	63	33	10	870	9	98	20	<2
LS1.0B1	10	26	65	43	10	940	9	99	20	2
LS1.0C1	10	27	67	36	10	840	9	100	20	2
LS1.5A1	10	27	73	42	10	810	9	120	23	2
LS1.5B1	10	26	68	38	10	790	<8	110	20	2
LS1.5C1	10	27	84	50	20	790	<8	130	25	2
LS2.0A1	8	32	86	28	20	730	10	130	26	3
LS2.0B1	10	35	99	37	20	710	10	160	29	3
LS2.0C1	10	37	83	33	20	820	10	130	27	3
LS004A1	10	21	40	52	7	440	10	57	10	<2
LS004B1	10	20	39	50	8	450	<8	61	10	<2
LS004C1	10	10	38	57	7	410	<8	57	10	<2
LS004C2	10	20	40	62	7	430	<8	56	10	<2
LS006A1	9	22	42	31	5	520	<8	38	9	<2
LS006A2	9	22	41	37	5	530	9	38	9	<2
LS006B1	5	34	51	31	8	500	20	50	10	<2
LS006C1	10	31	48	36	6	560	10	46	10	<2
LS008A1	10	20	47	29	5	550	<8	51	9	<2
LS008B1	10	10	38	25	5	480	<8	46	7	<2
LS008B2	10	10	42	32	5	510	<8	46	8	<2
LS008C1	10	26	44	34	6	520	20	50	10	<2
LS008C2	20	30	46	24	5	500	20	49	9	<2
LS014A1	64	10	40	41	5	570	<8	39	7	<2
LS014B1	20	23	84	29	5	650	<8	31	20	<2
LS016A1	10	10	35	27	<4	610	<8	23	4	<2
LS016B1	23	20	54	10	<4	660	<8	23	10	<2
LS025A1	9	10	40	28	<4	610	<8	25	5	<2
LS025B1	10	<8	42	20	<4	630	<8	23	4	<2
LS032A1	10	10	33	21	<4	700	<8	31	6	<2
LS032B1	20	<8	46	10	<4	780	<8	25	8	<2
					In-house Standard Lichen Sample					
STD	<4	10	43	20	10	480	<8	100	10	<2
STD	<4	10	43	10	10	480	<8	100	10	<2
STD	<4	23	46	20	10	520	<8	110	20	<2
STD	4	20	46	20	10	510	<8	110	10	<2
STD	<4	20	46	<8	10	500	<8	110	10	<2
STD	<4	20	47	10	10	510	<8	110	10	2

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
				Radial Arc Sites		
LA001A1	1500	0.09	<0.03	0.04	3.19	0.13
LA001B1	1700	0.12	0.04	0.06	2.60	0.11
LA002A1	1700	0.11	0.05	0.06	3.01	0.12
LA002B1	1800	0.11	0.04	0.05	3.09	0.11
LA003A1	1500	0.13	0.03	0.08	2.53	0.13
LA003B1	1200	0.16	0.03	0.06	3.15	0.10
LA004A1	1100	0.38	0.04	0.07	4.70	0.13
LA004B1	1300	0.24	0.03	0.09	7.29	0.14
LA005A1	1500	0.21	0.03	0.05	3.30	0.12
LA005B1	1800	0.16	<0.03	0.05	2.99	0.13
LA006A1	1800	0.15	0.06	0.08	2.97	0.14
LA006B1	1600	0.10	0.04	0.10	2.90	0.13
LA006B2	1700	0.11	0.04	0.05	3.09	0.14
LA007A1	1500	0.19	0.05	0.10	2.67	0.09
LA007B1	1300	0.21	0.06	0.06	2.93	0.10
LA032A1	1100	0.18	0.06	0.05	3.86	0.10
LA032B1	860	0.26	0.07	0.03	3.63	0.11
LA040A1	1100	0.15	0.04	0.06	2.94	0.12
LA040B1	940	0.14	<0.03	0.10	2.91	0.10
				Control Traverse Sites		
LC0.5A1	1200	0.15	0.05	0.05	3.29	0.13
LC0.5B1	1000	0.22	0.05	0.06	3.65	0.14
LC0.5C1	1100	0.22	0.06	0.06	3.82	0.16
LC1.0A1	1400	0.15	0.04	0.05	3.09	0.14
LC1.0B1	1500	0.18	0.05	0.05	3.62	0.15
LC1.0C1	1800	0.18	0.07	0.05	3.37	0.13
LC1.5A1	800	0.23	0.06	0.07	3.41	0.10
LC1.5B1	730	0.19	0.06	0.04	3.41	0.12
LC1.5C1	670	0.21	0.08	0.04	3.19	0.11
LC3.0A1	1000	0.09	0.07	0.04	2.39	0.09
LC3.0B1	1200	0.08	0.04	0.05	2.41	0.09
LC3.0C1	1500	0.11	0.03	0.06	2.39	0.10
LC7.5A1	1400	0.08	<0.03	N.D.	2.48	0.09
LC7.5A2	1400	0.09	0.05	N.D.	2.40	0.08
LC7.5B1	1600	0.07	0.04	0.11	2.15	0.12
LC008A1	2400	0.05	<0.03	0.08	2.15	0.10
LC008B1	2600	0.08	<0.03	0.10	2.40	0.09
LC008B2	2400	0.06	<0.03	0.05	2.40	0.11
LC016A1	1300	0.08	0.04	0.03	2.38	0.09
LC016B1	1400	0.08	<0.03	0.05	2.27	0.08

N.D., Not determined due to insufficient sample.

Table A2.--Chemical analyses for Peltigera aphthosa samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
			Meteorological Sites			
LM000A1	1100	0.10	0.05	0.06	3.04	0.08
LM000B1	1300	0.08	0.08	0.07	3.26	0.10
LM001A1	840	0.27	0.04	0.06	4.31	0.13
LM001A2	830	0.27	0.06	0.06	4.28	0.14
LM001B1	1000	0.10	<0.03	0.09	2.88	0.10
LM006A1	1700	0.13	0.04	0.10	3.05	0.14
LM006B1	1800	0.20	0.09	0.17	3.54	0.17
			Nenana River Traverse Sites			
LN000A1	660	0.54	0.13	0.13	6.22	0.16
LN000B1	710	0.62	0.18	N.D.	7.47	0.16
LN0.5A1	1200	0.17	0.06	0.10	3.65	0.12
LN0.5B1	1200	0.16	<0.03	0.12	3.25	0.12
LN0.5C1	1000	0.38	<0.03	0.14	4.02	0.10
LN001A1	1300	0.11	0.05	0.08	3.18	0.12
LN001B1	1100	0.16	0.07	0.08	3.45	0.16
LN001B2	1000	0.15	0.05	0.12	3.82	0.14
LN001C1	780	0.23	0.07	0.04	3.21	0.13
LN002A1	1400	0.25	0.05	0.08	3.44	0.16
LN002B1	1700	0.14	0.04	0.06	3.02	0.15
LN002C1	2100	0.20	0.05	0.06	3.19	0.15
LN004A1	2400	0.15	0.05	0.10	2.80	0.12
LN004B1	2000	0.15	0.06	0.08	3.44	0.16
LN004C1	1700	0.15	0.04	0.06	2.66	0.12
LN008A1	1400	0.08	0.04	0.12	2.80	0.13
LN008B1	1200	0.14	0.03	0.04	3.18	0.14
LN008C1	1100	0.16	0.04	0.05	3.18	0.12
LN016A1	1700	<0.05	0.03	0.07	2.63	0.10
LN016B1	860	0.09	0.05	0.04	2.36	0.08
LN016C1	1400	0.09	0.03	0.05	2.64	0.12
LN025A1	1800	0.09	0.04	0.05	2.53	0.10
LN025B1	1700	0.08	0.05	0.06	2.54	0.11
LN040A1	1100	0.14	0.04	0.05	2.85	0.09
LN040B1	1000	0.13	0.03	0.08	3.01	0.09
LN080A1	1000	0.13	0.03	0.04	3.57	0.14
LN080B1	1100	0.13	0.06	0.06	3.71	0.11

Table A2.--Chemical analyses for <u>Peltigera aphthosa</u> samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

Sample ID	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
			Stampede Trail Traverse			
LS0.5A1	550	0.91	0.32	0.09	7.50	0.16
LS0.5B1	580	0.57	0.24	0.07	5.70	0.16
LS0.5C1	590	0.68	0.23	0.08	6.04	0.15
LS1.0A1	920	0.34	0.12	0.08	4.39	0.16
LS1.0A2	910	0.33	0.12	N.D.	4.32	0.17
LS1.0B1	1100	0.27	0.12	0.08	3.81	0.13
LS1.0C1	670	0.28	0.11	0.10	4.42	0.14
LS1.5A1	970	0.36	0.18	0.09	4.47	0.14
LS1.5B1	880	0.30	0.13	0.09	4.05	0.12
LS1.5C1	1000	0.51	0.19	0.07	4.71	0.13
LS2.0A1	640	0.74	0.28	0.09	6.51	0.16
LS2.0B1	650	1.10	0.34	0.08	6.77	0.16
LS2.0C1	750	0.69	0.26	0.09	5.76	0.16
LS004A1	990	0.13	0.04	0.05	2.93	0.12
LS004B1	870	0.16	0.04	0.08	3.68	0.11
LS004C1	1300	0.12	0.03	0.06	2.01	0.10
LS004C2	1400	0.13	0.04	0.03	2.18	0.09
LS006A1	1000	0.11	0.03	0.06	2.57	0.10
LS006A2	990	0.08	<0.03	0.12	2.76	0.09
LS006B1	760	0.17	0.04	0.04	3.21	0.09
LS006C1	1400	0.21	0.04	0.05	3.38	0.12
LS008A1	1200	0.12	0.03	0.06	2.43	0.11
LS008B1	1200	0.14	0.04	0.08	2.30	0.09
LS008B2	1200	0.10	<0.03	0.08	2.66	0.09
LS008C1	1300	0.09	0.04	0.08	2.54	0.08
LS008C2	1300	0.13	0.05	0.03	2.28	0.10
LS014A1	1800	0.10	0.04	0.08	2.42	0.09
LS014B1	1600	0.07	<0.03	0.07	2.37	0.11
LS016A1	1600	0.07	<0.03	0.05	2.02	0.08
LS016B1	1600	<0.05	<0.03	0.04	2.47	0.14
LS025A1	1200	0.08	0.04	0.03	2.51	0.09
LS025B1	1900	0.06	0.05	0.07	2.63	0.08
LS032A1	1800	0.09	<0.03	0.05	2.65	0.10
LS032B1	1300	0.14	0.03	0.04	3.30	0.13
			In-house Standard Lichen Sample			
STD	460	0.21	0.47	0.08	5.53	0.09
STD	500	0.19	0.51	0.09	5.70	0.09
STD	450	0.22	1.30	0.07	6.63	0.09
STD	440	0.19	0.50	0.10	6.35	0.08
STD	480	0.17	0.74	0.07	5.52	0.08
STD	460	0.25	0.48	0.12	6.23	0.08

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	K, %	Ti, %
					Radial Arc Sites					
SA001A1	634945	1490138	9.7	2.0	5.8	3.4	0.86	0.81	0.24	0.26
SA002A1	635023	1490346	9.1	0.83	4.2	3.1	0.67	0.89	0.29	0.36
SA002A2	635023	1490346	9.3	0.84	4.4	3.0	0.69	0.88	0.30	0.33
SA003A1	635004	1490727	7.3	1.0	4.4	2.5	0.63	0.81	0.14	0.17
SA004A1	634854	1491006	7.0	0.38	4.7	2.6	0.65	0.67	0.08	0.15
SA005A1	634802	1491202	7.9	0.42	5.0	2.8	0.63	0.61	0.14	0.16
SA006A1	634706	1491851	6.4	0.44	2.3	2.2	0.36	0.32	0.08	0.14
SA007A1	635158	1490638	7.9	0.93	4.0	2.0	0.69	1.1	0.16	0.42
SA032A1	634256	1492900	7.8	1.7	4.2	1.6	1.0	1.2	0.16	0.50
SA040A1	633640	1493514	7.5	7.2	5.1	1.9	1.5	1.2	0.35	0.61
					Control Traverse Sites					
SC0.5A1	635935	1490701	7.1	2.0	3.7	2.0	1.0	1.3	0.13	0.35
SC1.0A1	640111	1492416	7.2	2.2	3.6	2.1	0.99	1.3	0.14	0.33
SC1.5A1	635934	1492905	7.5	1.6	3.8	1.9	0.94	1.2	0.18	0.34
SC3.0A1	635935	1490836	8.0	1.2	3.5	2.0	0.81	1.2	0.20	0.37
SC7.5A1	635950	1491753	8.1	1.5	3.4	2.1	0.81	1.1	0.24	0.39
SC7.5A2	635950	1491753	8.2	1.5	3.5	2.1	0.82	1.2	0.25	0.39
SC008A1	635936	1490735	6.7	1.6	3.7	1.5	0.98	1.2	0.17	0.37
SC016A1	635950	1491135	6.7	1.5	3.1	2.0	0.83	1.1	0.23	0.33
					Meteorological Sampling Sites					
SM000A1	634326	1485804	8.2	1.9	5.3	1.5	0.99	1.1	0.39	0.39
SM001A1	635117	1485808	6.6	1.7	3.7	1.7	0.89	1.1	0.15	0.36
SM006A1	634808	1485654	9.0	3.5	4.5	2.7	0.94	1.1	0.17	0.34
					Nenana River Traverse Sites					
SN000A1	635120	1485638	6.9	1.2	3.7	2.1	0.84	1.0	0.12	0.30
SN0.5A1	635109	1485729	6.5	1.7	3.5	1.7	1.0	1.3	0.15	0.33
SN001A1	635047	1485652	7.1	6.4	4.1	2.1	1.6	1.1	0.33	0.38
SN002A1	635028	1485804	7.3	1.3	3.9	2.2	1.0	1.2	0.18	0.35
SN004A1	634942	1490013	7.2	1.3	5.0	1.9	1.0	1.0	0.09	0.37
SN004A2	634942	1490013	7.3	1.3	5.1	2.0	1.0	1.0	0.10	0.38
SN004B1	634942	1490013	7.4	5.6	7.3	2.5	1.4	0.73	0.43	0.19
SN008A1	634619	1485407	7.0	9.3	5.5	1.8	1.4	1.2	0.32	0.30
SN016A1	634258	1485335	6.9	8.3	4.2	1.7	2.0	1.3	0.61	0.34
SN025A1	633741	1484720	6.1	11	3.5	1.3	1.1	1.3	0.57	0.30
SN040A1	633030	1484901	7.3	2.9	4.4	1.7	1.3	1.3	0.40	0.45
SN080A1	631839	1493323	7.2	1.0	3.0	1.6	0.77	1.4	0.28	0.49
SN080A2	631839	1493323	7.3	1.1	3.0	1.7	0.78	1.4	0.28	0.47

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	K, %	Ti, %
					<u>Stampede Trail Traverse Sites</u>					
SS0.5A1	635123	1485739	6.8	1.9	3.7	1.9	1.1	1.3	0.10	0.38
SS1.0A1	635138	1485757	7.3	2.7	3.7	1.8	1.1	1.2	0.17	0.36
SS1.5A1	635156	1485816	6.6	1.5	3.7	1.7	1.0	1.3	0.11	0.42
SS2.0A1	635230	1485818	6.7	1.9	3.7	1.8	1.1	1.4	0.09	0.36
SS004A1	635239	1490122	6.7	0.79	4.1	2.0	0.61	0.91	0.11	0.23
SS006A1	635328	1490242	7.1	0.71	4.1	2.0	0.68	1.0	0.14	0.27
SS008A1	635328	1490720	8.8	0.74	4.0	2.2	0.71	1.1	0.15	0.33
SS014A1	635244	1491158	7.7	1.5	14	2.0	0.78	0.89	0.70	0.26
SS014A2	635244	1491158	7.6	1.5	14	1.9	0.77	0.89	0.69	0.25
SS016A1	635225	1491513	8.2	2.9	5.6	2.7	1.2	0.91	0.98	0.24
SS025A1	635411	1492415	7.3	0.97	3.4	2.1	0.84	0.99	0.50	0.23
SS032A1	640414	1494727	7.7	3.3	4.4	1.9	1.2	1.1	0.49	0.47

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Mn, ppm	Ag, ppm	As, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
					Radial Arc Sites					
SA001A1	3300	<2	10	640	2	<2	170	38	91	98
SA002A1	1500	<2	10	1100	2	<2	110	21	89	45
SA002A2	1500	<2	10	1100	2	<2	120	21	87	45
SA003A1	1000	<2	20	780	2	<2	98	19	71	43
SA004A1	760	<2	10	680	2	<2	100	21	63	49
SA005A1	890	<2	10	820	2	<2	110	27	67	43
SA006A1	580	<2	<10	650	2	<2	94	11	54	24
SA007A1	460	<2	10	1200	2	<2	78	18	81	49
SA032A1	550	<2	10	1300	1	<2	58	19	130	54
SA040A1	2000	<2	20	1000	2	<2	74	22	75	45
					Control Traverse Sites					
SC0.5A1	590	<2	10	1200	2	<2	68	16	90	41
SC1.0A1	740	<2	20	1000	2	<2	67	17	87	46
SC1.5A1	410	<2	10	1200	2	<2	74	22	80	37
SC3.0A1	480	<2	10	1200	2	<2	82	14	89	33
SC7.5A1	410	<2	10	1300	2	<2	85	15	95	51
SC7.5A2	410	<2	10	1300	2	<2	95	15	90	53
SC008A1	950	<2	10	1100	1	<2	50	18	81	37
SC016A1	740	<2	<10	2900	1	<2	65	19	72	33
					Meteorological Sampling Sites					
SM000A1	1600	2	10	1500	2	7	80	34	99	140
SM001A1	1000	<2	10	1100	1	<2	60	17	74	33
SM006A1	680	<2	10	920	2	<2	88	23	88	51
					Nenana River Traverse Sites					
SN000A1	700	<2	10	980	1	<2	76	16	59	32
SN0.5A1	1200	<2	10	1200	1	<2	52	18	78	36
SN001A1	2100	<2	10	570	2	3	79	21	75	75
SN002A1	2900	<2	20	1100	2	<2	94	66	88	37
SN004A1	1200	<2	21	870	1	<2	66	26	100	60
SN004A2	1300	<2	20	890	2	<2	60	26	110	61
SN004B1	13000	<2	10	500	2	<2	85	90	89	120
SN008A1	7000	<2	10	350	1	<2	66	30	65	88
SN016A1	2800	<2	20	630	1	7	49	26	95	120
SN025A1	3700	<2	10	420	1	5	42	27	83	70
SN040A1	1000	<2	22	690	1	5	48	24	97	74
SN080A1	640	<2	25	910	<1	<2	41	10	84	27
SN080A2	650	<2	24	930	1	<2	46	10	84	28

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Mn, ppm	Ag, ppm	As, ppm	Ba, ppm	Be, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
					Stampede Trail Traverse Sites					
SS0.5A1	770	<2	10	1200	1	<2	71	18	87	39
SS1.0A1	1000	<2	10	1400	1	2	63	21	93	44
SS1.5A1	870	<2	20	1100	1	<2	79	18	85	37
SS2.0A1	690	<2	10	1000	1	<2	68	18	87	34
SS004A1	470	<2	10	730	1	<2	82	17	68	35
SS006A1	450	<2	10	820	2	<2	110	19	58	33
SS008A1	310	<2	10	1100	2	<2	91	15	89	39
SS014A1	360	<2	20	550	2	<2	99	31	92	85
SS014A2	360	<2	24	240	2	2	87	30	96	84
SS016A1	2000	<2	10	150	2	7	110	130	100	99
SS025A1	490	3	10	1300	1	3	51	22	95	43
SS032A1	3100	<2	10	1200	2	3	69	36	100	63

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Ga, ppm	La, ppm	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm
					Radial Arc Sites					
SA001A1	26	110	24	<2	8	90	93	23	20	170
SA002A1	24	61	27	<2	8	46	39	25	17	140
SA002A2	26	67	28	<2	6	52	38	24	17	140
SA003A1	18	54	25	<2	<4	41	37	23	12	110
SA004A1	17	55	24	<2	<4	43	43	24	12	65
SA005A1	20	61	28	<2	5	48	44	31	14	82
SA006A1	16	53	22	<2	<4	43	22	16	11	75
SA007A1	19	43	26	2	10	32	36	16	17	170
SA032A1	18	32	35	4	11	30	39	20	17	170
SA040A1	23	38	30	2	12	44	32	18	19	590
					Control Traverse Sites					
SC0.5A1	17	37	25	<2	8	32	41	17	15	210
SC1.0A1	18	36	26	<2	7	33	47	17	14	230
SC1.5A1	18	42	25	<2	8	35	39	20	15	210
SC3.0A1	22	46	25	<2	8	36	30	16	15	210
SC7.5A1	20	52	25	2	10	43	31	19	17	200
SC7.5A2	21	56	26	<2	8	49	32	14	17	200
SC008A1	16	27	27	<2	7	23	39	15	14	190
SC016A1	17	36	35	<2	8	30	37	17	13	170
					Meteorological Sampling Sites					
SM000A1	21	44	29	3	8	44	86	39	22	210
SM001A1	15	34	28	<2	8	29	37	18	14	170
SM006A1	24	48	33	<2	6	37	39	23	17	230
					Nenana River Traverse Sites					
SN000A1	17	43	23	<2	7	36	34	21	13	170
SN0.5A1	16	30	28	<2	8	24	38	35	13	200
SN001A1	20	44	28	3	10	43	53	50	15	410
SN002A1	18	51	25	<2	8	41	42	20	15	160
SN004A1	17	36	26	<2	7	33	47	28	16	140
SN004A2	18	32	27	<2	7	32	49	25	16	140
SN004B1	26	51	30	3	<4	44	150	30	14	310
SN008A1	23	38	20	2	6	40	74	20	14	400
SN016A1	19	28	25	4	7	35	84	21	17	570
SN025A1	17	23	21	9	6	29	48	17	13	640
SN040A1	18	26	34	<2	7	26	61	26	18	260
SN080A1	22	23	34	4	10	20	20	13	14	190
SN080A2	24	25	35	3	9	22	20	11	14	200

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Ga, ppm	La, ppm	Li, ppm	Mo, ppm	Nb, ppm	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm
					Stampede Trail Traverse Sites					
SS0.5A1	16	40	27	2	9	34	39	19	14	210
SS1.0A1	18	35	31	<2	8	32	44	31	16	360
SS1.5A1	15	42	30	<2	10	35	42	21	14	200
SS2.0A1	16	38	27	<2	7	32	38	15	14	180
SS004A1	16	45	24	<2	5	36	32	20	12	110
SS006A1	21	62	23	<2	5	46	35	19	13	120
SS008A1	24	52	27	<2	4	41	30	15	17	150
SS014A1	16	53	21	22	4	49	65	24	19	200
SS014A2	16	45	21	21	<4	42	64	23	18	190
SS016A1	20	58	27	8	6	58	96	30	23	350
SS025A1	18	29	24	3	<4	24	48	20	13	170
SS032A1	21	37	27	4	10	34	54	21	16	280

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
					Radial Arc Sites					
SA001A1	26	110	40	4	200	4.6	0.18	0.12	45.0	0.16
SA002A1	18	130	11	1	180	3.8	0.17	0.13	44.1	0.10
SA002A2	19	130	11	1	190	3.7	0.15	0.12	44.2	0.10
SA003A1	15	81	8	<1	180	4.1	0.11	0.14	46.3	0.11
SA004A1	19	70	8	<1	160	8.3	0.12	0.12	85.2	0.11
SA005A1	22	83	9	<1	170	6.0	0.12	0.11	56.5	0.11
SA006A1	18	69	5	<1	120	11	0.32	0.09	67.3	0.08
SA007A1	12	130	14	1	110	3.8	0.12	0.10	57.0	0.07
SA032A1	7	180	19	2	100	5.7	0.49	0.13	65.0	0.12
SA040A1	9	110	34	3	230	2.6	0.18	0.11	32.2	0.19
					Control Traverse Sites					
SC0.5A1	11	110	15	1	130	5.1	0.20	0.09	57.9	0.10
SC1.0A1	12	110	18	2	100	6.2	0.34	0.07	66.3	0.11
SC1.5A1	11	120	13	1	110	3.9	0.31	0.09	51.6	0.08
SC3.0A1	11	130	12	1	79	3.9	0.23	0.10	56.2	0.08
SC7.5A1	11	140	19	2	110	3.1	0.28	0.13	48.8	0.11
SC7.5A2	14	140	19	2	110	3.4	0.24	0.12	48.7	0.12
SC008A1	5	130	14	1	110	5.0	0.17	0.12	56.4	0.10
SC016A1	9	120	11	1	200	3.0	0.15	0.09	58.3	0.09
					Meteorological Sampling Sites					
SM000A1	10	150	35	3	150	3.8	0.48	0.12	47.6	0.10
SM001A1	10	120	12	1	110	6.9	0.31	0.08	71.6	0.07
SM006A1	12	120	14	1	140	3.7	0.17	0.13	47.8	0.14
					Nenana River Traverse Sites					
SN000A1	15	91	13	1	110	6.7	0.18	0.08	71.5	0.08
SN0.5A1	9	120	13	1	120	7.5	0.48	0.07	76.5	0.06
SN001A1	13	120	20	2	290	3.2	0.52	0.14	35.1	0.22
SN002A1	18	110	17	2	110	9.6	0.32	0.18	60.2	0.11
SN004A1	11	110	16	2	150	14	0.29	0.28	87.6	<0.05
SN004A2	12	110	16	2	160	14	0.30	0.26	85.7	0.05
SN004B1	20	88	22	2	370	3.1	0.32	0.15	28.9	0.22
SN008A1	13	93	23	2	240	2.1	0.27	0.11	34.2	0.23
SN016A1	9	130	27	2	470	1.9	0.31	0.09	20.7	0.17
SN025A1	7	110	16	1	120	1.5	0.39	0.08	20.8	0.20
SN040A1	7	170	15	1	300	3.7	0.27	0.14	23.0	0.13
SN080A1	6	180	9	1	82	7.6	0.25	0.10	57.8	0.13
SN080A2	7	180	9	1	84	9.0	0.23	0.09	57.8	0.13

Table A3.--Chemical analyses for Oa-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Th, ppm	V, ppm	Y, ppm	Yb, ppm	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*	Ash, %*	Total S, %*
					Stampede Trail Traverse Sites					
SS0.5A1	12	110	16	1	100	9.8	0.47	0.07	87.8	0.08
SS1.0A1	11	130	17	2	250	6.1	0.33	0.08	63.1	0.11
SS1.5A1	13	120	17	2	130	8.1	0.36	0.08	83.0	0.05
SS2.0A1	13	110	16	2	110	11	0.51	0.08	83.6	0.06
SS004A1	14	89	8	<1	110	6.1	0.13	0.11	67.0	0.08
SS006A1	13	94	11	<1	87	5.3	0.14	0.10	75.4	0.05
SS008A1	15	140	11	1	98	5.5	0.19	0.06	66.6	0.07
SS014A1	17	150	26	3	170	3.9	0.30	0.09	19.2	0.19
SS014A2	14	140	25	2	170	3.7	0.32	0.09	19.2	0.19
SS016A1	13	130	41	3	410	1.1	0.18	0.13	14.3	0.20
SS025A1	9	130	9	1	210	1.4	0.13	0.13	24.4	0.14
SS032A1	12	130	23	2	200	2.4	0.34	0.10	36.8	0.19

Table A4.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Radial Arc Sites					
PA002B1	635023	1490346	0.10	16	0.10	11	3.3	0.04	4.5	<0.01
PA003A1	635004	1490727	0.40	21	0.30	14	2.5	0.08	2.4	0.01
PA003A2	635004	1490727	0.54	21	0.42	13	2.5	0.09	2.4	0.02
PA003B1	635004	1490727	0.66	18	0.46	14	2.3	0.10	3.0	0.02
PA004A1	634854	1491006	0.60	23	0.46	9.9	1.8	0.09	1.6	0.02
PA004B1	634854	1491006	0.41	19	0.36	16	2.3	0.06	3.0	0.01
PA005A1	634802	1491202	0.36	19	0.35	17	2.8	0.06	3.6	<0.01
PA005B1	634802	1491202	0.33	22	0.26	15	2.6	0.06	2.6	0.01
PA006A1	634706	1491851	0.21	20	0.20	11	2.2	0.04	2.6	<0.01
PA006A2	634706	1491851	0.22	21	0.20	13	2.3	0.05	2.7	<0.01
PA006B1	634706	1491851	0.08	17	0.10	17	2.8	0.04	4.4	<0.01
					Control Traverse Sites					
PC3.0A1	635950	1491135	0.09	14	0.10	12	2.9	0.03	5.2	<0.01
PC7.5A1	635950	1491753	0.10	19	0.09	12	2.6	0.02	5.1	<0.01
PC7.5B1	635950	1491753	0.20	21	0.20	15	3.3	0.03	5.2	<0.01
PC008A1	640111	1492416	0.01	20	0.10	15	3.0	0.03	4.9	<0.01
PC008B1	640111	1492416	0.05	21	0.09	13	2.4	0.04	4.7	<0.01
PC016B1	635934	1492905	0.03	19	0.07	17	2.0	0.02	4.7	<0.01
					Meteorological Sites					
PM000A1	634326	1485804	0.20	23	0.20	10	1.9	0.06	2.2	0.01
PM000B1	634326	1485804	0.31	27	0.21	7.6	1.2	0.07	1.5	0.01
					Nenana River Traverse Sites					
PN0.5A1	635109	1485729	0.20	20	0.20	12	2.4	0.04	3.0	<0.01
PN0.5C1	635109	1485729	0.20	18	0.27	13	3.6	0.06	4.9	0.01
PN001A1	635047	1485652	0.10	19	0.20	14	2.2	0.04	3.1	<0.01
PN001B1	635047	1485652	0.10	20	0.20	9.3	2.2	0.04	2.9	<0.01
PN001B2	635047	1485652	0.20	21	0.21	11	2.2	0.04	2.9	<0.01
PN001C1	635047	1485652	0.10	19	0.24	11	2.3	0.04	3.8	<0.01
PN002A1	635028	1485804	0.10	15	0.20	16	2.4	0.04	3.0	<0.01
PN002B1	635028	1485804	0.20	16	0.20	18	1.8	0.04	3.1	<0.01
PN002C1	635028	1485804	0.03	16	0.10	14	3.0	0.04	3.3	<0.01
PN004A1	634942	1490013	0.10	19	0.20	14	2.2	0.04	3.6	<0.01
PN004B1	634942	1490013	0.20	21	0.23	15	2.5	0.06	3.0	0.01
PN004C1	634942	1490013	0.20	20	0.20	11	2.8	0.05	3.8	<0.01
PN004C2	634942	1490013	0.20	20	0.20	10	2.7	0.05	3.6	<0.01
PN016B1	634258	1485335	0.21	17	0.20	18	2.4	0.06	5.3	<0.01
PN016C1	634258	1485335	0.20	22	0.21	9.6	2.6	0.06	3.9	<0.01
PN025A1	633741	1484720	0.24	23	0.22	11	2.0	0.09	1.9	0.01
PN025B1	633741	1484720	0.20	21	0.10	9.5	1.6	0.07	2.2	<0.01
PN040A1	633030	1484901	0.39	24	0.27	9.3	1.6	0.10	2.2	0.01
PN040B1	633030	1484901	0.30	21	0.24	10	2.7	0.10	2.7	0.01
PN080A1	631839	1493323	0.25	24	0.20	14	2.0	0.10	3.6	<0.01
PN080B1	631839	1493323	0.38	17	0.24	12	2.8	0.10	4.2	0.01

Table A4.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					Stampede Trail Traverse					
PS032A1	640414	1494727	0.01	19	0.10	11	2.5	0.03	4.7	<0.01
PS032B1	640414	1494727	0.01	17	0.20	13	3.2	0.04	4.2	<0.01
					In-house White Spruce Standard					
STD			0.85	18	0.61	11	2.5	0.88	3.1	0.04
STD			1.0	18	0.66	13	2.5	0.87	3.2	0.04
STD			0.85	17	0.65	14	2.4	0.87	3.0	0.04
STD			0.96	18	0.70	14	2.6	0.92	3.3	0.06

Table A4.--Chemical analyses for <u>Picea glauca</u> (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
					Radial Arc Sites					
PA002B1	11000	1100	<4	<8	7	8	72	20	<4	<4
PA003A1	8800	1300	<4	9	5	10	59	10	4	10
PA003A2	8800	1400	<4	8	6	20	58	10	5	10
PA003B1	9400	1900	<4	20	6	22	72	10	9	5
PA004A1	3400	2200	<4	9	8	7	52	<8	10	<4
PA004B1	4500	1000	<4	10	6	10	76	<8	6	4
PA005A1	7300	880	<4	<8	5	20	90	<8	5	7
PA005B1	11000	1200	<4	<8	7	10	83	10	<4	8
PA006A1	10000	1200	<4	<8	8	10	76	10	<4	9
PA006A2	9300	1400	<4	<8	9	10	79	10	<4	9
PA006B1	18000	670	<4	<8	6	8	90	20	<4	4
					Control Traverse Sites					
PC3.0A1	8300	850	<4	<8	5	9	83	10	<4	<4
PC7.5A1	9100	1700	<4	<8	5	7	90	9	<4	<4
PC7.5B1	10000	1300	<4	<8	5	10	69	<8	<4	<4
PC008A1	10000	1500	<4	<8	6	8	130	10	<4	<4
PC008B1	13000	800	<4	<8	3	8	78	20	<4	<4
PC016B1	11000	2400	<4	<8	9	7	56	10	<4	4
					Meteorological Sites					
PM000A1	11000	3100	<4	<8	5	10	34	10	<4	<4
PM000B1	7500	3200	<4	<8	7	8	26	8	<4	<4
					Nenana River Traverse Sites					
PN0.5A1	6300	1900	<4	<8	6	7	46	<8	<4	5
PN0.5C1	10000	1700	<4	<8	5	10	92	9	<4	4
PN001A1	3600	1600	<4	<8	5	10	93	<8	<4	8
PN001B1	8600	2800	<4	<8	8	8	69	8	<4	5
PN001B2	8700	1900	<4	<8	8	10	73	10	<4	<4
PN001C1	6300	1700	<4	<8	7	20	80	<8	<4	<4
PN002A1	9100	800	<4	<8	4	10	70	10	<4	4
PN002B1	19000	840	<4	<8	4	10	94	22	<4	<4
PN002C1	5400	1300	<4	<8	5	8	84	9	<4	5
PN004A1	3100	1600	<4	<8	5	7	78	<8	<4	<4
PN004B1	13000	520	<4	<8	4	9	89	10	<4	6
PN004C1	11000	1100	<4	<8	6	10	93	10	<4	<4
PN004C2	9600	950	<4	<8	6	9	87	10	<4	<4
PN016B1	4000	2200	<4	8	5	10	250	<8	<4	<4
PN016C1	14000	1400	<4	<8	5	10	89	20	<4	<4
PN025A1	5100	1900	<4	<8	5	10	53	<8	6	4
PN025B1	7200	2200	<4	<8	5	10	31	8	<4	9
PN040A1	6300	1000	<4	<8	5	10	53	<8	<4	7
PN040B1	8700	2500	<4	<8	6	10	48	10	<4	5
PN080A1	9600	2300	<4	<8	8	10	82	10	<4	4
PN080B1	25000	1200	<4	<8	5	10	110	26	<4	<4

Table A4.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
					Stampede Trail Traverse					
PS032A1	4000	1800	<4	<8	5	10	68	<8	<4	<4
PS032B1	4300	1400	<4	<8	4	10	78	<8	<4	<4
					In-house Standard White Spruce					
STD	14000	850	9	<8	6	67	83	20	<4	6
STD	15000	940	8	9	5	76	80	10	4	8
STD	14000	840	8	<8	6	67	79	20	<4	6
STD	15000	960	7	9	7	63	83	10	<4	7

Table A4.--Chemical analyses for <u>Picea glauca</u> (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Nd, ppm	Ni, ppm	Pb, ppm	Sr, ppm	Th, ppm	V, ppm	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*
					Radial Arc Sites					
PA002B1	8	77	<8	670	<8	<4	1300	<0.05	<0.03	<0.02
PA003A1	20	26	<8	780	<8	5	1700	<0.05	<0.03	0.03
PA003A2	10	27	<8	780	<8	7	1700	<0.05	<0.03	0.03
PA003B1	10	20	<8	910	<8	7	2400	<0.05	<0.03	0.02
PA004A1	27	38	<8	1200	8	8	1900	<0.05	<0.03	0.03
PA004B1	20	52	<8	1100	<8	5	1800	<0.05	<0.03	0.04
PA005A1	<8	99	<8	500	<8	5	2000	<0.05	<0.03	0.03
PA005B1	10	34	<8	940	<8	4	1900	<0.05	<0.03	0.02
PA006A1	10	42	<8	950	<8	<4	1700	<0.05	<0.03	<0.02
PA006A2	9	43	<8	1000	<8	<4	1800	<0.05	<0.03	0.03
PA006B1	<8	53	<8	590	<8	<4	1700	<0.05	<0.03	0.02
					Control Traverse Sites					
PC3.0A1	<8	31	<8	680	<8	<4	1100	<0.05	<0.03	0.03
PC7.5A1	10	34	<8	790	<8	<4	1300	0.33	<0.03	0.05
PC7.5B1	<8	33	<8	560	<8	<4	1600	<0.05	<0.03	0.04
PC008A1	<8	35	<8	860	<8	<4	1800	<0.05	<0.03	0.03
PC008B1	10	10	<8	550	<8	<4	1400	<0.05	<0.03	0.02
PC016B1	9	47	<8	800	<8	<4	1400	<0.05	<0.03	0.03
					Meteorological Sites					
PM000A1	20	10	<8	1100	9	5	1400	<0.05	<0.03	0.05
PM000B1	10	20	<8	1000	<8	6	970	<0.05	<0.03	0.03
					Nenana River Traverse					
PN0.5A1	10	23	<8	1200	<8	<4	970	<0.05	<0.03	0.04
PN0.5C1	10	67	<8	1100	<8	5	3400	<0.05	<0.03	0.03
PN001A1	10	23	<8	1500	<8	<4	2000	0.10	<0.03	0.02
PN001B1	10	20	<8	1000	<8	<4	810	0.65	<0.03	0.03
PN001B2	10	20	<8	1000	<8	<4	820	<0.05	<0.03	<0.02
PN001C1	10	32	<8	1000	8	<4	1000	<0.05	<0.03	0.03
PN002A1	10	20	<8	460	<8	<4	1200	<0.05	<0.03	0.03
PN002B1	<8	38	<8	540	<8	<4	1400	<0.05	<0.03	0.02
PN002C1	10	53	<8	770	<8	<4	2300	<0.05	<0.03	0.02
PN004A1	10	58	<8	1100	<8	<4	1800	<0.05	<0.03	0.03
PN004B1	20	51	<8	1600	<8	4	1700	<0.05	<0.03	0.04
PN004C1	10	41	<8	480	<8	<4	1900	<0.05	<0.03	<0.02
PN004C2	10	38	<8	470	<8	<4	1900	<0.05	<0.03	0.03
PN016B1	<8	20	<8	740	<8	<4	1400	<0.05	<0.03	0.02
PN016C1	20	8	8	980	10	4	2600	<0.05	<0.03	0.03
PN025A1	10	7	<8	1500	<8	4	1300	<0.05	<0.03	0.04
PN025B1	10	7	<8	940	<8	<4	1800	<0.05	<0.03	0.05
PN040A1	20	20	10	830	<8	6	1400	<0.05	<0.03	0.03
PN040B1	10	42	<8	1100	<8	7	1500	<0.05	<0.03	0.02
PN080A1	10	20	<8	2200	<8	<4	2400	<0.05	<0.03	0.03
PN080B1	10	42	<8	890	<8	<4	2100	<0.05	<0.03	0.03

Table A4.--Chemical analyses for <u>Picea glauca</u> (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Nd, ppm	Ni, ppm	Pb, ppm	Sr, ppm	Th, ppm	V, ppm	Zn, ppm	As, ppm*	Se, ppm*	Hg, ppm*
					<u>Stampede Trail Traverse Sites</u>					
PS032A1	10	20	<8	940	<8	<4	2000	<0.05	<0.03	0.02
PS032B1	10	22	<8	1100	<8	<4	2300	<0.05	<0.03	0.04
					<u>In-house Standard White Spruce</u>					
STD	10	20	200	860	<8	20	1400	<0.05	4.0	0.04
STD	<8	21	180	860	<8	20	1500	<0.05	1.8	0.03
STD	10	20	220	840	<8	20	1400	<0.05	3.5	0.04
STD	10	23	200	880	<8	20	1500	<0.05	3.1	0.02

Table A4.--Chemical analyses for Picea glauca (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Ash, %*	Total S, %*
Radial Arc Sites		
PA002B1	3.15	0.08
PA003A1	4.05	0.05
PA003A2	3.88	0.07
PA003B1	3.14	0.07
PA004A1	4.44	0.06
PA004B1	3.90	0.09
PA005A1	3.02	0.07
PA005B1	3.88	0.09
PA006A1	3.38	0.08
PA006A2	3.63	0.08
PA006B1	3.17	0.09
Copntrol Traverse Sites		
PC3.0A1	2.89	0.08
PC7.5A1	3.00	0.08
PC7.5B1	3.44	0.08
PC008A1	2.89	0.08
PC008B1	3.02	0.07
PC016B1	3.65	0.07
Meteorological Sites		
PM000A1	4.66	0.06
PM000B1	5.91	0.08
Nenana River Traverse Sites		
PN0.5A1	3.92	0.07
PN0.5C1	2.40	0.08
PN001A1	3.15	0.06
PN001B1	4.15	0.08
PN001B2	4.31	0.07
PN001C1	3.44	0.08
PN002A1	3.43	0.09
PN002B1	3.63	0.09
PN002C1	3.42	0.08
PN004A1	4.18	0.08
PN004B1	3.65	0.08
PN004C1	3.67	0.09
PN004C2	3.76	0.09
PN016B1	2.98	0.08
PN016C1	2.90	0.09
PN025A1	4.12	0.07
PN025B1	4.31	0.06
PN040A1	4.79	0.06
PN040B1	4.36	0.07
PN080A1	3.88	0.08
PN080B1	3.17	0.09

Table A4.--Chemical analyses for <u>Picea glauca</u> (white spruce) twigs and needles, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

Sample ID	Ash, %*	Total S, %*
	Stampede Trail Traverse Sites	
PS032A1	3.53	0.08
PS032B1	2.38	0.08
	In-house Standard White Spruce	
STD	3.15	0.07
STD	3.62	0.08
STD	3.52	0.07
STD	3.54	0.07

Table A5.--Chemical analyses for miscellaneous lichen samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *).

Sample ID	Latitude	Longitude	Al, %	Ca, %	Fe, %	K, %	Mg, %	Na, %	P, %	Ti, %
					<u>Cladina rangiferina</u>					
CA003B1	635004	1490727	2.8	6.5	1.6	3.9	1.8	0.77	1.4	0.08
CA006B1	634706	1491851	4.2	15	1.8	8.3	4.3	1.40	4.3	0.09
CS025A1	635411	1492415	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
					<u>Usnea</u> Spp.					
UN000A1	635120	1485638	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Sample Id	Mn, ppm	Ba, ppm	Cd, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Ga, ppm	La, ppm	Li, ppm
					<u>Cladina rangiferina</u>					
CA003B1	1200	380	<4	57	9	22	80	<8	36	10
CA006B1	4900	230	8	46	10	30	240	10	30	20
CS025A1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
					<u>Usnea</u> Spp.					
UN000A1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Sample ID	Nd, ppm	Ni, ppm	Pb, ppm	Sc, ppm	Sr, ppm	V, ppm	Y, ppm	Zn, ppm	As, ppm*	Se, ppm*
					<u>Cladina rangiferina</u>					
CA003B1	28	22	21	5	420	31	6	400	N.D.	N.D.
CA006B1	30	38	10	8	1100	45	8	1200	0.09	<0.03
CS025A1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.09	<0.03
					<u>Usnea</u> Spp.					
UN000A1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.51	0.21

Sample ID	Hg, ppm*	Ash, %*	Total S, %*
			<u>Cladina rangiferina</u>
CA003B1	0.06	2.20	<0.05
CA006B1	0.03	1.39	<0.05
CS025A1	0.04	1.59	<0.05
			<u>Usnea</u> Spp.
UN000A1	0.39	N.D.	0.16

N.D., Not determined due to insufficient sample.