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

by

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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 Biomonitor

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 Hylomium 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 AO 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 (NO_x), 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 biomonitoring. 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/m³ (0.06 parts per million (ppm)) SO₂. Sensitive species were severely depleted above 60 ug/m³ (0.02 ppm), and effects were measurable as low as 30 ug/m³ (0.01 ppm) of SO₂. McCune (1988) showed that the variation in lichen community composition and cover were correlated with mean annual ambient air SO₂ levels. A mean annual concentration of 30 ug/m³ (0.01 ppm) of SO₂ 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 nylanderii, Ramalina americana, Rinodina papillata, and Xanthoria fallax were present only when the annual average of SO₂ was less than 13-26 ug/m³. Lichens growing on acid substrates are more sensitive to SO₂ than those growing on basic ones. Anderson and Treshow (1984) mentioned that a correlation between the concentration of atmospheric SO₂ 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 (NO₂). Through photochemical reactions involving the absorption of sunlight and interactions with hydrocarbons and oxygen, atmospheric NO is converted to NO₂, and some NO₂ is consumed in the production of ozone (Taylor and others, 1975).

Nitrogen oxide and NO₂ 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 CO₂ absorption and photosynthesis, while NO₂ 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; Ekweebelam 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 NO₂ (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 (Lapp, 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 (Lapp, 1981a and b).

Lichens have been established as biomonitoring 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 biomonitoring of the proposed HCCP facility. Peltigera aphthosa and Hypolecomium 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 least-

squares equation was used for the regression model and the prediction equation takes the form:

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

where X is the concentration of the element in the receptor material, D is the distance from GVEA, and a and 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 (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 (Hylocomium/Pleurozium/Polytrichum) with scattered clumps of Cladina and Peltigera. 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.

Sampling Plots At Each Site

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 shears. 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°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; Sanzalone 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 on 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 on 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 (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 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.

Zinc and Manganese

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-Traverses 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.

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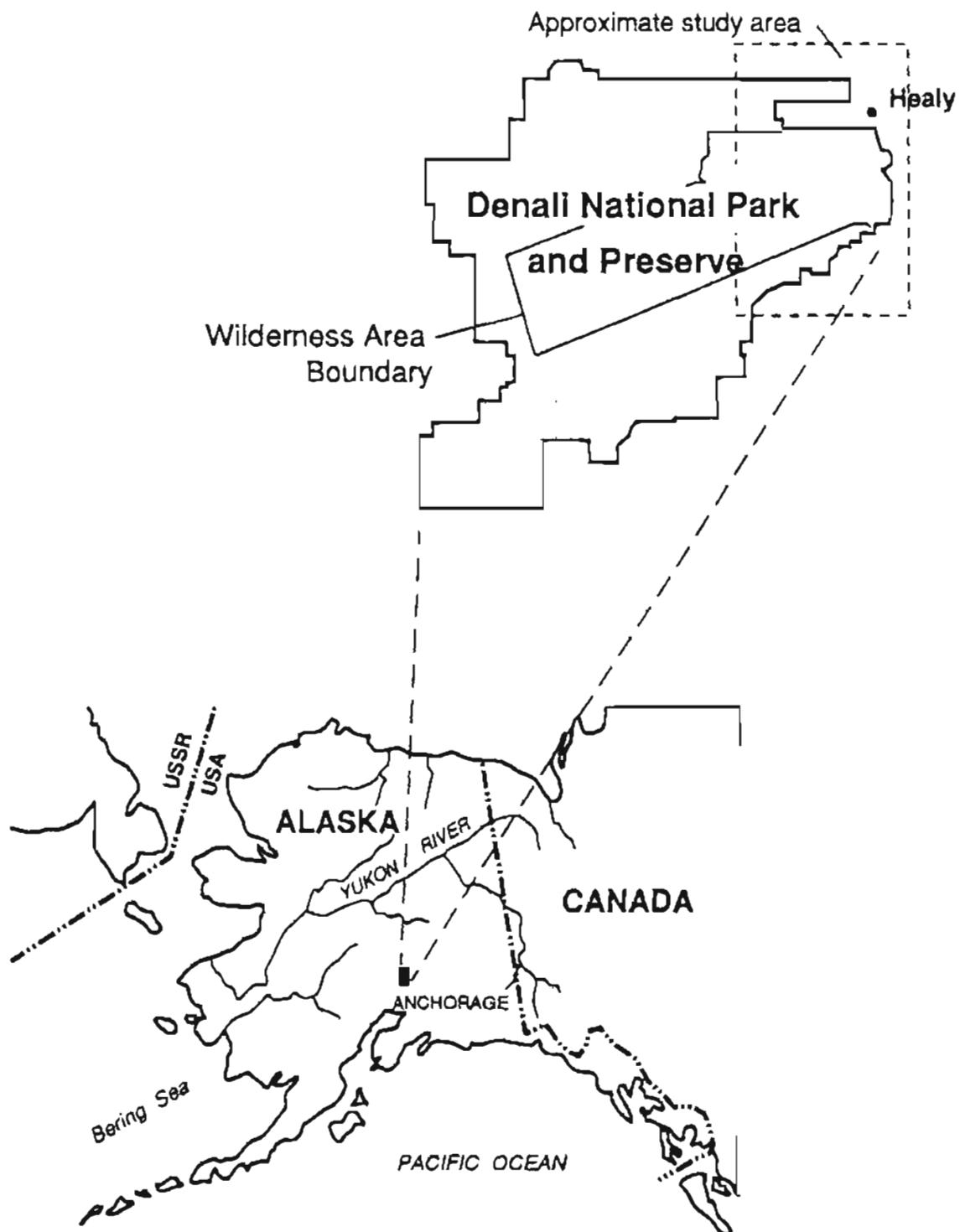


Figure 1. Index map showing location of Denali National Park and Preserve and the surrounding area.

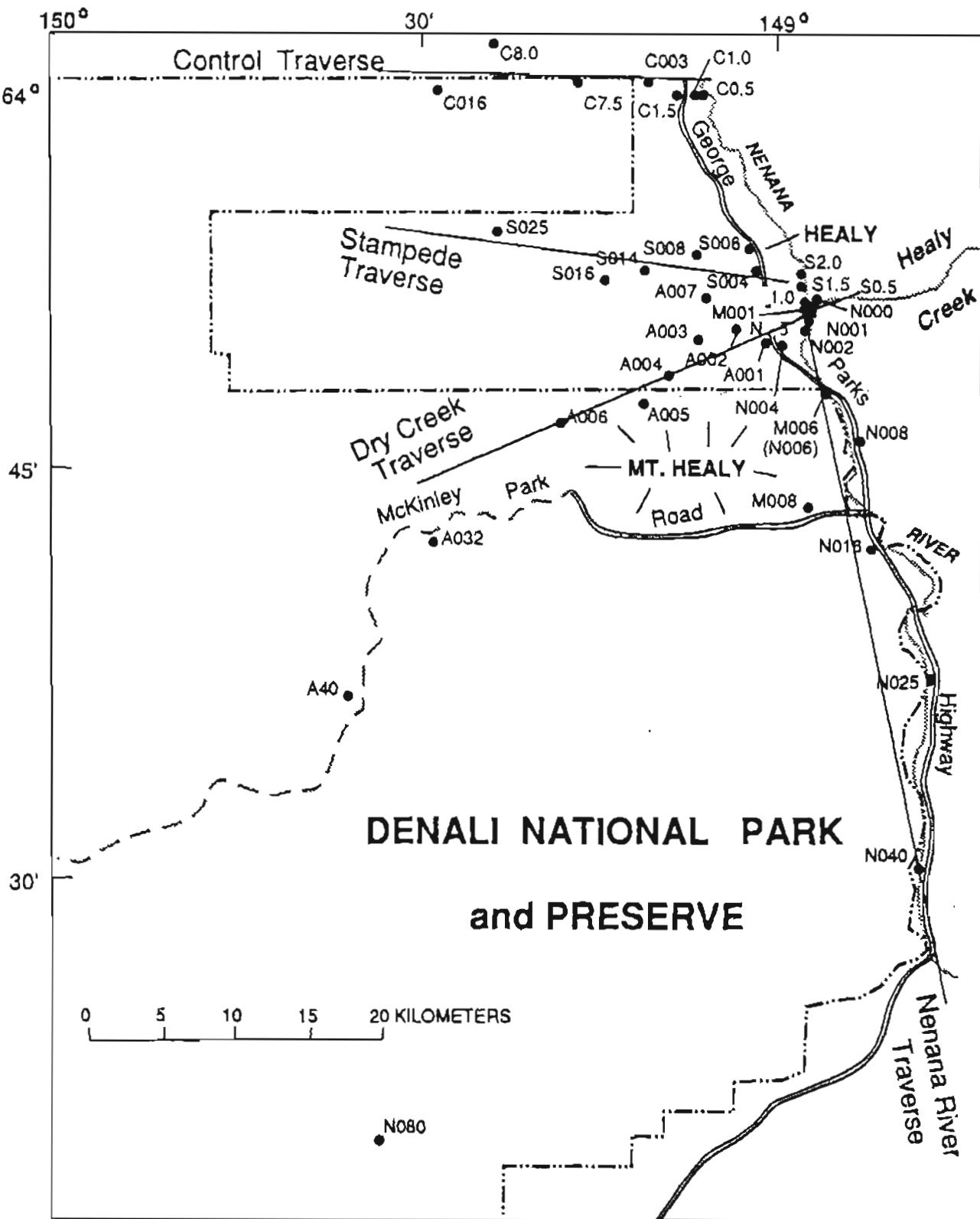


Figure 2. Location of sampling sites in and near the Denali National Park and Preserve

DENALI/HCCP PROJECT FIELD DATA SHEET

Date _____ Collector _____ / Site ID _____ Roll No. _____ Pic. No. _____

SITE LOCATION Lat _____ Long _____
 Waypoints _____ (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. _____

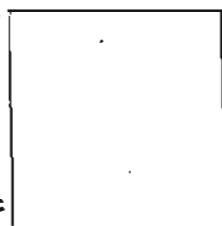
Spruce C: ID _____ DBH _____ Sp. _____
 Height _____ Canopy Class _____

Moss Sample ID _____ Sp. _____
 Lichen Sample ID _____ Sp. _____

SOIL Sample ID

Soil description (color; organic content; horizons; texture; moisture; etc.)

Top



Bottom

of
horizons

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

Sample ID code: A3001C1

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

S = transect (S, Streamer, R, river; T, central

C01 = site no. and distance from SWEA (0.5, 1.0, 1.5, 0.16, etc.)

C = Year sample A, T, or S

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

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

STAMPEDE TRAVERSE

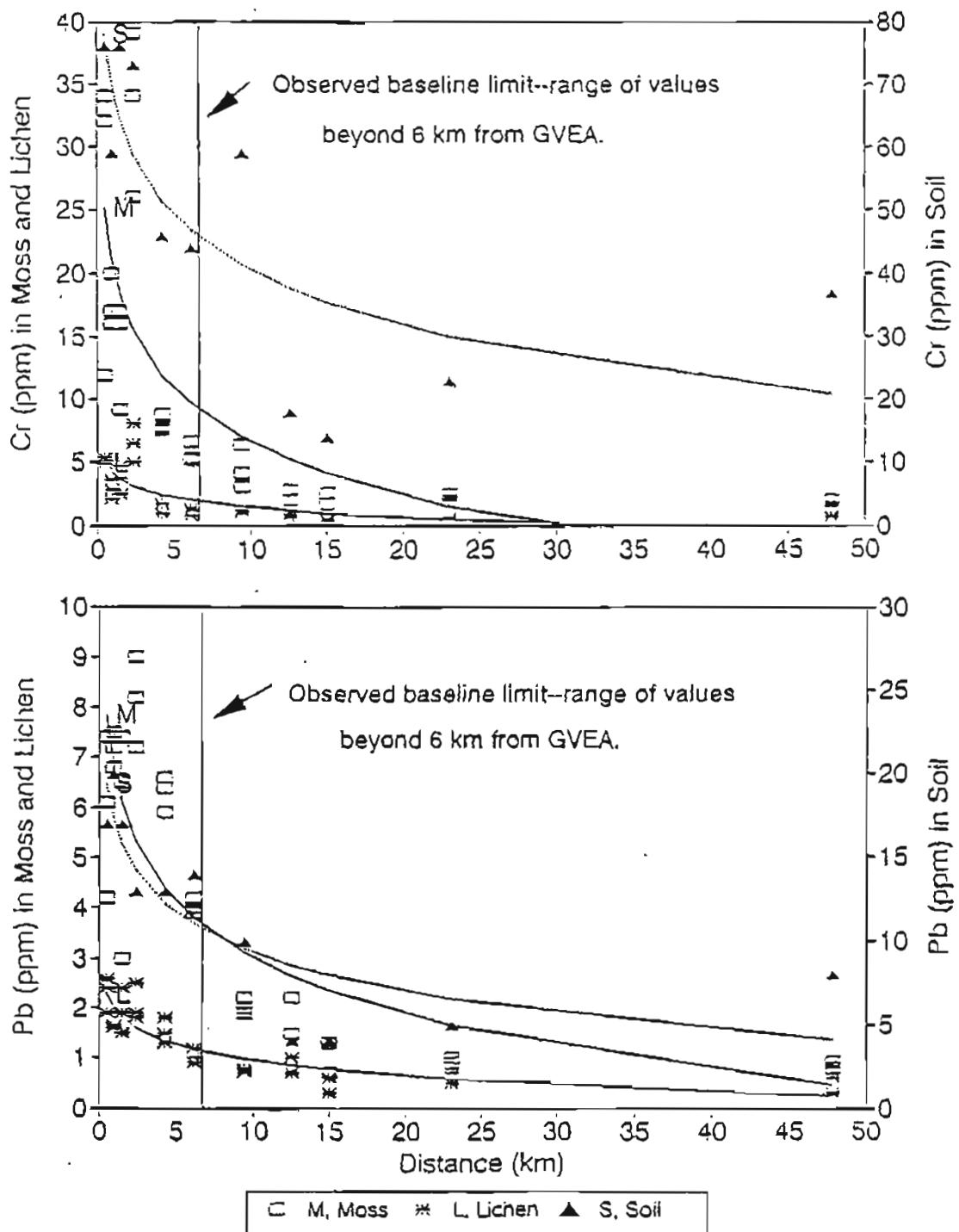


Figure 4. For this study, the observed baseline is defined as the range of element concentration values (dry weight base) for samples collected beyond 6 km from the Golden Valley Electric Association (GVEA) power plant along the Control, Stampede, and Nenana traverses (Tables 17, 18, and 20). As an example,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

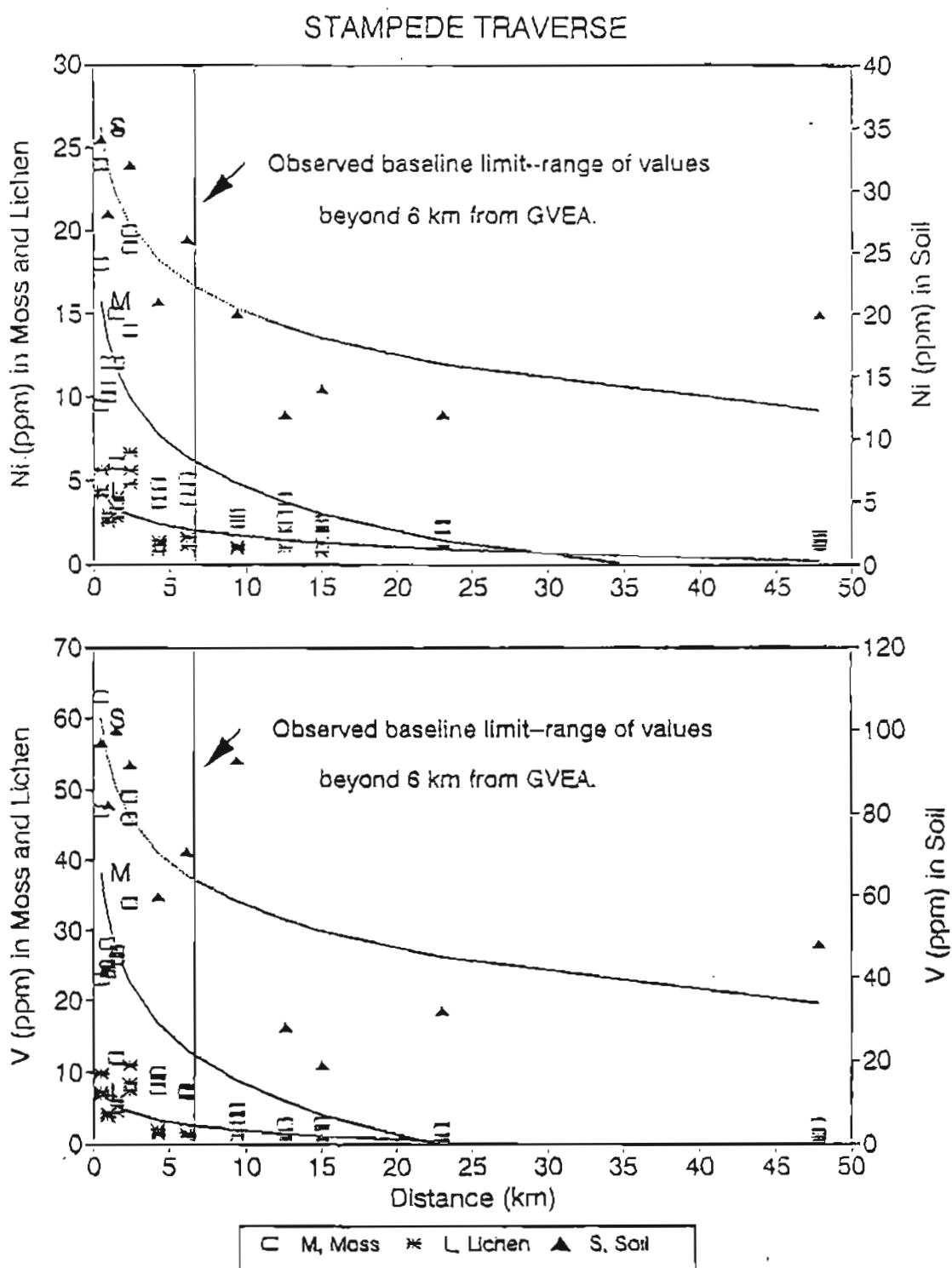


Figure 5. For this study, the observed baseline is defined as the range of element concentration values (dry weight base) for samples collected beyond 6 km from the Golden Valley Electric Association (GVEA) power plant along the Control, Stampede, and Nenana traverses (Tables 17, 18, and 20). As an example,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

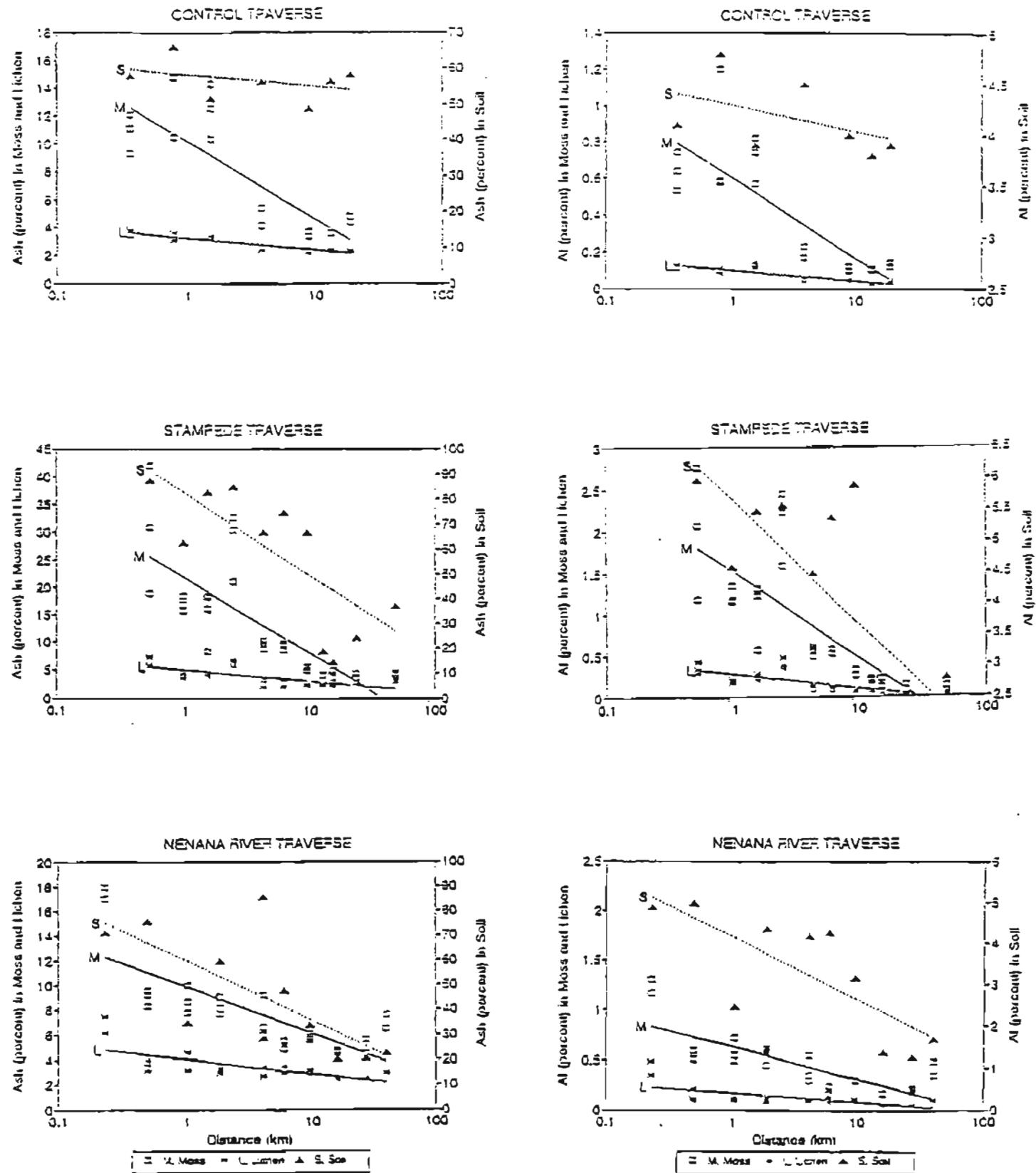


Figure 6. Regression trends for percent ash yield (ash) and aluminum (Al) versus distance from the Golden Valley Electric Association (GVEA) power plant for *Hylocomium splendens* (moss), *Peltigera aphthosa* (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table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

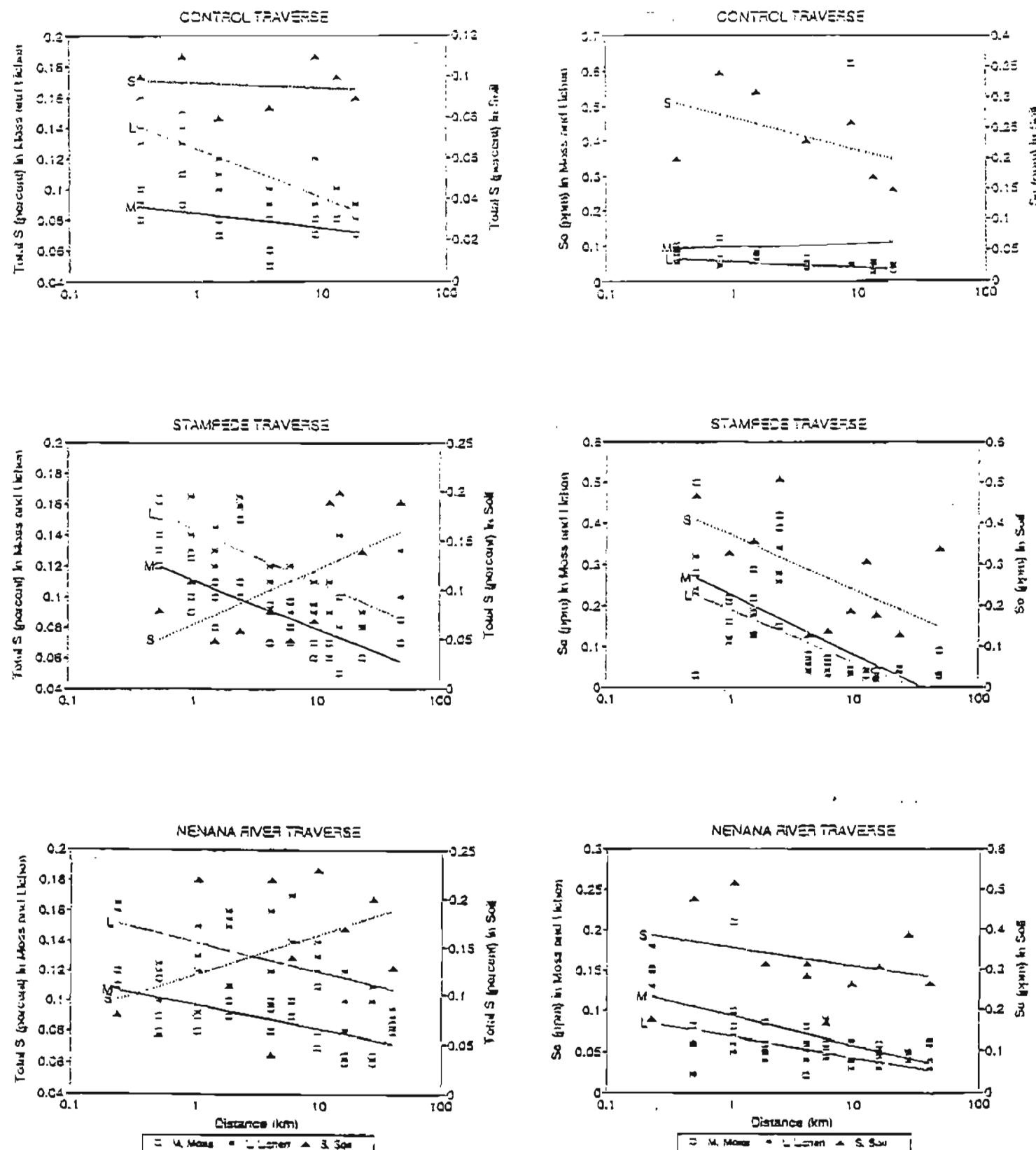


Figura 7. Regression trends for total sulfur (S) and selenium (Se) versus distance from the Golden Valley Electric Association (GVEA) power plant for *Hylocomium splendens* (moss), *Peltigera aphthosa* (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives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

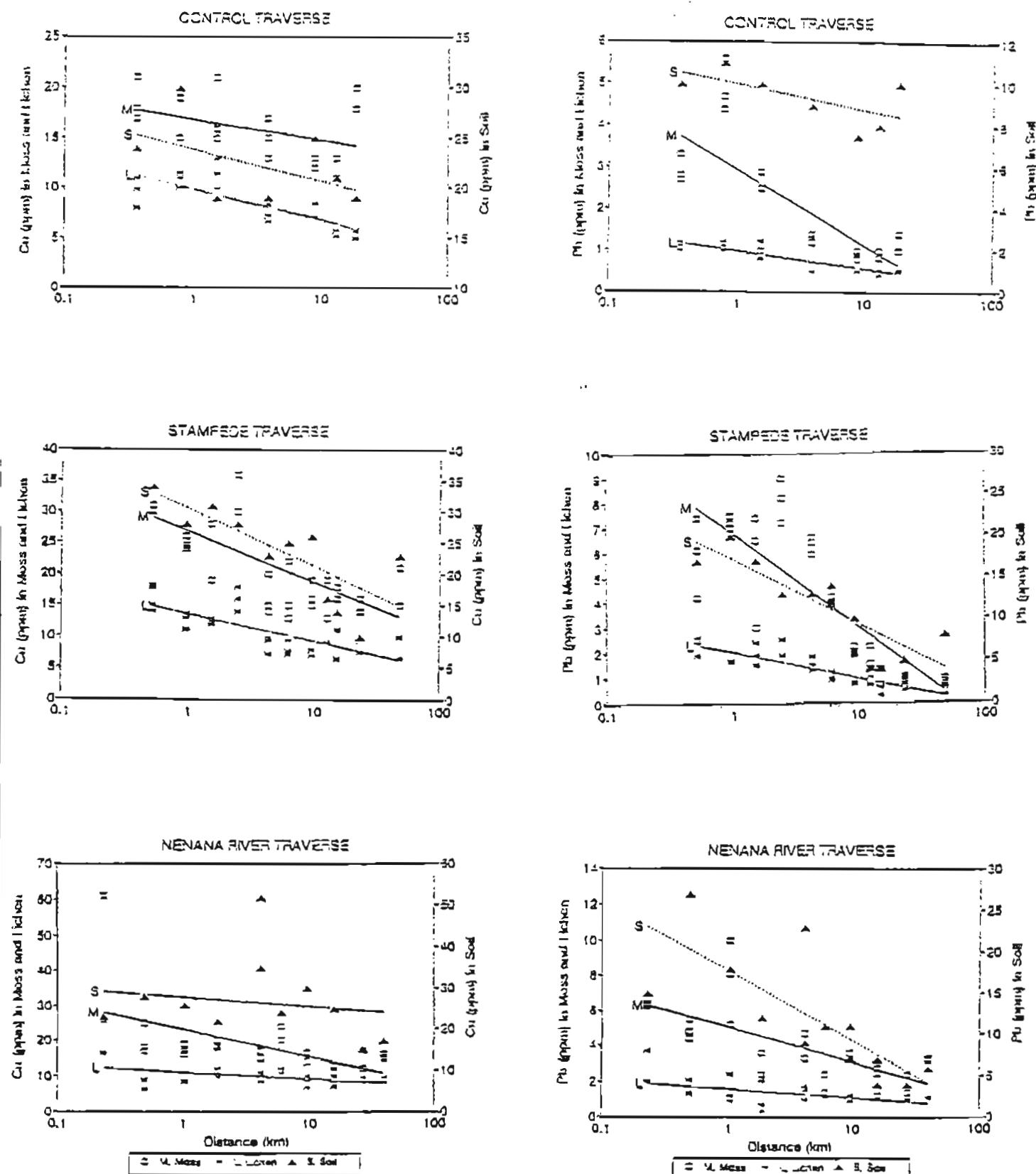


Figure 8. Regression trends for copper (Cu) and lead (Pb) versus distance from the Golden Valley Electric Association (GVEA) power plant for *Hylocomium splendens* (moss), *Peltigera aphthosa* (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression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

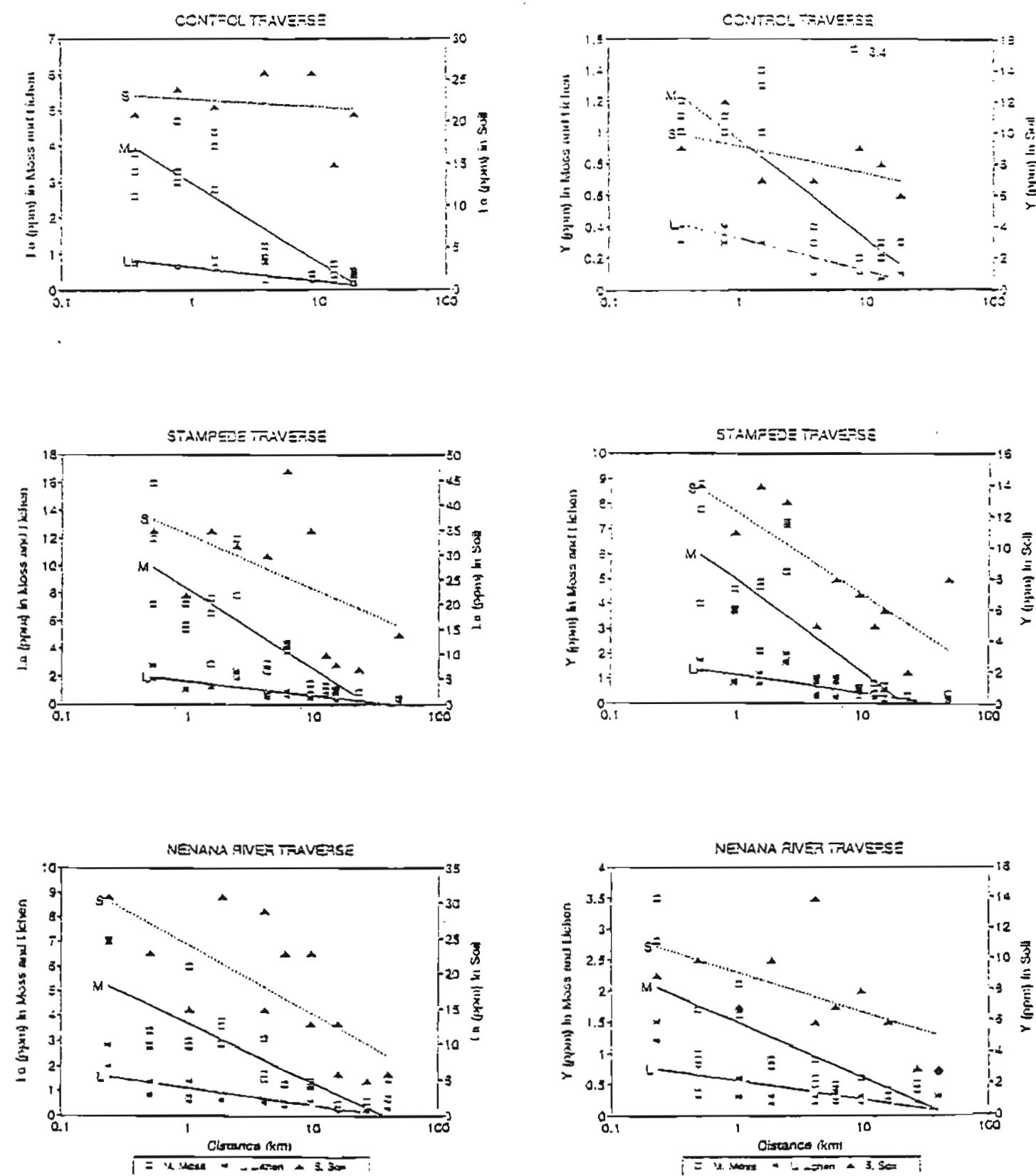


Figure 9. Regression trends for lanthanum (La) and yttrium (Y) versus distance from the Golden Valley Electric Association (GVEA) power plant for *Hylocomium splendens* (moss), *Peltigera aphthosa* (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the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

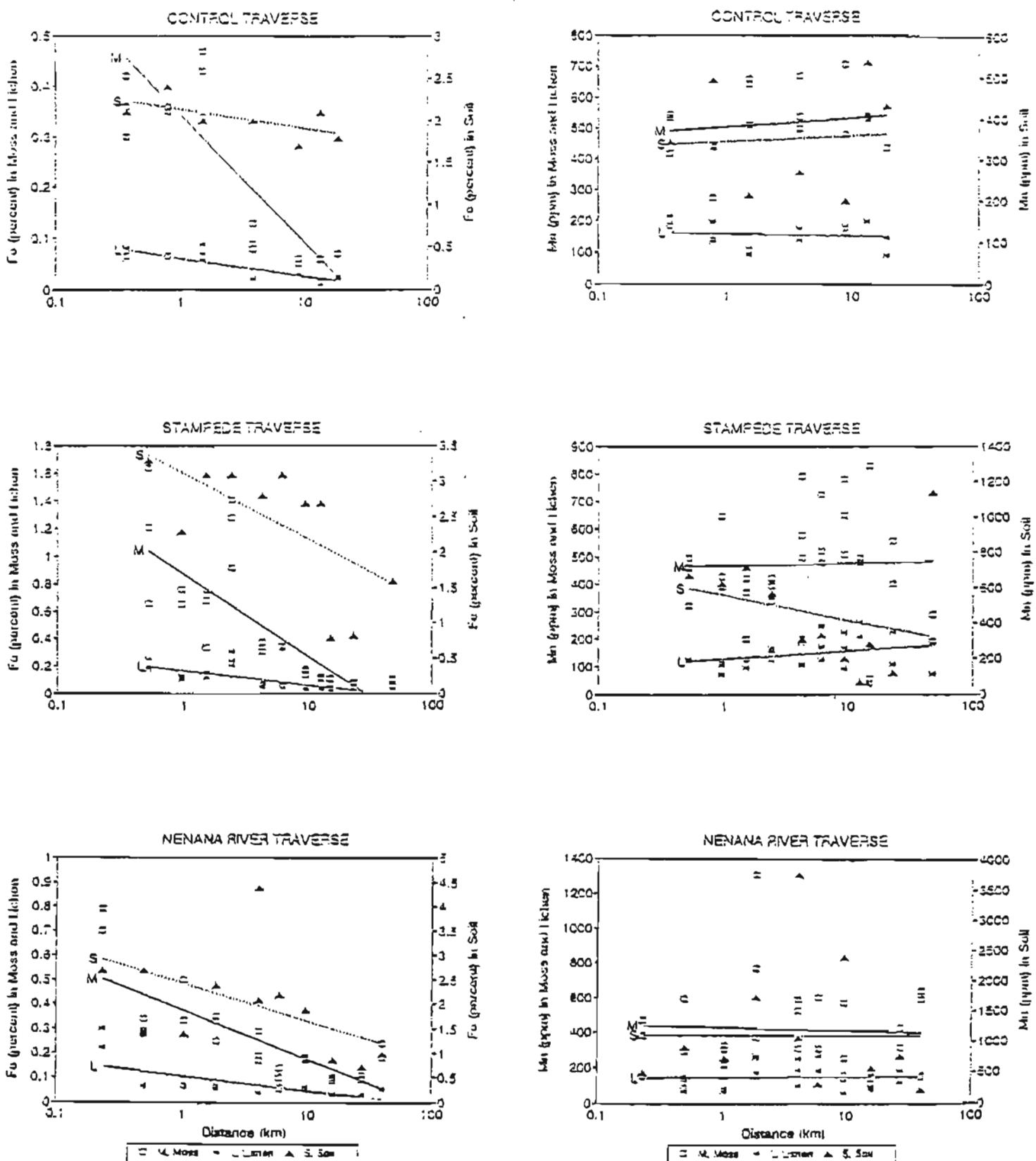


Figure 10. Regression trends for iron (Fe) and manganese (Mn) versus distance from the Golden Valley Electric Association (GVEA) power plant for *Hylocomium splendens* (moss), *Peltigera acanthosa* (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the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

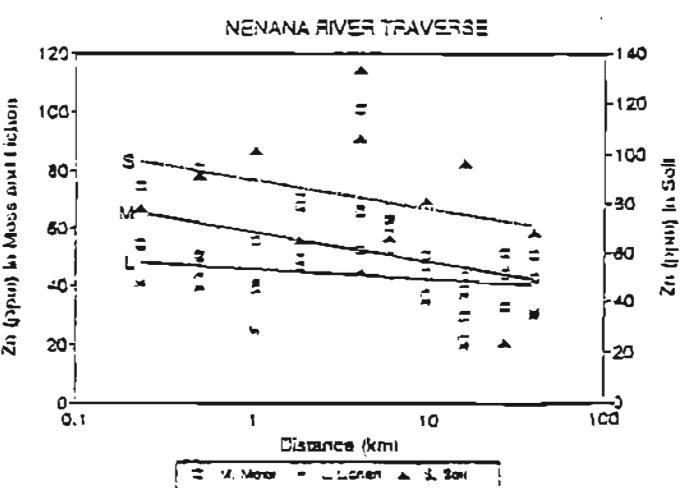
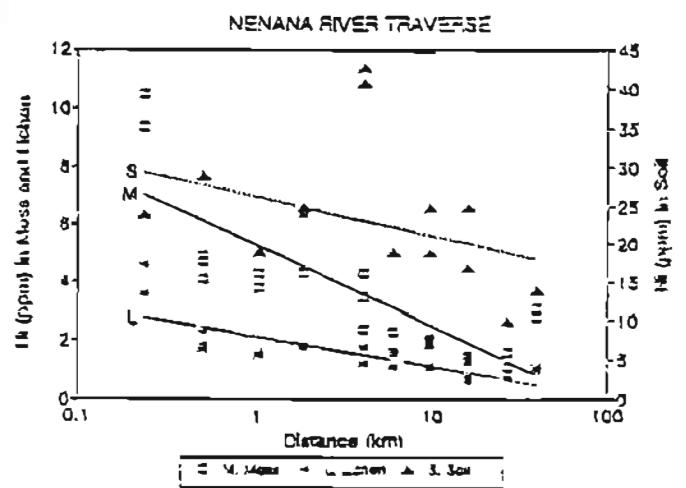
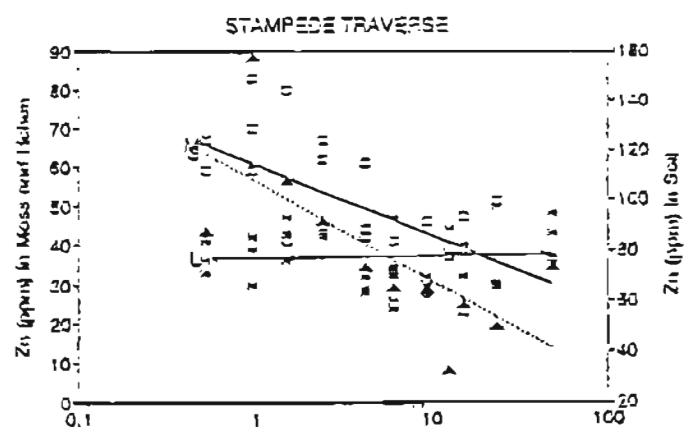
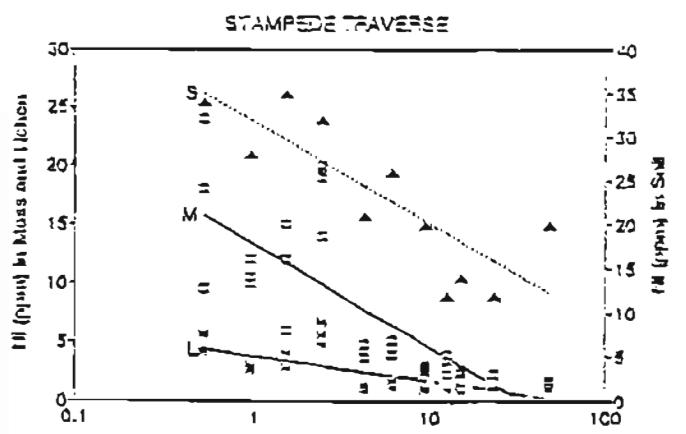
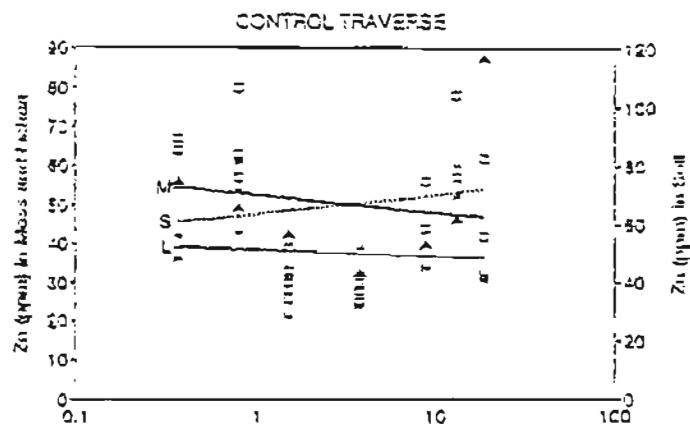
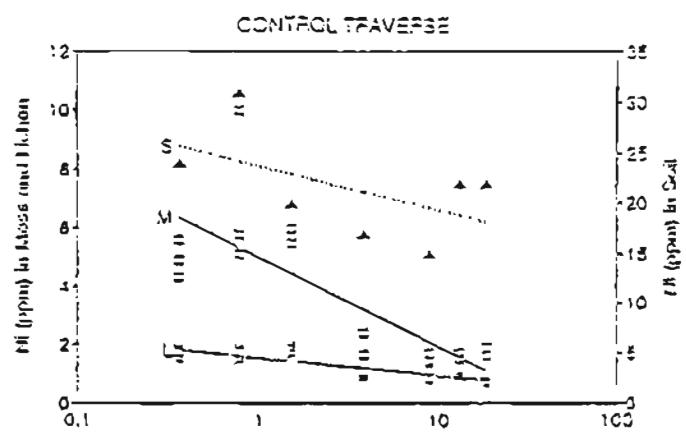


Figure 11. Regression trends for nickel (Ni) and zinc (Zn) versus distance from the Golden Valley Electric Association (GVEA) power plant for *Hypolecomium splendens* (moss), *Peltigera aphthosa* (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the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

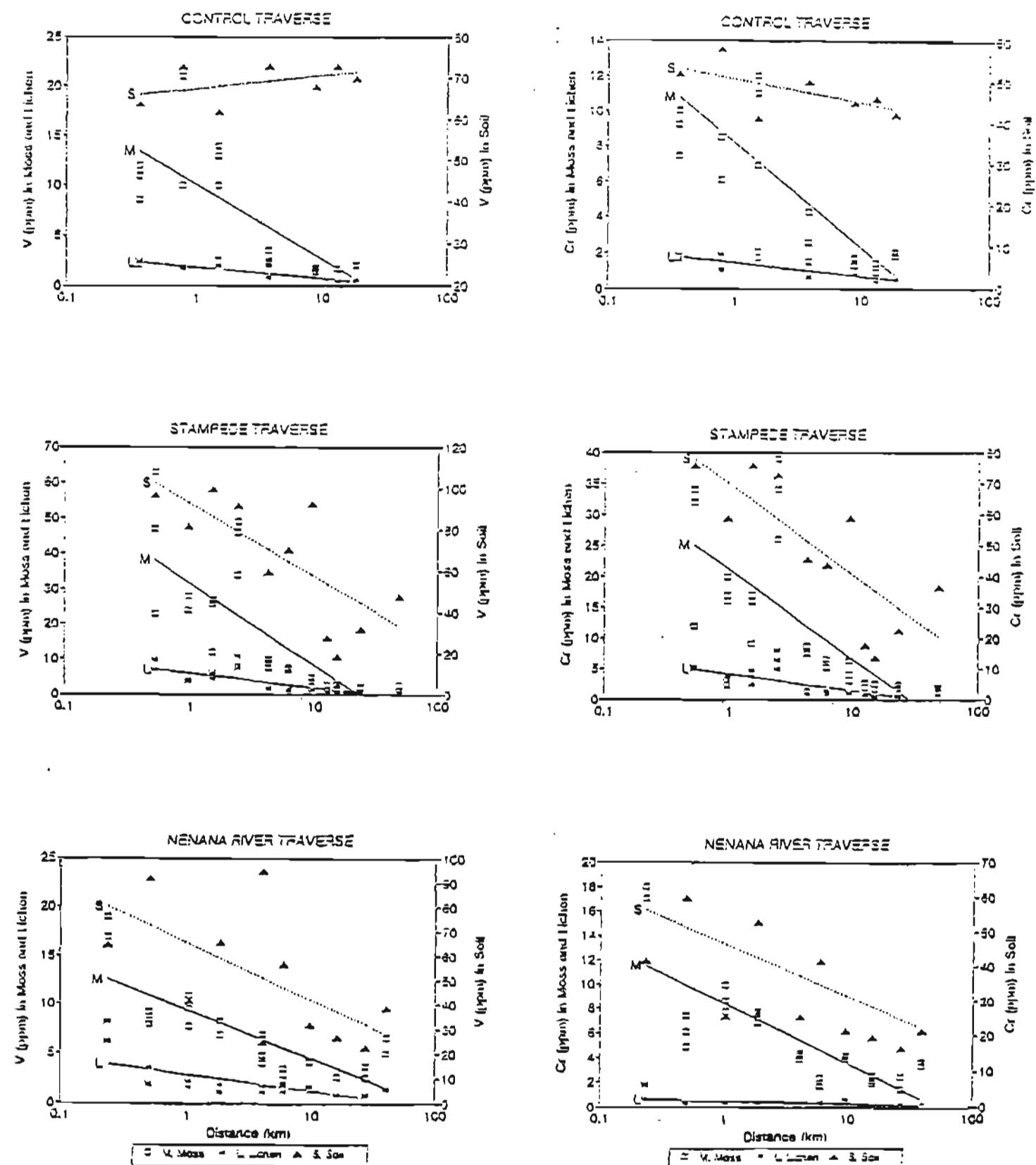


Figure 12. Regression trends for vanadium (V) and chromium (Cr) versus distance from the Golden Valley Electric Association (GVEA) power plant for Hypoleium splendens (moss), Peltigera aphthosa (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives the regression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

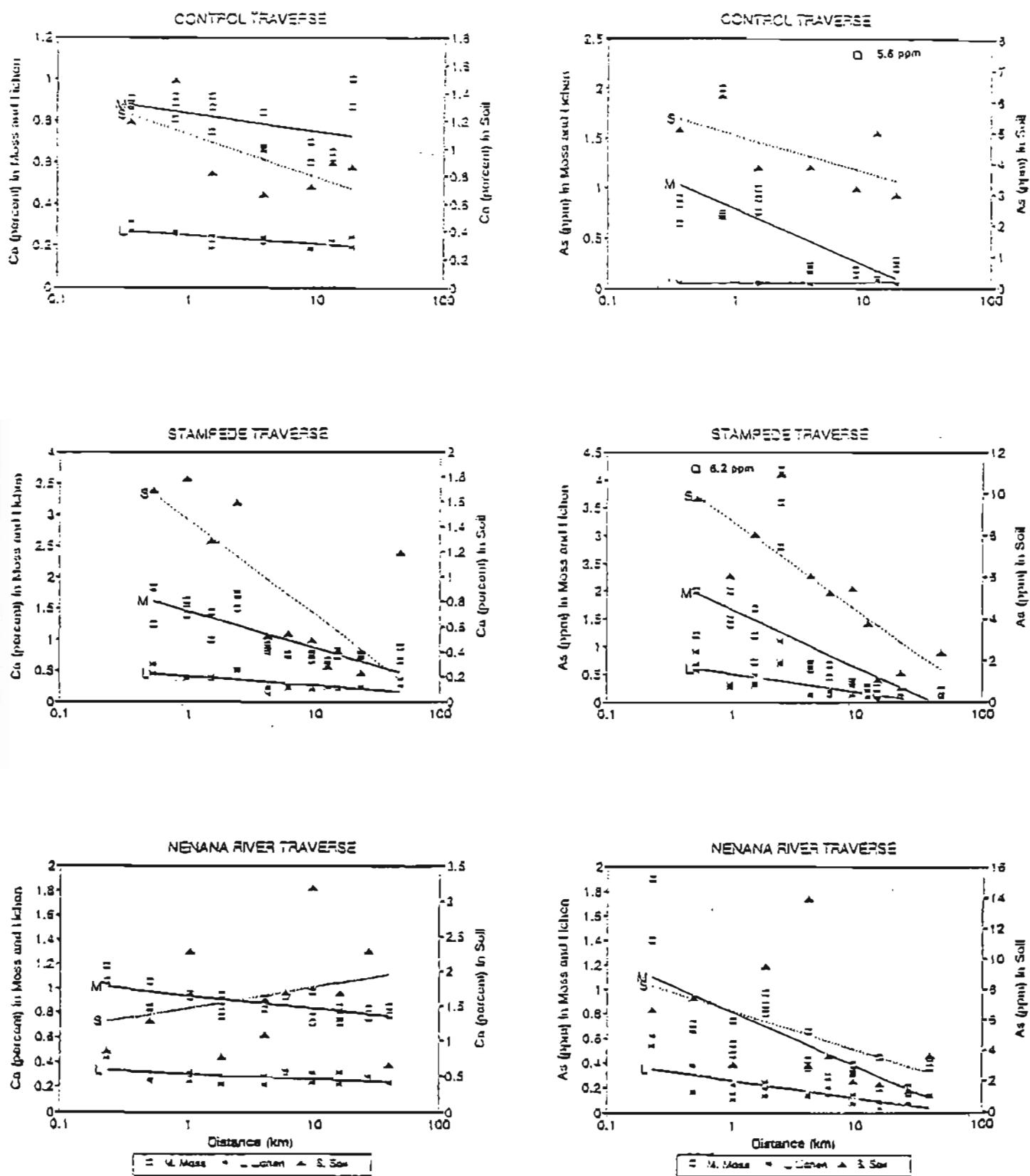


Figure 13. Regression trends for calcium (Ca) and arsenic (As) versus distance from the Golden Valley Electric Association (GVEA) power plant for *Hypolecomium splendens* (moss), *Peltigera sphoethosa* (lichen), and O₂-horizon soil along the Control, Stampede, and Nenana River traverses. Table 27 gives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

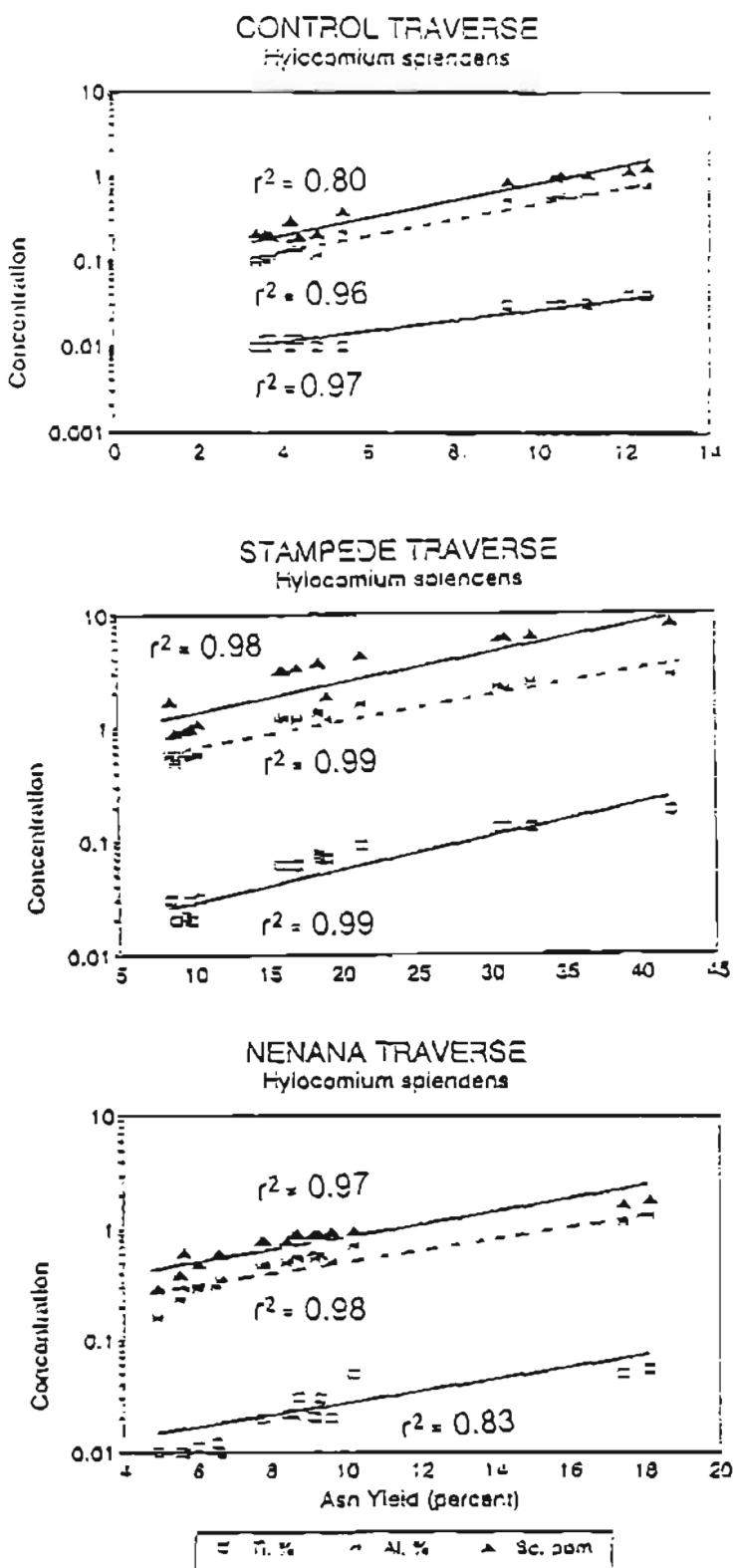


Figure 14. Relation between ash yield and moss tissue concentrations of Ti, Al, and Sc for samples collected along the Control, Stampede, and Nenana traverses. The coefficient of determination (r^2) of the relation is given for each regression.

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 1.0 1.5 2.0 4.0 6.0 8.0 14.0 16.0 25.0 32.0 | 0.52 0.95 1.50 2.41 4.27 6.11 9.36 12.5 15.0 23.0 47.8 | 3 3 3 3 3 3 3 2 2 2 2 (29, total) | 1 1 1 1 1 1 1 1 1 1 1 |
| Nenana River | 0.0 0.5 1.0 2.0 4.0 8.0 16.0 25.0 40.0 80.0 | 0.23 0.49 1.01 1.84 4.04 9.55 15.7 26.8 39.4 67.8 | 2 3 3 3 3 3 3 2 2 2 (26, total) | 1 1 1 1 1 1 1 1 1 1 |
| Northern Control (distances from the Nenana River) | 0.5 1.0 1.5 3.0 7.5 8.0 16.0 | 0.36 0.78 1.50 3.80 8.87 13.2 18.6 | 3 3 3 3 2 2 2 (18, total) | 1 1 1 1 1 1 1 |
| Radial Arc | 001 002 003 004 005 006 007 032 040 | 4.79 5.77 8.87 11.7 13.9 19.6 7.86 30.5 41.8 | 2 2 2 2 2 2 2 2 2 (18, total) | 1 1 1 1 1 1 1 1 1 |
| Meteorologic Site | 000 001 006 | 14.6 0.90 5.95 | 2 2 2 (6, total) | 1 1 1 |

Table 2. Listing of approximate limits of determination for elements reported.

| Analytical method | Medium | Determination limit | Variables |
|--|-------------------------------|---------------------|--|
| Continuous-flow hydride generation | Soil Plant ¹ | 0.1 ppm 0.05 ppm | As, Se |
| Inductively-coupled argon plasma optical emission spectroscopy (Values given are for 0.2 g soil sample) | Soil and Plant ^{2,3} | 2.0 ppm 0.05 % | Ag, Cd, La, Li, Mo, Ni, Sc, Sr, V, Y, Zn |
| | | 1.0 ppm | Al, Ca, Fe, K, Mg, Na, P, Ti |
| | | 4.0 ppm | Ba, Be, Co, Cr, Cu, Yb |
| | | 8.0 ppm | Ce, Ga, Ho, Mn, Nb, Nd, Pb, Th |
| | | 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 ash³ 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, % | Tl, % |
|-----------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| 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 |
| MA080A1 | 631839 | 1493323 | 0.49 | 0.72 | 0.23 | 0.38 | 0.19 | 0.17 | 0.11 | 0.02 |
| MA080B1 | 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 | Ca, 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 | 6.1 |
| 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 | 6.4 | 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 |
| MA080A1 | 491 | 67 | <0.2 | <0.3 | 1.8 | 0.8 | 3.3 | 15 | 1.5 | 0.8 |
| MA080B1 | 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 | <0.6 | 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 | 6.6 |
| 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 | 3.65 | 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 Hypothecium 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 | Ca, 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 | 0.6 |
| 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 | 0.6 |
| MC016B1 | 436 | 18 | <0.1 | 0.2 | 1.0 | 0.5 | 2.0 | 20 | 0.5 | 0.5 |

Table 4.--Chemical analyses for *Hyalomimium 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 | Wf, 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 | <0.6 | 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 |
| MN006A1 | 634808 | 1485654 | 0.16 | 0.89 | 0.10 | 0.33 | 0.16 | 0.05 | 0.13 | 0.01 |
| MN006B1 | 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 | Be, ppm | Ba, 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 | 6.2 | 15 | 1.3 | 1.7 |
| MN004C1 | 596 | 72 | <0.1 | <0.2 | 2.8 | 1.3 | 3.9 | 17 | 1.2 | 1.5 |
| MN006A1 | 311 | 40 | <0.1 | <0.2 | 1.4 | 0.5 | 1.7 | 20 | 0.5 | 0.5 |
| MN006B1 | 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 | 67 | <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 | Na, 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 |
| MN006A1 | 0.5 | 1.1 | <0.4 | 1.0 | 1.6 | 1.4 | 0.3 | 54 | <0.4 | 2.4 |
| MN006B1 | 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 |
| MN006A1 | 0.3 | <0.1 | 64 | 0.29 | 0.05 | 0.11 | 4.93 | 0.09 |
| MN006B1 | 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 | 0.06 | 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 *Hylocomium splendens* (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 | 634 | 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 | 176 | 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 *Xylocomium 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 | 0.03 | 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 *Myioconium 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 | No, 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 sphagnicola* 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 | 0.26 | 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 | Cr, ppm | Co, ppm | Cr, ppm | Cu, ppm | Ge, 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 *Peltigera aphthosa* 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 | Be, 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 | 0.06 | 0.10 | 3.05 | 0.14 | | | | |
| LM006B1 | 64 | 0.20 | 0.09 | 0.17 | 3.34 | 0.17 | | | | |

Table 12.--Chemical analyses for *Peltigera sphagna* 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 |
| LN006A1 | 634808 | 1485654 | 0.08 | 0.30 | 0.05 | 0.40 | 0.08 | 0.02 | 0.14 | <0.01 |
| LN006B1 | 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 Peltigera aphthosa 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 | Ca, ppm | Co, ppm | Cr, ppm | Cu, ppm | Ge, 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 |
| LN006A1 | 189 | 15 | 0.2 | 0.9 | 0.3 | 1.3 | 11 | 0.3 | 0.6 | 0.3 |
| LN006B1 | 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 |
| LN006A1 | 0.2 | 0.6 | 1.1 | 1.1 | 0.2 | 18 | <0.2 | 1.3 | 0.2 | <0.1 |
| LN006B1 | <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, % |
|-----------|---------|---------|---------|---------|--------|------------|
| LW000A1 | 41 | 0.54 | 0.13 | 0.13 | 6.22 | 0.16 |
| LW000B1 | 53 | 0.62 | 0.18 | <0.01 | 7.47 | 0.16 |
| LW0.5A1 | 44 | 0.17 | 0.06 | 0.10 | 3.65 | 0.12 |
| LW0.5B1 | 39 | 0.16 | <0.03 | 0.12 | 3.25 | 0.12 |
| LW0.5C1 | 40 | 0.38 | <0.03 | 0.14 | 4.02 | 0.10 |
| LW001A1 | 41 | 0.11 | 0.05 | 0.08 | 3.18 | 0.12 |
| LW001B1 | 38 | 0.16 | 0.07 | 0.08 | 3.45 | 0.16 |
| LW001B2 | 38 | 0.15 | 0.05 | 0.12 | 3.82 | 0.14 |
| LW001C1 | 25 | 0.23 | 0.07 | 0.04 | 3.21 | 0.13 |
| LW002A1 | 48 | 0.25 | 0.05 | 0.08 | 3.44 | 0.16 |
| | | | | | | |
| LW002B1 | 51 | 0.14 | 0.04 | 0.06 | 3.02 | 0.15 |
| LW002C1 | 67 | 0.20 | 0.05 | 0.06 | 3.19 | 0.15 |
| LW004A1 | 67 | 0.15 | 0.05 | 0.10 | 2.80 | 0.12 |
| LW004B1 | 68 | 0.15 | 0.06 | 0.08 | 3.44 | 0.16 |
| LW004C1 | 45 | 0.15 | 0.04 | 0.06 | 2.66 | 0.12 |
| LW006A1 | 52 | 0.13 | 0.04 | 0.10 | 3.05 | 0.14 |
| LW006B1 | 64 | 0.20 | 0.09 | 0.17 | 3.54 | 0.17 |
| LW008A1 | 39 | 0.08 | 0.04 | 0.12 | 2.80 | 0.13 |
| LW008B1 | 38 | 0.14 | 0.03 | 0.04 | 3.18 | 0.14 |
| LW008C1 | 35 | 0.16 | 0.04 | 0.05 | 3.18 | 0.12 |
| LW016A1 | 45 | <0.05 | 0.03 | 0.07 | 2.63 | 0.10 |
| LW016B1 | 20 | 0.09 | 0.05 | 0.04 | 2.36 | 0.08 |
| | | | | | | |
| LW016C1 | 37 | 0.09 | 0.03 | 0.05 | 2.64 | 0.12 |
| LW025A1 | 46 | 0.09 | 0.04 | 0.05 | 2.53 | 0.10 |
| LW025B1 | 43 | 0.08 | 0.05 | 0.06 | 2.54 | 0.11 |
| LW040A1 | 31 | 0.14 | 0.04 | 0.05 | 2.85 | 0.09 |
| LW040B1 | 30 | 0.13 | 0.03 | 0.08 | 3.01 | 0.09 |

Table 13.--Chemical analyses for *Peltigera aphthosa* 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 | 0.6 | 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 | 2.6 | 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 sphathaea samples from the Stampede Trail Traverse sampling sites, Denali National Park and Preserve, Alaska (dry-weight basis) (continued).

| Sample ID | Mo, ppm | Mn, 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, % |
|-----------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Kenai River Transect Sites</u> | | | | | | | | | | |
| 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, % |
|--------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Stampede Trail Traverse</u> | | | | | | | | | | |
| 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 |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 |
| SN006A1 | 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 |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 | 64 | 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 0- cm horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis)
(continued).

| Sample ID | Ga, ppm | La, ppm | Ti, ppm | Mo, ppm | Nb, ppm | Nd, ppm | Ni, ppm | Pb, ppm | Sc, ppm | Sr, ppm |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological sites</u> | | | | | | | | | | |
| SM000A1 | 10 | 21 | 14 | 1 | 4 | 21 | 61 | 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 |
| SN006A1 | 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 | No, ppm | Nb, ppm | Nd, ppm | Ni, ppm | Pb, ppm | Sc, ppm | Sr, ppm |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 | 67 | 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, % |
|------------------------------------|---------|--------|--------|---------|---------|---------|---------|---------|--------|------------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| SA001A1 | 18 | 69 | 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 | 67 | 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 | 34 | 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 |
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 |
| SN006A1 | 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 0- m -horizon soil samples, Denali National Park and Preserve, Alaska (dry-weight basis)
(continued).

| Sample ID | Th, ppm | V, ppm | T, ppm | Yb, ppm | Zn, ppm | As, ppm | Se, ppm | Hg, ppm | Ash, % | Total S, % |
|--------------------------------------|---------|--------|--------|---------|---------|---------|---------|---------|--------|------------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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, % |
|------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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, % |
|---------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>In-house Standard White Spruce</u> | | | | | | | | | | |
| 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 | Cr, ppm | Co, ppm | Cr, ppm | Cu, ppm | Ga, ppm | La, ppm | Li, ppm |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 | 173 | 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 | 63 | <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 |
| <u>Metatopological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| PN0.5A1 | 267 | 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 |
|---------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>In-house White Spruce Standard</u> | | | | | | | | | | |
| 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 | Mn, ppm | Ni, ppm | Pb, ppm | Sr, ppm | Th, ppm | V, ppm | Zn, ppm | As, ppm | Se, ppm | Hg, ppm |
|-----------------------------------|---------|---------|---------|---------|---------|--------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Metorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Kenai River Traverse Sites</u> | | | | | | | | | | |
| 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 |
|---------------------------------------|---------|---------|---------|---------|---------|--------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>In-House White Spruce Standard</u> | | | | | | | | | | |
| 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, % |
|---------------------------------------|--------|------------|
| <u>Stampede Trail Traverse Sites</u> | | |
| PS032A1 | 3.53 | 0.08 |
| PS032B1 | 2.38 | 0.08 |
| <u>In-house White Spruce Standard</u> | | |
| 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 | | | Kenai Peninsula, Alaska (Severson and others, 1990) | | | Wrangell-Saint Elias, Alaska Observed Baseline (n=67) | | |
|---------------------------------|-----------------------------|---|-------|--|---|-------|---|---|-------|
| | Observed Baseline (n=45) | | | Calculated Baseline (n=21) | | | | | |
| | | | | | | | | | |
| 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 | | Wrangell-Saint Elias, Alaska | | |
|---------------------------------|-----------------------------|---|------------------------------|---|-------|
| | Observed Baseline (n=45) | | Observed Baseline (n=67) | | |
| Al, % | 0.022 | - | 0.19 | - | 0.72 |
| Ca, % | 0.17 | - | 0.27 | - | 0.66 |
| Fe, % | 0.014 | - | 0.10 | - | 0.41 |
| K, % | 0.18 | - | 0.49 | - | 0.76 |
| Mg, % | 0.058 | - | 0.11 | - | 0.25 |
| Na, % | 0.012 | - | 0.06 | - | 0.23 |
| P, % | 0.099 | - | 0.09 | - | 0.20 |
| Ti, % | 0.0003 | - | 0.0073 | - | 0.040 |
| Mn, ppm | 32 | - | 490 | - | 290 |
| Ba, ppm | 9 | - | 49 | - | 60 |
| Cd, ppm | <0.1 | - | 0.4 | | |
| Ce, ppm | <0.2 | - | 7.3 | - | 3.1 |
| Co, ppm | 0.2 | - | 2.0 | - | 2.4 |
| Cr, ppm | 0.4 | - | 3.6 | - | 6.7 |
| Cu, ppm | 5 | - | 18 | - | 11 |
| Ga, ppm | <0.2 | - | 0.7 | - | 1.7 |
| La, ppm | <0.1 | - | 4.1 | - | 2.0 |
| Li, ppm | <0.1 | - | 1.0 | - | 1.2 |
| Mo, ppm | <0.2 | - | 1.5 | - | 0.9 |
| Nd, ppm | <0.2 | - | 3.5 | - | 2.0 |
| Ni, ppm | 0.6 | - | 5.9 | - | 6.8 |
| Pb, ppm | 0.2 | - | 3.3 | - | 1.1 |
| Sc, ppm | <0.1 | - | 0.4 | - | 1.5 |
| Sr, ppm | 11 | - | 38 | - | 53 |
| Th, ppm | <0.2 | - | 1.5 | | |
| V, ppm | 0.4 | - | 3.9 | - | 12 |
| Y, ppm | <0.1 | - | 0.8 | - | 1.7 |
| Zn, ppm | 20 | - | 95 | - | 50 |
| As, ppm | <0.05 | - | 0.38 | | |
| Se, ppm | <0.03 | - | 0.07 | | |
| Hg, ppm | <0.02 | - | 0.12 | - | 0.12 |
| Ash, % | 2.02 | - | 7.29 | - | 10.0 |
| Total S, % | 0.08 | - | 0.14 | - | 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 | | Kenai Peninsula, Alaska (Severson and others, 1990) | | | Wrangell-Saint Elias, Alaska Observed Baseline (n=67) | | | |
|---------------------------------|-----------------------------|---|--|---------|---|---|--------|---|--------|
| | Observed Baseline (n=23) | | Calculated Baseline (n=21) | | | | | | |
| | | | | | | | | | |
| 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 | 0.3 | - | 1.8 |
| Ni, ppm | 0.2 | - | 3.0 | 0.4 | - | 2.3 | 18 | - | 77 |
| Sr, ppm | 15 | - | 62 | 18 | - | 84 | 0.2 | - | 2.2 |
| V, ppm | <0.1 | - | 0.4 | 0.1 | - | 0.9 | 36 | - | 100 |
| Zn, ppm | 39 | - | 84 | 20 | - | 79 | <0.02 | - | 0.07 |
| Hg, ppm | <0.02 | - | 0.05 | <0.02 | - | 0.05 | 2.48 | - | 5.52 |
| Ash, % | 2.38 | - | 4.79 | 2.95 | - | 4.81 | <0.05 | - | 0.08 |
| Total S, % | 0.05 | - | 0.09 | 0.05 | - | 0.09 | | | |

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 | | | Kenai Peninsula, Alaska (Severson and others, 1990) | | | Wrangell-Saint Elias, Alaska Observed Baseline (n=35) | | |
|---------------------------------|-----------------------------|---|------|--|---|-------|---|---|------|
| | Observed Baseline (n=21) | | | Calculated Baseline (n=21) | | | | | |
| | | | | | | | | | |
| 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 | <0.6 | - | 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 sphagna*, Control Traverse and the Stampede Trail Traverse, Denali National Park and Preserve, Alaska (log₁₀ dry-weight basis).

| Variable, Unit of Measure | Control Traverse | | | | Stampede Trail Traverse | | | |
|---------------------------------|--|------------------------|------|------------|--|------------------------|------|------------|
| | Total Log ₁₀ Variance | Percentage of Variance | | | Total Log ₁₀ Variance | Percentage of Variance | | |
| | | Distance | Plot | Procedural | | 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 |
| Co, ppm | 0.0707 | 79.4 | 19.6 | 1.0 | 0.146 | 91.5 | 3.3 | 5.2 |
| Cr, 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 sphoethosa*, Nenana River Traverse and the Dry Creek Traverse, Denali National Park and Preserve, Alaska (log₁₀ dry-weight basis).

| Variable, Unit of Measure | Nenana River Traverse | | | | Dry Creek Traverse | | | |
|---------------------------------|----------------------------|------------------------|------|------------|----------------------------|------------------------|------|------------|
| | Total Log ₁₀ | Percentage of Variance | | | Total Log ₁₀ | Percentage of Variance | | |
| | Variance | Distance | Plot | Procedural | Variance | 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 |
| Tl, % | 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 |
| Co, ppm | 0.119 | 79.8 | 20.1 | 0.0 | 0.116 | 73.8 | 14.9 | 11.3 |
| Cr, ppm | 0.0704 | 76.0 | 22.6 | 1.4 | 0.0898 | 64.2 | 35.6 | 0.2 |
| Cu, ppm | 0.0683 | 85.0 | 13.0 | 2.0 | 0.0842 | 83.1 | 15.6 | 1.2 |
| Ga, ppm | 0.0123 | 37.8 | 59.4 | 2.9 | 0.0135 | 61.6 | 35.3 | 3.1 |
| La, ppm | 0.0346 | 65.5 | 34.5 | 0.0 | 0.0675 | 60.0 | 0.0 | 40.0 |
| Li, ppm | 0.110 | 91.1 | 8.0 | 0.9 | 0.0933 | 78.6 | 21.2 | 0.2 |
| No, 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 Hylacomium splendens, Control

Traverse and Stampede Trail Traverse, Denali National Park and Preserve, Alaska (log₁₀ dry-weight basis).

| Variable, Unit of Measure | Control Traverse | | | | Stampede Trail Traverse | | | |
|---------------------------------|--|------------------------|------|------------|--|------------------------|------|------------|
| | Total Log ₁₀ Variance | Percentage of Variance | | | Total Log ₁₀ 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 |
| Cr, 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 splendens*, Nenana River Traverse and the Dry Creek Traverse, Denali National Park and Preserve, Alaska (log₁₀ dry-weight basis).

| Variable, Unit of Measure | Nenana River Traverse | | | | Dry Creek Traverse | | | |
|---------------------------------|--|------------------------|------|------------|--|------------------------|-------|--|
| | Total Log ₁₀ Variance | Percentage of Variance | | | Total Log ₁₀ Variance | Percentage of Variance | | |
| | | Distance | Plot | Procedural | | Distance | 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 | | | | |
|---------------------------------|----------|------------------------|------|------------|
| Variable, Unit of Measure | Total | Percentage of Variance | | |
| | 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 | 0.45 |
| | | 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.

| <u>feedstock Coal, Dry-weight basis</u> | | | | | | | | | | |
|---|-------|-------|-------|------|-------|-------|-------|-------|---------|--|
| 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).

| <u>Feedstock Coal, Ash-weight basis</u> | | | | | | | | | | | |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--|
| 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 | |
| <u></u> | | | | | | | | | | | |
| Sample ID | Ba, ppm | Be, ppm | Ca, 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 | |
| <u></u> | | | | | | | | | | | |
| 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 | |
| <u></u> | | | | | | | | | | | |
| 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 | Ca, 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 was 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 Hypothecium splendens (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, % | Tl, % |
|-------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 | 0.88 | 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, % |
|------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 | 4.6 | 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 |
| <u>Menana River Traverse Sites</u> | | | | | | | | | | |
| 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 *Hyalacomium 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, % | Tl, % |
|--------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>In-house Standard Moss Sample</u> | | | | | | | | | | |
| 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 | Ca, ppm | Co, ppm | Cr, ppm | Cu, ppm | Ga, ppm | La, ppm |
|-------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 | 68 | 20 | 48 | 270 | 10 | 25 |
| MA040B1 | 2000 | 1100 | <2 | <4 | 38 | 10 | 69 | 250 | 10 | 21 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 | Ca, ppm | Co, ppm | Cr, ppm | Cu, ppm | Ga, ppm | La, ppm |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Metaprotological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 *Myioecium 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 | Ge, ppm | La, ppm |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 | 2600 | 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 |
| <u>In-house Standard Moss Sample</u> | | | | | | | | | | |
| 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 Hypoleium 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 |
|-------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Central Traverse Sites</u> | | | | | | | | | | |
| 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 |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| <u>Meteorological Sites</u> | | | | | | | | | | |
| MN000A1 | 20 | 34 | <8 | 10 | 52 | 32 | 6 | 920 | <8 | 59 |
| MN000B1 | 10 | 29 | <8 | 10 | 48 | 32 | 6 | 990 | <8 | 61 |
| MN001A1 | 20 | 8 | <8 | 27 | 63 | 31 | 10 | 900 | 10 | 94 |
| MN001B1 | 20 | 10 | <8 | 20 | 59 | 33 | 10 | 900 | 8 | 93 |
| MN006A1 | 10 | 22 | <8 | 20 | 33 | 29 | 6 | 1100 | <8 | 48 |
| MN006B1 | 20 | 32 | <8 | 22 | 42 | 44 | 8 | 1100 | 10 | 63 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 Hyalacomium 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 |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>In-house Standard Moss Sample</u> | | | | | | | | | | |
| 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 Hyalacomium 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, %* |
|-------------------------------|--------|---------|---------|----------|----------|----------|---------|-------------|
| <u>Radial Arc Sites</u> | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | |
| 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, %* |
|------------------------------------|--------|---------|---------|----------|----------|----------|---------|-------------|
| <u>Meteorological Sites</u> | | | | | | | | |
| 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 |
| <u>Henana River Traverse Sites</u> | | | | | | | | |
| 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 Hypnum 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, %* |
|--------------------------------------|--------|---------|---------|----------|----------|----------|---------|-------------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | |
| 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 |
| <u>In-house Standard Moss Sample</u> | | | | | | | | |
| 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 sphathosa 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>Radial Arc Sites</u> | | | | | | | | | | |
| 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 | 635006 | 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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, % |
|------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| LN001A1 | 635117 | 1485808 | 4.2 | 7.3 | 2.4 | 15 | 2.2 | 0.84 | 6.0 | 0.20 |
| LN001A2 | 635117 | 1485808 | 4.2 | 7.3 | 2.5 | 14 | 2.3 | 0.86 | 6.0 | 0.20 |
| LN001B1 | 635117 | 1485808 | 2.9 | 8.7 | 1.7 | 16 | 3.0 | 0.75 | 5.2 | 0.10 |
| LN006A1 | 634808 | 1485654 | 2.7 | 10 | 1.7 | 13 | 2.7 | 0.77 | 4.5 | 0.10 |
| LN006B1 | 634808 | 1485654 | 3.3 | 9.2 | 1.9 | 13 | 2.8 | 0.71 | 5.3 | 0.10 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 sphoethosa* 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, % |
|--|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>In-house Standard Lichen-Sample</u> | | | | | | | | | | |
| 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 sphagnicola samples, Denali National Park and Preserve, Alaska (ash-weight basis, unless noted with an *) (continued).

| Sample ID | Mn, ppm | Ba, ppm | Cd, ppm | Ca, ppm | Co, ppm | Cr, ppm | Cu, ppm | Ga, ppm | La, ppm | Li, ppm |
|-------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 | 380 | 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 | 530 | 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 sphagna 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 |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Meteorological Sites</u> | | | | | | | | | | |
| LN000A1 | 7000 | 760 | 28 | 20 | 8 | 28 | 270 | 9 | 9 | 10 |
| LN000B1 | 7700 | 840 | 21 | 20 | 10 | 33 | 190 | 20 | 9 | 10 |
| LN001A1 | 1700 | 750 | 5 | 41 | 20 | 60 | 210 | 10 | 22 | 20 |
| LN001A2 | 1700 | 990 | 5 | 35 | 20 | 57 | 210 | 10 | 22 | 20 |
| LN001B1 | 5200 | 950 | 7 | 30 | 20 | 42 | 270 | 9 | 20 | 10 |
| LN006A1 | 6200 | 490 | 5 | 29 | 10 | 43 | 350 | 10 | 20 | 10 |
| LN006B1 | 7600 | 290 | <4 | 51 | 20 | 48 | 350 | 10 | 10 | 20 |
| <u>Menana River Traverse Sites</u> | | | | | | | | | | |
| 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 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 | Ge, ppm | La, ppm | Li, ppm |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede River Traverse Sites</u> | | | | | | | | | | |
| 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 | 6 | 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 | 5 | 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 |
| <u>In-house Standard Lichen Sample</u> | | | | | | | | | | |
| 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 |
|-------------------------------|---------|---------|---------|---------|---------|---------|---------|--------|--------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 | <6 |
| 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 |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|--------|--------|---------|
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Menana River Traverse Sites</u> | | | | | | | | | | |
| 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 | 6 | 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 |
|--|---------|---------|---------|---------|---------|---------|---------|--------|--------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>In-house Standard Lichen Sample</u> | | | | | | | | | | |
| 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 polydactylon 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, %* |
|-------------------------------|---------|----------|----------|----------|---------|-------------|
| <u>Radial Arc Sites</u> | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | |
| 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, %* |
|------------------------------------|---------|----------|----------|----------|---------|-------------|
| <u>Meteorological sites</u> | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | |
| 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 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, %* |
|--|---------|----------|----------|----------|---------|-------------|
| <u>Stampede Trail Traverse</u> | | | | | | |
| 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 | M.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 |
| <u>In-house Standard Lichen Sample</u> | | | | | | |
| 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 Oe-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, % |
|--------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sampling Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 O_H-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, % | Tl, % |
|--------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <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 0a-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 |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sampling Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 | No, ppm | Nb, ppm | Nd, ppm | Ni, ppm | Pb, ppm | Sc, ppm | Sr, ppm |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sampling Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 | 660 |
| 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 O_H-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

| Sample ID | Ga, ppm | La, ppm | Lf, ppm | Mo, ppm | Nb, ppm | Nd, ppm | Ni, ppm | Pb, ppm | Sc, ppm | Sr, ppm |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse Sites</u> | | | | | | | | | | |
| 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 | 65 | 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 0a-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, %* |
|--------------------------------------|---------|--------|--------|---------|---------|----------|----------|----------|---------|-------------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sampling Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 Oe-horizon soil samples, Denali National Park and Preserve, Alaska (ash-weight basis unless noted with an *) (continued).

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

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, % |
|------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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, % | Tl, % |
|---------------------------------------|----------|-----------|-------|-------|-------|------|-------|-------|------|-------|
| <u>Stampede Trail Traverse</u> | | | | | | | | | | |
| 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 |
| <u>In-house White Spruce Standard</u> | | | | | | | | | | |
| STD | | | 0.05 | 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 | | | 0.05 | 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 *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 |
|------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sites</u> | | | | | | | | | | |
| PM000A1 | 11000 | 3100 | <4 | <8 | 5 | 10 | 34 | 10 | <4 | <4 |
| PM000B1 | 7500 | 3200 | <4 | <8 | 7 | 8 | 26 | 8 | <4 | <4 |
| <u>Nenana River Traverse Sites</u> | | | | | | | | | | |
| 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 |
|---------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <u>Stampede Trail Traverse</u> | | | | | | | | | | |
| PS032A1 | 4000 | 1800 | <4 | <8 | 5 | 10 | 68 | <8 | <4 | <4 |
| PS032B1 | 4300 | 1400 | <4 | <8 | 4 | 10 | 78 | <8 | <4 | <4 |
| <u>In-house Standard White Spruce</u> | | | | | | | | | | |
| 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 Picea glauca (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>Radial Arc Sites</u> | | | | | | | | | | |
| 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 |
| <u>Control Traverse Sites</u> | | | | | | | | | | |
| 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 |
| <u>Meteorological Sites</u> | | | | | | | | | | |
| 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 |
| <u>Nenana River Traverse</u> | | | | | | | | | | |
| 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 *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 | 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, %* |
|------------------------------------|---------|-------------|
| <u>Radial Arc Sites</u> | | |
| 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 |
| <u>Control Traverse Sites</u> | | |
| 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 |
| <u>Meteorological Sites</u> | | |
| PM000A1 | 4.66 | 0.06 |
| PM000B1 | 5.91 | 0.08 |
| <u>Nenana River Traverse Sites</u> | | |
| 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 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, %*

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> | | | | | | | | | | |
| CA00381 | 635004 | 1490727 | 2.8 | 6.5 | 1.6 | 3.9 | 1.8 | 0.77 | 1.4 | 0.08 |
| CA00681 | 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 Spp.</u> | | | | | | | | | | |
| 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 | Ca, ppm | Co, ppm | Cr, ppm | Cu, ppm | Ga, ppm | La, ppm | Li, ppm |
| <u>Cladina rangiferina</u> | | | | | | | | | | |
| CA00381 | 1200 | 380 | <4 | 57 | 9 | 22 | 80 | <8 | 36 | 10 |
| CA00681 | 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 Spp.</u> | | | | | | | | | | |
| 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> | | | | | | | | | | |
| CA00381 | 28 | 22 | 21 | 5 | 420 | 31 | 6 | 400 | N.D. | N.D. |
| CA00681 | 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 Spp.</u> | | | | | | | | | | |
| 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> | | | | | | | | | | |
| CA00381 | 0.06 | 2.20 | <0.05 | | | | | | | |
| CA00681 | 0.03 | 1.39 | <0.05 | | | | | | | |
| CS025A1 | 0.04 | 1.59 | <0.05 | | | | | | | |
| <u>Usnea Spp.</u> | | | | | | | | | | |
| UN000A1 | 0.39 | N.D. | 0.16 | | | | | | | |

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