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# Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

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## Volume 124

# BOREAS TE-1 SSA Soil Lab Data

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# BOREAS TE-1 SSA Soil Lab Data

Tim Nerbas, Darwin Anderson

## Summary

This data set was collected by TE-1 to provide a set of soil properties for BOREAS investigators in the SSA. The soil samples were collected at sets of soil pits in 1993 and 1994. Each set of soil pits was in the vicinity of one of the five flux towers in the BOREAS SSA. The collected soil samples were sent to a lab, where the major soil properties were determined. These properties include, but are not limited to, soil horizon; dry soil color; pH; bulk density; total, organic, and inorganic carbon; electric conductivity; cation exchange capacity; exchangeable sodium, potassium, calcium, magnesium, and hydrogen; water content at 0.01, 0.033, and 1.5 MPascals; nitrogen; phosphorus; particle size distribution; texture; pH of the mineral soil and of the organic soil; extractable acid; and sulfur. The data are stored in tabular ASCII text files.

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## 1. Data Set Overview

### 1.1 Data Set Identification

BOREAS TE-01 SSA Soil Lab Data

### 1.2 Data Set Introduction

This data set was collected by the Terrestrial Ecology (TE)-01 team to provide a set of soil properties for BOReal Ecosystem-Atmosphere Study (BOREAS) investigators in the Southern Study Area (SSA). The soil samples were collected at sets of soil pits. Each set of soil pits was in the vicinity of one of the five flux towers in the SSA. These soil samples were sent to a lab, where the major soil properties were determined. These properties include, but are not limited to, soil horizon; dry soil color; pH; bulk density; total, organic, and inorganic carbon; electric conductivity; cation exchange capacity; exchangeable sodium, potassium, calcium, magnesium, and hydrogen; water content at 0.01,

0.033, and 1.5 MegaPascals; nitrogen; phosphorus; particle size distribution; texture; pH of the mineral soil and of the organic soil; extractable acid; and sulfur. These data are stored in American Standard Code for Information Interchange (ASCII) text files.

### 1.3 Objective/Purpose

The objective of this study was to develop a complete characterization of all soil types at the BOREAS SSA sites. This data set was collected by the TE-01 team to provide a set of soil properties for BOREAS investigators in the SSA. The soil samples were collected at sets of soil pits. Each set of soil pits was in the vicinity of one of the five towers in the SSA. These soil samples were sent to a lab, where the major soil properties were determined.

### 1.4 Summary of Parameters

The soil survey samples were examined for the visual characteristics: horizon designation, color, structure, and depth. The pH, bulk density, total carbon (TC), organic carbon (OC), and inorganic carbon (IC) values were measured on the general soil survey samples. Detailed analyses were performed on pit soil samples representing the soil types at each tower, which included the measurements listed above and: TC, IC, electric conductivity (EC), cation exchange capacity (CEC), exchangeable Na+, K+, $Ca_2$+, $Mg_2$+, and H+; soil moisture retentions (0.01, 0.033, and 1.5 MPascals); total N; total P; particle size fractions (coarse, medium, fine, and very fine sand, silt, and clay); and texture.

### 1.5 Discussion

A general survey of soils was performed at each SSA site in a 1-km$^2$ area with the tower in the center. Soils were sampled with a frequency that allowed the production of a 1:5,000 map. The soil maps represent a different data set.

A more thorough examination of the soil was performed on a series of soil pits (four or five) dug on a transect that covered the dominant soil types in each SSA site. In the summer of 1993, the Old Aspen (OA), Old Jack Pine (OJP), Young Jack Pine (YJP), and Fen sites were surveyed. The Old Black Spruce (OBS) site was surveyed in the summer of 1994. The soil survey was performed by an experienced soil surveyor, using all methods for measuring soil characteristics that are routinely used in soil surveys. The survey provides a data base that forms the basic measurements that are necessary for a complete ecological study of the boreal forests.

The Northern Study Area (NSA) soil survey field work was performed by the BOREAS TE-20 team, but the analysis of the soil samples were performed by the same lab and methods as these SSA soil samples.

### 1.6 Related Data Sets

Agriculture Canada Central Saskatchewan Vector Soils Data
CanSIS Regional Soils Data in Vector Format
BOREAS Regional Soils Data in Raster Format and AEAC Projection
BOREAS Soils Data over the SSA in Raster Format and AEAC Projection
BOREAS TE-20 NSA Soil Lab Data
BOREAS TE-20 Soils Data over the NSA-MSA and Tower Sites in Vector Format
BOREAS TE-20 Soils Data over the NSA-MSA and Tower Sites in Raster Format
BOREAS TE-01 Soils Data over the SSA Tower Sites in Raster Format
BOREAS TGB-12 Soil Carbon and Flux Data of NSA-MSA in Raster Format
BOREAS TGB-12 Soil Carbon Data over the NSA

# 2. Investigator(s)

## 2.1 Investigator(s) Name and Title

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University of Saskatchewan

## 2.2 Title of Investigation

General Soil Survey for Primary Sites in SSA (OA, OBS, OJP, YJP, Fen)

## 2.3 Contact Information

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## 3. Theory of Measurements

A number of different soil properties were measured for use by BOREAS investigators. The theory and methods used to measure these properties are as follows:

- Bulk Density: An intact known volume of soil is removed, dried, and weighed; the density can then be calculated.
- TC: All types of carbon will be combusted into carbon dioxide ($CO_2$) in a flow of oxygen ($O_2$) at 2,500 °F.
- IC: IC reacts with acid producing $CO_2$, which is quantified through titration.
- OC: Equals measured TC minus measured IC.
- EC: The ability of the soil to carry an electrical current, which is indicative of salt content.
- CEC: If a soil is washed with one cation (Ba), and the other cations are leached, the first cation fills the exchange sites of the leached cation, and equals the soil's CEC.
- Exchangeable Cations: Equals the quantity of cations in the leachate after they have been exchanged off the soil.
- Soil Moisture Retentions: Equals the amount of water in soils under a suction equal to 0.01, 0.033, and 1.5 MPascals (i.e., field moisture 10th, saturated moisture, and wilting moisture, respectively).
- Soil Size Fractions: Clay and silt are measured based on the principle that the speed at which a particle will fall in water will depend on the size of the particle.

## 4. Equipment

### 4.1 Sensor/Instrument Description

- Bulk density: 10 cm diameter tube, 10 cm long.
- TC: LECO CR12 Carbon Determinator 781-600
- CEC and exchangeable cations: Cation concentrations were measured by atomic adsorption-Perkin Elmer 3100.

Equipment used in other procedures is listed in the references and manuals listed in Section 17.

#### 4.1.1 Collection Environment

None given.

#### 4.1.2 Source/Platform

Not applicable.

#### 4.1.3 Source/Platform Mission Objectives

Not applicable.

#### 4.1.4 Key Variables

Soil Horizon
Soil Color (Dry)
pH
Bulk Density
Total Carbon
Organic Carbon
Inorganic Carbon
Electric Conductivity
Cation Exchange Capacity
Exchangeable Sodium
Exchangeable Potassium

Exchangeable Calcium
Exchangeable Magnesium
Exchangeable Hydrogen
Water Content at a pressure of 0.01 MPascals (0.1 atmospheres)
Water Content at a pressure of 0.033 MPascals (0.33 atmospheres)
Water Content at a pressure of 1.5 MPascals (15 atmospheres)
Nitrogen
Phosphorus
Percentage of Very Coarse Sand
Percentage of Coarse Sand
Percentage of Medium Sand
Percentage of Fine Sand
Percentage of Very Fine Sand
Percentage of Total Sand
Percentage of Total Silt
Percentage of Total Clay
Texture
Horizon Number
pH of the Mineral Soil ($CaCl_2$)
pH of the Organic Soil ($CaCl_2$)
pH of the Mineral Soil ($H_2O$)
pH of the Organic Soil ($H_2O$)
Extractable Acid
Sulfur

### 4.1.5 Principles of Operation
None given.

### 4.1.6 Sensor/Instrument Measurement Geometry
Not applicable.

### 4.1.7 Manufacturer of Sensor/Instrument
None given.

### 4.2 Calibration
Calibration information was provided for the following instruments:

TC: LECO 501-034 12%

Dry soil colors were measured according to the Munsell color chart.

All other standards were prepared in the laboratory from pure analytical compounds and tested against National Institute of Standards and Technology (NIST) standards.

### 4.2.1 Specifications
None given.

### 4.2.1.1 Tolerance
None given.

### 4.2.2 Frequency of Calibration
None given.

### 4.2.3 Other Calibration Information
None.

# 5. Data Acquisition Methods

Bulk Density: Cylinders of known volume and weight are pressed into the soil and filled with soil in its natural state. The soil and cylinder are dried at 105 °C and weighed. The soil weight is then calculated and divided by the cylinder volume (Manual on Soil Sampling and Methods of Analysis).

- TC: Measured by combustion of dried soil samples in a LECO CR12 Carbon Determinator (LECO Corporation Application Bulletin form no. 203-601-071).
- IC: Measured through digestion in acid, and evolved $CO_2$ is measured directly as carbonic acid in a two-endpoint titration (Tiessen et al., 1983).
- OC: Equals measured TC minus measured IC.
- Total Nitrogen and Phosphorus: Digestion in $H_2SO_4$ and $H_2O_2$ (Thomas et al., 1967). Products $NH_4$+ and P were measured colorimetrically by the ammonia-salicylate method (Technicon, 1973) and acid-molybdate blue method (Murphy and Riley, 1962), respectively.

Electrical conductivity and pH: Standard laboratory meter.

- CEC: The cations on the exchange are replaced with barium (Ba), which is then exchanged off the soil with $NH_4$ and the amount of Ba is measured (p. 54, Manual on Soil Sampling and Methods of Analysis).
- Exchangeable Cations: Measured in leachate after Ba has exchanged them off the soil; Na+, K+, $Ca_2$+, $Mg_2$+ by atomic absorption and H+ by back titration with HCl to pH 5.1 (p. 83, Manual on Soil Sampling and Methods of Analysis).
- Soil Moisture Retentions: Pressure plate extraction (p. 45, Manual on Soil Sampling and Methods of Analysis).
- Soil Size Fractions: Pipette method (p. 6, Manual on Soil Sampling and Methods of Analysis).

# 6. Observations

## 6.1 Data Notes

The table below lists soil classification (by order and subgroup), site location, soil pit number, and BOREAS site location of soil pits in this study. This information enables the user to spatially link soils data from this study to the TE-01 Soils Data over the NSA-MSA and Tower Sites in Raster Format and BOREAS Soils Data over the SSA in Raster Format and AEAC Projection. See TE-01 soils data documentation and Soil Classification Working Group (1998) for detailed description of soil classification. See also TE-20 Soils Report.

| Site location | Pit number | Order | Subgroup | BOREAS Site | Location |
|---|---|---|---|---|---|
| OA | 1 | LUVISOL | OGL | SSA-9OA-FLXTR | 9TE01-SOLO1 |
| OA | 2 | LUVISOL | OGL | SSA-9OA-FLXTR | 9TE01-SOLO2 |
| OA | 3 | LUVISOL | OLG | SSA-9OA-FLXTR | 9TE01-SOLO3 |
| OA | 4 | LUVISOL | OGL | SSA-9OA-FLXTR | 9TE01-SOLO4 |
| OA | 5 | LUVISOL | OGL | SSA-9OA-FLXTR | 9TE01-SOLO5 |
| OJP | 1 | BRUNISOL | OEB | SSA-OJP-FLXTR | 9TE01-SOLO1 |
| OJP | 2 | BRUNISOL | OEB | SSA-OJP-FLXTR | 9TE01-SOLO2 |
| OJP | 3 | BRUNISOL | EB | SSA-OJP-FLXTR | 9TE01-SOLO3 |
| OJP | 4 | BRUNISOL | ? | SSA-OJP-FLXTR | 9TE01-SOLO4 |
| YJP | 1 | BRUNISOL | EB | SSA-YJP-FLXTR | 9TE01-SOLO1 |
| YJP | 2 | BRUNISOL | EB | SSA-YJP-FLXTR | 9TE01-SOLO2 |
| YJP | 3 | BRUNISOL | OEB | SSA-YJP-FLXTR | 9TE01-SOLO3 |
| FEN | 1a | | | SSA-FEN-FLXTR | 9TE01-SOLO1 |

| | | | | |
|---|---|---|---|---|
| FEN | 1b | | SSA-FEN-FLXTR | 9TE01-SOLO2 |
| FEN | 1c | | SSA-FEN-FLXTR | 9TE01-SOLO3 |
| FEN | 1d | | SSA-FEN-FLXTR | 9TE01-SOLO4 |
| FEN | 1e | | SSA-FEN-FLXTR | 9TE01-SOLO5 |
| FEN | 2a | | SSA-FEN-FLXTR | 9TE01-SOLO6 |
| FEN | 2b | | SSA-FEN-FLXTR | 9TE01-SOLO7 |
| FEN | 2c | | SSA-FEN-FLXTR | 9TE01-SOLO8 |
| FEN | 2d | | SSA-FEN-FLXTR | 9TE01-SOLO9 |
| FEN | 2e | | SSA-FEN-FLXTR | 9TE01-SOLO10 |
| FEN | 3a | | SSA-FEN-FLXTR | 9TE01-SOLO11 |
| FEN | 3b | | SSA-FEN-FLXTR | 9TE01-SOLO12 |
| FEN | 3c | | SSA-FEN-FLXTR | 9TE01-SOLO13 |
| FEN | 3d | | SSA-FEN-FLXTR | 9TE01-SOLO14 |
| FEN | 3e | | SSA-FEN-FLXTR | 9TE01-SOLO15 |
| OBS | 1 | | SSA-OBS-FLXTR | 9TE01-SOLO1 |
| OBS | 2_1 | Peat | SSA-OBS-FLXTR | 9TE01-SOLO21 |
| OBS | 2_2 | Peat | SSA-OBS-FLXTR | 9TE01-SOLO22 |
| OBS | 2_3 | Peat | SSA-OBS-FLXTR | 9TE01-SOLO23 |
| OBS | 3_1 | Peat | SSA-OBS-FLXTR | 9TE01-SOLO31 |
| OBS | 3_2 | Peat | SSA-OBS-FLXTR | 9TE01-SOLO32 |
| OBS | 3_3 | Peat | SSA-OBS-FLXTR | 9TE01-SOLO33 |
| OBS | 3_4 | Peat | SSA-OBS-FLXTR | 9TE01-SOLO34 |

SOILDEV = Soil development (soil classification).

| Order | Subgroup |
|---|---|
| Brunisolic | |
| EDYB | Eluviated Dystric Brunisol |
| GLEDYB | Gleyed Eluviated Dystric Brunisol |
| EEB | Eluviated Eutric Brunisol |
| GLEEB | Gleyed Eluviated Eutric Brunisol |
| | |
| Gleysolic | |
| OHG | Orthic Humic Gleysol |
| RHG | Rego Humic Gleysol |
| OG | Orthic Gleysol |
| FEG | Ferric Gleysol |
| OLG | Orthic Luvic Gleysol |
| HULG | Humic Luvic Gleysol |
| | |
| Luvisolic | |
| OGL | Orthic Gray Luvisol |
| DGL | Dark Gray Luvisol |
| GLGL | Gleyed Gray Luvisol |
| GLDGL | Gleyed Dark Gray Luvisol |
| | |
| Organic | |
| TYF | Typic Fibrisol |
| MEF | Mesic Fibrisol |
| TF | Terric Fibrisol |
| TMEF | Terric Mesic Fibrisol |
| HYF | Hydric Fibrisol |
| TYM | Typic Mesisol |

| | |
|---|---|
| FIM | Fibric Mesisol |
| TM | Terric Mesisol |
| TFIM | Terric Fibric Mesisol |
| THUM | Terric Mesic Humisol |
| TH | Terric Humisol |
| TFIH | Terric Fibric Humisol |
| TMEH | Terric Mesic Humisol |
| | |
| Cryosolic | |
| OSC | Orthic Static Cryosol |
| RSC | Regosolic Static Cryosol |
| OTC | Orthic Turbic Cryosol |
| RTC | Regosolic Turbic Cryosol |
| FIOC | Fibric Organic Cryosol |
| MEOC | Mesic Organic Cryosol |
| HUOC | Humic Organic Cryosol |
| TFIOC | Terric Fibric Organic Cryosol |
| TMEOC | Terric Mesic Organic Cryosol |
| THUOC | Terric Humic Organic Cryosol |

Note: EB is described as Degraded Eutric Brunisol.

### 6.2 Field Notes

No important problems were encountered.

## 7. Data Description

### 7.1 Spatial Characteristics

#### 7.1.1 Spatial Coverage

The general soil survey had soil profiles examined on a 100-m by 100-m grid system in a 1-km$^2$ area with the tower in the center at the SSA OA, OBS, OJP, YJP, and Fen sites. The soil pits from which the soil samples were collected fell within these areas. The tower flux sites are located in the SSA at the following North American Datum of 1983 (NAD83) coordinates:

| | Longitude | Latitude |
|---|---|---|
| OBS | 105.11779 W | 53.98718 N |
| OJP | 104.69203 W | 53.91634 N |
| OA | 106.19779 W | 53.6289 N |
| YJP | 104.64527 W | 53.87581 N |
| Young Aspen (YA) | 105.32313 W | 53.65602 N |

#### 7.1.2 Spatial Coverage Map

None.

#### 7.1.3 Spatial Resolution

These data represent point locations.

#### 7.1.4 Projection

Not applicable.

### 7.1.5 Grid Description
Not applicable.

## 7.2 Temporal Characteristics

### 7.2.1 Temporal Coverage
In the summer of 1993, the OA, OJP, YJP, and Fen sites were surveyed. The OBS site was surveyed in the summer of 1994. The soil properties that were measured from the samples do not tend to change significantly with time. All measured parameters will change only over the long term, so any data could be valuable to generalize the soil characteristics of the area for many years in the future.

### 7.2.2 Temporal Coverage Map
None.

### 7.2.3 Temporal Resolution
The soil samples were collected at a certain point in time. However, the soil properties that were derived from the samples do not tend to change significantly with time.

## 7.3 Data Characteristics

### 7.3.1 Parameter/Variable
The parameters contained in the data files on the CD-ROM are:

| Column Name |
|---|
| SITE_NAME |
| SUB_SITE |
| MEASUREMENT_YEAR |
| PIT |
| HORIZON |
| START_DEPTH |
| END_DEPTH |
| DRY_SOIL_COLOR |
| STRUCTURE_DESCR |
| SOIL_PH |
| BULK_DENSITY |
| PEAT_DESCR |
| TOTAL_SOIL_C_CONTENT |
| SOIL_ORG_C_CONTENT |
| SOIL_INORG_C_CONTENT |
| ELECTRIC_CONDUCTIVITY |
| CATION_EX_CAPACITY |
| EXCHANGE_SODIUM |
| EXCHANGE_POTASSIUM |
| EXCHANGE_CALCIUM |
| EXCHANGE_MAGNESIUM |
| EXCHANGE_HYDROGEN |
| WATER_CONTENT_10KPA |
| WATER_CONTENT_33KPA |
| WATER_CONTENT_1500KPA |
| SOIL_NITROGEN_CONTENT |
| SOIL_PHOSPHORUS_CONTENT |
| VERY_COARSE_SAND |
| COARSE_SAND |

MEDIUM_SAND
FINE_SAND
VERY_FINE_SAND
TOTAL_SAND
TOTAL_SILT
TOTAL_CLAY
SOIL_TEXTURE
CRTFCN_CODE
REVISION_DATE

### 7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files onmthe CD-ROM are:

| Column Name | Description |
|---|---|
| SITE_NAME | The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type. |
| SUB_SITE | The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument. |
| MEASUREMENT_YEAR | The year in which the data were collected. |
| PIT | The pit identifier from which the sample was taken. |
| HORIZON | The soil horizon from which the sample was taken. |
| START_DEPTH | The start depth from the surface where the sample was collected. |
| END_DEPTH | The end depth from the surface where the sample was collected. |
| DRY_SOIL_COLOR | The Munsell color of the soil when it is dry. |
| STRUCTURE_DESCR | A description of the soil structure (e.g. amorphous, weakly decomposed, single grain). |
| SOIL_PH | The pH of the soil sample. |
| BULK_DENSITY | Bulk density of the soil sample. |
| PEAT_DESCR | A one word description of the peat (e.g. FIBRIC, HUMIC, MINERAL), for fen site only. |
| TOTAL_SOIL_C_CONTENT | The percent total carbon in the soil sample. |
| SOIL_ORG_C_CONTENT | The percent organic carbon in the soil sample. |
| SOIL_INORG_C_CONTENT | The percent inorganic carbon in the soil sample. |
| ELECTRIC_CONDUCTIVITY | The electric conductivity of the soil sample. |
| CATION_EX_CAPACITY | The cation exchange capacity in the soil sample. |
| EXCHANGE_SODIUM | The exchangeable sodium in the soil sample. |
| EXCHANGE_POTASSIUM | The exchangeable potassium in the soil sample. |
| EXCHANGE_CALCIUM | The exchangeable calcium in the soil sample. |
| EXCHANGE_MAGNESIUM | The exchangeable magnesium in the soil sample. |
| EXCHANGE_HYDROGEN | The exchangeable hydrogen in the soil sample. |

| | |
|---|---|
| WATER_CONTENT_10KPA | The water content of the soil in percent by weight of water held at 0.01 MegaPascals. |
| WATER_CONTENT_33KPA | The water content of the soil in percent by weight of water held at 0.033 MegaPascals. |
| WATER_CONTENT_1500KPA | The water content of the soil in percent by weight of water held at 1.5 MegaPascals. |
| SOIL_NITROGEN_CONTENT | The nitrogen content of the soil sample. |
| SOIL_PHOSPHORUS_CONTENT | The phosphorus content of the soil sample. |
| VERY_COARSE_SAND | The amount of very coarse sand in the soil sample. |
| COARSE_SAND | The amount of coarse sand in the soil sample. |
| MEDIUM_SAND | The amount of medium sand in the soil sample. |
| FINE_SAND | The amount of fine sand in the soil sample. |
| VERY_FINE_SAND | The amount of very fine sand in the soil sample. |
| TOTAL_SAND | The total amount of sand in the soil sample. |
| TOTAL_SILT | The total amount of silt in the soil sample. |
| TOTAL_CLAY | The total amount of total clay in the soil sample. |
| SOIL_TEXTURE | The texture of the soil sample. |
| CRTFCN_CODE | The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable). |
| REVISION_DATE | The most recent date when the information in the referenced data base table record was revised. |

The following information should help in describing the soil horizon codes:

| **Organic Horizons** | |
|---|---|
| **Horizon Code** | **Code Description** |
| O | This is an organic horizon developed mainly from mosses, rushes, and woody materials. |
| Of | The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply. |
| Om | The mesic horizon is the intermediate stage of decomposition with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic. |
| Oh | The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less. |
| LFH | These organic horizons developed primarily from leaves, twigs, woody materials, and a minor component of mosses under imperfectly to well-drained forest conditions. |

| | |
|---|---|
| L | This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible. |
| F | This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor. |
| H | This is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon. |

**Mineral Horizons**

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizon.

| Horizon Code | Code Description |
|---|---|
| A | This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:<br>• horizons in which organic matter has accumulated as a result of biological activity (Ah);<br>• horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);<br>• horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);<br>• horizons markedly disturbed by cultivation or pasture (Ap). |
| B | This is a mineral horizon or horizons characterized by one or more of the following:<br>• an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt, Bf, Bfh, Bhf, and Bh);<br>• a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);<br>• an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm, Bg). |
| C | This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca, Csa, Cg, and C). Marl and diatomaceous earth are considered to be C horizons. |

| | |
|---|---|
| R | This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact. |
| W | This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils. |
| | |
| **Lower-Case Suffixes** | |
| **Horizon Code** | **Code Description** |
| b | Buried soil horizon. |
| c | A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples. |
| ca | A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a $CaCO_3$ equivalent of less than 15 percent it should have at least 5 percent more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15 percent $CaCO_3$ equivalent it should have 1/3 more $CaCO_3$ equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms. |
| cc | Cemented (irreversible) pedogenic concretions. |
| e | A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae). |
| f | A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002 mm) is more than 0.05 and OC exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of OC to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. |
| | |
| The following horizons are differentiated on the basis of OC content: Bf - 0.5% to 5% OC. Bhf - more than 5% OC. | |
| **Horizon Code** | **Code Description** |

| | |
|---|---|
| g | A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist, despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks. |
| Aeg | This horizon must meet the definitions of A, e, and g. |
| Bg | These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are: (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more prominent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols. |
| Bfg, Bhfg, Btg, and others. | When used in any of these combinations the limits set for f, hf, t, and others must be met. |
| Bgf | The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma. |
| Cg, Ckg, Ccag, Csg, Csag | When g is used with C alone, or with C and one of the lowercase suffixes k, ca, s, or sa, it must meet the definition for C and for the particular suffix. |
| h | A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf). |
| Ah | A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more OC than the IC, or both. It contains less than 17% OC by weight. |
| Ahe | An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter colored Ae. |

| | |
|---|---|
| Bh | This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of OC to pyrophosphate-extractable of 20 or more. Generally the color value and chroma are less than 3 when moist. |
| Bhf | Defined under 'f'. |
| j | Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right of and adjacent to the suffix it modifies. For example, Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features. |
| Aej | An eluvial horizon that is thin, discontinuous, or slightly discernible. |
| Btj | A horizon with some illuviation of clay, but not enough to meet the limits of Bt. Btgj, Bmgj Horizons that are mottled but do not meet the criteria of Bg. |
| Bfj | A horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf. Bntj or Bnj Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt. |
| k | Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk). |
| m | A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:<br>• Evidence of alteration in one of the following forms:<br>  • Higher chromas and redder hues than the underlying<br>  • Removal of carbonates, either partially (Bmk) or completely (Bm).<br>• Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.<br>• Some weatherable minerals.<br>• No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms. |
| n | A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt. |
| p | A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O. |
| s | A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix. |

| | |
|---|---|
| sa | A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third. |
| t | An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc. |
| Bt | A Bt horizon is one that contains illuvial layer lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:<br>• If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:<br>  • If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2 mm), the Bt horizon must contain at least 3% more clay, e.g., Ae 10% clay, Bt minimum 13% clay.<br>  • If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.<br>  • If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g., Ae 50% clay, Bt at least 58% clay.<br>• A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.<br>• In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.<br>• If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.<br>• If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies. |
| Btj | Btj and Btg are defined under j and g. |
| u | A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc., must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g., Aeu, Bfu, BCu. |

| | |
|---|---|
| x | A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water. |
| y | A horizon affected by cryoturbation as manifested by disrupted and broken horizons, incorporation of materials from other horizons, and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g., Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc. |
| z | A frozen layer. It may be used with any horizon or layer, e.g., Ohz, Bmz, Cz, Wz. |

### 7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

| Column Name | Units |
|---|---|
| SITE_NAME | [none] |
| SUB_SITE | [none] |
| MEASUREMENT_YEAR | [unitless] |
| PIT | [none] |
| HORIZON | [none] |
| START_DEPTH | [meters] |
| END_DEPTH | [meters] |
| DRY_SOIL_COLOR | [none] |
| STRUCTURE_DESCR | [none] |
| SOIL_PH | [pH] |
| BULK_DENSITY | [kilograms][meter^-3] |
| PEAT_DESCR | [none] |
| TOTAL_SOIL_C_CONTENT | [percent] |
| SOIL_ORG_C_CONTENT | [percent] |
| SOIL_INORG_C_CONTENT | [percent] |
| ELECTRIC_CONDUCTIVITY | [siemens][meter^-1] |
| CATION_EX_CAPACITY | [millimoles +ve charge][kilograms^-1 of soil] |
| EXCHANGE_SODIUM | [millimoles +ve charge][kilograms^-1 of soil] |
| EXCHANGE_POTASSIUM | [millimoles +ve charge][kilograms^-1 of soil] |
| EXCHANGE_CALCIUM | [millimoles +ve charge][kilograms^-1 of soil] |
| EXCHANGE_MAGNESIUM | [millimoles +ve charge][kilograms^-1 of soil] |
| EXCHANGE_HYDROGEN | [millimoles +ve charge][kilograms^-1 of soil] |
| WATER_CONTENT_10KPA | [percent] |
| WATER_CONTENT_33KPA | [percent] |
| WATER_CONTENT_1500KPA | [percent] |
| SOIL_NITROGEN_CONTENT | [percent by weight] |
| SOIL_PHOSPHORUS_CONTENT | [percent by weight] |
| VERY_COARSE_SAND | [percent] |
| COARSE_SAND | [percent] |
| MEDIUM_SAND | [percent] |
| FINE_SAND | [percent] |
| VERY_FINE_SAND | [percent] |
| TOTAL_SAND | [percent] |

| | |
|---|---|
| TOTAL_SILT | [percent] |
| TOTAL_CLAY | [percent] |
| SOIL_TEXTURE | [none] |
| CRTFCN_CODE | [none] |
| REVISION_DATE | [DD-MON-YY] |

### 7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

| Column Name | Data Source |
|---|---|
| SITE_NAME | [Assigned by BORIS] |
| SUB_SITE | [Assigned by BORIS] |
| MEASUREMENT_YEAR | [Supplied by Investigator] |
| PIT | [Supplied by Investigator] |
| HORIZON | [Supplied by Investigator] |
| START_DEPTH | [Supplied by Investigator] |
| END_DEPTH | [Supplied by Investigator] |
| DRY_SOIL_COLOR | [Supplied by Investigator] |
| STRUCTURE_DESCR | [Supplied by Investigator] |
| SOIL_PH | [Supplied by Investigator] |
| BULK_DENSITY | [Supplied by Investigator] |
| PEAT_DESCR | [Supplied by Investigator] |
| TOTAL_SOIL_C_CONTENT | [Supplied by Investigator] |
| SOIL_ORG_C_CONTENT | [Supplied by Investigator] |
| SOIL_INORG_C_CONTENT | [Supplied by Investigator] |
| ELECTRIC_CONDUCTIVITY | [Supplied by Investigator] |
| CATION_EX_CAPACITY | [Supplied by Investigator] |
| EXCHANGE_SODIUM | [Supplied by Investigator] |
| EXCHANGE_POTASSIUM | [Supplied by Investigator] |
| EXCHANGE_CALCIUM | [Supplied by Investigator] |
| EXCHANGE_MAGNESIUM | [Supplied by Investigator] |
| EXCHANGE_HYDROGEN | [Supplied by Investigator] |
| WATER_CONTENT_10KPA | [Supplied by Investigator] |
| WATER_CONTENT_33KPA | [Supplied by Investigator] |
| WATER_CONTENT_1500KPA | [Supplied by Investigator] |
| SOIL_NITROGEN_CONTENT | [Supplied by Investigator] |
| SOIL_PHOSPHORUS_CONTENT | [Supplied by Investigator] |
| VERY_COARSE_SAND | [Supplied by Investigator] |
| COARSE_SAND | [Supplied by Investigator] |
| MEDIUM_SAND | [Supplied by Investigator] |
| FINE_SAND | [Supplied by Investigator] |
| VERY_FINE_SAND | [Supplied by Investigator] |
| TOTAL_SAND | [Supplied by Investigator] |
| TOTAL_SILT | [Supplied by Investigator] |
| TOTAL_CLAY | [Supplied by Investigator] |
| SOIL_TEXTURE | [Supplied by Investigator] |
| CRTFCN_CODE | [Assigned by BORIS] |
| REVISION_DATE | [Assigned by BORIS] |

### 7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

| Column Name | Minimum Data Value | Maximum Data Value | Missng Data Value | Unrel Data Value | Below Detect Limit | Data Not Cllctd |
|---|---|---|---|---|---|---|
| SITE_NAME | SSA-90A-FLXTR | SSA-YJP-FLXTR | None | None | None | None |
| SUB_SITE | 9TE01-SOL01 | 9TE01-SOL34 | None | None | None | None |
| MEASUREMENT_YEAR | 1994 | 1994 | None | None | None | None |
| PIT | 1 | 5 | None | None | None | None |
| HORIZON | AB | peat | None | None | None | None |
| START_DEPTH | -.15 | 3 | None | None | None | None |
| END_DEPTH | -0.1 | 4.1 | -9.99 | None | None | None |
| DRY_SOIL_COLOR | 10YR4/2 | n/a | None | None | None | None |
| STRUCTURE_DESCR | N/A | N/A | None | None | None | None |
| SOIL_PH | 3.4 | 9.2 | None | None | None | None |
| BULK_DENSITY | 70 | 1790 | -999 | None | None | None |
| PEAT_DESCR | N/A | N/A | None | None | None | None |
| TOTAL_SOIL_C_CONTENT | .02 | 51.69 | None | None | None | None |
| SOIL_ORG_C_CONTENT | .01 | 49.13 | None | None | None | None |
| SOIL_INORG_C_CONTENT | 0 | 12.66 | None | None | None | None |
| ELECTRIC_ CONDUCTIVITY | 0 | 124.7 | -999 | None | None | None |
| CATION_EX_CAPACITY | 8.4 | 1196.2 | -999 | None | None | None |
| EXCHANGE_SODIUM | .1 | 4.3 | -999 | None | None | None |
| EXCHANGE_POTASSIUM | .3 | 82.8 | -999 | None | None | None |
| EXCHANGE_CALCIUM | 2.9 | 1374.7 | -999 | None | None | None |
| EXCHANGE_MAGNESIUM | .2 | 262.4 | -999 | None | None | None |
| EXCHANGE_HYDROGEN | 0 | 483.9 | -999 | None | None | None |
| WATER_CONTENT_10KPA | 1.36 | 34.24 | -999 | None | None | None |
| WATER_CONTENT_33KPA | .96 | 27.37 | -999 | None | None | None |
| WATER_CONTENT_ 1500KPA | .43 | 15.66 | -999 | None | None | None |
| SOIL_NITROGEN_ CONTENT | 0 | 2.241 | None | None | None | None |
| SOIL_PHOSPHORUS_ CONTENT | 0 | .195 | None | None | None | None |
| VERY_COARSE_SAND | .11 | 39.17 | -999 | None | None | None |
| COARSE_SAND | .53 | 68.94 | -999 | None | None | None |
| MEDIUM_SAND | .63 | 53.59 | -999 | None | None | None |
| FINE_SAND | 3.8 | 63.95 | -999 | None | None | None |
| VERY_FINE_SAND | .43 | 34.76 | -999 | None | None | None |
| TOTAL_SAND | 21 | 98.62 | -999 | None | None | None |
| TOTAL_SILT | .49 | 58.94 | -999 | None | None | None |
| TOTAL_CLAY | .81 | 29.41 | -999 | None | None | None |
| SOIL_TEXTURE | N/A | N/A | None | None | None | None |
| CRTFCN_CODE | CPI | CPI | None | None | None | None |
| REVISION_DATE | 22-OCT-96 | 22-OCT-96 | None | None | None | None |

Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the

```
                        parameter value, but the attempt was unsuccessful.
Unrel Data Value    -- The value that indicates unreliable data.  This is used
                       to indicate an attempt was made to determine the
                       parameter value, but the value was deemed to be
                       unreliable by the analysis personnel.
Below Detect Limit  -- The value that indicates parameter values below the
                       instruments detection limits.  This is used to
                       indicate that an attempt was made to determine the
                       parameter value, but the analysis personnel determined
                       that the parameter value was below the detection
                       limit of the instrumentation.
Data Not Cllctd     -- This value indicates that no attempt was made to
                       determine the parameter value.  This usually
                       indicates that BORIS combined several similar but
                       not identical data sets into the same data base table
                       but this particular science team did not
                       measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.
N/A   -- Indicates that the value is not applicable to the respective column.
None  -- Indicates that no values of that sort were found in the column.
-------------------------------------------------------------------------------
```

### 7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

```
SITE_NAME,SUB_SITE,MEASUREMENT_YEAR,PIT,HORIZON,START_DEPTH,END_DEPTH,
DRY_SOIL_COLOR,STRUCTURE_DESCR,SOIL_PH,BULK_DENSITY,PEAT_DESCR,
TOTAL_SOIL_C_CONTENT,SOIL_ORG_C_CONTENT,SOIL_INORG_C_CONTENT,
ELECTRIC_CONDUCTIVITY,CATION_EX_CAPACITY,EXCHANGE_SODIUM,EXCHANGE_POTASSIUM,
EXCHANGE_CALCIUM,EXCHANGE_MAGNESIUM,EXCHANGE_HYDROGEN,WATER_CONTENT_10KPA,
WATER_CONTENT_33KPA,WATER_CONTENT_1500KPA,SOIL_NITROGEN_CONTENT,
SOIL_PHOSPHORUS_CONTENT,VERY_COARSE_SAND,COARSE_SAND,MEDIUM_SAND,FINE_SAND,
VERY_FINE_SAND,TOTAL_SAND,TOTAL_SILT,TOTAL_CLAY,SOIL_TEXTURE,CRTFCN_CODE,
REVISION_DATE
'SSA-90A-FLXTR','9TE01-SOL01','1993','1','L',-.08,-.06,'n/a',
'weakly decomposed leaf material',6.7,110,'N/A',44.24,43.81,.43,60.2,1018.4,
1.3,27.1,1323.1,204.9,320.5,-999.0,-999.0,-999.0,2.194,.14,-999.0,-999.0,-999.0,
-999.0,-999.0,-999.0,-999.0,-999.0,'N/A','CPI',22-OCT-96
'SSA-90A-FLXTR','9TE01-SOL01','1993','1','F',-.06,-.03,'n/a',
'moderately decomposed leaf material',6.7,230,'N/A',40.19,39.74,.45,52.01,1101.9,
1.5,34.4,1050.5,192.3,363.3,-999.0,-999.0,-999.0,2.125,.174,-999.0,-999.0,-999.0,
-999.0,-999.0,-99 9.0,-999.0,-999.0,'N/A','CPI',22-OCT-96
```

## 8. Data Organization

### 8.1 Data Granularity

The smallest amount of data that can be ordered from this data set is the entire data set from all soil pits at the SSA sites.

### 8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain ASCII numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe

marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

## 9. Data Manipulations

### 9.1 Formulae

All relevant data manipulation information can be obtained in the manuals and references listed Section 17 or described in Section 5. These standard measurements used the standard manipulations.

### 9.1.1 Derivation Techniques and Algorithms

None given.

### 9.2 Data Processing Sequence

None given.

### 9.2.1 Processing Steps

None given.

### 9.2.2 Processing Changes

None.

### 9.3 Calculations

### 9.3.1 Special Corrections/Adjustments

None.

### 9.3.2 Calculated Variables

None given.

### 9.4 Graphs and Plots

None.

## 10. Errors

### 10.1 Sources of Error

Much of the errors incurred would be due to the heterogeneity of soils and to equipment precision. These errors associated with measuring these soil properties are within the limits required for the use of these data.

### 10.2 Quality Assessment

The soil survey was performed by a soil expert who has many years of soil survey field experience. As a result, there is a great deal of confidence in the field visual observations and in the quality of soil samples brought into the lab for analysis. All methods for measuring soil characteristics have been performed routinely in the department's soil survey division. All methods have been tested thoroughly for accuracy, accepted for the general soil survey of Saskatchewan, and approved at the federal research level.

### 10.2.1 Data Validation by Source

A cursory review of the data was made to ensure that the data were as expected. Some spot checks were made to confirm that the data were within the realm of possibility.

### 10.2.2 Confidence Level/Accuracy Judgment

None given.

### 10.2.3 Measurement Error for Parameters

The error ranges for some of the parameters are:

- pH: 5%
- Bulk Density: 5%
- TC and IC: 3%
- Total Nitrogen and Phosphorus: 5%
- EC and CEC: 5%
- Exchangeable H+: 10%
- Soil Moisture Retentions (0.1, 0.33, and 15 atm): 5%
- Particle Size Fractions: 5%

### 10.2.4 Additional Quality Assessments

None.

### 10.2.5 Data Verification by Data Center

The data were checked after loading into the relational data base to ensure that no errors occurred during loading.

## 11. Notes

### 11.1 Limitations of the Data

None given.

### 11.2 Known Problems with the Data

None given.

### 11.3 Usage Guidance

None given.

### 11.4 Other Relevant Information

None.

## 12. Application of the Data Set

This data set was collected to provide major soil parameter data for modeling and other research purposes for the BOREAS project.

## 13. Future Modifications and Plans

None.

## 14. Software

### 14.1 Software Description
None.

### 14.2 Software Access
None.

## 15. Data Access

The SSA soil lab data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

### 15.1 Contact Information
For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

### 15.2 Data Center Identification
Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

### 15.3 Procedures for Obtaining Data
Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

### 15.4 Data Center Status/Plans
The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

## 16. Output Products and Availability

### 16.1 Tape Products
None.

### 16.2 Film Products
None.

### 16.3 Other Products
These data are available on the BOREAS CD-ROM series.

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## 17.1 Platform/Sensor/Instrument/Data Processing Documentation

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## 17.3 Archive/DBMS Usage Documentation

None.

## 18. Glossary of Terms

None.

## 19. List of Acronyms

| | |
|---|---|
| AEAC | - Albers Equal-Area Conic |
| ASCII | - American Standard Code for Information Interchange |
| BOREAS | - BOReal Ecosystem-Atmosphere Study |
| BORIS | - BOREAS Information System |
| CD-ROM | - Compact Disk-Read-Only Memory |
| CEC | - Cation Exchange Capacity |
| DAAC | - Distributed Active Archive Center |
| EC | - Electric Conductivity |
| EOS | - Earth Observing System |
| EOSDIS | - EOS Data and Information System |
| GIS | - Geographic Information System |
| GSFC | - Goddard Space Flight Center |
| HTML | - HyperText Markup Language |
| IC | - Inorganic Carbon |
| MSA | - Modeling Sub-Area |
| NAD83 | - North American Datum of 1983 |
| NASA | - National Aeronautics and Space Administration |
| NIST | - National Institute of Standards and Technology |
| NSA | - Northern Study Area |
| OA | - Old Aspen |
| OBS | - Old Black Spruce |
| OC | - Organic Carbon |
| OJP | - Old Jack Pine |
| ORNL | - Oak Ridge National Laboratory |
| PANP | - Prince Albert National Park |
| PI | - Principal Investigator |
| SSA | - Southern Study Area |
| TC | - Total Carbon |
| TE | - Terrestrial Ecology |
| TGB | - Trace Gas Biogeochemistry |
| URL | - Uniform Resource Locator |
| YA | - Young Aspen |
| YJP | - Young Jack Pine |

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This data set was collected by TE-1 to provide a set of soil properties for BOREAS investigators in the SSA. The soil samples were collected at sets of soil pits in 1993 and 1994. Each set of soil pits was in the vicinity of one of the five flux towers in the BOREAS SSA. The collected soil samples were sent to a lab, where the major soil properties were determined. These properties include, but are not limited to, soil horizon; dry soil color; pH; bulk density; total, organic, and inorganic carbon; electric conductivity; cation exchange capacity; exchangeable sodium, potassium, calcium, magnesium, and hydrogen; water content at 0.01, 0.033, and 1.5 MPascals; nitrogen; phosphorus; particle size distribution; texture; pH of the mineral soil and of the organic soil; extractable acid; and sulfur. The data are stored in tabular ASCII text files.

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