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United States Department of Agriculture

NEON Site-Level Plot Summary
Healy, Alaska (HEAL)

Document Information

Date
May 2017

Author
Dennis Mulligan, Soil Scientist, Wasilla, AK

Site Background

The Healy (HEAL) site is near Healy, Alaska and the Northern boundary of Denali National Park. The site is in Major Land Resource Area (MLRA) 228 – Interior Alaska Mountains. The site consists of 11,161 acres and is located in a glaciated, high elevation valley of the Alaska Range. Elevation at the site ranges from approximately 580 to 1189 m (1900 feet to 3900 feet) above sea level.

Site Information

The parent material at the HEAL site is dominantly loess over gravelly till and outwash. The loess material has been reworked by gravity, water and cryoturbation.

Land cover is dominated by subalpine shrubs and sedge meadows with a few forested drainage ways. In the far south western portion of the site the elevation rises above 3000 feet where alpine dwarf shrubs and forbs become dominant. However, no distributed plots are located in this area.

Plant communities are dominated by ericaceous shrubs, willow scrub, tussock grasses and spruce forests in the drains.

Landforms and/or slope positions where the soils occur are foot and toe slopes, alluvial fans, stream terraces, and drains.

Analysis of Plots for Sampling

No Soil Survey exists for this area but it is in close proximity to the Soil Survey of Denali National Park and Preserve. In selecting representative plots to sample, landform and vegetative communities were observed on SPOT5 satellite imagery, and probable map units and soil components were selected from the Denali Soil Survey. The entire Healy site broke out into 4 or 5 map units, including water (at 1:63,360 scale or order 3-4 soil survey). All of the distributed plots fell within map units 11P or 11P1, which represent approximately 77 percent of the HEAL site (Table 1). These map units are similar, differing primarily in percent composition. In both map units, Alpine-tussock-scrub silty loess slopes, frozen, and similar soils are the dominant

Major component. The remaining 23% of the HEAL site area consists of unnamed map units, here denoted as Boreal Mountain Toeslopes with Discontinuous Permafrost, Subalpine and Alpine Plateau Escarpments, and Water: these unnamed units did not contain any NEON plots (Table 2). The plot evaluation resulted in 12 plots and 4 alternate plots being selected for field description, sampling, and lab characterization. The 18 plots not sampled either occurred in non-typical settings, were close to or straddling component edges or were duplicates of one of the 12 selected plots and 4 alternates.

Map unit symbol	Map Unit Name	% Total site area
11P	Alpine Plains with Continuous Permafrost	77
	OR	
11P1	Alpine Plains and Drainages with Continuous Permafrost	77
	Total	**77**

Table 1. Probable soil map units sampled at the NEON HEAL site. Map units are based on the Soil Survey of Denali National Park, which was performed at 1:63,360 resolution.

Map unit symbol	Map Unit Name	% Total site area
10TS1	Boreal Mountain Toeslopes with Discontinuous Permafrost, Nenana Gravels	20
10ES	Subalpine and Alpine Plateau Escarpments with Discontinuous Permafrost	2
W	Water	1
Total		**23**

Table 2. Probable soil map units not sampled at the HEAL site. These map units do not contain any NEON soil plots. Map units are based on the Soil Survey of Denali National Park, which was performed at 1:63,360 resolution.

Plot Findings

The 12 pedons sampled represent the most extensive soil map unit on the site. The major soil components sampled are:

- Alpine-tussock-scrub silty loess slopes, frozen – HEAL_007, HEAL_012,HEAL_022, HEAL_045, and HEAL_047;
- Subalpine-riparian scrub loamy drains - HEAL_026 and HEAL_028;
- Alpine-sedge bog organic depressions - HEAL_016, HEAL_018, and HEAL_020;

- Convex variation of the Alpine-tussock-scrub silty loess slopes, frozen – HEAL_023 and HEAL_046. Note that due to difficulties sampling at HEAL_023, no samples were obtained from this plot and no field or laboratory data were obtained . Several attempts were made to obtain a core during field sampling, and all resulted in core refusal. Field observations, however, such as landform, parent material, and presence of permafrost were recorded. Any reference to HEAL_023 in this summary is based on the field observations and is included for completeness.

Landforms— All the distributed plots occur on broad toe slopes or valley bottoms dissected by small drainages. NEON distributed plots HEAL_002, HEAL_006, HEAL_007, HEAL_012, HEAL_022, HEAL_045 and HEAL_047 occur on relatively plainer landscapes with gentle slopes. Plots HEAL_023 and HEAL_046 occur on more convex positions. Plots HEAL_016, HEAL_017, HEAL_018 and HEAL_020 occur in concave depressions. Plots HEAL_026, HEAL_027 and HEAL_029 occur in drainages.

Parent Material—The local geology is dominated by quaternary deposits (either loess or alluvium) underlain by the Nenana gravels, a sedimentary group of pebble to boulder-conglomerate that is interbedded with sandstone mudflow deposits and coal.

Plots HEAL_002, 006, 007, 012, 022, 045 and 047 are all formed in loess that has been reworked by gravity, water and cryoturbation. These samples typically have a thick organic layer and have coarse fragments that have been frost heaved into the soil profile from below.

Of the plots that were supposed to capture Alpine-sedge bog organic depressions, only plot HEAL_016 has a thick enough organic layer to classify as a Histel. Plot HEAL_018 has a histic epipedon over coarse silty loess material and plots HEAL_017and 020 both have stratified textures and organic material that may indicate fluvial processes.

Plots HEAL_026, 027 and 029 were formed in alluvium expected in drains.

Plots HEAL_023 and 046 have evidence of strong cryoturbation and frost heaving that would be consistent with congeloturbate parent material expected on mud boils or non-sorted circles.

Summary of Soils

The dominant component in the HEAL site is Alpine-tussock-scrub silty loess slopes, frozen. This component is classified as a Typic Histoturbel. Plots sampled for this component were HEAL_007, HEAL_012, HEAL_022, HEAL_045, HEAL_047, with alternate plots HEAL_002 and HEAL_006. These soils have a thick (> 20cm) organic layer over mineral soil. The mineral part of the soil is developed in loess that overlies gravelly glacial till or outwash at some depth. The loess on these surfaces has been reworked by water, slope and cryogenic processes.

Diagnostic features Alpine-tussock-scrub silty loess slopes:

Histic epipedon - Was present in plots HEAL_006, 007, 012, 022; at plots HEAL_045 and 047 the O horizons alone are not thick enough, but the highly organic A horizons qualify to be part of the Histic epipedon. HEAL_002 only had a 7 cm organic horizon, which is not thick enough to be classified as a Histic epipedon.

Cryoturbation – The typical expression of convoluted, mixed and broken horizons was observed in plots HEAL_007, 012, 022 and 045. While these very obvious expressions of cryoturbation were not observed in plots HEAL_002, 006 or 047, these soil profiles did have coarse fragments frost heaved into the overlying silty horizons.

Permafrost - All pedons were entirely frozen at the time of describing; as such, other signs of permafrost were used. Plots HEAL_002, 022 and 045 did not show the increases in interstitial or lenticular ice typically associated with the permafrost table and therefore were described without a permanently frozen (or 'f') horizon. It is likely that permafrost exists deeper than the depth sampled.

The gravels frost-heaved into the silty mantle occasionally caused issues with sampling, which was performed using a SIPRE permafrost auger.

The second most common component was Alpine-sedge bog organic depressions, frozen. This component is classified as a Terric Firistel. Plots sampled for this component were HEAL_017, 018, 020 and HEAL_016. These soils occur on similar land forms and materials as Alpine-tussock-scrub silty loess slopes, frozen soils, but have had some thaw-associated subsidence. These soil components are concave and have accumulated thick organic mats. Over time, these depressions will often link together, resulting in beaded drainage patterns.

Diagnostic features of Alpine-sedge bog organic depressions soil components:

- Fibric Soil Materials - HEAL_018 and 020 both have thin Oi horizons, but the dominant organic material described on these plots was hemic rather than fibric.
- Organic thickness - None of the primary plot pedons meet the thickness criteria for organic soil material comprising 80 percent or more by volume, from the soil surface to a depth of 50 cm. The alternate plot HEAL_016 does meet the thickness requirement, but was described as an Oe horizon, which is hemic material.
- Permafrost - None of the primary plot pedons showed typical evidence for permafrost: therefore, horizons were described without an 'f' modifier. Only the alternate plot, HEAL_016 shows typical evidence of permafrost. The characteristic sedge bog depressions are often caused by subsidence due to thawing. The permafrost, especially the near-surface permafrost, may be compromised or entirely gone in some of these depressions.
- Mineral horizon thickness – Soils have a mineral horizon 30 cm or more thick. All samples have thick mineral horizons below the organic horizon.
- In addition, plots HEAL_017 and 020 show evidence of stratification. This may be a result of the depressions becoming involved with a beaded drainage system.

The third most common component was Subalpine-riparian scrub loamy drains. This component is classified as an Aquic Cryofluvent. Plots sampled for this component were HEAL_026, 029 and 027. These components occur in well established drainageways and the soils usually have evidence of this fluvial environment such as stratified textures and an irregular decrease in organic carbon.

Diagnostic features of Subalpine-riparian scrub loamy drains:

- An irregular decrease in organic-carbon content (Holocene age) – HEAL_026 and 029 have visible stratified organic material and stratified textures.
- Redox depletions within 50 cm of mineral soil surface – HEAL_026 appears to have depleted matrix and redox concentrations. HEAL_029 has redox concentrations but no depletions. HEAL_027 has both depletions and concentrations.

A note about HEAL_026: this plot had 26 cm of organic horizon. Due to the presence of Histic or Folistic epipedon, this pedon will not classify the same as the map unit component. This is common for cold soils and is part of the cycle of non-permafrost soils becoming permafrost soils. As soils age, the organic matter thickens due to cold and increasingly acidic conditions. The thicher organic layer insulates the soil, causing the annual thermal cycles to slow until the soil remains frozen throughout the year.

Plots were also sampled from the Alpine-tussock-scrub silty loess slopes – convex component. While this doesn't match any of the named soil components in the Denali mapunits, based on SPOT5 imagery a distinct convex position can be seen in plots HEAL_023 and HEAL_046. Therefore, these plots were selected for sampling.

These convex positions differ significantly from the alpine plain and concave components and often have mud boils or non-sorted circles. Since they are visible in the imagery and two of the NEON plots were within these features, we sample these convex positions to more accurately represent the variability on the landscape. Gravel at the surface of HEAL_023 stopped progress right below the O horizon (10 to 20 cm depth): 4 attempts were made, and all ended at or near the bottom of the organic layer. For HEAL_046 a sample was obtained to 70 cm depth. This sample was highly cryotubated and had a high concentration of coarse fragments (~20 %). The results from both HEAL_023 and 046 would be consistent for a landscape with mud boil or nonsorted circles.