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NEON Site-Level Plot Summary
Toolik Lake (TOOL)

Document Information

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Site Background

The Toolik Lake (TOOL) NEON site is 132 miles south of Prudhoe Bay and 365 miles north of Fairbanks along the Dalton Highway. The site is in MLRA 245—Arctic Foothills and 244—Northern Brooks Range Mountains in the North Slope Borough, Alaska and consists of 77,373 acres. The TOOL site occurs on moderately dissected, rolling till and outwash plains, grading to steep mountain slopes in the far south end of the site. The elevation at the TOOL site ranges from approximately 670 to 1,422 meters (2198 to 4,666 ft) above sea level.

Site Information

Most of the TOOL site is on rolling till plains and moraines with various superposed periglacial features that include stripes, non-sorted circles and thermokarst pits. Loess and alluvim holocene deposits of varying thickness blanket the area. In concave positions the soils have developed a thick organic layer and on convex slopes gelic or frost churned materials are exposed at the surface. South of the TOOL site the similar periglacial-modified glacial moraines occur adjacent to the Brooks Range. The bedrock geology of the mountains consists primarily of Cretaceous and late Paleozoic to lower Mesozoic stratified sedimentary rocks. However, no NEON distributed plots fall on these landforms or bedrock.

The Tool site is in continuous permafrost zone, although taliks - small pockets of non-frozen material - often exist beneath lakes and rivers.

The Dalton Highway (known locally as the Haul Road) and the Trans-Alaska Pipeline bisect the TOOL site. Toolik Field Station (TFS) is operated and managed by the Institute of Arctic Biology at the University of Alaska Fairbanks (UAF) and occupies about 60 acres within the site.

Analysis of Plots for Sampling

There is no soil survey for this site. No soil series or mapunit components have been established for this site. A preliminary soil map was created for the area utilizing SPOT5 Ortho Imagery; Digital Raster Graphic image from USGS topographic maps; hill shade, slope and elevation maps derived from a 2002 5m DEM data acquired by the National Science Foundation's Arctic Logistics and Research Support Program and obtained from the Toolik Field Station website; Upper Kuparuk Geobotanical Map (Walker, D. A. and H. A. Maier. 2008); the NEON Site Boundary and NEON plot locations provided by NEON; as well as field observations made from other projects and observations on file at National Soil Survey Center (NSSC) Kellogg Soil Survey Laboratory (KSSL). Mapping major breaks was delineated based on land form and parent material. The mapping was then refined as much as reasonable based on geomorphic shape, vegetation and readily identifiable features. Some basic components and map unit (MU) composition were assigned primarily on professional experience, data collected from other projects, KSSL points and the Alaska State Soil Geographic Database (STATSGO). These points, however, were not collected with map unit development in mind and no transect data exists for this site.

This preliminary soil map of the site consisted of 12 different map units. The 40 NEON pre-selected sampling plots occurred in only 6 of the map units. This preliminary analysis resulted in 19 plots being selected for field description, field sampling, and lab characterization. The 21 plots not sampled either occurred in non-typical settings or were duplicates of one of the chosen plots.

Sampled preliminary soil map units represent approximately 72.4 percent of the TOOL site:

Map unit symbol	Map Unit Name	% Total site area
CV	Till, Convex Ridgetops	3.2
OW	Outwash	4.0
SS	Stoney Surface	13.7
TD	Till Plains, dendritic drainage	17.2
TP	Till Plains, pitted	9.0
TS	Till Plains, stripes	25.3
	Total	**72.4**

27.6 percent of the TOOL site area represented by 6 preliminary soil map units were not represented by any NEON distributed plots. These soils are listed:

Map unit symbol	Map Unit Name	% Total site area
ALL	Alluvial	2.8
BR	Bedrock	11.1
HET	High Elevation Tundra	8.5
OR	Organic	3.5

W	Water	0.5
WR	Wet rills	1.2
	Total	**27.6**

Plot Findings

The 19 pedons sampled represent 6 of the most extensive soil map units on the site. The soil components sampled are Orthels, Gelaquepts, Turbels and Histels.

Landforms—All but one of the Toolik Lake (TOOL) NEON plots are on rolling till plain modified by periglacial processes. Periglacial features present include stripes, non-sorted circles and thermokarst pits. TOOL_023 is situated on a convex ridge. Plots TOOL_017, 031, 035 and 071 are on broad plains that appear to have stony surfaces or possibly nonsorted circles, while TOOL_008, 018, 028, 032 and 036 occur on a broad till plain with well-defined dendritic drainage. Plots TOOL_003 and 020 occur on pitted till plain. Plots TOOL_002, 009, 013, 019, 022 and 072 occur on broad slopes with periglacial stripes or what appear to be parallel rills. Plot TOOL_011 occurs in a depression on an outwash plain.

Parent Material—Most of the TOOL plots are dominated by till that has undergone either periglacial processes and/or erosion, deposition processes. Some concave positions have accumulated enough organic material to classify as Histels. TOOL Plots TOOL_003 and 011 occur in such organic depressions. In general, soils on ridge tops and shoulder positions have more coarse fragments and have loamy skeletal particle classes. These convex positions have many unsorted circles, a periglacial feature caused by frost heaving coarse fragments to the surface. These convex areas are also more prone to erosion from wind and water carrying away the finer soil particles to be deposited on the mid and lower slopes. Plots situated on convex positions are TOOL_008, 013, 017, 018, 020, 023 and 032. Soils on mid and lower slopes tend to have finer textures as they are the deposition areas of material from upslope. Plots TOOL_002, 009, 019, 022, 031, 035, 071, and 072 occur on mid and lower slopes. Plots TOOL_028 and 036 differ from the general pattern in that they have loamy skeletal soils but occur on lower slope positions..

Summary of Soils

Since no soil survey exists for this area, nor is there a reasonably close soil survey to extrapolate from, the main goal was to sample plots that best represented a specific land form or segment of a land form as soils are closely associated with landform. Much more transecting and mapunit development would have to be done to make the conventional NEON site summary where the sample pedon is compared to an existing series or map unit component. Some preliminary soil groupings are given in in the landform and parent material sections.

At the coarsest classification, the Order the site has Gelisols (soils with permafrost) and non Gelisols. At this latitude Gelisols are the most expected soil order, but five pedons (plots) where sampled where no permafrost was encountered. These are plots TOOL_013, 017, 018, 020, 023, and 032. All these soils occur on convex positions and have very coarse, skeletal particle size classes. While these soils have a pergelic temperature regime with mean annual soil temperature

of less than 0 degrees C (32 degrees F), the thermal conductivity of these very rocky soils allows them to thaw briefly during the summer.

The Gelisols fall into three major categories: Histels, Turbels and Orthels. Histels are organic soils, having 80 percent by volume organic soil materials to a depth of 50 cm (20 inches) or more, and have permafrost. Histels can be further divided based on the decomposition degree of the organic matter. The pedon from TOOL_003 has moderately decomposed organic matter and classifies as a Hemistel. Likewise, the pedon from TOOL_011 has a higher degree of decomposition and classifies as a Sapristel. Note that plot TOOL_011 is very close to the gravel pad where the Toolik Lake research facility is located, and as such this relationship may be artificially affecting the local drainage. TOOL_011, however, was the only distributed plot on the outwash parent material.

Turbels are soils that have evidence of cryoturbation usually expressed as broken, inverted or mixed horizons. Turbels occurred in plots TOOL_031, 035, and 072. Orthels are Gelisols that do not meet either criteria for Histels or Turbels. Orthel occur on TOOL_002, 008, 009, 019, 022, 028, and 071. All the Gelisols observed at TOOL were wet. Turbels and Orthels are subdivided by presence or absence of a histic epipedon. Gelisols that have, in 30 percent or more of the pedon, more than 40 percent by volume organic soil materials from the soil surface to a depth of 50 cm and meet the saturation (wetness) requirement, classify as Histic great group. At the Toolik site, a Histoturbel occurs on plot TOOL_072 and Historthels occur on plots TOOL_002, 009, 019 and 028. Aquiturbels occurred on plots TOOL_031 and 035. Aquorthels occur on plots TOOL_008, 022, 036 and 071.

Overall the soils on the NEON plots conformed to the expected landscape model, but more intensive transect observations are needed to fully understand and characterize the major soil catena (e.g. series of distinct but co-evolving soils arrayed along a slope. Each soil type or "facet" differs somewhat from its neighbours, but all occur in the same climate and on the same underlying parent material) at the Toolik site.