Tanana
Alaska State Soil

Soil Science Society of America

Introduction

Many states have a designated state bird, flower, fish, tree, rock, etc. And, many states also have a state soil – one that has significance or is important to the state. The **Tanana** is the official state soil of Alaska. Let's explore how the Tanana is important to Alaska.

History

The Tanana series is found only in Alaska and was established in the Yukon-Tanana Area in 1914. It was named after the Tanana River, whose name in-turn was derived from the Athabaskan word for "Mountain River." The Tanana soil was chosen by Alaskan soil scientists because it is a *permafrost* soil, a property in the United States that is unique to Alaska. Tanana soils range widely through the interior of Alaska and when cleared can thaw and become productive farm land.

What is Tanana Soil?

Under mature native vegetation, Tanana soils are poorly drained and contain permafrost within 50 inches of the surface. If the surface vegetation and organic mat is disturbed, either through wildfire or cultural activities such as farming, the soil will warm and become well drained. Tanana soils are on flood plains and alluvial terraces (a river terrace of alluvium-material transported and deposited by moving water- rather than carved in solid rock. When undisturbed and frozen, Tanana soils support a native plant community of black spruce, shrubs and feather moss. When thawed, white spruce and paper birch forests dominate. When cleared and developed for agriculture, Tanana soils are used for hay, pasture, small grains, and vegetables.

Every soil can be separated into three separate size fractions called *sand*, *silt*, and *clay*, which makes up the *soil texture*. They are present in all soils in different proportions and say a lot about the character of the soil.

Undisturbed, Tanana soils have an organic layer that ranges from 2 to 8 inches thick. This *organic material* is slightly to moderately decomposed and derived mostly from moss. The top soil is black mucky silt loam enriched with highly decomposed organic material called humus. The sub soil is gray and light olive-brown stratified silt loam and very fine sandy loam that has streaks and pockets of black mucky material moved from above. These streaks and pockets are caused from a process called cryoturbation. Cryoturbation, or frost churning, causes a mixing of soil horizons due to freezing and thawing. The subsoil of an undisturbed Tanana is permanently frozen silt loam and very fine sandy loam. This frozen soil limits root growth and also perches the water table causing the soil to be poorly drained. When disturbed, Tanana soils thaw, which allow free drainage and the soil becomes well-drained. Once thawed, deeper observation of the soil can be made and a sandy and gravelly substratum can sometimes be found, usually below 3 feet (**Figure 1**).

Photo Soil Monolith: Chip Clark/Smithsonian Institution

Fig. 1. Thawing Tanana soil. Credit:Alaska USDA-NRCS.

Fig. 2. Location of the Tanana soil in Alaska. Credit: Smithsonian Institution's Forces of Change.

Fig. 3 Alaskan Cabbage from Tanana Valley Fair. Credit: Alaska USDA-NRCS.

Where to dig Tanana

Yes, you can dig a soil. It is called a soil pit and it shows you the *soil profile*. The different horizontal layers of the soil are called *soil horizons*. This does not mean that other types of soil cannot be found there but that the Tanana is very common. Tanana soils exist in the interior of Alaska on the flood plains and low terraces of rivers. They occur in the Fairbanks North Star Borough, Denali Borough, the Yukon-Koyukuk Census Area and the Southeast Fairbanks Census Area (**Figure 2**). Tanana soil may cover an estimated 3 to 5 million acres though a very small portion of its range has actually been mapped. Most commonly, it will be found under a stunted black spruce forest, but if the site has been disturbed, the forest may be white spruce and birch or being farmed. In all, there are a total of 561 named soils (series) in Alaska.

Importance

What makes the Tanana soil so important is its use and prevalence in the State. When undisturbed, Tanana soils support a wetland forest of black spruce and shrubs that support an abundance of wildlife and recreation. They are unique in that they are permanently frozen below 50 inches. Wild fire or human disturbance, such as plowing, will cause the soil to warm and dry, significantly altering its characteristics. After thawing, Tanana soils support hay, grains, potatoes and cool season vegetables.

Uses

In general, soils can be used for agriculture (growing foods, raising animals, stables); engineering (roads, buildings, tunnels); ecology (wildlife habitat, wetlands), recreation (ball fields, playground, camp areas) and more. Tanana soils are important for all of these uses in Alaska. Under natural black spruce forest conditions, wildlife habitat and recreational uses are plenty. When altered, they support a forest of aspen, paper birch, and white spruce which will also provide adequate habitat for wildlife and recreation. When cultivated, Tanana soils are used for farming. Due to nearly constant sunlight throughout the summer, some crops can grow to an enormous size. Examples include a 19 pound carrot, a 76 pound rutabaga, and a 106 pound cabbage (**Figure 3**).

When Tanana soils are allowed to thaw and drain they have few limitations. The process changes the soil so drastically it actually becomes a different soil. When thawed, Tanana typically changes to recognized soils Salchaket or Jarvis. Areas that were historically Tanana soils now support homes, urban areas, roads and streets, parks, as well as agriculture

Limitations

When a soil cannot be used for one or more of the described functions, it is referred to as a limitation. Soil experts, called *Soil Scientists*, studied Tanana soil and identified that, under natural conditions it has *permafrost* limitation. Permafrost in this soil impedes the internal drainage causing the soil to be wet. The cold, hard layer of permafrost also limits the rooting depth for plants. Since this soil occurs on floodplains there is also risk of flooding. The restricted drainage make Tanana soils poorly suited for things such as trails, camp grounds and waste disposal. Wind and water erosion are a concern on areas that have been cleared of native vegetation.

Fig. 4. (Above) Extreme winter conditions under which Tanana soils develop. Credit:Alaska USDA-NRCS Staff, Brant Dallas. **Fig. 5**. (Above right) Black spruce and moss environment that greatly influence soil pH. Credit:Alaska USDA-NRCS Staff, Blaine Spellman. **Fig. 6**. (Inset) Young bull moose grazing on willow shrubs. Credit: Cory Cole

Management

In its natural state Tanana is typically managed for wildlife habitat and limited recreation. Tanana soils support a black spruce forest with an ericaceous (heather) shrub and moss understory. Animals typically encountered include moose, grouse, snowshoe hares, and many various song birds. The shrub layer provides many varieties of wild berries including blue berries (*Vaccinium uliginosum*), lingonberries (low bush cranberries)(*Vaccinium vitis-idaea*) and cloud berries(Rubus chamaemorus). Common management strategies to protect against wind and water erosion are recommended in areas where native vegetation has been cleared.

Tanana Formation

Before there was soil there were rocks and in between, CLORPT. Without CLORPT, there will be no soil. So, what is CLORPT? It is the five major factors that are responsible for forming a soil like the Tanana series. It stands for **Cl**imate, **O**rganisms, **R**elief, **P**arent material and **T**ime. CLORPT is responsible for the development of soil profiles and chemical properties that differentiate soils. So, the characteristics of Tanana (and all other soils) are determined by the influence of CLORPT. Weathering takes place when environmental processes such as rainfall, freezing and thawing act on rocks causing them to dissolve or fracture and break into pieces. CLORPT then acts on rock pieces, marine sediments and vegetative materials to form soils.

Climate – Temperature and precipitation influence the rate at which parent materials weather and dead plants and animals decompose (**Fig. 4**). They affect the chemical, physical and biological relationships in the soil. Tanana soils occur in an area that has a continental subarctic climate with long, cold winters and short, warm summers. Summer (June, July, and August) temperatures average 58 degrees F (15 degrees C). Winter (November through March) temperatures average 0.5 degree F (-18 degrees C). Extreme summer temperatures may exceed 90 degrees F (32 degrees C) while extreme winter temperatures may dip below -60 degrees F (-51 degrees C). The average annual precipitation is 12 inches (30 cm), with July and August being the wettest months and April the driest. Snow covers the ground continuously from October to late April or early May. These strong freeze thaw cycles cause cryoturbation in the soil.

Organisms – This refers to plants and animal life. In the soil, plant roots spread, animals burrow in, and bacteria break down plant and animal tissue. These and other soil organisms speed up the breakdown of large soil particles into smaller ones. Plants and animals also influence the formation and differentiation of soil horizons. Plants determine the kinds and amounts of *organic matter* that are added to a soil under normal conditions. Animals breakdown complex compounds into small ones and in so doing add organic matter to soil. Tanana soils typically support a black spruce forest with a shrub understory. These plants contribute organic acids to the soil causing the Tanana soil to be acid or have a low pH in its upper horizons (**Figure 5**). Common mammals in the area include brown and black bear, moose, wolf, lynx, furbearers and rodents (**Figure 6**). Birds are attracted to the wet, boggy forest for the plethora of insects to eat. Spruce hens and rough grouse also frequent to the area.

Relief – Landform position or relief describes the shape of the land (hills and valleys), and the direction it faces which makes a difference in how much sunlight the soil gets and how much water it keeps. Deeper soils form at the bottom of the hill rather than at the top because gravity and water move soil particles downhill. Tanana soils occur on floodplains and low terraces so the relief is very flat with slopes usually not exceeding 2% (**Figure 7**). These very flat surfaces, combined with the permafrost do not allow the soil to drain, resulting in the poorly drained condition of the Tanana soil (**Figure 8**).

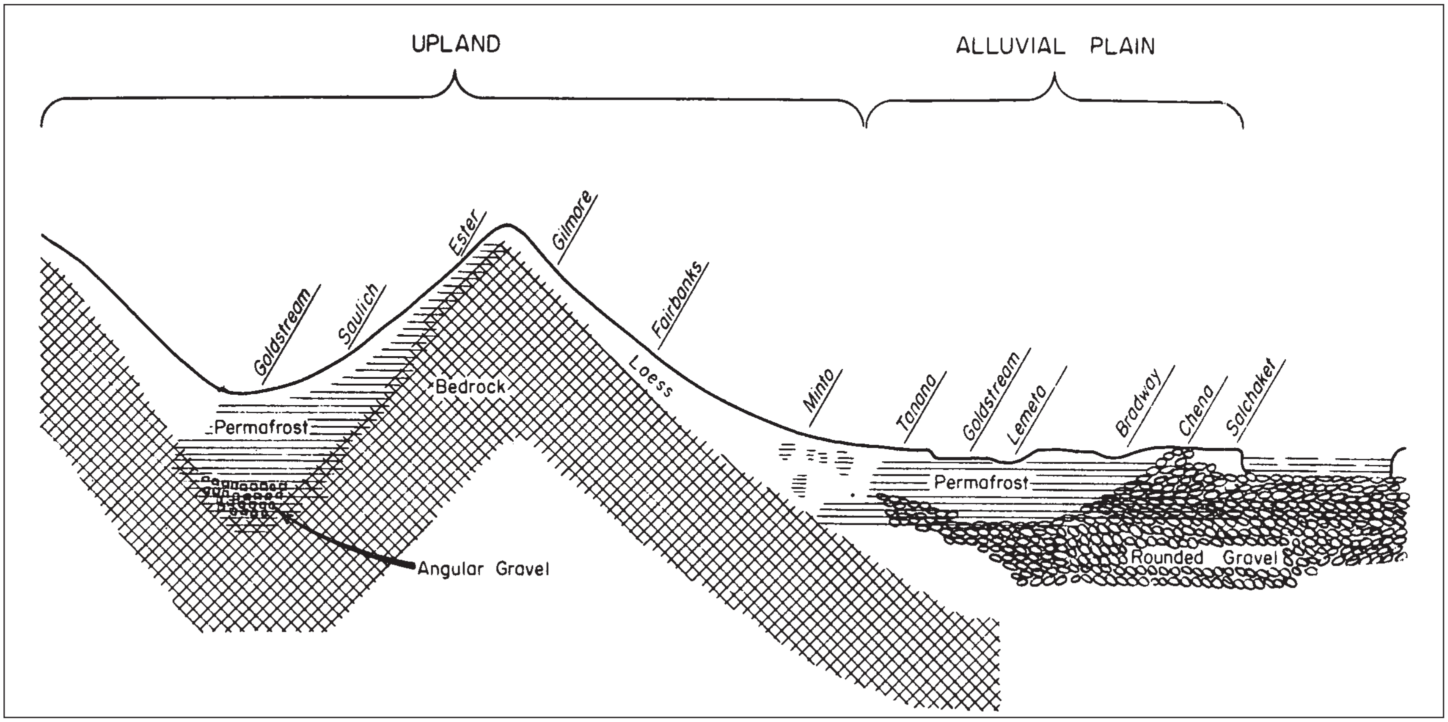

Fig. 7. Diagram of a landscape showing relationship of soil series, underlying material, and permafrost. Adapted from Pewe (Soil Survey of Fairbanks Area, Alaska; 1959).

Fig. 8. Aerial view of Tanana Flats Landscape. Photo courtesy of Blaine Spellman.

Parent material (C horizon) – Just like people inherit characteristics from their parents, every soil inherits some traits from the material from which it forms. Some parent materials are transported and deposited by glaciers, wind, water, or gravity. Tanana soils occur on flood plains and low terraces so the parent material is primarily alluvium with the addition of loess. Alluvium is material that has been transported and deposited by moving water. Loess is silty material that has been transported and deposited by wind.

Time – All the factors act together over a very long period of time to produce soils. As a result, soils vary in age. The length of time that soil material has been exposed to the soil-forming processes makes older soils different from younger soils. Generally, older soils have better defined horizons than younger soils. Less time is needed for a soil profile to develop in a humid and warm area with dense vegetative cover than in a cold dry area with sparse plant cover. More time is required for the formation of a well-defined soil profile in soils with fine textured material than in soils with coarse-textured soil material. The alluvium that forms the Tanana soil is *Holocene* in age so it is fairly young, by soil standards.

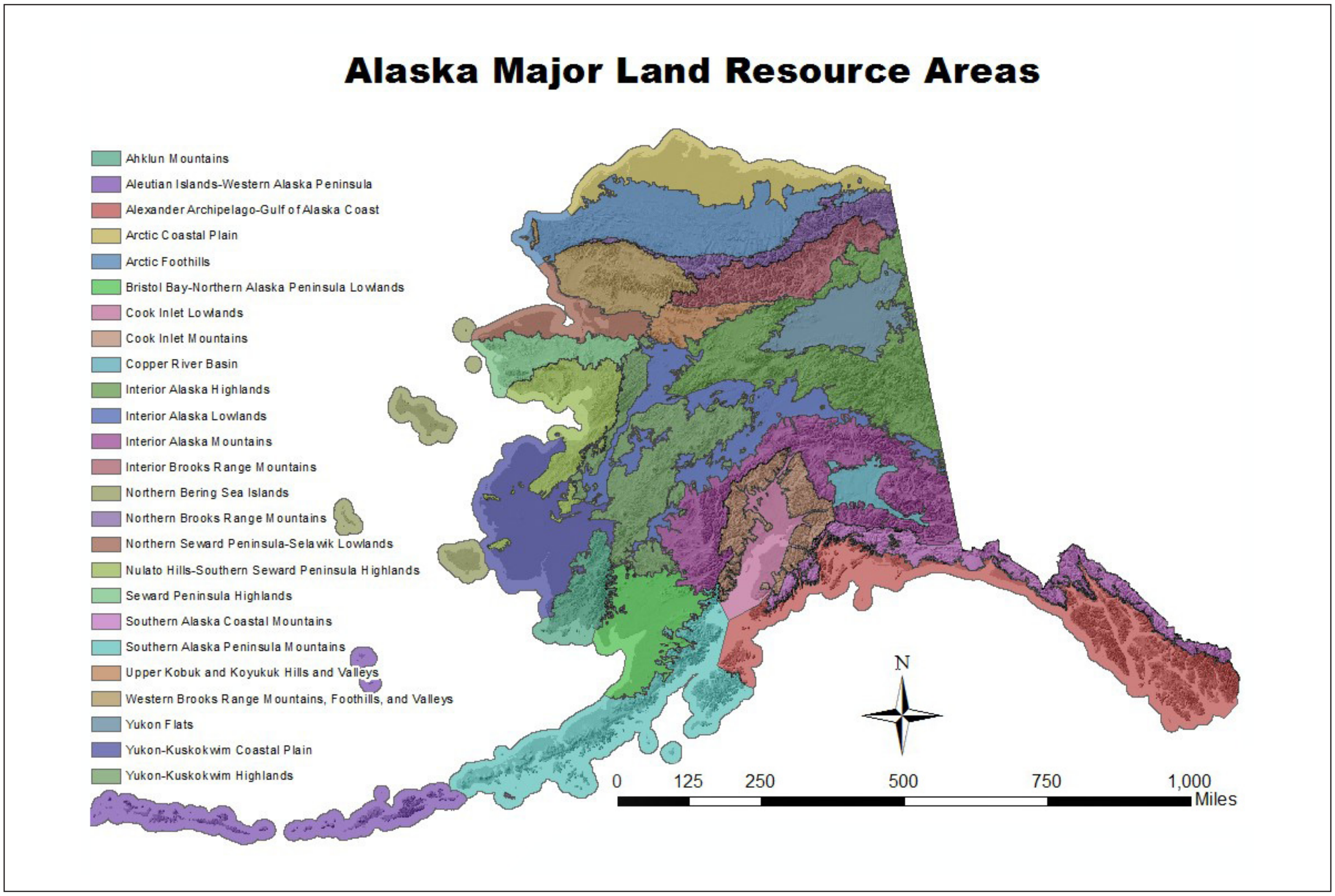

Fig. 9. Alaska Ecoregions, ftp://newftp.epa.gov/EPADataCommons/ORD/Ecoregions/ak/ak_eco.pdf

Ecoregions, Soils and Land Use in Alaska

The Interior Bottomlands Ecoregion of Alaska includes the flood plains and terraces along the upper reaches of the Tanana and Kuskokwim Rivers and the middle reaches of the Yukon River (**Fig. 9**). The area makes up about 36,320 square miles (94,120 square kilometers). This ecoregion includes Alaska's second largest city, Fairbanks; as well the towns of Nenana, Delta Junction, and Tok on the road system. The communities of Tanana, Galena, and McGrath are accessible only by air or by river. Also within the ecoregion are parts of Fort Wainwright and Fort Greely, the two largest military reservations in Alaska as well as Portions of Denali National Park and Preserve and Tetlin National Wildlife Refuge. Portions of the Trans-Alaska Pipeline traverses this area as it makes its 800 mile journey from the Prudhoe Bay in the north to Valdez in the south.

Physiography

The Interior Bottomlands Ecoregion is on broad, nearly level, braided and meandering flood plains, stream terraces, and outwash plains. These lowlands are dotted with hundreds of lakes and wetlands. Elevation ranges from about 100 feet (30 meters) along the lower Yukon River, to about 1,900 feet (580 meters) in the upperTanana Valley. This area is in the zone of discontinuous permafrost. Permafrost is close to the surface in areas of the finer textured alluvial and *eolian* sediments on plains and stream terraces,

Geology

Although never glaciated, this area is filled with a deep layer of Pleistocene age *glaciofluvial deposits*. Additional fluvial sediments have accumulated along the major rivers and their tributaries during the Holocene epoch. Much of the interior of Alaska is mantled with a layer of silty micaceous loess originating from the unvegetated flood plains and outwash plains of the Interior Bottomlands Ecoregion.

Climate

The interior of Alaska has a sub-arctic continental climate characterized by Short, warm summers and long, very cold winters. The average annual precipitation ranges from 10 to 20 inches (255 to 510 millimeters). Most precipitation occurs in late summer, mainly from thunderstorms. About half the annual precipitation comes as Snow. The average annual snowfall ranges from 30 to 80 inches (75 to 205 centimeters). The average annual temperature ranges from about 22 degrees F to 28 degrees F (-6 to -4 degrees C). Winter temperatures are often colder than -70 degrees F and have been recorded near 100 degrees F in the summer. The freeze free period averages about 70 to 120 days. The temperature usually remains above freezing from June through mid-September.

Glossary

Alluvium: Sediments deposited by running water of streams and rivers. It may occur on terraces well above present streams, on the present flood plains or deltas, or as a fan at the base of a slope.

Clay: A soil particle that is less than 0.002 mm in diameter. Clay particles are so fine they have more surface area for reaction. They hold a lot of nutrients and water in the soil. A clay soil is a soil that has more than 40% clay, less than 45% sand and less than 40% silt.

Cryoturbation: The mixing of soil layers, due to repeated freeze/thaw processes results in irregular or broken horizons, accumulations of organic matter on the permafrost table, oriented rock fragments, and silt caps on rock fragments.

Eolian: Pertaining to earth material transported and deposited by the wind including dune sands, sand sheets, loess, and parna.

Loess: Material transported and deposited by wind and consisting dominantly of silt-sized particles

Ecoregion: Represents areas with similar biotic and abiotic characteristics which determine the resource potential and likely responses to natural and man-made disturbances. Characteristics such as climate, topography, geology, soils, and natural vegetation define an ecoregion. They determine the type of land cover that can exist and influence the range of land use practices that are possible.

Glaciofluvial Deposits: Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice.

Horizon: see Soil horizons

Organic matter: Material derived from the decay of plants and animals. Always contains compounds of carbon and hydrogen.

Holocene: The geological period comprising approximately the last 10,000 years.

Permafrost: A thermal condition in which a material (including soil material) remains below 32° F for 2 or more years in succession.

Sand: A soil particle between 0.05 and 2.0 mm in diameter. Sand is also used to describe soil texture according to the soil textural triangle, for example, loamy sand.

Silt: A soil particle between 0.002 and 0.05 mm diameter. It is also used to describe a soil textural class.

Soil Horizon: A layer of soil with properties that differ from the layers above or below it.

Soil Profile: The sequence of natural layers, or horizons, in a soil. It extends from the surface downward to unconsolidated material. Most soils have three major horizons, called the surface horizon, the subsoil, and the substratum.

Soil Scientist: A soil scientist studies the upper few meters of the Earth's crust in terms of its physical and chemical properties; distribution, genesis and morphology; and biological components. A soil scientist needs a strong background in the physical and biological sciences and mathematics.

Soil Texture: The relative proportion of sand, slit, and clay particles that make up a soil. Sand particles are the largest and clay particles the smallest. Learn more about soil texture at www.soils4teachers.org/physical-properties

Additional Resources

Soil! Get the Inside Scoop. David Lindbo and others. Soil Science Society of America, Madison, WI.

Know Soil, Know Life. David L. Lindbo, Deb A. Kozlowski, and Clay Robinson, editors. Soil Science Society of America, Madison, WI.

Web Resources

Soils for Teachers—www.soils4teachers.org

Soils for Kids—http://www.soils4kids.org/

Have Questions? Ask a Soil Scientist—https://www.soils.org/ask

Soil Science Society of America—https://www.soils.org/

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This state soil booklet was developed under the auspices of the Soil Science Society of America's K-12 Committee—their dedication to developing outreach materials for the K-12 audience makes this material possible.