TOKUL
Washington 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 Tokul is the official state soil of Washington. Let's explore how the Tokul is important to Washington State.

History

The Tokul soil became the Washington state soil because of its unique volcanic ash cap, in fact, Washington was the first state to recognize *Andisols* as a state soil. There are many active and non-active volcanoes found in Washington and their eruptions and subsequent ash fall have formed rich, productive soils that are found throughout the State. The Tokul series was named after a small creek and community in King County (the most populous county in the state).

What is Tokul Soil?

The Tokul soil series is very unique. Parent material is volcanic ash and loess over glacial till. Tokul soils are generally found on lowland plains and glacially modified hills and mountains. Native vegetation is Douglas-fir, western hemlock and western red cedar. The understory generally consists of western Swordfern, vine maple, huckleberry, trailing blackberry, and Oregon grape. Tokul can have *andic* and *spodic* properties associated with different *pedons.*

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.

Tokul soils have 3-5 cm of organic matter on top of the A horizon. The A horizon texture is medial loam with some gravel, the B horizons can be broken out into 3 groups: Bs1, Bs2, and Bs3. Bs1 has a reddish hue from iron oxides leaching through the soil profile, while Bs2 and Bs3 have lighter colors, generally yellow to white. A root limiting layer (roots cannot penetrate the soil) exists at 60-80 cm and is classified as a BC horizon **(Figure 1)**.

Where to dig Tokul

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 Tokul soil is the most common. Tokul soils are on lowland plains to glacially modified hills and mountains in King, Pierce, Skagit, and Snohomish Counties in Washington State **(Figure 2)**. Tokul soils are found on the west side of the Cascade Mountains, locally referred to as the "wet side" due to over 1500 mm of annual precipitation. Tokul covers about 1,000,000 acres of land in 4 counties of Washington. In all, there are a total of about 725 named soils (series) in Washington State.

Photo: Chip Clark/Smithsonian Institution

Fig. 1. Typical soil pedon on the right and location of Tokul soils in Washington (inset). Credit: WA State NRCS.

Fig. 2. Location of the Tokul soil in WA. Credit: Smithsonian Institution's Forces of change. http://forces.si.edu/soils/interactive/statesoils/index.html

Fig. 3. Mixed conifer forest growing on Tokul soils. Credit: WA State NRCS

Fig. 4. Field of ornamental tulips growing on Tokul soil in western Washington. Credit: WA State NRCS.

Importance

What makes the Tokul soil so important is its use and prevalence in the State. Tokul soils are among the most productive soils not only in Washington State, but in the world. They support forests of Douglas fir, Hemlock, Cedars, and various true Fir species. Tokul soils support vast areas of forest that inspired Washington States nickname, The Evergreen State **(Figure 3)**. Washington State is covered with soils that started as volcanic ash, and they are used to grow crops, timber, graze livestock, and for various recreational endeavors. Tokul soils help store, and keep water clean that people in major metropolitan areas such as Seattle depend upon.

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. Tokul soils are on the western side of the Cascade Mountains along the Puget Trough, from south of Seattle north to the Canadian border. There are many crops that are grown from this soil: berries, leafy greens, row crops, livestock, and ornamental flowers and shrubs used for landscaping **(Figure 4)**.

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 Tokul soil and identified that it has moderate limitation. Tokul soil has a cemented layer at 20 to 40 inches below the soil surface that can limit rooting depth and restrict water flow. Steep slopes in areas limit some uses.

Management

Due to the high precipitation and water holding capacity of Tokul soils any ground based machinery should be restricted to dry, summer months to reduce soil compaction, rutting, and displacement. Slopes over 35% are generally not conducive to ground based machinery due to high risk of soil/slope failure and machine roll-overs. Management activities should use Best Management Practices to reduce the mixing of the volcanic ash cap with the underlying glacial till (e.g. operating on slash mats). Mixing of these two soil horizons can reduce the inherent water holding capacity of the volcanic ash.

Tokul 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 Downer series. It stands for Climate, Organisms, Relief, Parent material and Time. ClORPT is responsible for the development of soil profiles and chemical properties that differentiate soils. So, the characteristics of Tokul (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. They affect the chemical, physical and biological relationships in the soil. Tokul soils are found in areas where the average annual precipitation is about 60 inches and average annual soil temperature is about 50 degrees F. The climate is characterized by cool, moist summers and cold, wet winters with an average of 140 to 200 frost free days.

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. Tokul soils have large amounts of organic matter deposition from abundant plant life growing in these soils. Tokul soils sustain a temperate rain forest that is very unique to the Pacific Northwest. Tokul soils are full of microbial life, insects, worms, mammals, and most importantly fungi **(Figure 5)**.

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. Tokul soils formed on gentle, rolling mountain slopes shaped by glaciers from the late Pleistocene. The gentle topography allowed the volcanic ash to stay in place creating the productive soils that are found in the Puget Sound region of Washington today.

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. Tokul soils parent material is volcanic ash and loess deposited over glacial till. The glacial till parent material was transported to the Puget Sound region by the Cordilleran Ice Sheet ~9500 years ago. The volcanic ash is comprised of various eruption events that occurred after the retreat of the Cordilleran Ice Sheet.

Fig. 5. Morel mushroom on National Forest System lands. Credit: USDA Forest Service

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 general age of the volcanic ash associated with Tokul soils is ~7500-4500 years old, but there can be areas that have much more recent volcanic ash deposition. The glacial till that is under the volcanic ash cap was deposited during the end of the last ice age ~9500 years ago. So, Tokul soils are relatively young when compared to other soils found around the world.

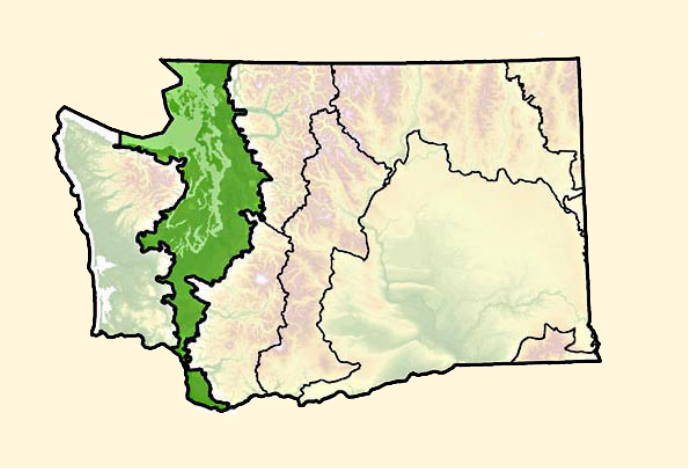

Fig. 6. Location of the Puget Trough ecoregion in WA State.Credit: Landscope America

Ecoregions, Soils and Land Use in Washington

The Puget Trough ecoregion runs from north to south in Washington **(Figure 6)**, rising to about 1000 feet elevation between the Cascade Mountains on the east and the Olympic Mountains and Willapa Hills on the west. The Puget Trough ecoregion is home to over 75% of Washington's citizens, and encompassing about 8% of Washington State's area. Accessibility, rich natural resources, and economic potential have encouraged major population growth in this ecoregion. It is part of the larger Willamette Valley-Puget Trough-Georgia Basin ecoregion that extends south into Oregon and north into British Columbia.

The Puget Sound is a globally important estuary; home to orcas, porpoises, and harbor seals, with rich nearshore and deep-water habitats. This ecoregion links freshwater and saltwater habitats creating iconic salmon and steelhead trout spawning runs. From the sound the land opens into grasslands and oak woodlands that support rare and endemic plant species. From there the land rises to low elevation to mid elevation mountain environments. The land uses include timber, livestock grazing, agricultural crops, and a variety of outdoor recreation activities.

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Glossary

Andisols: Soils formed in volcanic ash.

Andic: Soil properties related to volcanic origin of materials.

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.

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.

Horizon: see Soil horizons

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

Pedon: A three dimensional sample or parcel of soil, just large enough to show all of the characteristics of all of its horizons.

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

Spodic: Presence of organic matter that bonds to metals, forming aluminum oxide and iron oxide.

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

SOIL SCIENCE LINKS:

Soils for Teachers—www.soils4teachers.org

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

Have Questions? Ask a Soil Scientist—https://www.soils4teachers.org/ask

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

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