The Geology of Fort Worden State Park

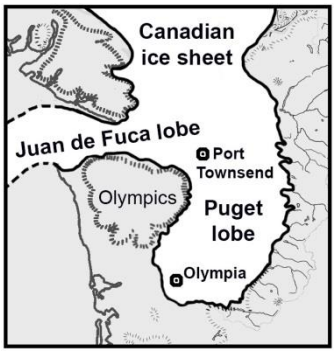
•Glaciers •Bluffs •Beaches •The Human Hand

Geologic processes created the land we call Fort Worden—and the land will continue to change as water, wind, gravity, people, and time influence this beautiful part of Washington.

GLACIERS

The land you are standing on and that you see all around you is a legacy of glacial activity.

About two million years ago a great, global Ice Age began. During the Ice Age, at least six glacial cycles occurred in the Puget Sound region. Each glacier ground its way south from a Canadian ice mass, gouging and shoving the terrain it crossed and carrying immense loads of rock from the north that were deposited as the ice moved and when it melted. During warmer interglacial periods, the climate was similar to today's.



The most recent ice advance, the Fraser Glaciation, entered Washington about **18,000 years ago**. While the Puget lobe slowly filled the existing lowland between the Olympic Mountains and the Cascade Mountains, the Juan de Fuca lobe moved westward in the area that is now the Strait of Juan de Fuca.

Global sea level dropped as water was bound up in the ice masses. At its greatest extent regionally, about **17,000 years ago**, the ice was as much as 4,000 feet thick at Port Townsend and its great weight pressed the regional land surface down about 200 feet below its present level.

The global climate soon began to warm. By about **16,000 years ago**, most of the ice here had melted away, leaving this region under a shallow sea. The Chinese Gardens in the park's west may be a remnant of this ancient seafloor, as is the flat top of Whidbey Island to the northeast of the park. Relieved of the great weight of the ice, the land rose again within a few thousand years and stabilized at its present level. Tiny marine fossils in the clay near the top of Artillery Hill show us the amount of local rebound.

Glacial and interglacial processes left layer upon layer of sand, gravel, and boulders—deposited, shoved about, compacted, and eroded—building and shaping the land of the Puget Sound region. Above ground, the north-south trend of most Puget Sound landforms reflects the path of the southbound glaciers. Below ground, deep layers of glacial sand-and-gravel deposits create aquifers that provide water for our wells.

BLUFFS *The bluffs record our local geologic history.*

Artillery Hill in the north of the park and Morgan Hill to the south are bordered by beaches which give us excellent views of the hills' bluff faces. The lower portion of the park's Artillery Hill bluff is mostly sediment from ancient interglacial streams. The upper bluff layers include massive glacial deposits of silt, sand, gravel and boulders deposited and compacted by the ice.

The peat and clay layers seen at beach level developed between glaciations and are about **120,000 years old**, whereas the youngest layers, at the top of the bluff, are about **12,000 years old**.

If each deposit were neatly stacked, like a layer cake, reading the record of events here would be simple…but that is not the case. Repeated glacial and interglacial activity deposited, reformed, and removed material, making the bluffs more like a complicated and incomplete 3-D jigsaw puzzle.

Wind, waves, rain, emerging groundwater, and gravity all contribute to the instability of the nearly bare *north* bluff face of Artillery Hill. The resulting surface erosion and landslides continually bring glacial and interglacial material—from silt and sand to boulders—tumbling down to beach level. This process is especially active during stormy winter weather.

Artillery Hill's *east* bluff face is now protected from wave action by the broad beach and the campground area, and this bluff face is quite stable. Erosion of this largely vegetated slope consists of a slow, downward creep of the upper few feet of material that rests on the ice-compacted sediments.

Bluff erosion of Artillery Hill in the park and Morgan Hill to the south continually feed the beaches at Fort Worden.

BEACHES *Rocks and sand also have a story to tell*

Fort Worden's beaches contain a tremendous variety of rocks and all are gifts from the glaciers. Glacial materials of all sizes erode from the bluffs and land on the beach. Silt and clay are rapidly washed away. Large boulders tend to stay where they fall. Sand and gravel are moved along the beach by wave action.

The *north*-facing beach is one of the most active beaches in the state. The sand-gravel-boulder texture of this beach changes dramatically from tide to tide, and from season to season.

Over thousands of years, powerful waves blown across the Strait of Juan de Fuca have worn away the north-facing bluff and driven the eroded material eastward. This sand and gravel material creates the dynamic and beautiful north-facing beach, while mostly sand forms the north side of the Point Wilson spit.

In contrast, the *east*-facing beach and the south side of Point Wilson are built largely of sand that erodes from the Morgan Hill bluff south of the park and that is moved northward by waves traveling up Puget Sound from the south. The park's pier (built in 1943) has interrupted this movement of sediment, trapping material and forming the wider beach just south of the pier.

Geologic processes are dramatic on the north-facing beach and calmer on the east-facing beach, but the beaches are always on the move!

THE HUMAN HAND *We leave our mark on the land*

When the original Point Wilson Lighthouse was built in 1879, the spit was larger than it is now. The current lighthouse, built in 1913, now sits at the edge of the water because the beach has shifted south over time. Large rocks placed on the north side of the point somewhat protect the lighthouse's foundation from wave erosion. Nevertheless, erosion continues, and someday the lighthouse will fall if it is not moved landward.

In the late 19th century, before the arrival of the military, Charles Eisenbeis, a prominent local citizen, built a brick factory and kiln on the beach near the lighthouse. Made of local sand and clay, the bricks were of inferior quality due to their high salt content but, probably, were used to build Alexander's Castle in 1883 and, certainly, many buildings in Port Townsend. A Washington State University archeological dig on that beach found remnants of a brick road and other brick debris.

In Port Townsend's 19th century heyday, the Chinese Gardens tidal marsh was drained and the local Asian citizens farmed that area extensively, providing food for the community. In the late 20th century, the Gardens were returned to their former role as a wetland.

Two thousand years ago, the Beach Campground area was forested, with a small lake to the north and sand dunes beyond. At low tide, remnants of this forest can be seen in the tidelands west of Knapp's Loop. In modern times, trees were removed and substantial fill was added to the beach to support the military's fortifications.

The Parade Ground is a natural low, open area, but the military reshaped it a bit, creating higher ground at the edges for the Officers' Row houses, dormitories, and other structures built around 1904. The surface of Artillery Hill was extensively altered during construction of the fortifications, but the hill itself is all glacial material. To reduce the amount of concrete required, local rocks and boulders were embedded in the fortification's walls.

Many building foundations at Fort Worden are made of 45-million-year-old Chuckanut sandstone from a quarry near Bellingham. The original slate for the roofs on these buildings was most likely brought in from the northeast part of the country. Most of the modern renovations at the park have retained slate roofs as part of the historic character of the buildings.

As park visitors use and enjoy this magnificent public area, there are sure to be more human handprints on the land. And as time passes, geologic processes will continue to shape and reshape the terrain.

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