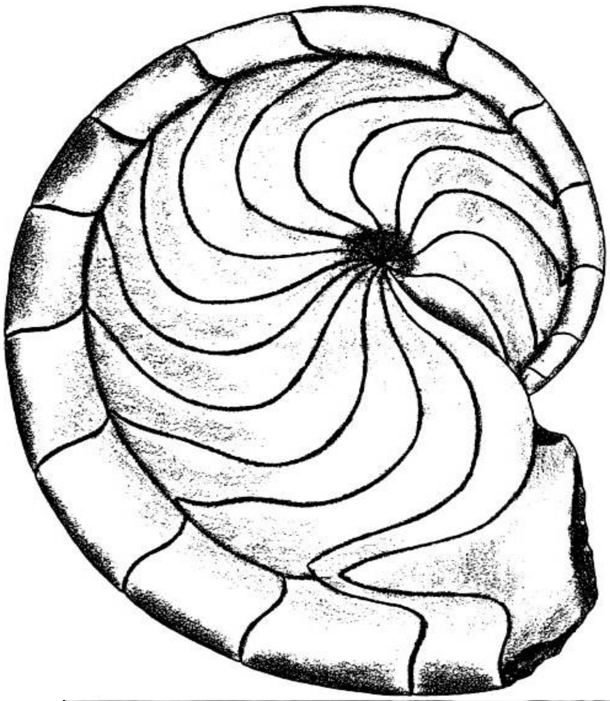
Sucia Island: The Geologic Story

Research · October 2015

DOI: 10.13140/RG.2.1.4361.0328

George E. Mustoe
Western Washington University

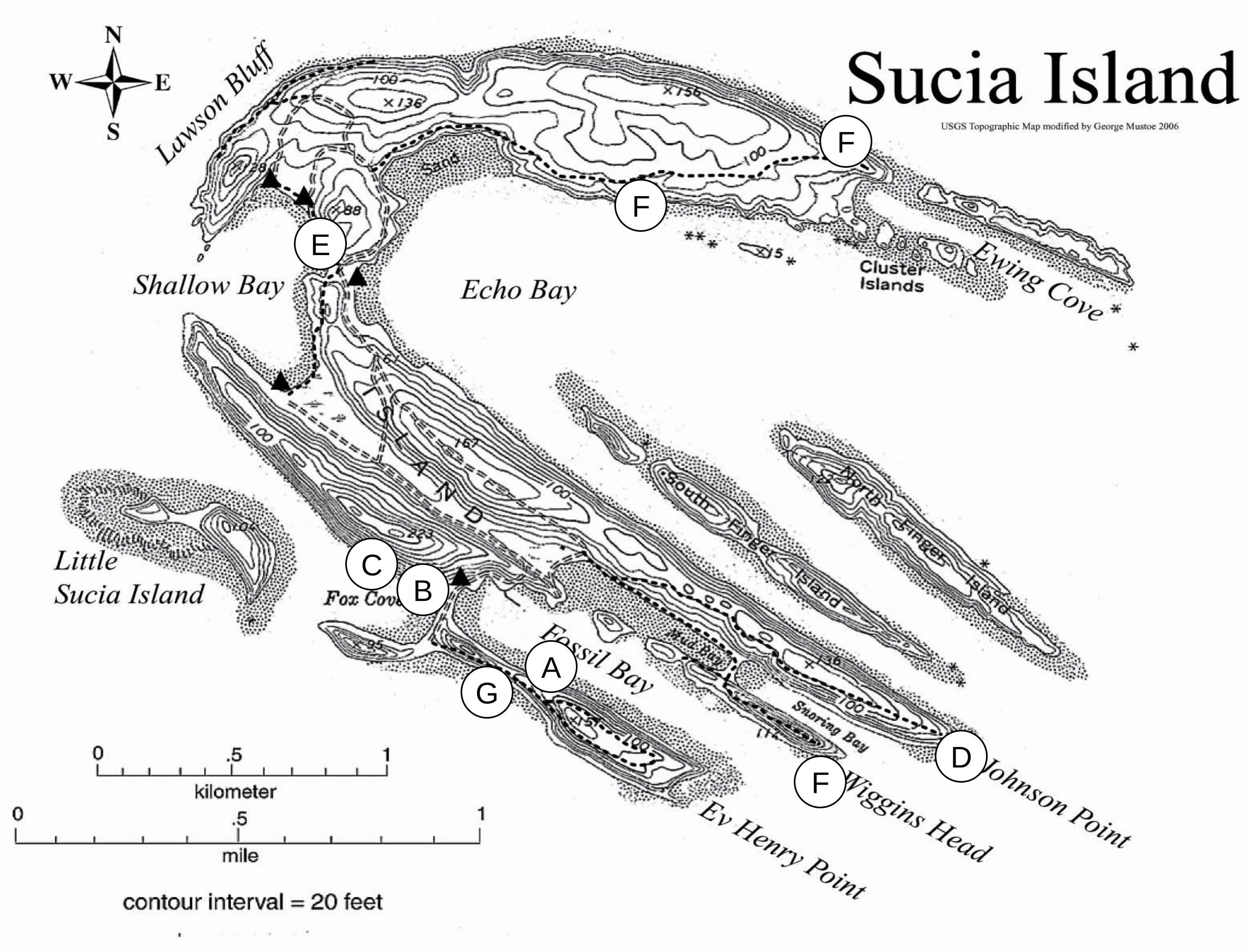


Sucia Island

the geologic story

George Mustoe
Geology Department
Western Washington University
Bellingham, WA 98225
April 2008

Fossil Bay was the site of a stone quarry that operated intermittently from 1890 to 1908, producing blocks of Chuckanut Formation sandstone that were barged to Seattle for use as paving stones.



(A)	70 million year old marine fossils*
(B)	Fault separating Nanaimo Group marine sediments and Chuckanut Formation continental sediments.
(C)	Mushroom rock
(D)	Fossil of 50 million year old driftwood log*
(E)	China Caves
(F)	Honeycomb weathering
(G)	Glacial erratic

* Fossil collecting is not permitted on Sucia Island

Fossil Bay
a record of ancient marine life

The oldest rocks on Sucia island comprise the ridge of bedrock that forms the southwest side of Fossil Bay, and on Little Sucia Island. Geologists have named these sedimentary rocks the **Nanaimo Group**. Outcrops of siltstone and sandstone contain an abundance of marine invertebrate fossils, including clams, snails, and ammonites. These sediments were originally deposited on the sea floor about 75 million years ago during the late Cretaceous. Slightly older beds exposed along the beach northwest of near Ev Henry Point contain sandstone and conglomerate layers that were deposited on land as ancient river deposits.

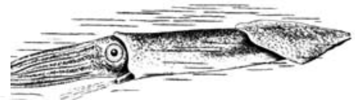
Like much of the bedrock in the San Juan Islands, Nanaimo Group sedimentary rocks appear to have been deposited a long ways from their present location, and transported to as much as a thousand miles by plate tectonics.

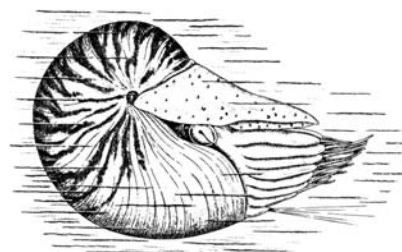
Oyster

snail

ammonite

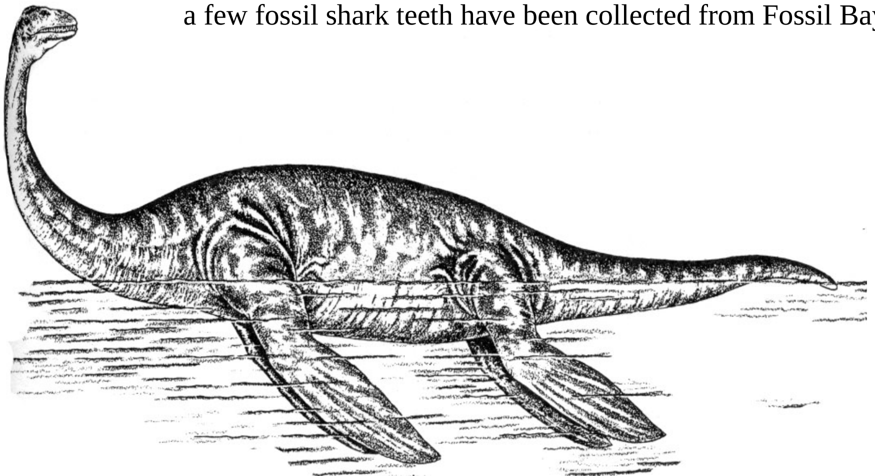
Belemnite



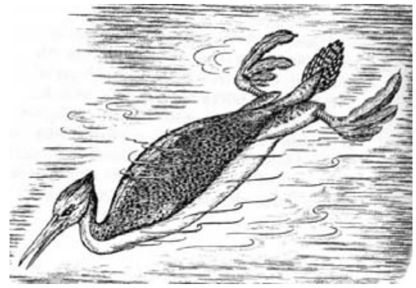


Reconstructions of extinct cephalopods

Swimming birds and reptiles are known to have lived during the time the Nanaimo Group sediments were deposited, but no skeleton fossils have been found on Sucia Island. However, a few fossil shark teeth have been collected from Fossil Bay outcrops.

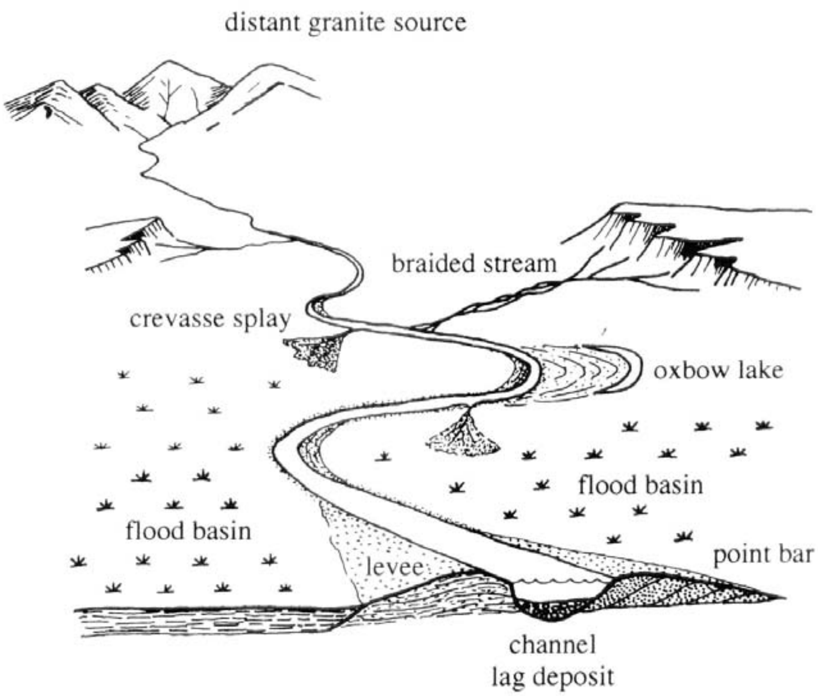


Plesiosaur



Cretaceous diving bird

Non-marine sediments comprise most of Sucia Island

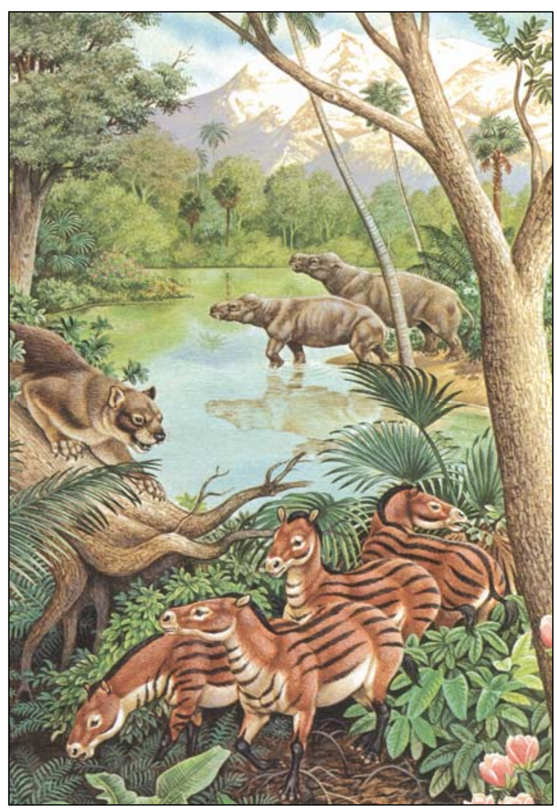


Except for the bedrock ridge that forms the southwest side of Fossil Bay, Sucia Island is composed of sediments that were deposited 50 million years ago by an ancient meandering river that flowed westward across Washington at a time when the North Cascade Range had not yet been uplifted. These **Chuckanut Formation** beds underlie a large part of northwest Washington, including much of the Bellingham area.

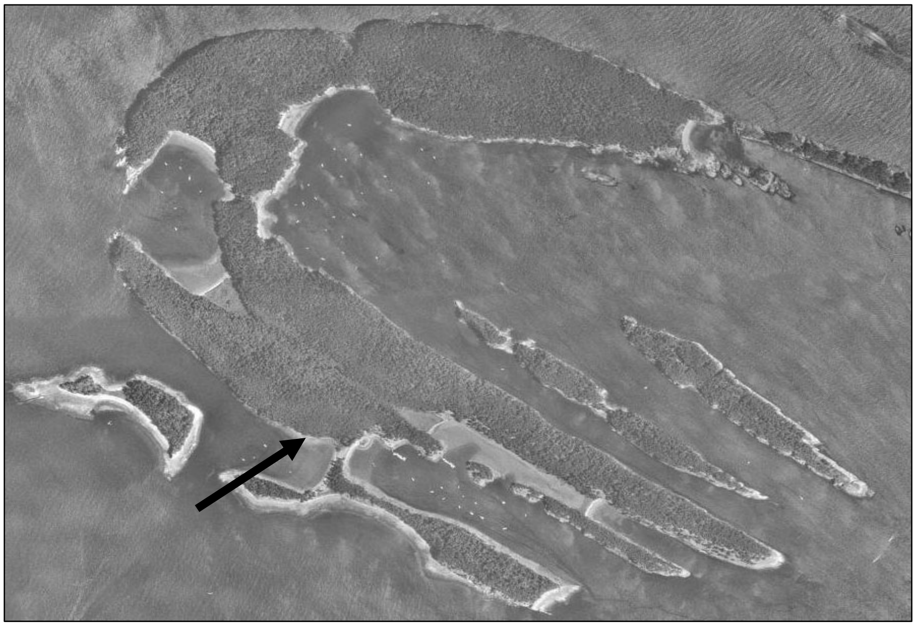
Different depositional environments along the ancient river produced a variety of sediment types: gravel, sand, and silt, later compressed and hardened to form conglomerate, sandstone, and siltstone.

Plant fossils are abundant in the Chuckanut Formation, and fossilized wood fossils can be observed at several locations on Sucia Island. Animal and bird tracks have been found in Chuckanut Formation beds on the Whatcom County mainland. These fossils provide evidence of a subtropical environment..

Driftwood log impressions in sandstone at Johnson Point



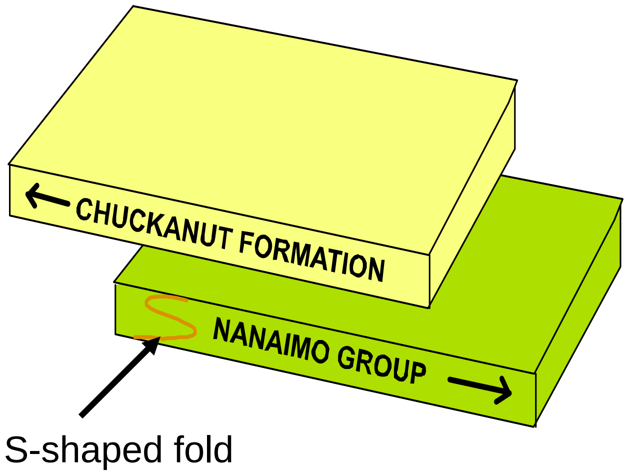
Reconstruction of the ancient landscape



The Fox Cove fault

Bringing the Nanaimo & Chuckanut rocks together

The late Cretaceous Nanaimo Group rocks appear to have been transported a long distance from their original depositional environment. The much younger Chuckanut Formation beds also arrived at Sucia thanks to the forces of crustal movement, but these Chuckanut Formation rocks probably moved less than 50 miles. The juxtaposition of the the 75 million year old Nanaimo beds and the 50 million year old Chuckanut Formation rock is evident at Fox Cove, where a large fault is evident. Here the friction of the Chuckanut Formation sliding over the Nanaimo Group distorted the Nanaimo siltstone into large S-shaped folds.



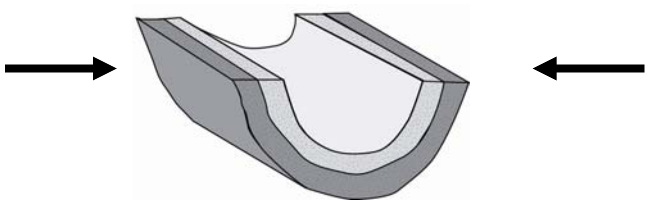
Folds exposed in beach bluff at Fox Cove

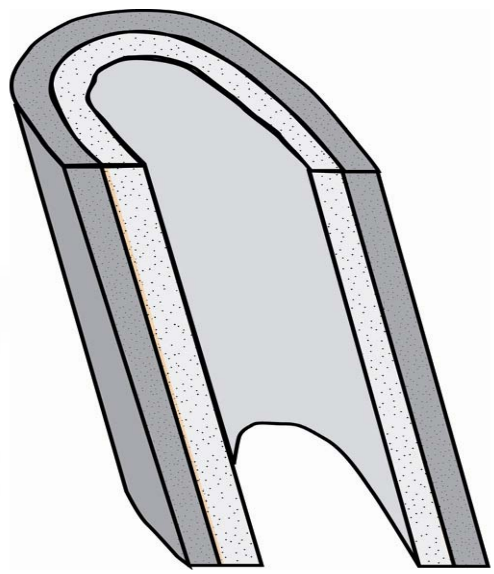
Folding the bedrock

How Sucia Island got its horseshoe shape

Sucia Island owes its characteristic shape to folded layers of sedimentary rock. At the time when the Nanaimo Group and Chuckanut Formation beds were brought together by faulting, these layers were more or less horizontal. Later, compression generated by the collision of the oceanic crust plate and the North American continent caused these rocks to be folded into a **syncline**, and this U-shaped fold became tilted to the southeast.

syncline

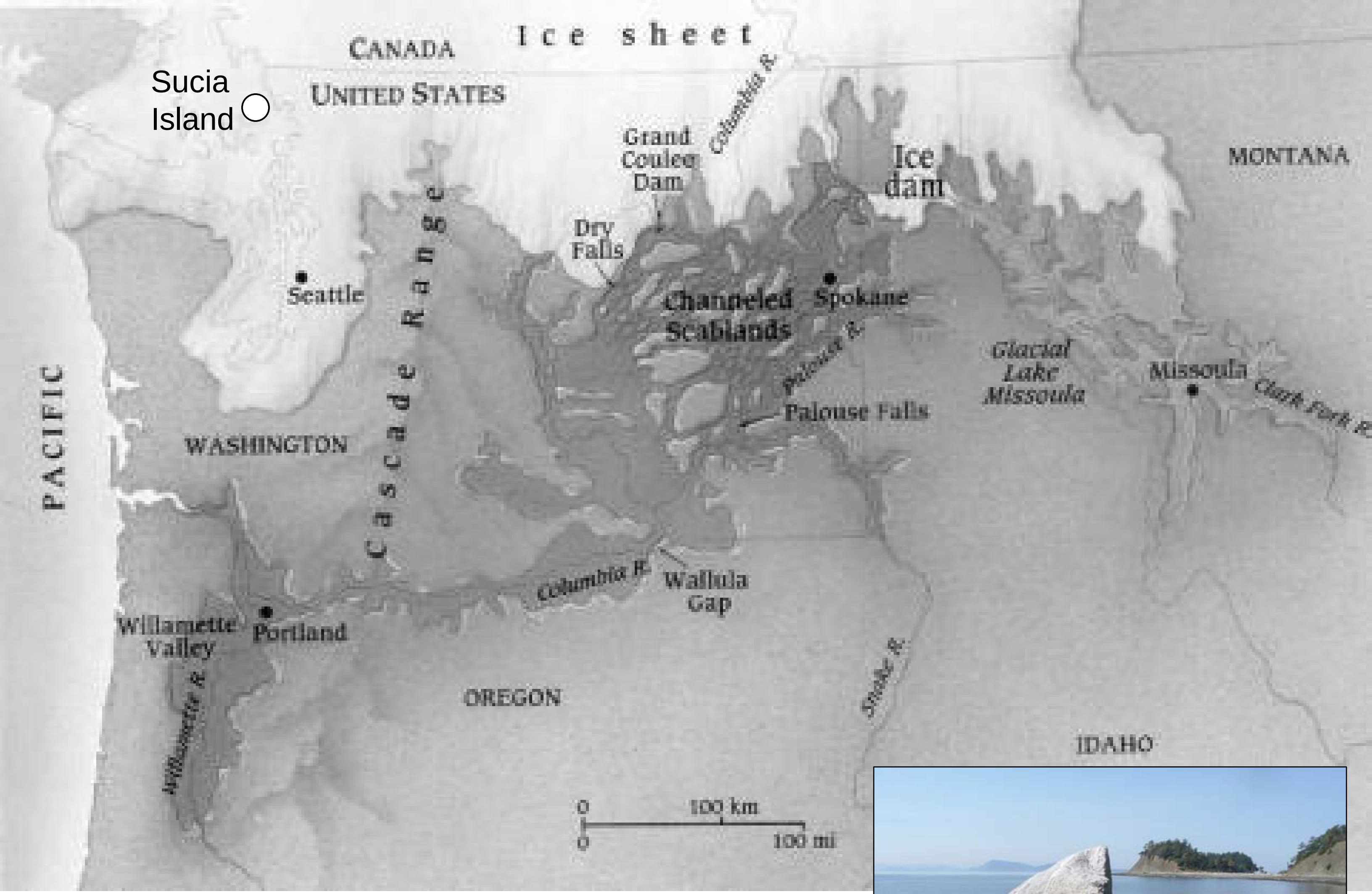




Plunging syncline

This computer-generated map shows how Sucia Island would look if the water of Puget Sound was drained away. Resistant sandstone beds give the island its horseshoe shape. Softer beds of shale were eroded to become valleys and embayments.

Map provided by Ralph Haugerud, U.S. Geological Survey

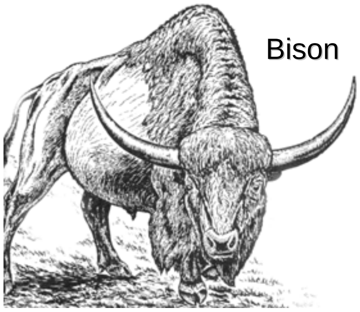


The Ice Age

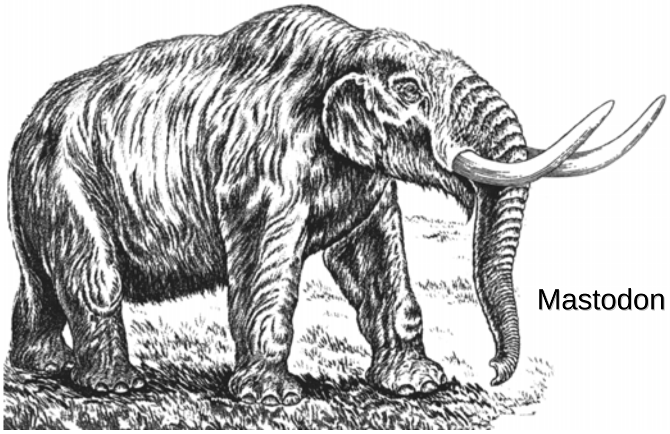
During the late Ice Age, final advance of the continental glacier 20,000 years ago, Sucia Island was covered by a mile-thick layer of ice. Today, evidence of the Ice Age can be seen as granite erratics on Sucia beaches, and layers of gravel blanketing parts of the island's interior.

This granite boulder was transported from Canada about 20,000 years ago by the advance of the continental glacier, and left behind when the ice sheet retreated 10,000 years ago.

Pleistocene fossils have so far not been found on Sucia Island, but bones and teeth from a variety of animals have been found in Ice Age sediments on nearby Orcas Island and in the Puget Lowlands.



Bison



Mastodon

Giant ground sloth

Shallow Bay “ghost forest”

A grove of dead Red Cedar trees lies in a wetland situated behind the sandy beach at Shallow Bay. These trees appear to have died within the past one hundred years when water inundated their roots. The site was the subject of a 1998 Masters Thesis by a geology student who suggested two possible explanations: a local earthquake caused the land to suddenly drop, allowing sea water to saturate the forest soil, or an severe storm that produced waves that eroded the upper beach and allowed sea water to flood the interior lowland.

The actual explanation proved to be quite different. In the spring of 2008, the gravel beach was eroded to reveal a wooden trough constructed from sawn cedar planks, providing a controlled drainage outlet for the swamp. Early settlers apparently blocked the natural outlet channel from the lowland area to create a fresh-water pond, and the rise in water level led to death of the cedar grove.

China Caves

Weathering features

Geologists call large cave-like cavities in rock “tafoni”, an Italian word. Tafoni may form in many environments, ranging from hot deserts and damp coastal regions to cold, dry valleys of Antarctica. They probably do not form exactly the same way in all of these different environments, but microclimate probably always plays an important role. When a cavity begins to form, the shady interior region is likely to be more humid than the exposed rock surface. This dampness favors chemical weathering. In addition, repeated cycles of wetting and drying may cause mineral salts to alternately dissolve and crystallize, wedging apart the sand grains that comprise the sandstone bedrock.

Mushroom shaped rocks are common along Sucia Island coasts. Also a type of tafoni, the overhanging caps are evidence of “case hardening”, a phenomenon that occurs when chemical weathering causes certain rocks become more durable instead of weaker. This hardening results when elements such as iron or calcium are dissolved from the interior of the outcrop and precipitated near the surface, providing additional strength.

Mushroom rocks

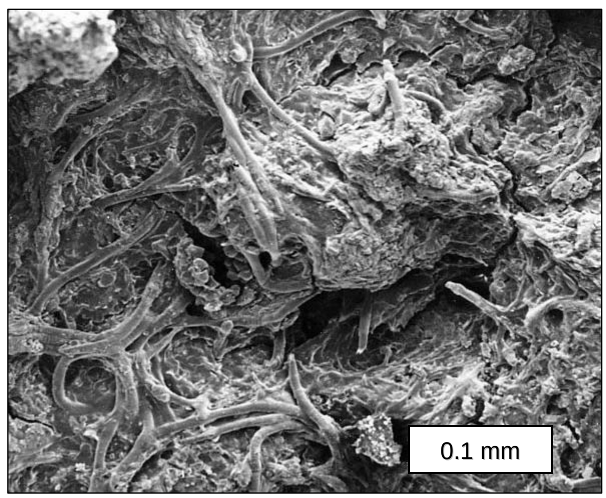
Honeycomb weathering

Honeycomb weathering is a form of "salt weathering", where erosion is caused when saline solution is absorbed into porous rock. Evaporation causes expanding salt crystals to wedge apart mineral grains. In coastal outcrops honeycomb weathering can form in two environments:

Horizontal rock surfaces in the upper intertidal zone, where sea water is left when the tide recedes.

Vertical rock walls up to one meter above the high tide line. In this zone, salt water arrives as wave splash.

As cavities develop, microscopic algae take advantage of the sheltered environment, forming a coating on the side walls. This protective layer inhibits salt weathering, so the cavities deepen inward rather than expanding laterally.



Scanning electron microscope photo of cavity wall

Honeycomb weathering requires three conditions: soluble salt, porous rocks, and an alternating cycle of wetting and drying.

These conditions are sometimes present at inland sites. A spectacular example can be found high on a ridge that overlooks the Shallow Bay trail.