OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES INTERPRETIVE MAP 28

OREGON: A GEOLOGIC HISTORY

150 Years of Statehood, 150 Million Years in the Making

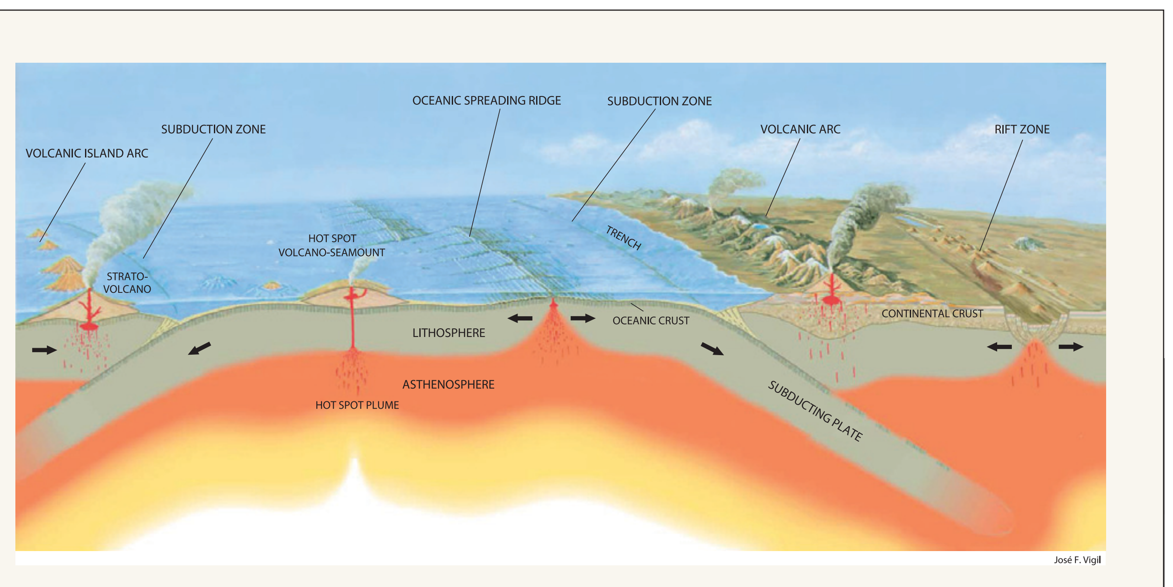
for 2009 — Oregon's Sesquicentennial Year

by Ian P. Madin

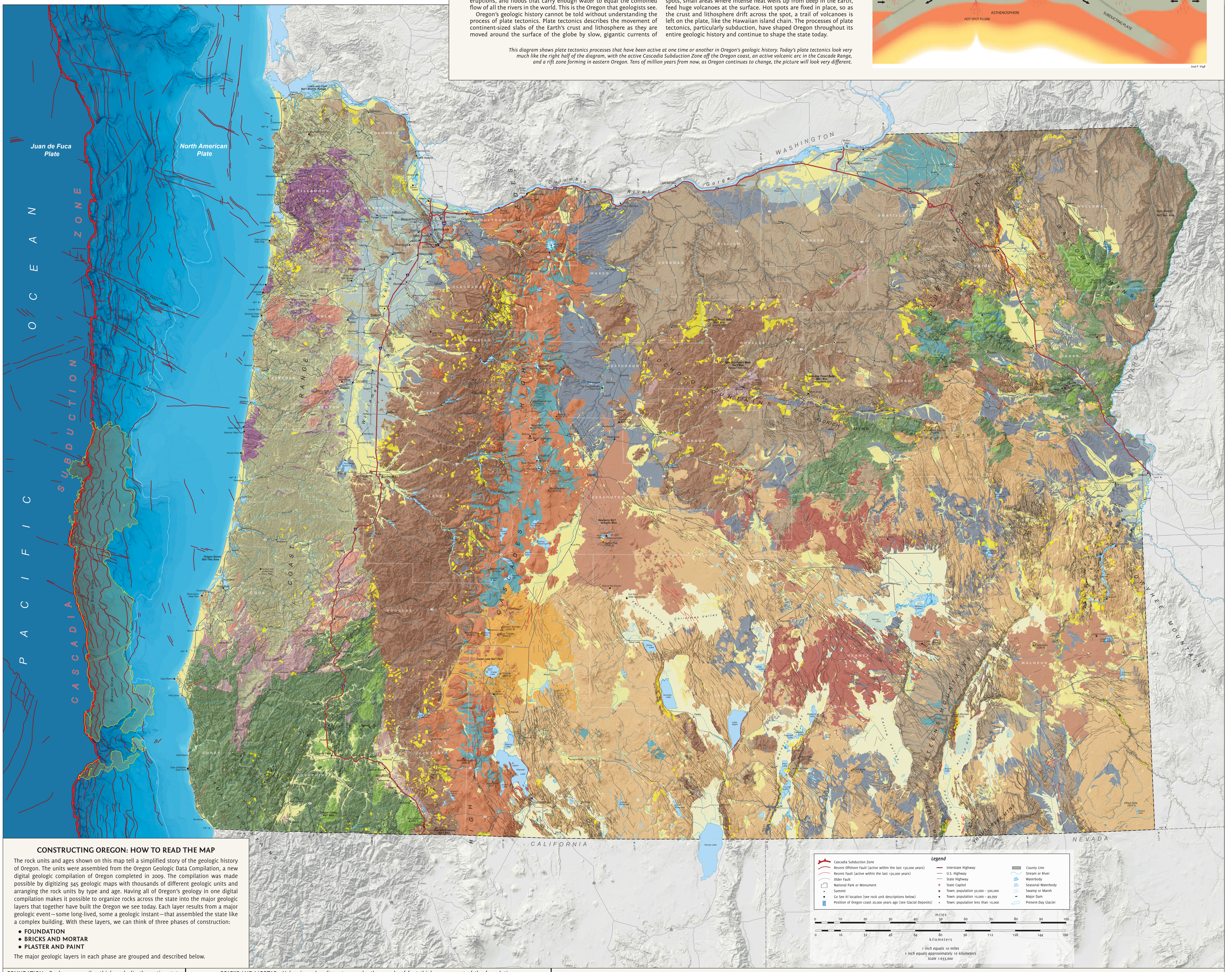
THE BIG PICTURE: PLATE TECTONICS AND HOT SPOTS

The spectacular landscape of Oregon today was shaped over millions of years by fire and flood, earthquakes and eruptions, and the movement of oceans and continents on a huge scale. Where most people see an unchanging landscape, geologists see rocks that tell the story of an ever-shifting world. It is a story that began several hundred million years ago, an eternity for humans, but only about 4% of the Earth's 4.5 billion year history. And what a story! Imagine an oceanic and a continental plate colliding, pushing hundreds of miles of ocean floor deep into the body of the Earth. Imagine some of the largest lava flows in the history of the world blanketing the state, thousand upon thousands of volcanic eruptions, and floods that carry enough water to equal the combined flow of all the rivers in the world. This is the Oregon that geologists see.

Oregon's geologic history cannot be told without understanding the process of plate tectonics. Plate tectonics describes the movement of continent-sized slabs of the Earth's crust and lithosphere as they are moved around the surface of the globe by slow, gigantic currents of hot rock deep in the asthenosphere. Where plates pull apart, lava wells up to form new ocean floor along submarine mountain ranges called spreading ridges. Where an ocean plate collides with a continent, as it currently does off Oregon, the ocean floor subducts, or slides beneath the edge of the continent, and is drawn deep into the Earth, where it causes rock to melt. This process feeds a chain of volcanoes called a volcanic arc. Inland from the volcanic arc a rift zone may open, tearing apart the continent along dozens of faults. Where ocean plates collide with each other, subduction builds a volcanic island arc. The island arc, attached to its underlying plate, then moves along the surface. Hot spots, small areas where intense heat wells up from deep in the Earth, feed huge volcanoes at the surface. Hot spots are fixed in place, so as the crust and lithosphere drift across the spot, a trail of volcanoes is left on the plate, like the Hawaiian island chain. The processes of plate tectonics, particularly subduction, have shaped Oregon throughout its entire geologic history and continue to shape the state today.



This diagram shows plate tectonics processes that have been active at one time or another in Oregon's geologic history. Today's plate tectonics look very much like the right half of the diagram, with the active Cascadia Subduction Zone off the Oregon coast, an active volcanic arc in the Cascade Range, and a rift zone forming in eastern Oregon. Tens of million years from now, as Oregon continues to change, the picture will look very different.



CONSTRUCTING OREGON: HOW TO READ THE MAP

The rock units and ages shown on this map tell a simplified story of the geologic history of Oregon. The units were assembled from the Oregon Geologic Data Compilation, a new digital geologic compilation of Oregon completed in 2009. The compilation was made possible by digitizing 345 geologic maps with thousands of different geologic units and arranging the rock units by type and age. Having all of Oregon's geology in one digital compilation makes it possible to organize rocks across the state into the major geologic layers that together have built the Oregon we see today. Each layer results from a major geologic event—some long-lived, some a geologic instant—that assembled the state like a complex building. With these layers, we can think of three phases of construction:

- **FOUNDATION**
- **BRICKS AND MORTAR**
- **PLASTER AND PAINT**

The major geologic layers in each phase are grouped and described below.

FOUNDATION—Rocks many miles thick underlie the entire state and range from 400 million to 50 million years old.

BRICKS AND MORTAR—Volcanic and sedimentary rocks thousands of feet thick cover most of the foundation. These rocks are generally between 60 million and 2 million years old.

PLASTER AND PAINT—This is the familiar land that we live on. Rocks hundreds of feet thick began forming 15 million years ago and continue to be shaped today.

Exotic Terranes: foundation blocks of Oregon

400 to 100 million years ago

sandstone, shale, basalt, pillow basalt, limestone, chert, serpentinite, peridotite, schist, phyllite, argillite, greenstone

Oregon's oldest rocks originated as volcanic island arcs far out in the ocean, at a time when the Pacific Northwest coast ended near the present Oregon-Idaho border. These rocks are known as "exotic terranes" because they came from other places. Riding on the floor of the Pacific Ocean as it subducted beneath North America, they were too big or too thick to easily slide beneath the edge of the North American continent; instead, they remained in the subduction zone and welded themselves to the edge of the growing plate. The result we see today is a fascinating array of varied rocks; thick slices of the **oceanic crust**, limestone with tropical corals, volcanic seamounts, shiny blue-green serpentinite, and large areas of totally crushed and broken rock called mélange, produced by the incredible forces of two tectonic plates smashing together. Although these rocks probably extend beneath the entire state, they are largely buried by younger rocks and can be found at the surface only in the Klamath Mountains and in northeast Oregon.

OGDC units: Paleozoic-Mesozoic Baker, Olds Ferry, Wallowa, Mountain Home, Pueblo Mountains and Grindstone Terranes in Eastern Oregon; Triassic to Jurassic Applegate, Condrey Mountain, Gold Beach, Pickett Peak, Sexton Mountain, Sixes River, Snow Camp, Western Klamath, and Yolla Bolly Terranes in southwest Oregon; and Eocene Siletz Terrane in northwest Oregon

DID YOU KNOW? Josephinite, a rare natural nickel-iron alloy that resembles the material in iron meteorites, is found only in the exotic terranes of the Klamath Mountains.

■ **GO SEE IT!** Hellgate Recreation Area; Cape Sebastian State Park; Hells Canyon National Recreation Area

Batholiths and Plutons: mortar for the foundation

165 million to 130 million years ago

granodiorite, granite, gabbro, diorite, tonalite, quartz diorite

As the Exotic Terranes were plastered onto the edge of the North American continent, magma from deep within Earth was injected into them and then cooled. The magma formed large masses of granite and related rocks called batholiths and smaller blobs called plutons. Some of the rocks that form the larger batholiths can be seen in the Wallowa and Elkhorn Mountains of northeast Oregon and near Grants Pass and Medford in southwest Oregon. These intrusive igneous rocks appear to be the first rocks that truly originated in Oregon.

OGDC units: Jurassic-Cretaceous Bald Mountain and Wallowa batholiths Pedro Mountain, North Fork and Sunrise Butte stocks in northeastern Oregon; Buckskin Peak, Gold Hill, Grants Pass, Grayback, and Jacksonville plutons in southwest Oregon

DID YOU KNOW? A water well in the Grants Pass pluton acts like a seismograph by rising and falling when large earthquakes occur even far away.

■ **GO SEE IT!** Mount Ashland and Anthony Lakes ski areas

Early Sediments: Oregon's first coast

130 million to 50 million years ago

sandstone, shale, conglomerate

As the Exotic Terranes settled into position and were fused in place by the hot Batholiths and Plutons, sedimentary rocks began to be deposited in what is now Oregon. Starting about 130 million years ago, rocks made of sand and mud were forming along Oregon's first coastline, which stretched northeast across the state from Grants Pass to Pendleton. Coal beds from these ancient coastal swamps and ammonite fossils from these rocks remind us that this was the age of the dinosaurs.

OGDC units: shallow marine deltaic and terrestrial sedimentary rocks of the Jurassic-Cretaceous Myrtle Group, Cretaceous Mitchell Group and Hornbrook Formation, Paleocene Herren and Payne Cliffs Formations

DID YOU KNOW? Fossils from the Early Sediments include ichthyosaurs, pteranodons, and ammonites, but no dinosaur bones have been found in Oregon yet!

■ **GO SEE IT!** Myrtle Creek; Siskiyou Pass on I-5; south side of Highway 26 at Mitchell

Siletz Terrane: last exotic arrival

60 million to 48 million years ago

basalt, pillow basalt

Beginning about 60 million years ago, another exotic terrane moved into the **subduction zone** and smashed into North America. Like Hawaii, this exotic terrane formed where a hot spot developed beneath the oceanic crust. These rocks formed a pile too thick to slide under North America; instead, they stuck on the edge of the continent, creating the foundation of the Coast Range. Over the next few million years the **subduction zone** moved westward into the Pacific Ocean, to the position the zone now occupies. The era of exotic terranes is not over. All of California west of the San Andreas fault will arrive in Oregon 20 million to 40 million years from now.

OGDC units: Eocene Siletz Terrane in northwest Oregon

DID YOU KNOW? Much of Siletzia is composed of pillow basalt, lava that is squeezed out in long tube-shaped blobs underwater.

■ **GO SEE IT!** Fitton Green Natural Area

Early Volcanic Arc: Oregon's tropical volcanoes

52 million to 6 million years ago

basalt, andesite, dacite, rhyolite, mudflow breccia, conglomerate, tuff

As the **subduction zone** moved westward under the Pacific Ocean about 52 million years ago, volcanic activity from this shift built a broad **volcanic arc** across much of the eastern two thirds of the state. The eruptions continued until about 20 million to 6 million years ago and built a huge pile of lava flows, tuff, and interlayered river and lake sediments. Hundreds of volcanoes of all types and sizes erupted across the landscape. Huge explosive calderas erupted enormous ash clouds that deposited ash tuff over large areas. The near-tropical climate supported a wide range of now extinct plants and animals, whose fossils are spectacularly preserved in ash layers and old lake beds in the John Day Fossil Beds National Monument. Much of the ancient arc is now buried in the east by Columbia River Basalt, Rift Volcanoes, and High Cascade Volcanoes.

OGDC units: Eocene through Miocene volcanic, intrusive and volcaniclastic rocks and interbedded terrestrial sedimentary rocks of the Little Butte, Early Western Cascades and Late Western Cascades, Skamania, Steens Mountain, Tower Mountain, Warner Peak, and Goble Volcanics; Colestine, John Day, Clarno, Alvord Creek, Eagle Creek, Heppsie, Mollala, Pike Creek, Rhododendron, Roxy, Sardine, Scorpion Mountain, and Wasson Formations

DID YOU KNOW? Early Volcanic Arc rocks are one of the best sources of Oregon's state rock, the thunderegg.

■ **GO SEE IT!** Smith Rock State Park; John Day Fossil Beds National Monument

Coast Range Sediments: 50 million years of mud

50 million years ago to now

mudstone, sandstone, siltstone, shale

After the volcanic rocks of Siletz Terrane were stuck onto the edge of North America, silt, sand, and mud began to build up on the Pacific Ocean floor off the coast of Oregon. Over tens of million of years, sea level went up and down, nearby volcanoes erupted and were eroded away, species arose and went extinct, and the two tectonic plates continued to smash into each other. Throughout this time, ocean sediments accumulated steadily and were compressed into a thick stack of sedimentary rocks. Today, many of the older rocks remain beneath the water offshore, but uplift, folding, and faulting associated with the **subduction zone** have pushed up others to form much of the Coast Range. Today, sediment washed into the ocean by Oregon's rivers continues to pile up off the coast, covering virtually all of the ocean floor as far west as the Cascadia Subduction Zone.

OGDC units: Eocene Lorane Shale and the Bastendorff, Bateman, Bushnell Rock, Camas Valley, Coaledo, Cowlitz, Elkton, Hamlet, Keasey, Kings Valley, Nestucca, Spencer, Tenmile, Trask River, Tyee, White Tail Ridge, and Yamhill Formations; Eocene-Oligocene Alsea and Eugene Formations; Oligocene Sager Creek, Pittsburg Bluff, Scotts Mills, Yaquina, and Tunnel Point Formations; Oligocene-Miocene Scappoose, Smuggler Cove and Northrup Creek Formations; Miocene Nye Mudstone, Whalecove Sandstone and Astoria, Gnat Creek, and Empire Formations

DID YOU KNOW? Oregon's only known significant natural gas field is in the Coast Range Sediments, near the town of Mist.

■ **GO SEE IT!** Shore Acres State Park; Gold and Silver Falls State Park

Coast Range Volcanoes: Oregon's first hot spot

45 million to 36 million years ago

basalt, diabase

A few million years after the Siletz Terrane joined the continent and began to be buried by sand and mud, the newly formed northwest corner of Oregon, moving with the North American continent, drifted west across a hot spot, triggering huge eruptions of lava that built up along the coast. For several million years the hot spot fed magma from deep within the Earth into the layer of marine sedimentary rocks (Coast Range Sediments) that was growing on the ocean floor. Today these volcanic and intrusive rocks make up the Tillamook Highlands and some of Oregon's most famous coastal landmarks, including Cascade Head and Cape Perpetua.

OGDC units: mafic intrusive and volcanic rocks of the Eocene Grays River Volcanics, Mary's Peak Intrusives, Tillamook Volcanics, Yachats Basalt, basalt of Cannery Hill, basalt of Waverly Heights, basalt of Cascade Head and diabase of Lee's Falls

DID YOU KNOW? Mary's Peak, the highest point in the Coast Range (4,097 ft), is supported by resistant intrusive basalt of the Coast Range Volcanoes.

■ **GO SEE IT!** Heceta Head Lighthouse State Park; Neptune State Park

Columbia River Basalt: the Yellowstone hot spot arrives in a flood of fire

17 to 6 million years ago

basalt

Seventeen million years ago the Yellowstone hot spot, a **plume** of very hot rock, rose from deep within the Earth beneath eastern Oregon, setting off a huge pulse of volcanic activity. The first eruptions were a series of gigantic lava floods erupted from great fissures near the Oregon-Idaho-Washington border. These lava flows are among the largest to have occurred anywhere on Earth. Some of these rapidly moving sheets of lava traveled as far as 400 miles from their vents to their far ends at Newport, Oregon. Individual flows cover as much as 10,000 square miles, equivalent to one tenth of the state, and many are over 100 feet thick. Most of this huge body of lava (originally covering half of the state) was erupted between 17 million and 15 million years ago, a very brief period in geologic history. Columbia River Basalt often cools to form stone columns, an iconic part of Oregon's scenery.

OGDC units: Miocene Grande Ronde, Hunter Creek, Imnaha, Picture Gorge, Prineville, Saddle Mountains, Steens, Venator Ranch and Wanapum Basalts

DID YOU KNOW? The largest individual Columbia River Basalt flows covered an area the size of the state of Maine.

■ **GO SEE IT!** Cape Lookout State Park; Saddle Mountain State Park; Camassia Natural Area; Silver Falls State Park; Hat Rock State Park; Steens Mountain

Rift Volcanoes: aftermath of the Yellowstone hot spot

15 million to 2 million years ago

basalt, andesite, dacite, rhyolite, tuff, siltstone, sandstone

After setting off the eruption of the Columbia River Basalt, the Yellowstone hot spot remained stationary as North America drifted west. This movement left a trail of volcanoes that extends to the east, ending at the Yellowstone caldera, a giant dormant volcano in Yellowstone National Park, Wyoming. Back in Oregon, the arrival of the hot spot had caused the crust to break and stretch, **rifting** apart to allow hundreds of volcanoes to break through and create a huge swath of volcanic rocks covering the southeast third of the state. These hot spot volcanoes range from 15 million to about 2 million years old and include everything from small cinder cones to calderas many miles across. The rifting caused the crust to break into large blocks separated by faults. Some blocks rose to form mountain ranges, while others sank to form basins; together they produced a landscape called the Basin and Range.

OGDC units: Miocene-Pliocene volcanic and volcaniclastic vent rocks and interbedded terrestrial sedimentary rocks of the High Lava Plains Volcanic Province and Oregon Idaho Graben; Kivett, Strawberry, and Northern Nevada Volcanics; Early Winema, Winema, Quaternary Winema, Harney Basin, Lake Owyhee, McDermitt, and Powder River Volcanic Fields

DID YOU KNOW? At least 790 individual volcanic vents have been mapped in the Rift Volcanoes.

■ **GO SEE IT!** Leslie Gulch Recreation Area; Lake Owyhee State Park; Fort Rock State Park

Ancient Waterways: home of Oregon's first salmon

15 million to 2 million years ago

sandstone, siltstone, mudstone, claystone, conglomerate, tuff

Beginning about 15 million years ago, inland waters became the home to the ancestors of our modern salmon. These ancient rivers and lakes deposited sand and gravel, mud and clay in valleys and basins similar to the landscape of today. Over millions of years, these deposits have been cemented and compacted into soft rock and in some areas have been uplifted from their original position and then eroded away. Many of these rocks formed in the sinking basins of the Basin and Range or in the valleys of the early Willamette, Deschutes, Snake, and Columbia rivers. In many places the rocks are layered with lava flows and volcanic deposits from violent nearby eruptions.

OGDC units: Miocene-Pliocene terrestrial sedimentary rocks, includes the Alkali Canyon, Bully Creek, Dalles, Deschutes, Drewsey, Fern Ridge, Glenns Ferry, Hillsboro, McKay, Simtustus, Trout Creek, and Troutdale Formations

DID YOU KNOW? The Troutdale Formation in the Portland area contains cobbles that can be traced back to eastern Idaho and western Montana.

■ **GO SEE IT!** The Cove Palisades State Park

Rattlesnake Tuff: Oregon's largest known eruption

7 million years ago

tuff

Seven million years ago, from a volcano beneath the modern Harney Basin, a single gigantic eruption launched a huge cloud of red-hot ash, gas, and broken rock tens of thousands of feet into the atmosphere. The debris fell back to Earth and blanketed one fifth of the state (18,000 square miles) in a red-hot layer that welded itself into a compact volcanic rock and completely transformed the landscape of Oregon in just a few hours or days. Geologists call this rock the Rattlesnake Ash-Flow Tuff. Although this eruption was one of the largest, it was only one of hundreds of rift volcano eruptions left in the wake of the Yellowstone hot spot.

OGDC units: includes the Miocene Rattlesnake Tuff and Rattlesnake Formation

DID YOU KNOW? Ash-flow tuff from the Rattlesnake eruption has been found up to 100 miles away from the vent.

■ **GO SEE IT!** Devine Canyon; Picture Gorge

High Cascade Volcanoes: land of fire and ice

6 million to 220 years ago

basalt, andesite, scoria, tuff

The crest of the Cascade Range of Oregon has been built by the continuing eruptions of hundreds of volcanoes ranging in age from a few million years old to just a few hundred years old. Most of the eruptions have occurred at small cinder cones and produced lava flows that cover a few hundred acres to a few square miles. A few larger volcanoes including Mount Hood, the Three Sisters, and Mount McLoughlin, alternate between lava flows and explosive eruptions of ash, pumice, and broken lava. Even rarer are huge eruptions like the Mazama explosion that created Crater Lake and blanketed surrounding states with ash. Some of these young volcanoes extend beyond the Cascade Range. Portland is one of the few cities in the world where young volcanoes lie within the urban area. Most of the largest peaks in the Cascade Range are still considered active volcanoes.

OGDC units: Pliocene to Quaternary volcanic, and volcaniclastic vent rocks of the late High Cascade volcanics and early High Cascade volcanics, predominantly basalt and basaltic andesite with minor andesite

DID YOU KNOW? The most recent volcanic eruption in Oregon occurred in the 1790s on Mount Hood.

■ **GO SEE IT!** Timberline Lodge; Dee Wright Observatory on McKenzie Pass; Mount Tabor Park in Portland

High Desert Volcanoes: sleeping giants of eastern Oregon

3 million to 3,000 years ago

basalt

Beginning about 3 million years ago, a string of young volcanoes in eastern Oregon began erupting and covering large areas with lava flows of fluid basalt. These volcanoes stretch across the high desert of southeast Oregon from Newberry Volcano in the west to Jordan Craters on the Idaho border. Newberry Volcano alone covers more than 2,000 square miles and sent basalt flows down the canyon of the Deschutes River as far as 65 miles from the main crater. At Jordan Craters, hundreds of square miles are covered with young, fresh lava, creating an otherworldly landscape in the Oregon High Desert.

OGDC units: Quaternary basalt flows from Newberry Volcano, Diamond Craters and Jordan Craters, other minor Quaternary volcanic centers

DID YOU KNOW? The large fields of fresh lava around Newberry Volcano were used by NASA to train astronauts for moon landings.

■ **GO SEE IT!** Newberry National Volcanic Monument; Diamond Craters; Jordan Craters

Lakes, Rivers, and Dunes: painting the landscape

2 million years ago to now

gravel, sand, silt, clay

Water, wind, ice, and gravity move loose sediment (sand, gravel, dirt, volcanic ash, and mud) across the surface of the land, producing a wide range of surficial, or surface, deposits. Although these deposits are formed by many of the same processes that create sedimentary rocks, surficial deposits are generally loose and uncemented and are still part of the environment in which they were formed. Beaches, sand dunes, and floodplains of rivers are all familiar examples of surficial deposits, which form a thin layer over much of the state, covering the older bedrock below.

OGDC units: Quaternary river, stream and lake alluvium, alluvial fans, beach and dune deposits, river and coastal terraces, shelf and slope sediments

DID YOU KNOW? The Oregon Dunes between Coos Bay and Florence contain approximately 4.5 billion cubic yards of sand, enough to fill 450 million dump trucks or build 50 billion sand castles.

■ **GO SEE IT!** Oregon Dunes National Recreation Area; Sauvie Island

Pluvial Lakes: Oregon's inland seas

2 million to 10,000 years ago

gravel, sand, silt, clay

Over the past 2 million years, climate change caused ice ages to occur again and again. During these times, increased rainfall filled many of the large closed basins in eastern Oregon, forming big bodies of water called pluvial lakes. Lakes as large as 500 to 1000 square miles filled the Harney, Klamath, Catlow, and Goose Lake basins as well as innumerable other smaller basins. Most eastern Oregon lakes, like Summer Lake, Hart Lake, and Lake Abert, are lonely salty remnants of great pluvial lakes, whose ghostly shorelines can be seen high above the modern shores. When the next ice age occurs, these ancient lakes will fill again.

OGDC units: Quaternary playa lake deposits, and Quaternary alluvium, pluvial lake deposits and terrace deposits in closed basins

DID YOU KNOW? Fort Rock Lake was the largest pluvial lake in Oregon. It covered over 1260 square miles to a depth of 320 feet in Fort Rock and Christmas Valleys.

■ **GO SEE IT!** Fort Rock State Natural Area; Lake Abert; Hart Lake

Glacial Deposits: runaway global cooling

2 million to 10,000 years ago

gravel, silt

Ice ages can last tens of thousands of years. Ice caps grow at the poles and push their way toward the equator in great sheets that can be over 2 miles thick. In mountain ranges away from these ice sheets, smaller glaciers cover mountain tops and fill valleys with rivers of ice that carve out rounded valleys and leave behind great piles of rock rubble called glacial moraines. Rock flour ground by the ice is carried by wind and deposited as thick blankets of silt called loess. Although the great ice sheets have never made it as far south as Oregon, mountain glacier deposits can be found throughout the Cascade and Blue Mountains and on many of the isolated mountains and ranges in eastern Oregon. Remnants of the great mountain glaciers cling to a few of the highest Cascade peaks, and loess blankets large areas around Pendleton and Portland. About 20,000 years ago, so much water was frozen in ice sheets and mountain glaciers that sea level was nearly 400 feet lower than it is today. The Oregon coast was located some 10 to 40 miles west of the modern shore.

OGDC units: glacial deposits, glacial outwash deposits, loess

DID YOU KNOW? Glaciers moved 18 million cubic yards of gravel sand and clay to build the moraines that surround Wallowa Lake. That's 1.8 million dump truck loads.

■ **GO SEE IT!** Wallowa Lake

Ice Age Floods: Oregon's best soils lifted from eastern Washington

23,000 to 17,000 years ago

gravel, silt

Toward the end of the last ice age, 15,000 to 20,000 years ago, the massive ice cap that covered the northern hemisphere repeatedly blocked the Clark Fork of the Columbia River in Montana, forming a huge lake behind the ice dam equal to two of today's Great Lakes. When the dam broke, some of the largest floods known to have occurred on Earth raged across eastern Washington and down the Columbia River to the ocean. Over 40 of these huge floods, called Missoula, Ice Age, or Bretz floods (for J Harlen Bretz, the geologist who identified the floods), scoured the landscape and left behind thick deposits of sand, silt, and gravel along the Columbia River in Umatilla and Morrow counties and in the Willamette and Tualatin valleys. Boulders embedded in the ice were carried in these massive floods and were dropped along the way as the ice melted. These "glacial erratics" include famous rocks like the Willamette Meteorite and the rock at Erratic Rock State Natural Site near Sheridan. Topsoil in Montana, Idaho, and eastern Washington was scoured away by the floods and deposited here, producing the rich agricultural lands of the Willamette Valley and Columbia Basin.

About 14,500 years ago a giant pluvial lake (Lake Bonneville) in Utah flooded north along the Snake River, leaving deposits near Ontario.

OGDC units: includes Quaternary Missoula and Bonneville Flood Deposits

DID YOU KNOW? The peak flow of the ice age floods through the Columbia Gorge was 350 million cubic feet per second, 350 times greater than the historic 1948 Columbia River flood that destroyed the city of Vanport.

■ **GO SEE IT!** Columbia River Gorge; Erratic Rock State Natural Site

Mazama Deposits: a jewel born of destruction

7,700 years ago

ash, tuff

Just 7,700 years ago, Mount Mazama, an active, 12,000-foot tall High Cascade volcano, exploded in a massive eruption that blew 50 cubic miles of rock and ash into the air. The eruption blanketed the surrounding landscape with red-hot flows of ash and pumice and produced a cloud of ash that rained down over an area covering eight western states and three Canadian provinces. What was left of the volcano collapsed on itself, leaving a gaping hole that subsequently filled with snow melt to form Oregon's iconic Crater Lake, today Oregon's only national park. The amount of material erupted would cover the entire state to a depth of almost three feet.

OGDC units: includes all mapped Holocene air fall and ash flow deposits from the climactic Mazama eruption

DID YOU KNOW? A layer of ash from Mount Mazama has been found in Edmonton, Alberta, more than 800 miles away.

■ **GO SEE IT!** Crater Lake National Park; Annie Canyon

Unstable Oregon: land of 10,000 landslides

500,000 years ago to now

broken rock, soil

Landslides are common in Oregon, and geologists have mapped thousands of them, ranging from a few acres to a truly gigantic offshore landslide covering over 2,000 square miles. The slide off the southern Oregon coast is one of the largest known in the world and may have produced a massive tsunami when it occurred tens of thousands of years ago. Over thousands of years the combination of steep terrain, heavy rainfall, and periodic great earthquakes has produced landslides in all parts of the state. Most are inactive . . . for now.

OGDC units: landslide deposits

DID YOU KNOW? In 850 AD, a mountainside on the Washington side of the Columbia River Gorge collapsed in a massive landslide near modern-day Cascade Locks. The slide temporarily dammed the Columbia River and may be the source of the Native American "Bridge of the Gods" legend.

■ **GO SEE IT!** Bridge of the Gods in the Columbia River Gorge; Hole in the Wall near the Powder River

Cascadia Subduction Zone Earthquakes: the big one(s)

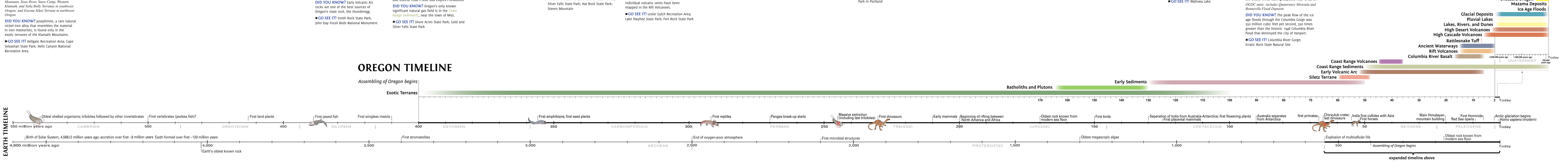
10,000 to 309 years ago . . . and counting

The modern version of the many subduction zones that have shaped Oregon over the last hundreds of millions of years is called the Cascadia Subduction Zone. Dozens of active faults off the Oregon coast mark the **subduction zone**, which has produced 19 very large earthquakes over the past 10,000 years—an average one every 530 years. When these great earthquakes occur, western Oregon lurches as much as 20 to 40 feet to the west in a few minutes. The most recent event occurred January 26, 1700, and was probably a magnitude 9 or larger earthquake. This earthquake caused strong shaking lasting several minutes over most of western Oregon and produced a tsunami that flooded coastal lowlands within minutes.

DID YOU KNOW? The tsunami from the 1700 earthquake was recorded in Japan, where the tsunami caused minor damage.

■ **GO SEE IT!** The Schooner Creek Wayside historical marker, located on U.S. Highway 101 south of Lincoln City, recalls the great earthquake and tsunami of 1700, which destroyed Native American villages along the Northwest coast.

OREGON TIMELINE



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