

2. Coastal Processes

1. Plate Tectonics and Landscape Formation:

Building Oregon

Cascadia Subduction Zone

Columbia Plateau Basalt

2. Ongoing Coastal Processes:

Dynamic Duo: Uplift and Erosion

Coastal Headlands

3. Coastal Geological Hazards:

Earthquakes

Tsunamis

Landslides

4. Interpretive Methods:

Presenting Coastal Geology to Coastal Audiences

The Dynamic Landscape of Oregon's Coast: A Tale of Beauty and the Beast

Bob Lillie

Professor of Geology

Certified Interpretive Trainer

Oregon State University

Oregon Coast Region of the Oregon Master Naturalist Program

Unit 9: Geology of the Oregon Coast

***Cape Perpetua Scenic Area, Oregon
February 26, 2011***

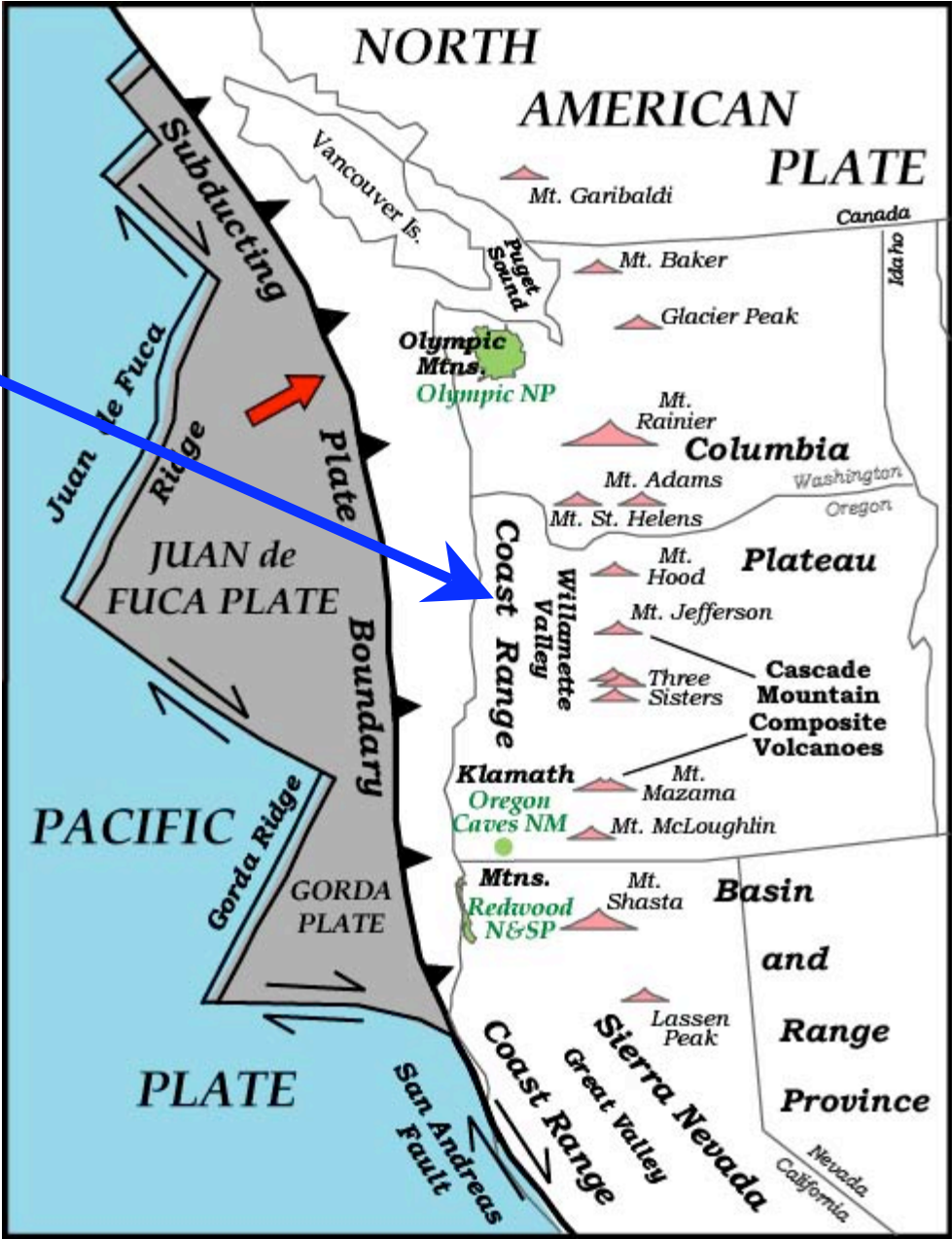
Marine Gardens, Newport, Oregon

Robert J. Lillie

Coastal Ranges

Parks in the Coastal Ranges contain materials that were manufactured in the sea, then scrapped off the subducting Juan de Fuca Plate.

National Park Lands in the Coastal Ranges



The Edge of the Sea

(Rachel Carson, ©1955, Houghton Mifflin Company)

“Now I hear the sea sounds about me; the night high tide is rising, swirling with a confused rush of waters against the rocks below

Once this rocky coast beneath me was a plain of sand; then the sea rose and found a new shore line.

And again in some shadowy future the surf will have ground these rocks to sand and will have returned the coast to its earlier state.

And so in my mind's eye these coastal forms merge and blend in a shifting, kaleidoscopic pattern in which there is no finality, no ultimate and fixed reality --

Earth becoming fluid as the sea itself.”

Ken Benick

Cape Perpetua Scenic Area, Oregon



“..... Earth becoming fluid, as the sea itself”

Rachel Carson

Deep Thought:

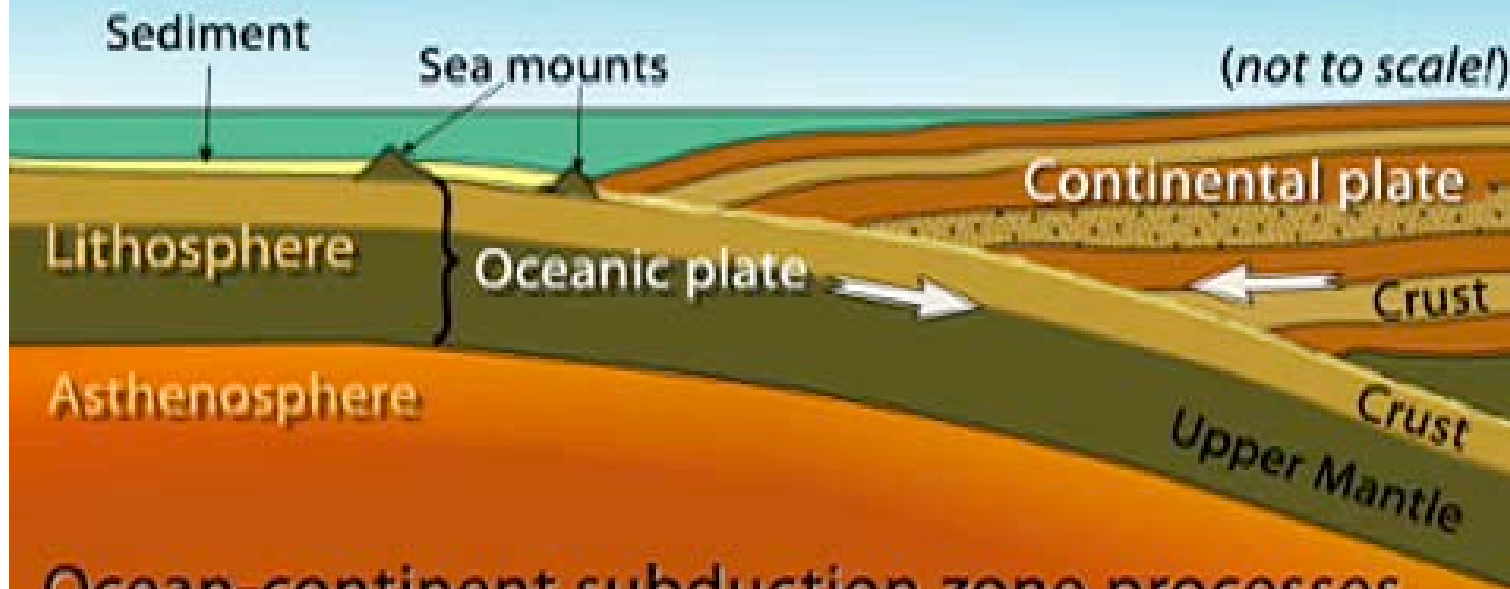
“Speeding up the geological clock along the Oregon Coast reveals Earth becoming fluid as the sea itself.”

Basalt Lava Flows

- **Manufactured in Ocean Realm**
- **About 35 million years ago**

Cape Perpetua Scenic Area, Oregon

Convergent Boundary



Ocean-continent subduction zone processes

- 1) Plates locked—stress & deformation
- 2) Plates release—earthquake & tsunami

Coastal Ranges

Layers lifted out of
the sea, deformed,
and eroded

*“... Earth becoming
fluid as the sea itself.”*

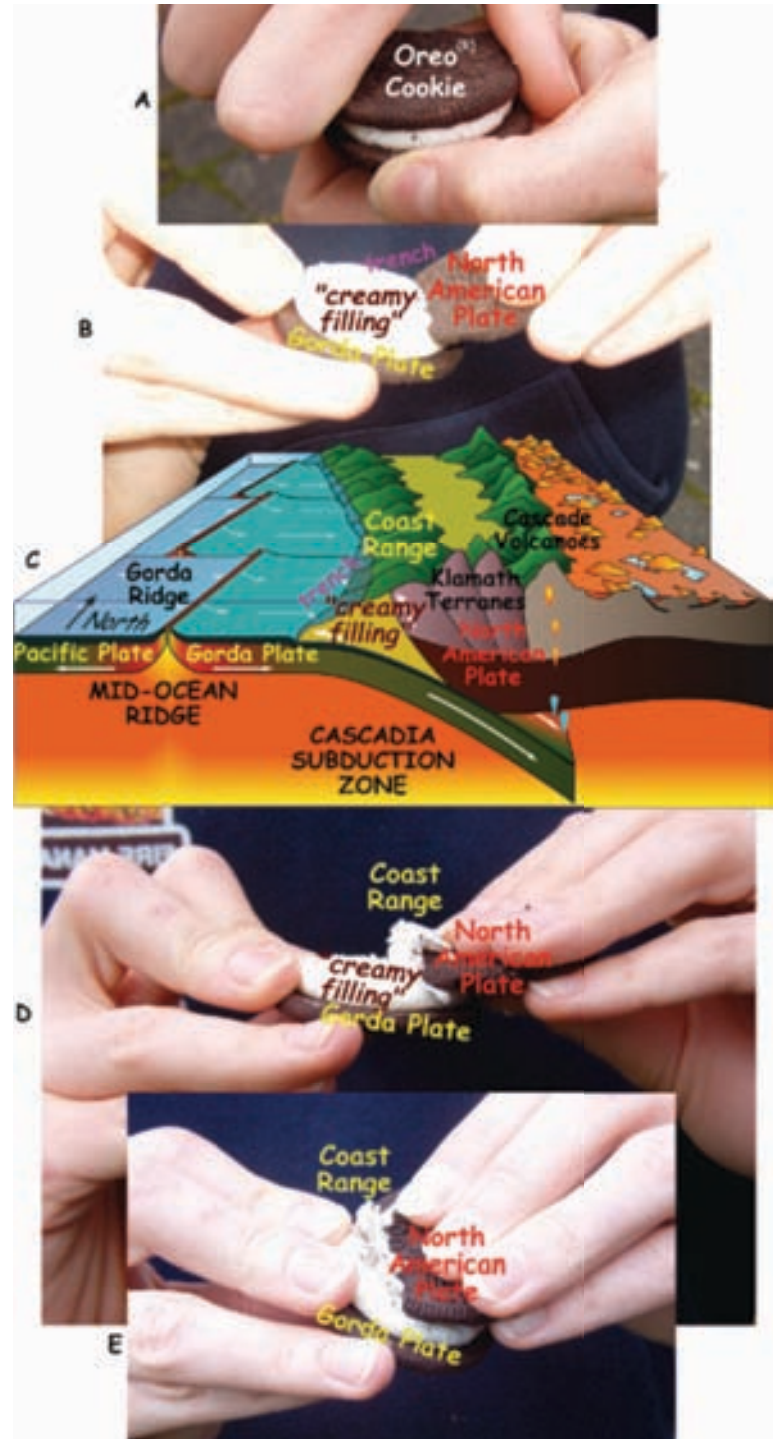


Robert J. Lillie

Parks and Plates
©2005 Robert J. Lillie

Ranger Jen's Oreo Subduction Demo

Coast ranges are material scraped off the ocean floor.

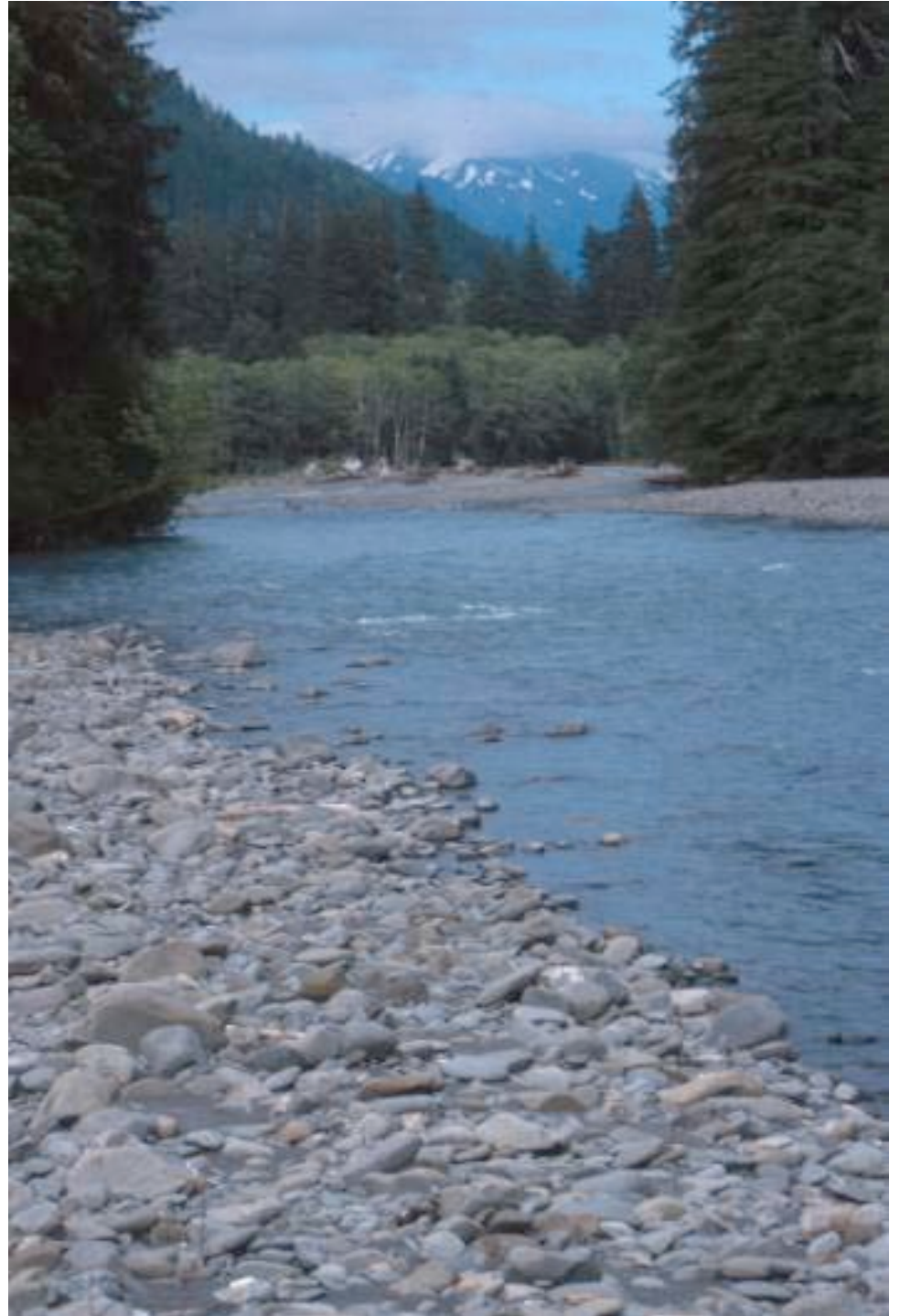


**National Parks reveal the recycling nature
of the Earth.**

*A grain of sand is eroded from high in
the Olympic Mountains.*



*Where it's carried
by the Hoh River.*



Robert J. Lillie

*To the Pacific Ocean,
where it's deposited in a
layer of sand.*

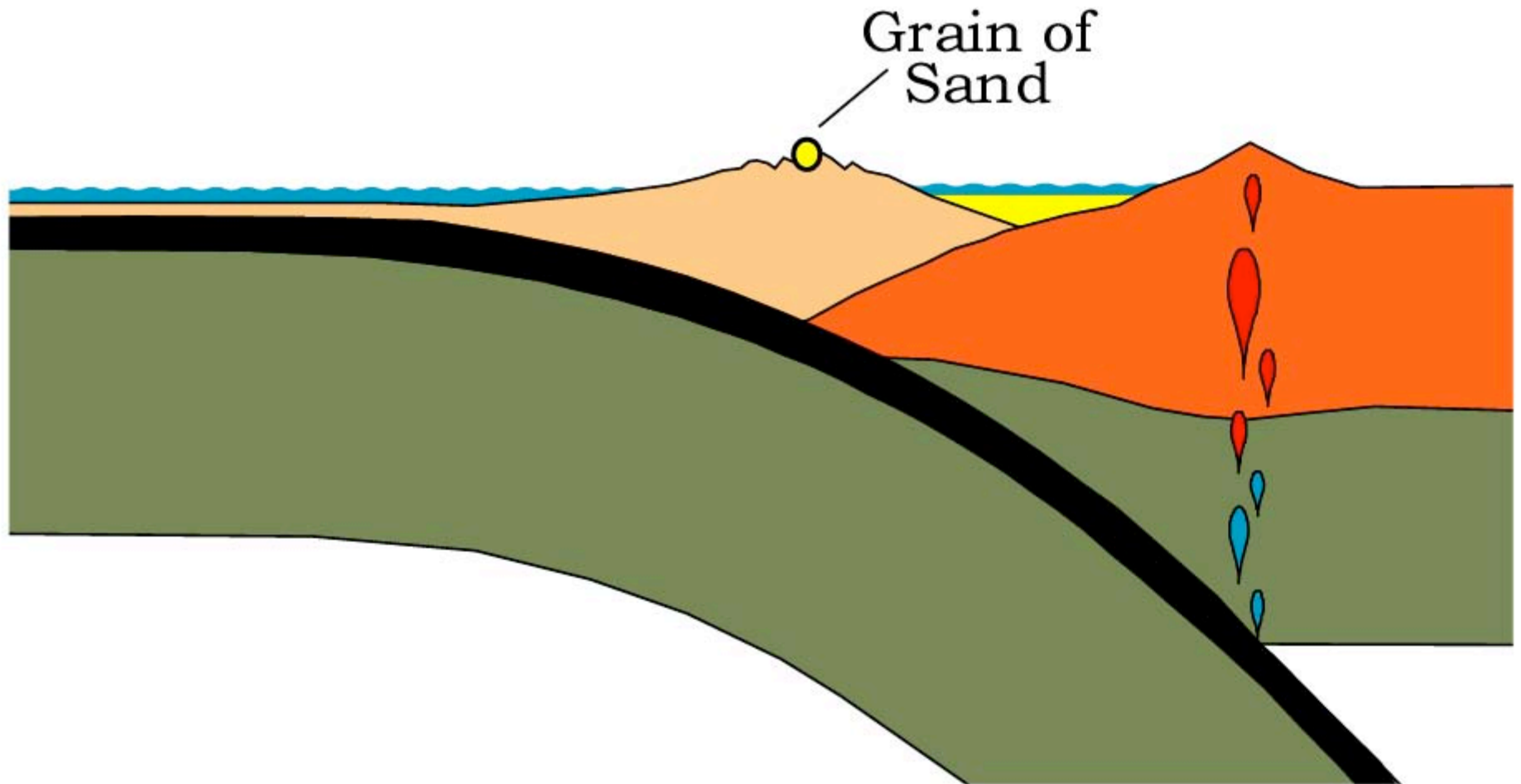




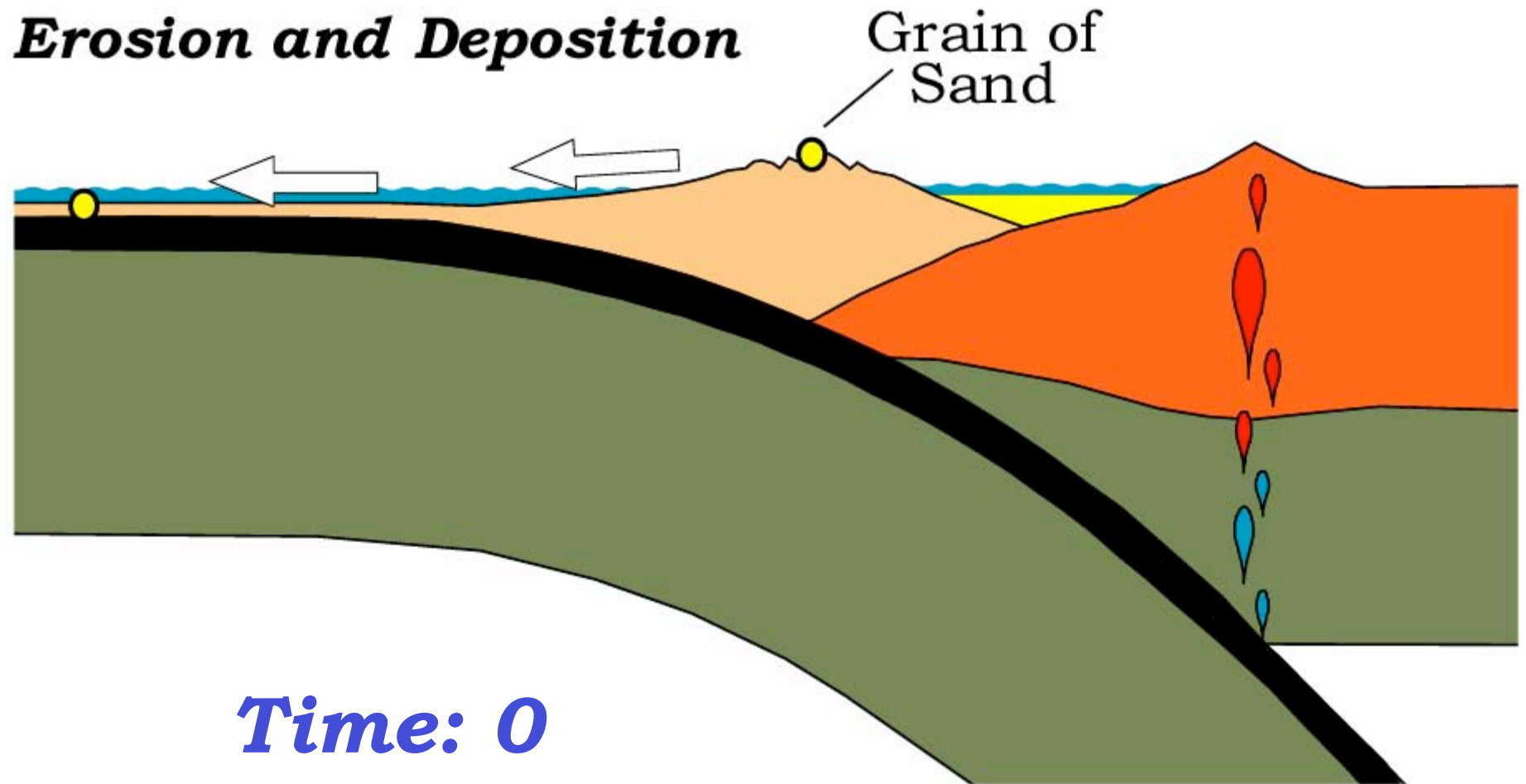
*Only to be uplifted and exposed again in
the Olympic Mountains.*

“..... Earth becoming fluid, as the sea itself”
Rachel Carson

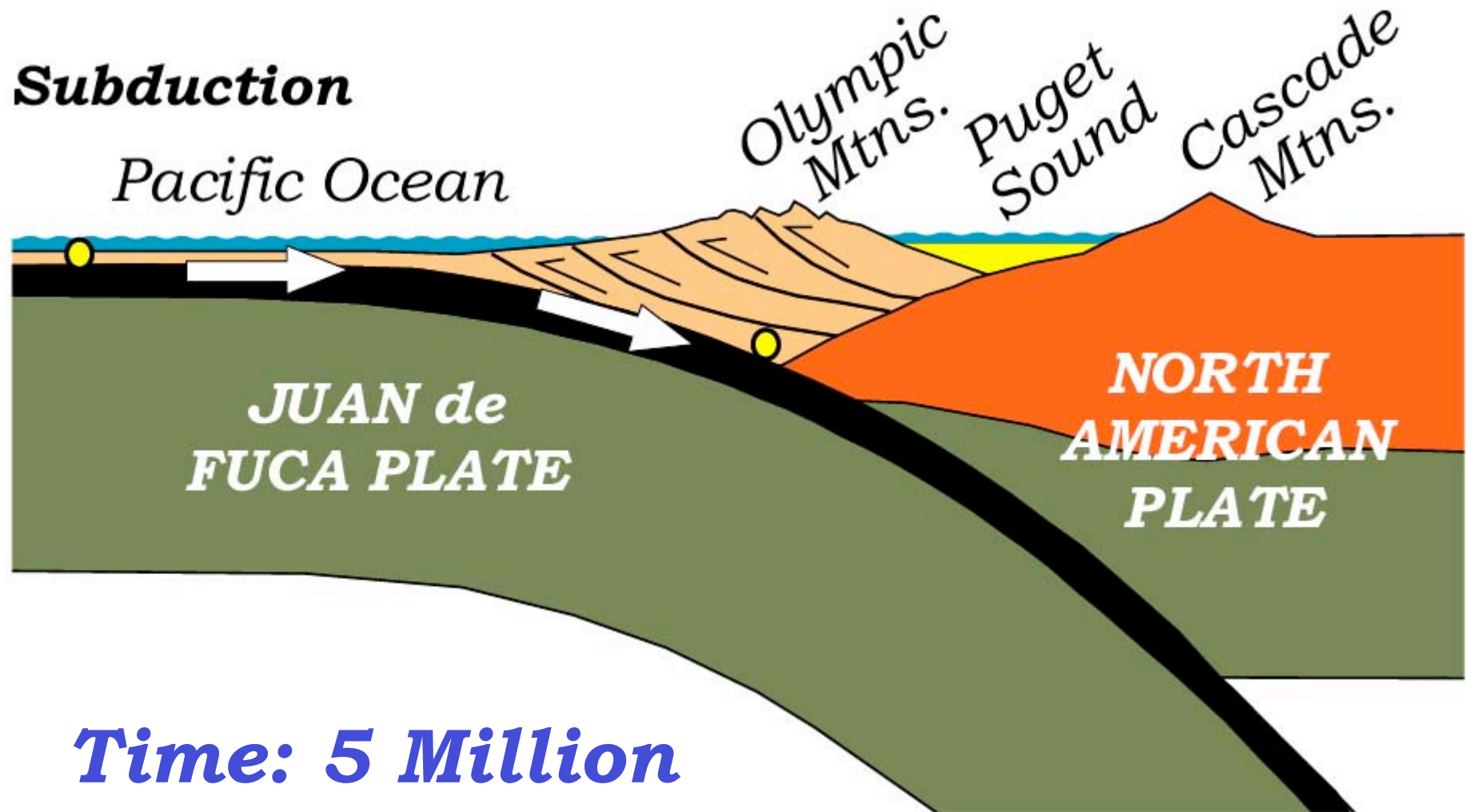
Erosion, Subduction, and Uplift in the Olympic Mountains



Olympic - Sized Recycling Machine!



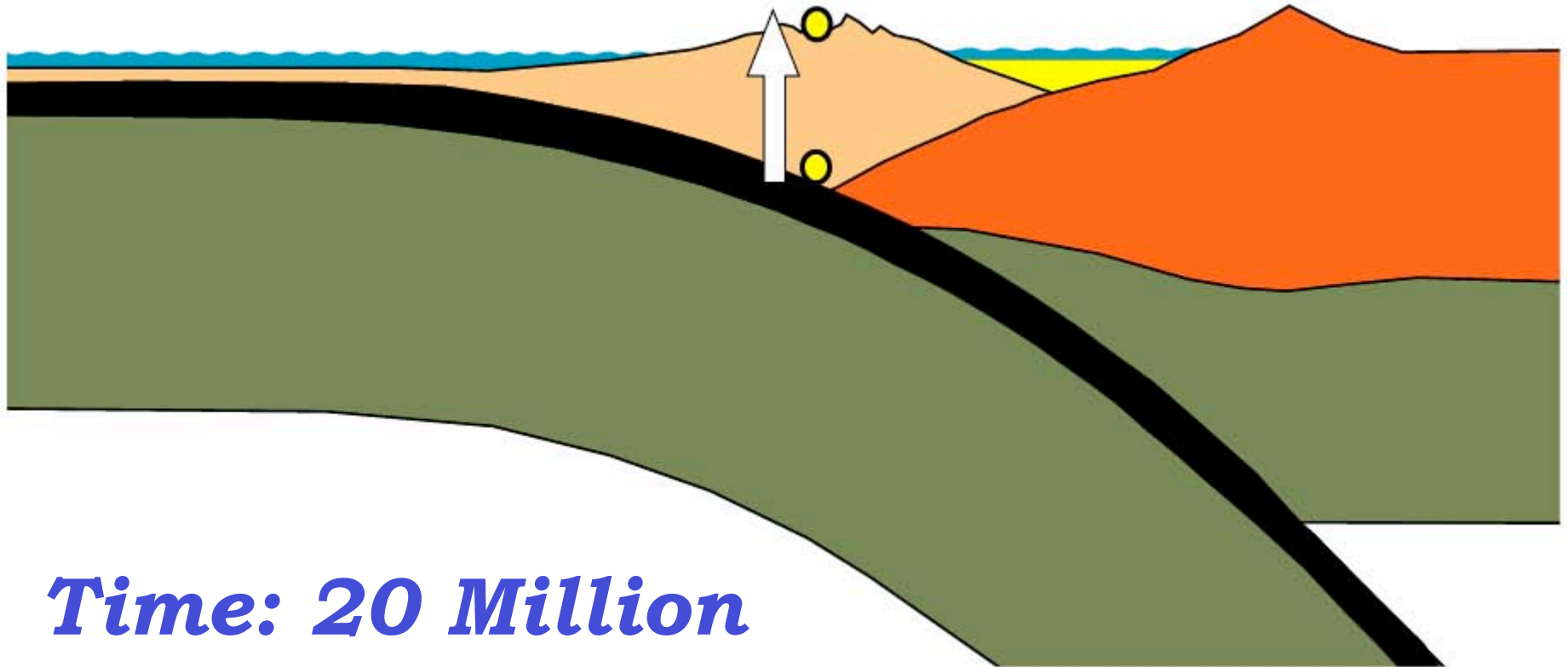
Olympic - Sized Recycling Machine!



**Time: 5 Million
Years**

Olympic - Sized Recycling Machine!

Uplift and Erosion



*Time: 20 Million
Years*

Coastal Ranges

Volcanic rocks
formed in the ocean

Olympic National Park, Washington

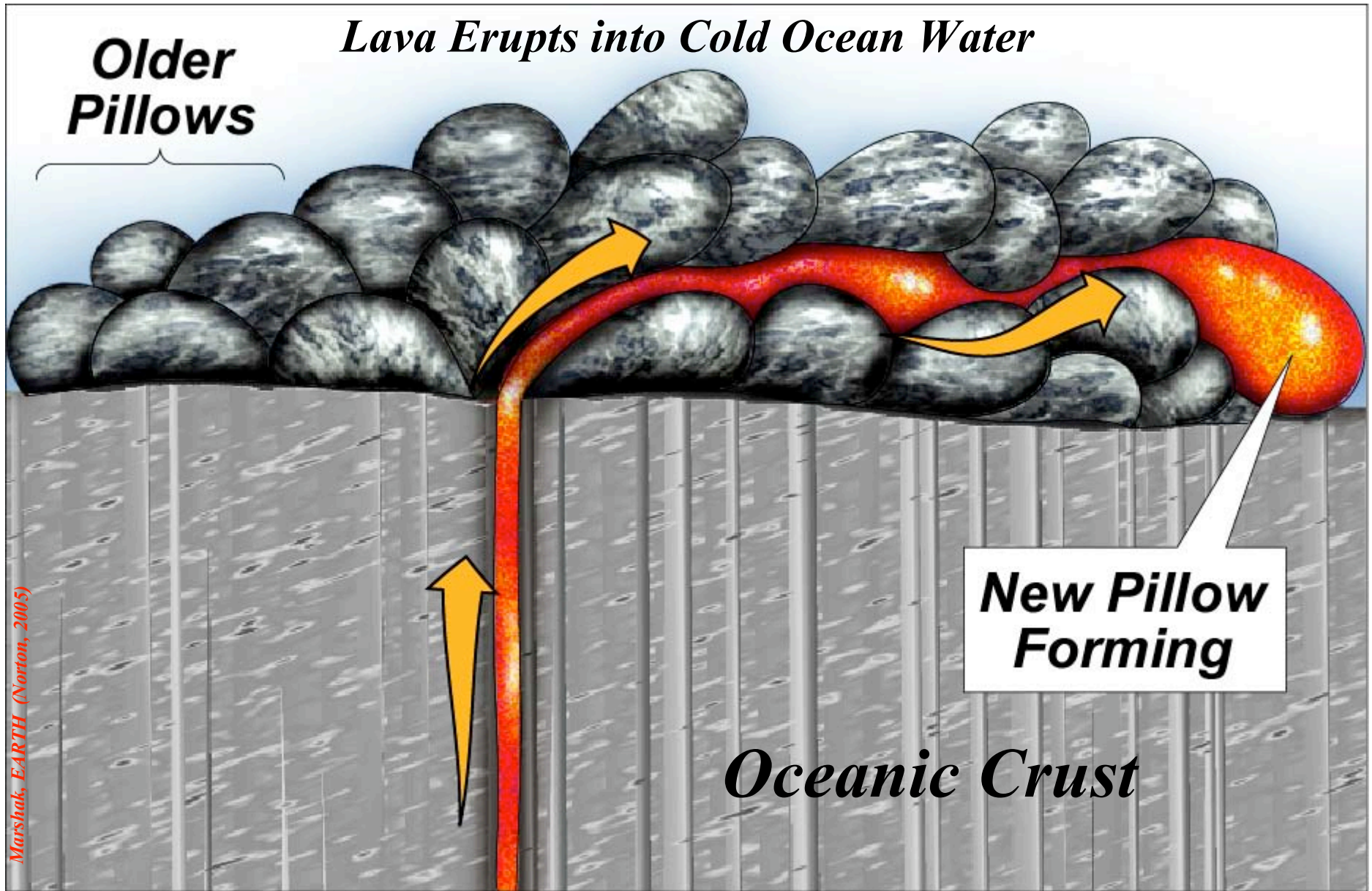
Formation of Pillow Lava



The formation of pillow lava in the deep ocean has never been observed, but it probably looks a lot like this. This movie shows pillow lava flowing underwater off the coast of Hawaii, after it was erupted on land and flowed into the ocean. Video footage from the movie "Pele Meets the Sea" courtesy of Richard Pyle (deepreef@bishopmuseum.org) at Lava Video Productions.

http://oceanexplorer.noaa.gov/explorations/04fire/background/volcanism/media/pillow_lava_video.html

Formation of Pillow Lava



Olympic National Park

Pillow Basalt

1 Foot



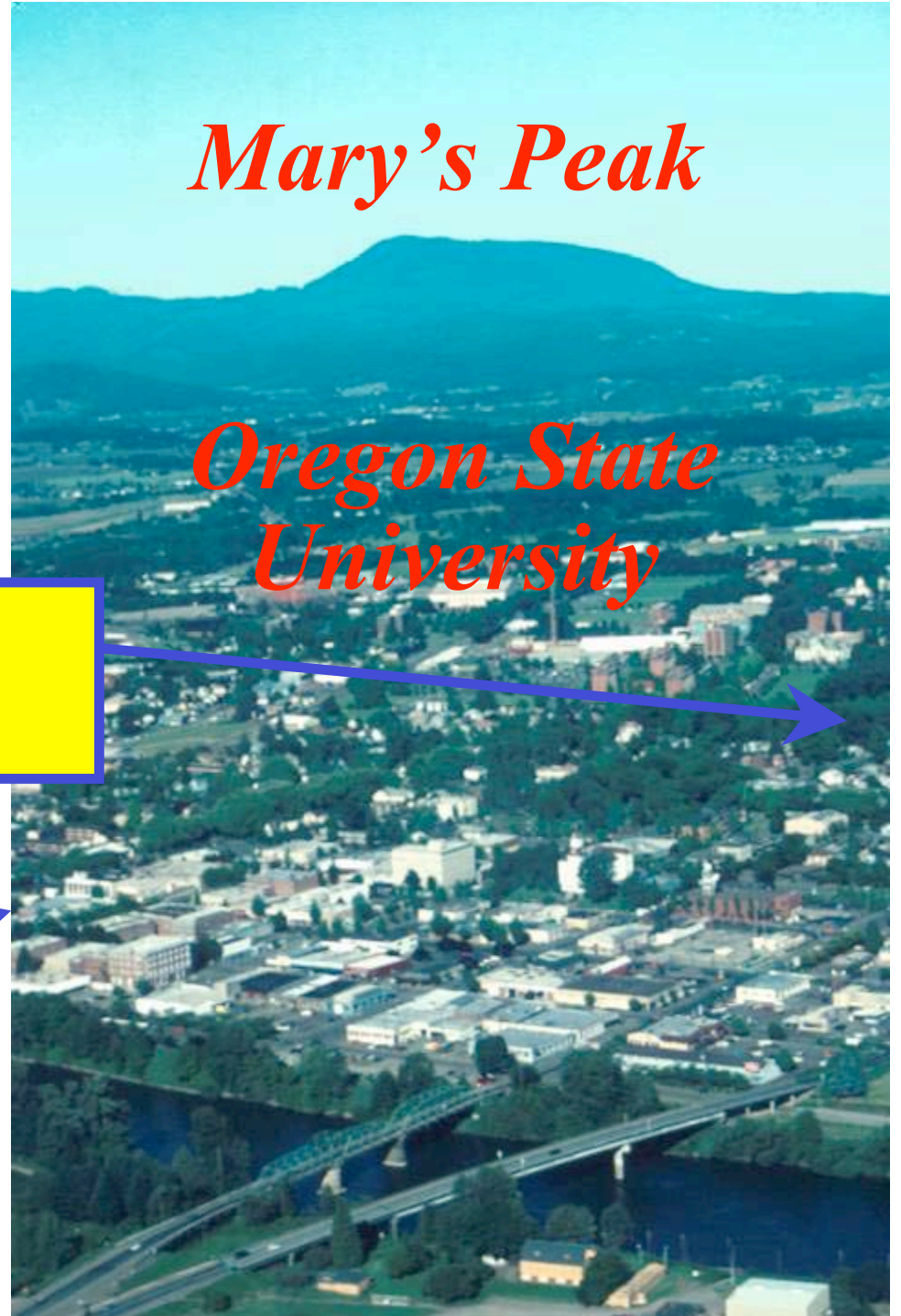
Corvallis, Oregon

Mary's Peak

*Oregon State
University*

*Campus
Beanery*

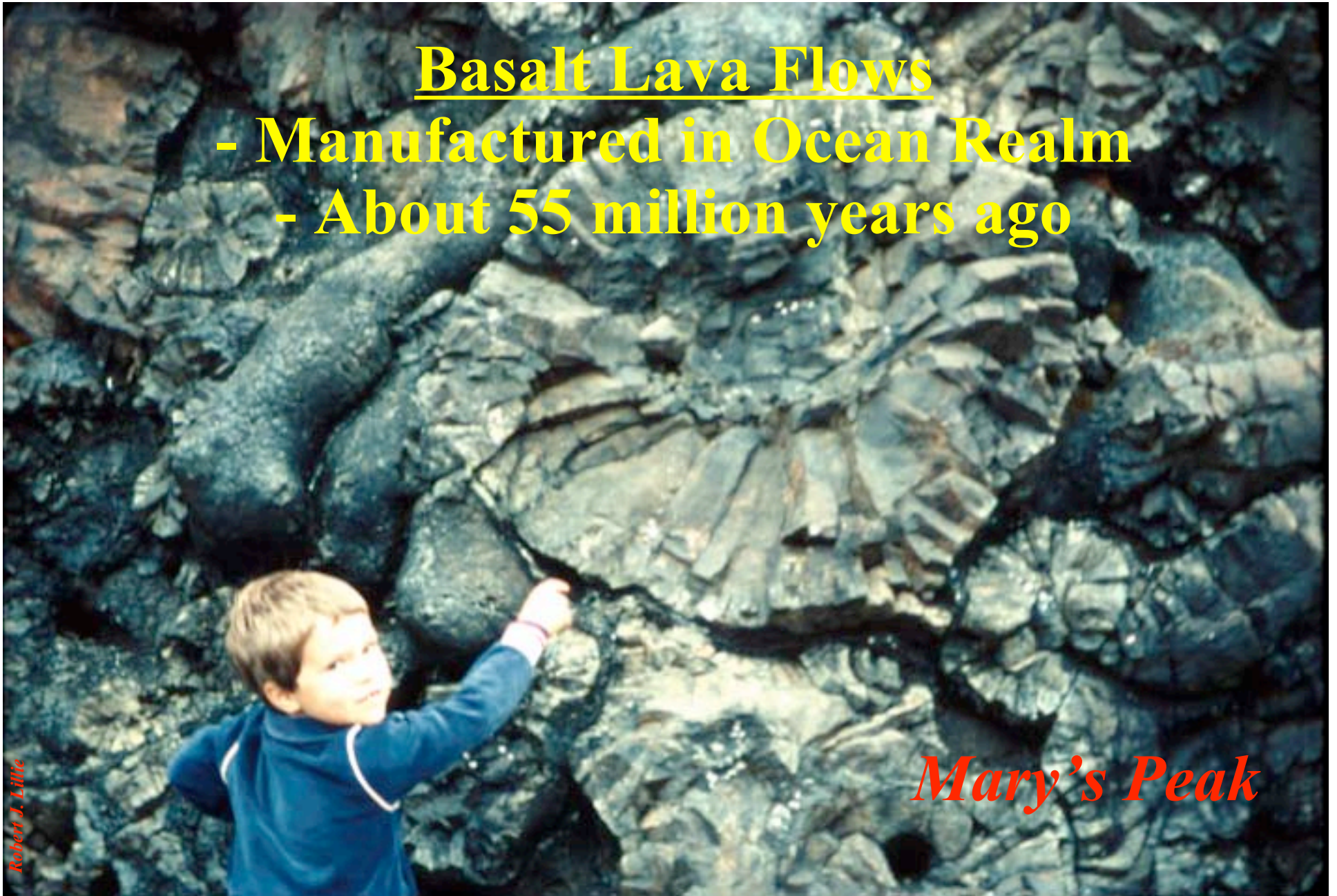
*Downtown
Beanery*



Basalt Lava Flows

- Manufactured in Ocean Realm
- About 55 million years ago

Mary's Peak



**What about these younger lava flows?
Only 9 – 15 million years old**



Robert J. Lillie

Seal Rock State Park, Oregon



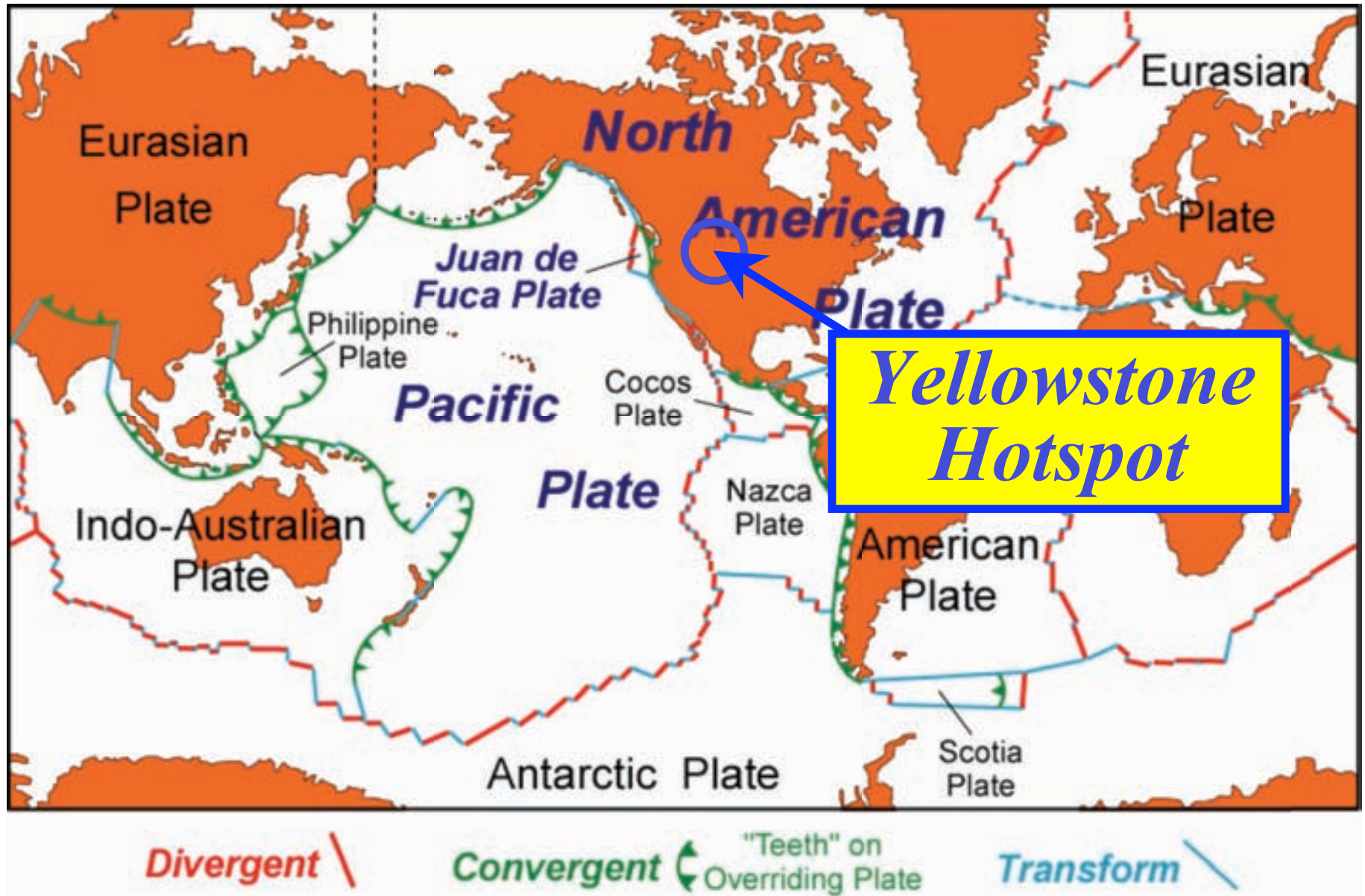
“..... Earth becoming fluid, as the sea itself”

Rachel Carson

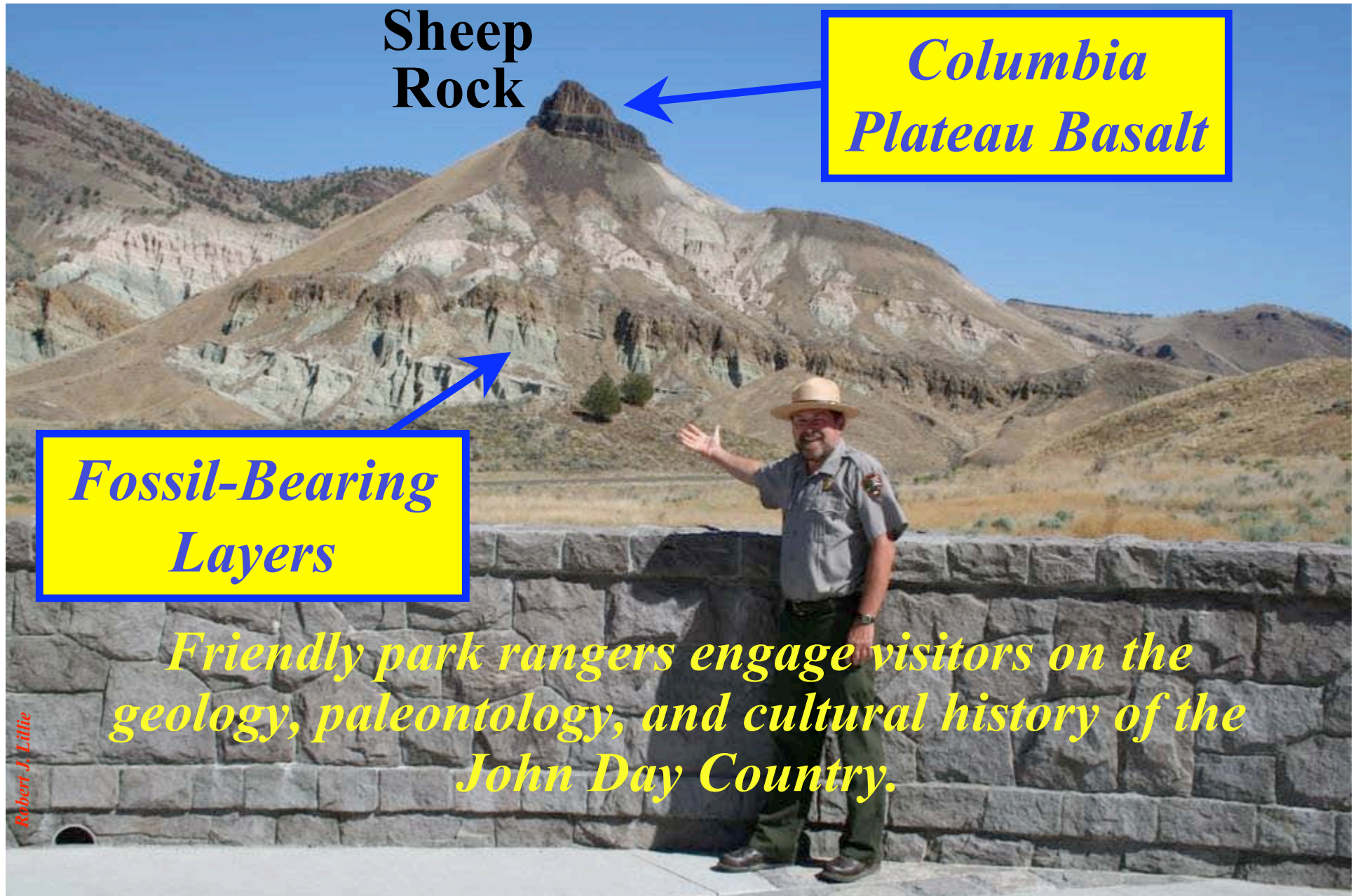
Robert J. Little

Looking South from Cape Fowlweather, Oregon

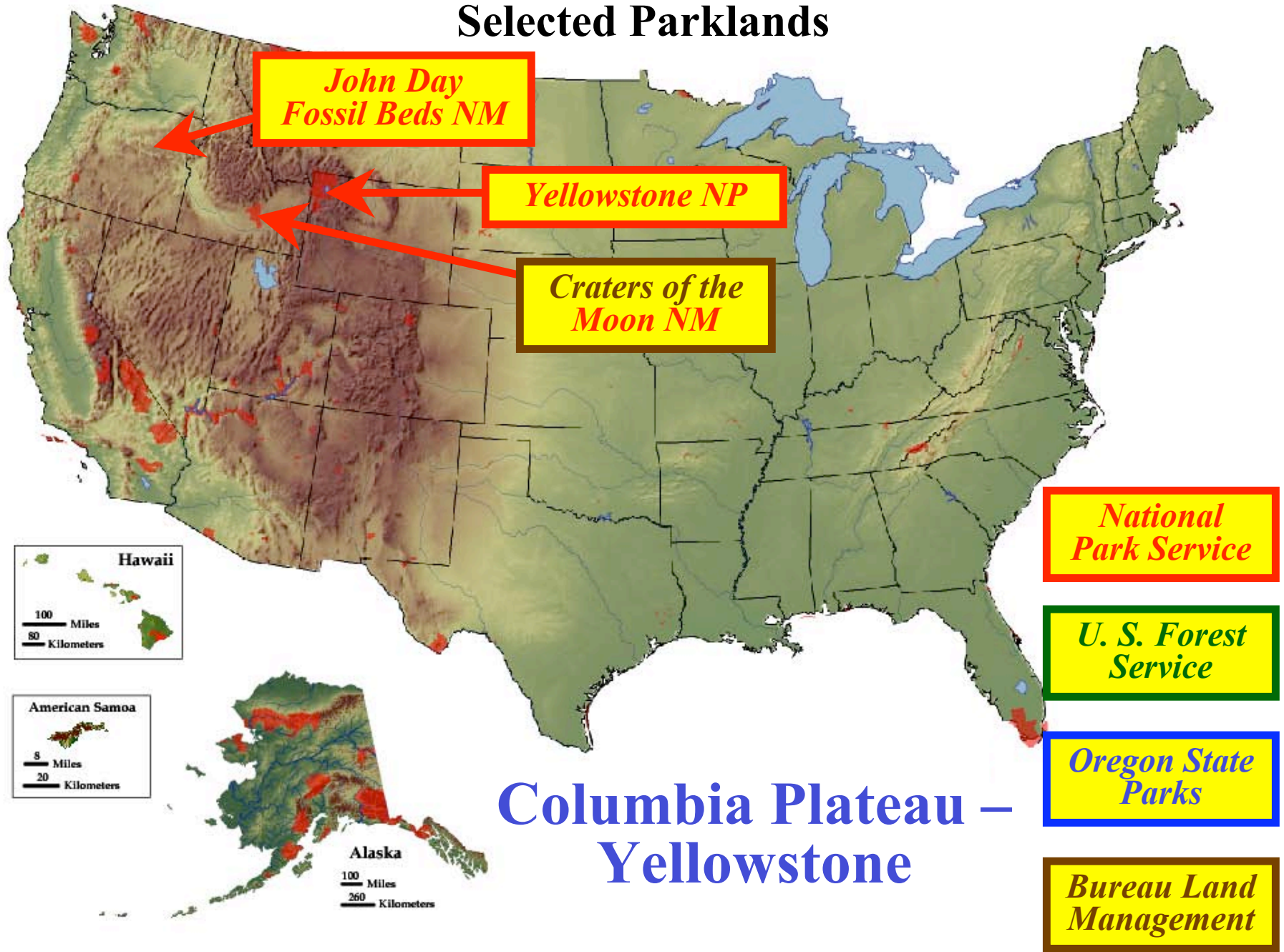
Plate Boundaries



John Day Fossil Beds National Monument, Oregon



Selected Parklands



*John Day
Fossil Beds NM*

Yellowstone NP

*Craters of the
Moon NM*

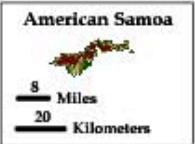
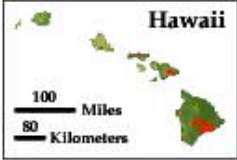
*National
Park Service*

*U. S. Forest
Service*

*Oregon State
Parks*

*Bureau Land
Management*

**Columbia Plateau –
Yellowstone**



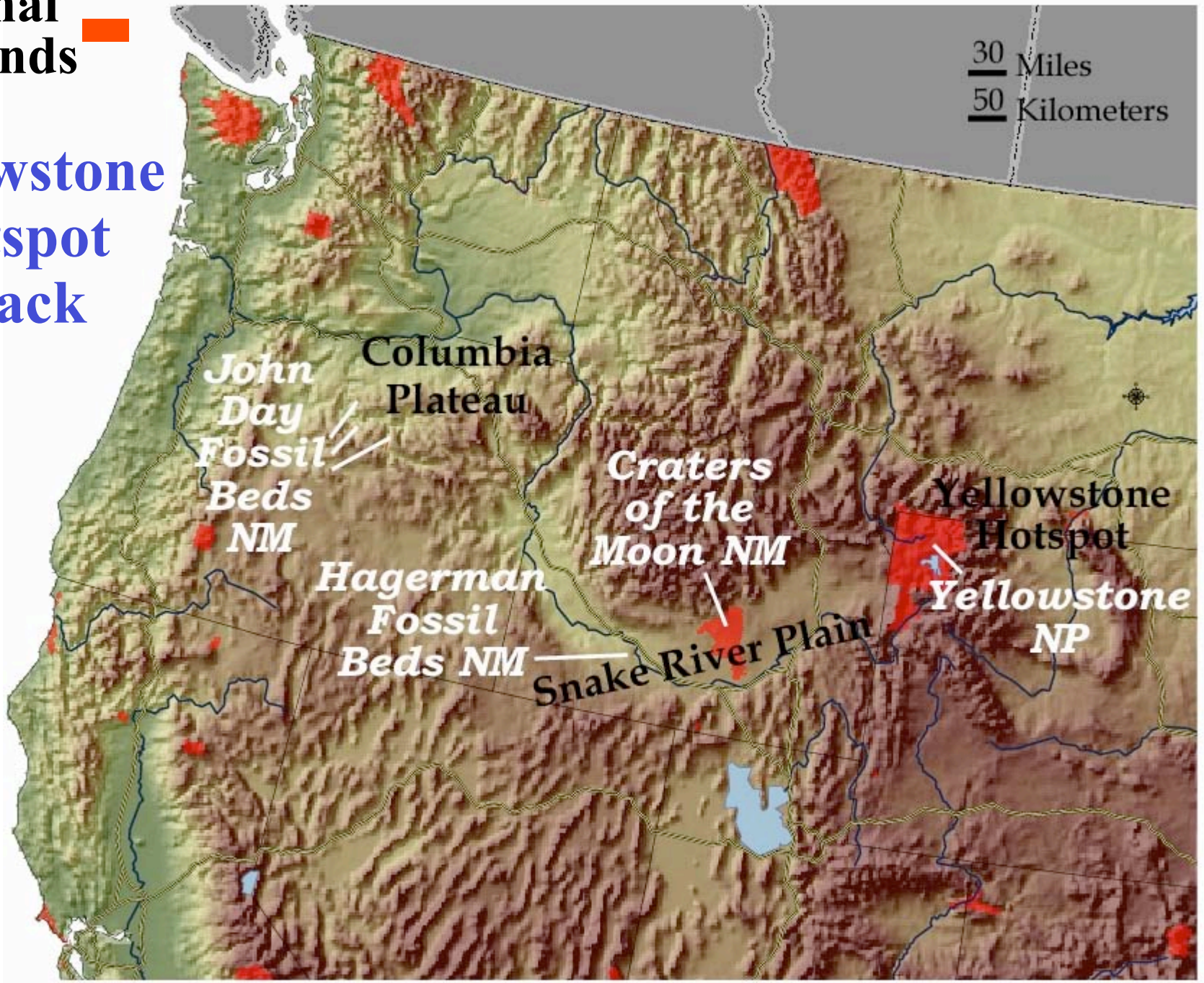


Robert J. Lillie

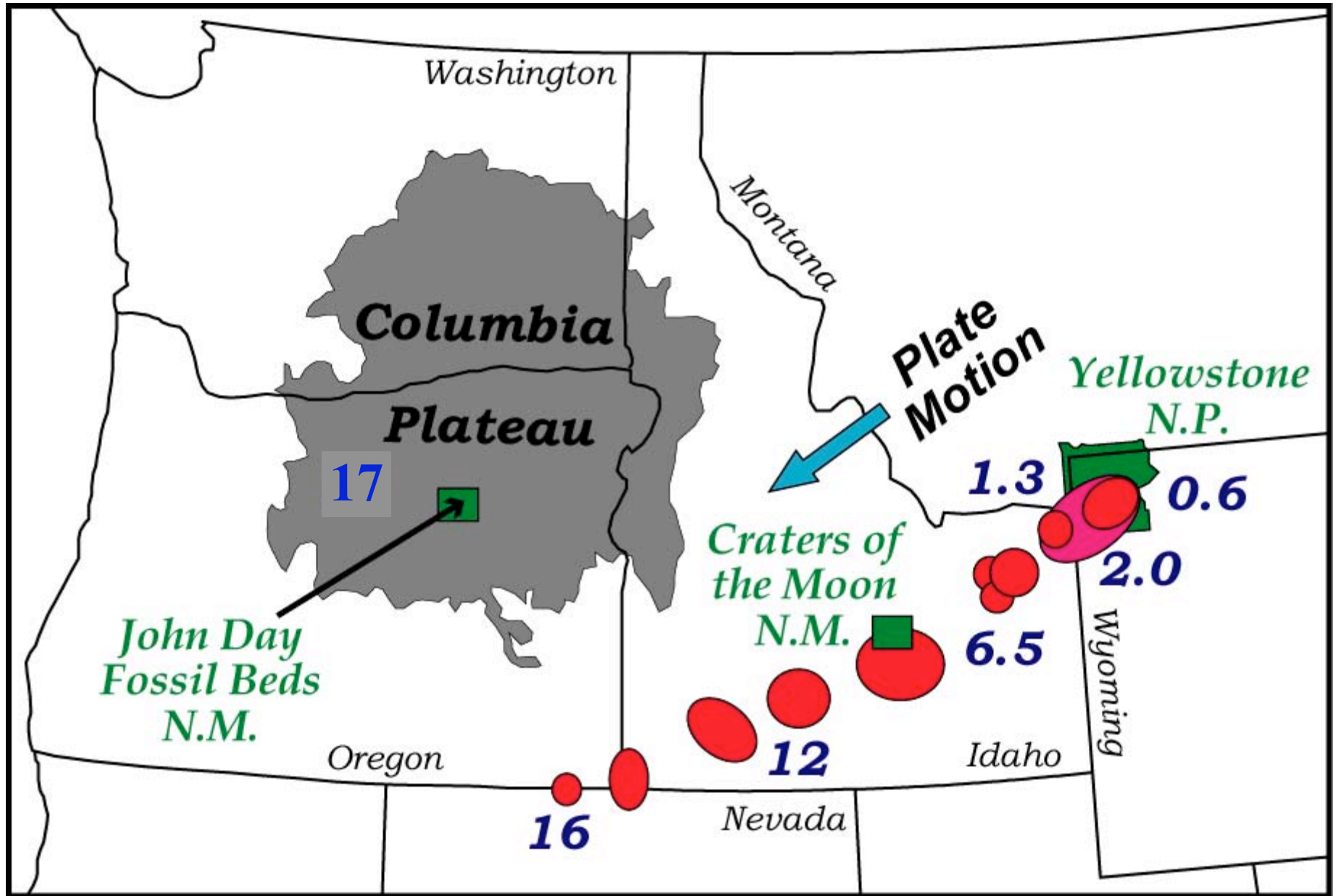
Plate moving over Hotspot

National Parklands

Yellowstone Hotspot Track



Yellowstone Hotspot Track



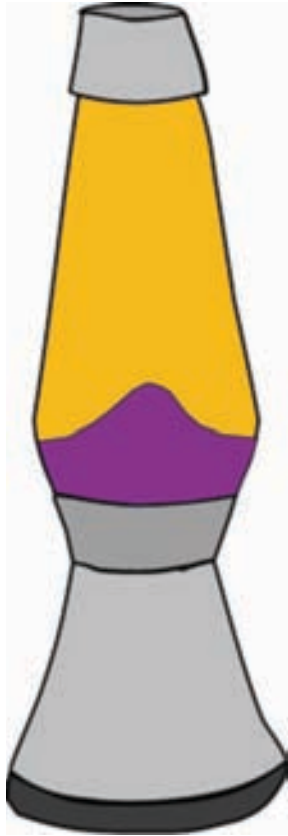
Blue #'s = Age of Initial Volcanism (Million Years Ago)

Lava Lamp

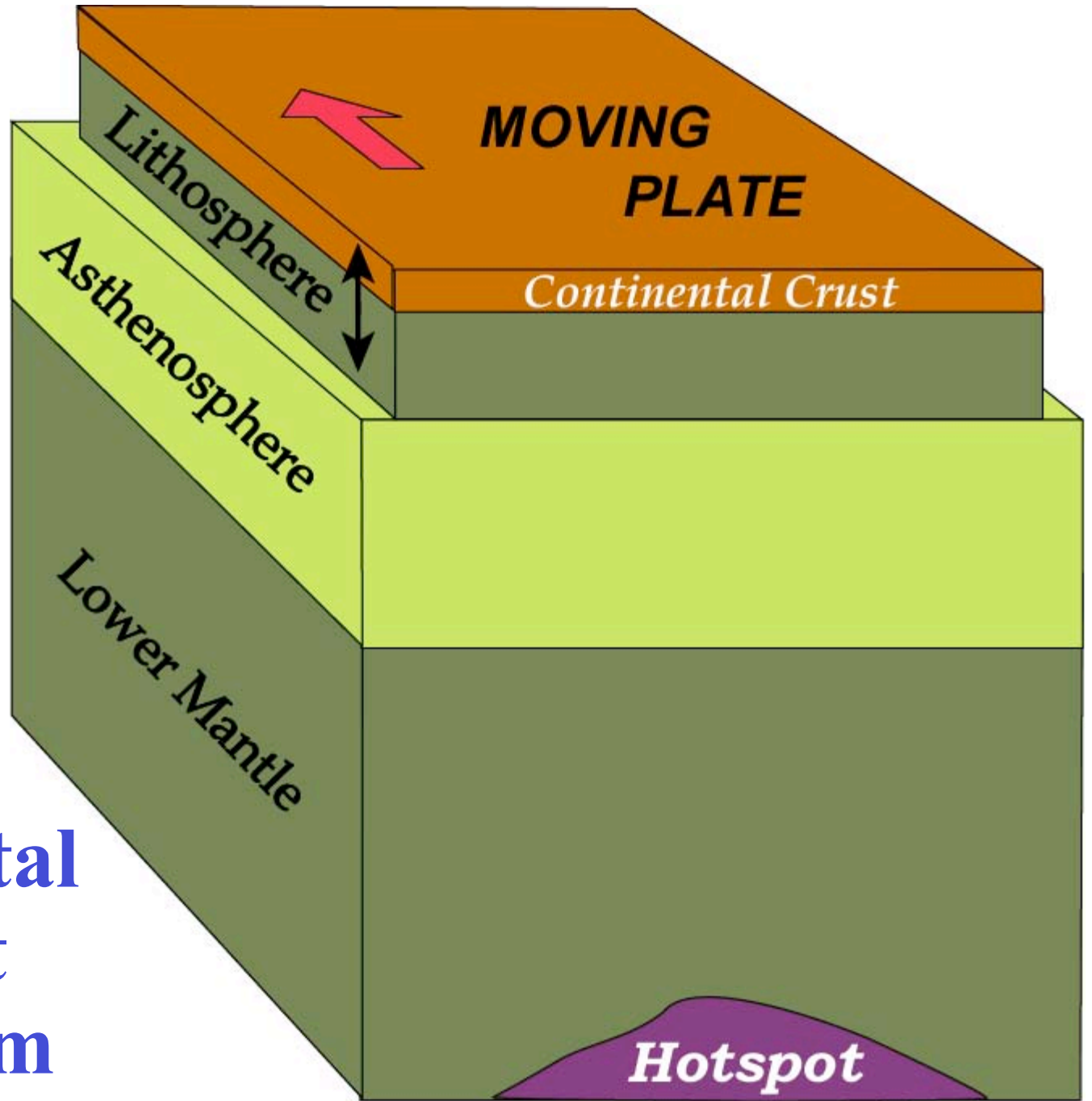


Continental Hotspot Volcanism

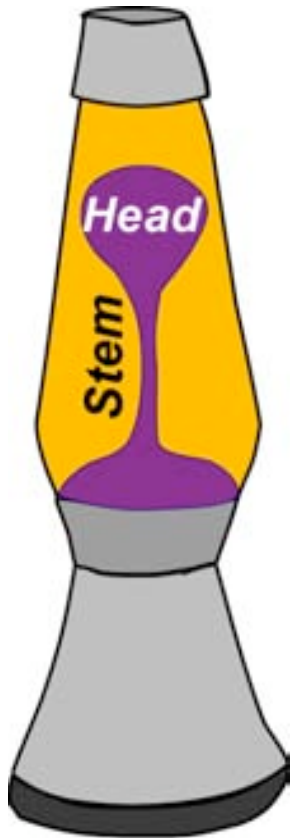
Lava Lamp



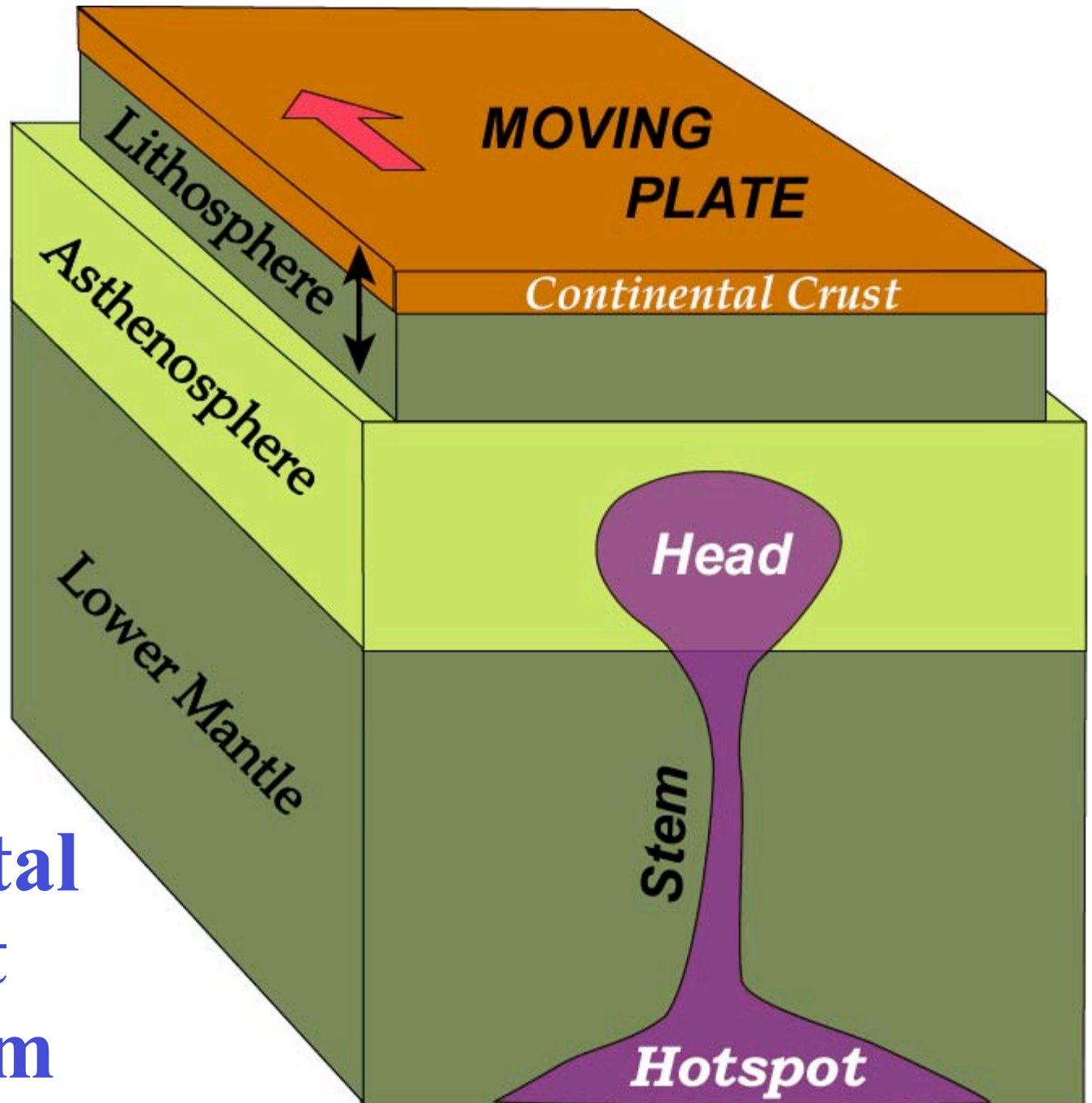
Continental Hotspot Volcanism



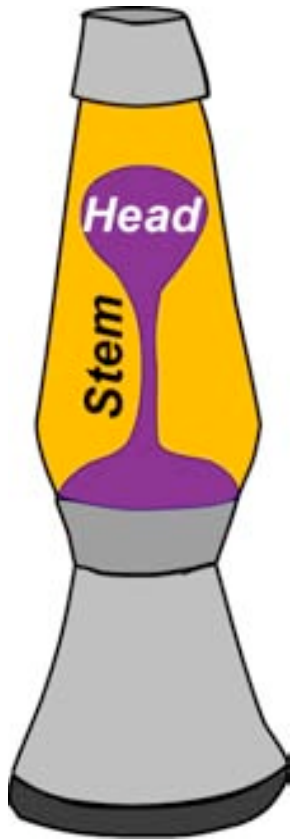
Lava Lamp



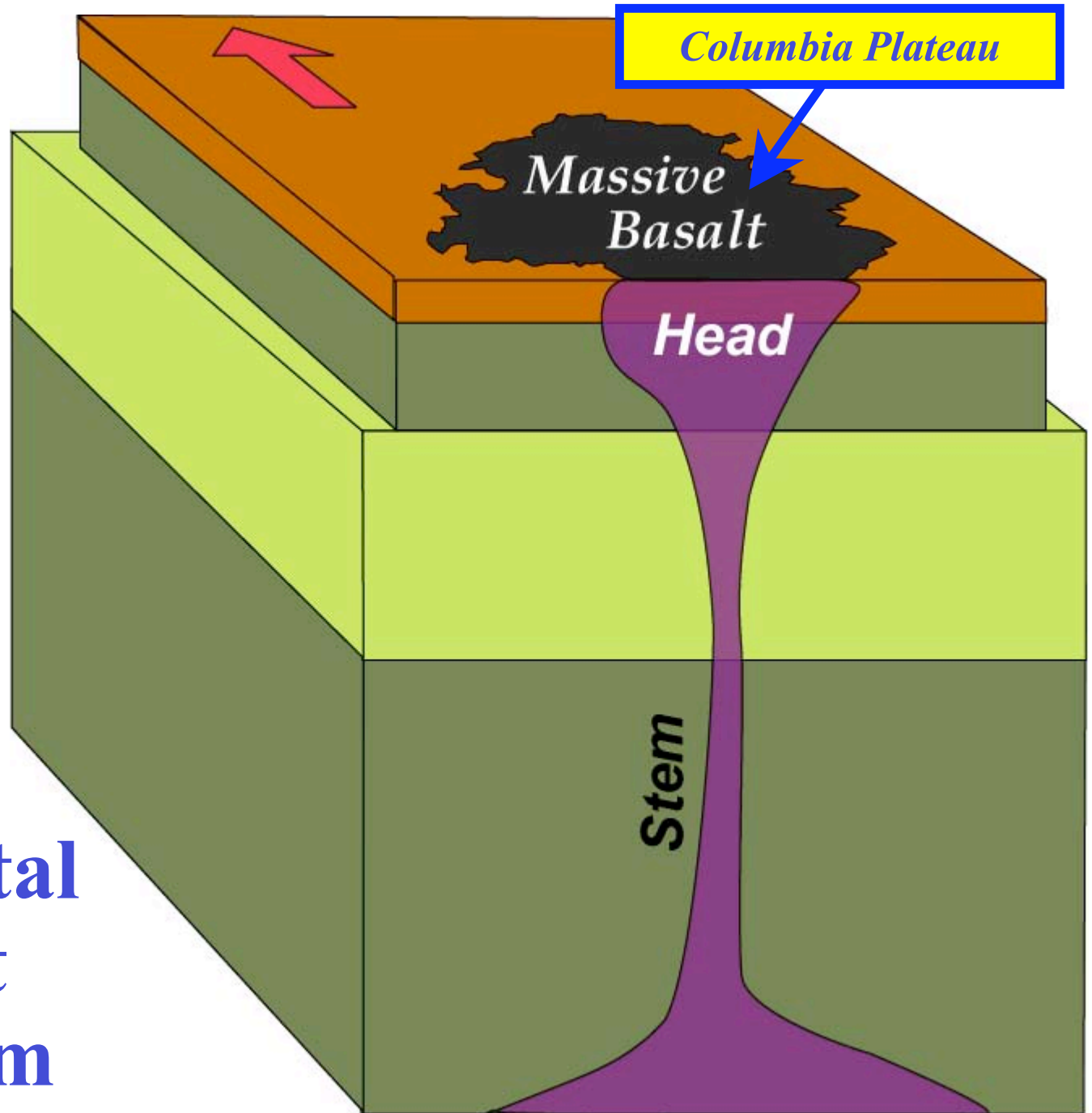
Continental Hotspot Volcanism



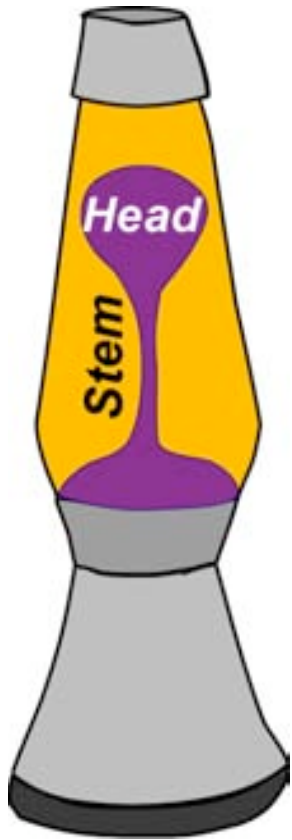
Lava Lamp



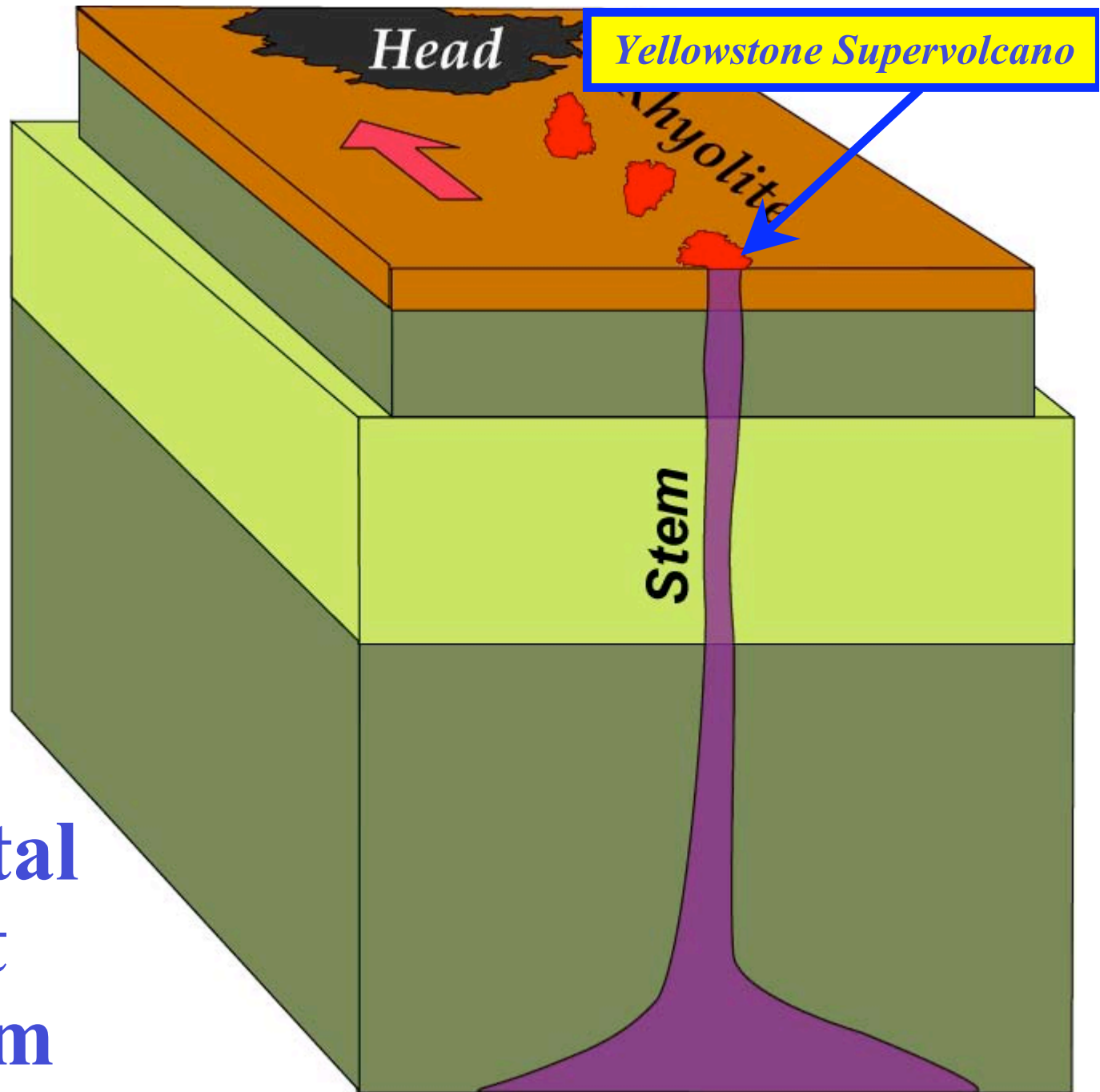
Continental Hotspot Volcanism



Lava Lamp



Continental Hotspot Volcanism



John Day Fossil Beds National Monument, Oregon



**Columbia
Plateau
Basalt**

Surfacing of Hotspot

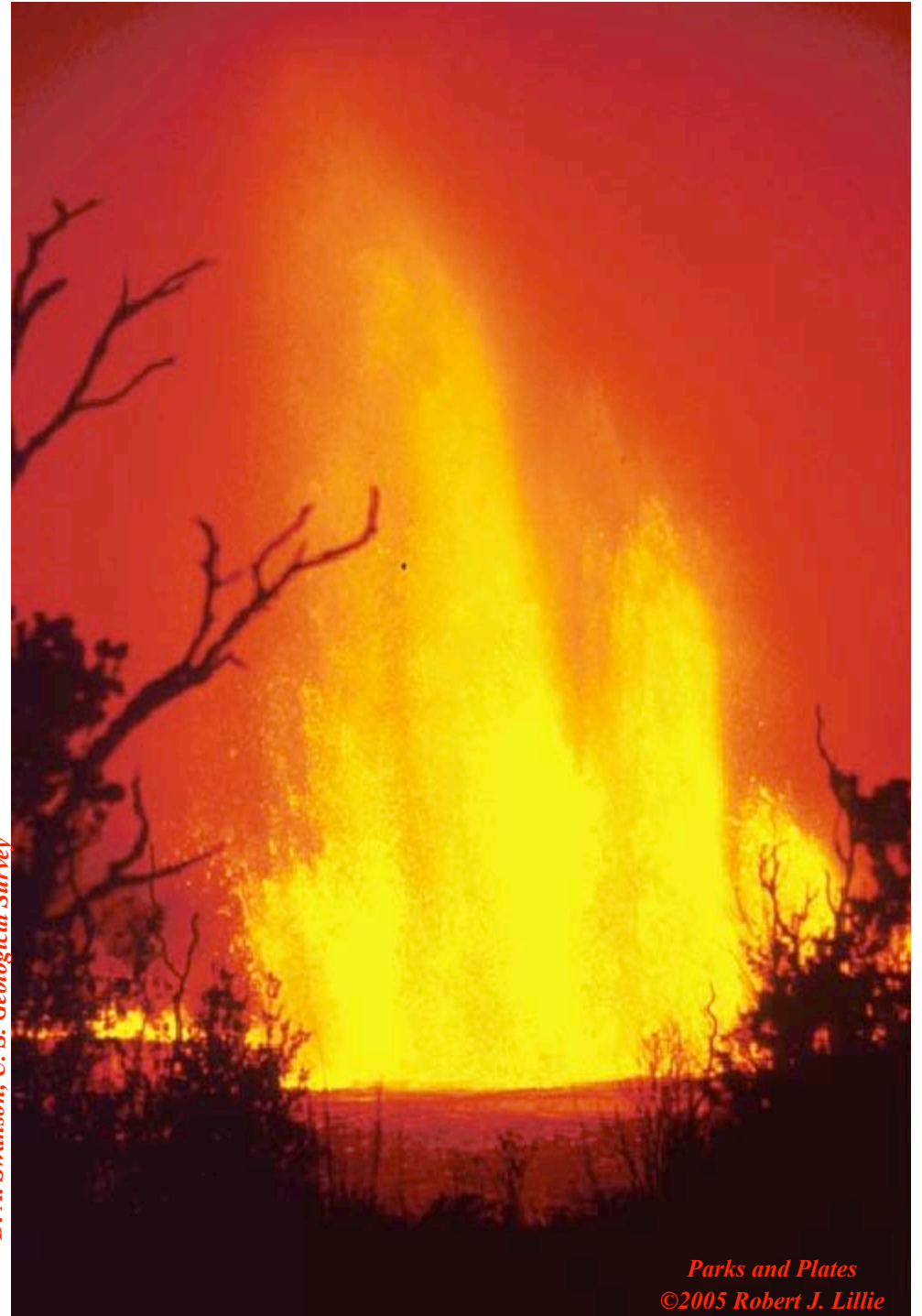
Picture Gorge

*Hawai`i Volcanoes
National Park*

**1969-74 Eruptions
of Mauna Ulu**

*The low-silica lava is
so fluid that it erupts
as a “curtain of fire”
through the East Rift
Zone.*

D. A. Swanson, U. S. Geological Survey



*Parks and Plates
©2005 Robert J. Lillie*

*Craters of the Moon National
Monument, Idaho*

**Passed Recently
Passed Over Hotspot**





Rhyolite Lava

On Top of Hotspot

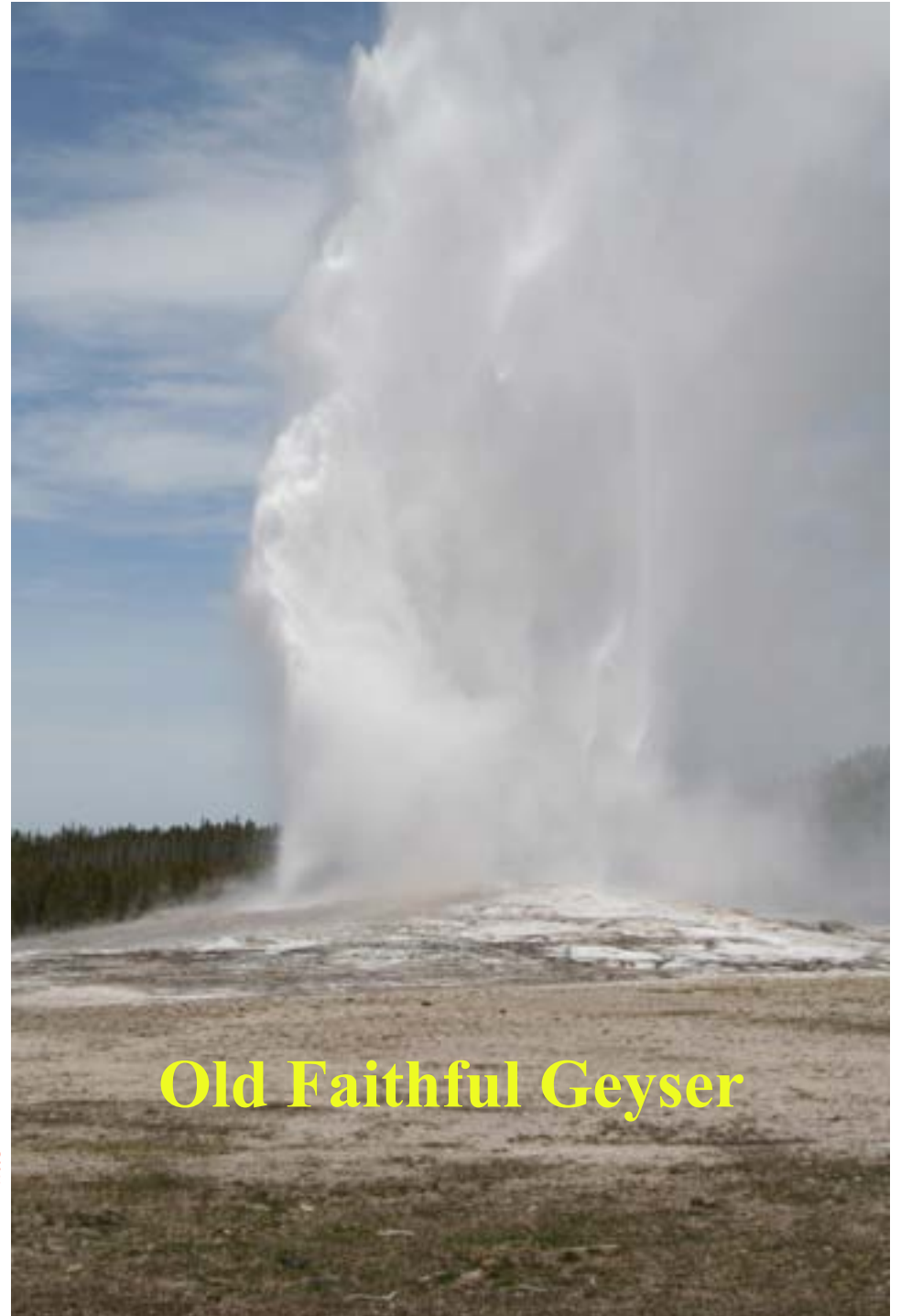


Yellowstone National Park, Wyoming

Robert J. Lillie

*Yellowstone National Park,
Wyoming*

On Top of Hotspot



Old Faithful Geyser

Robert J. Lillie



SUPERVOLCANO

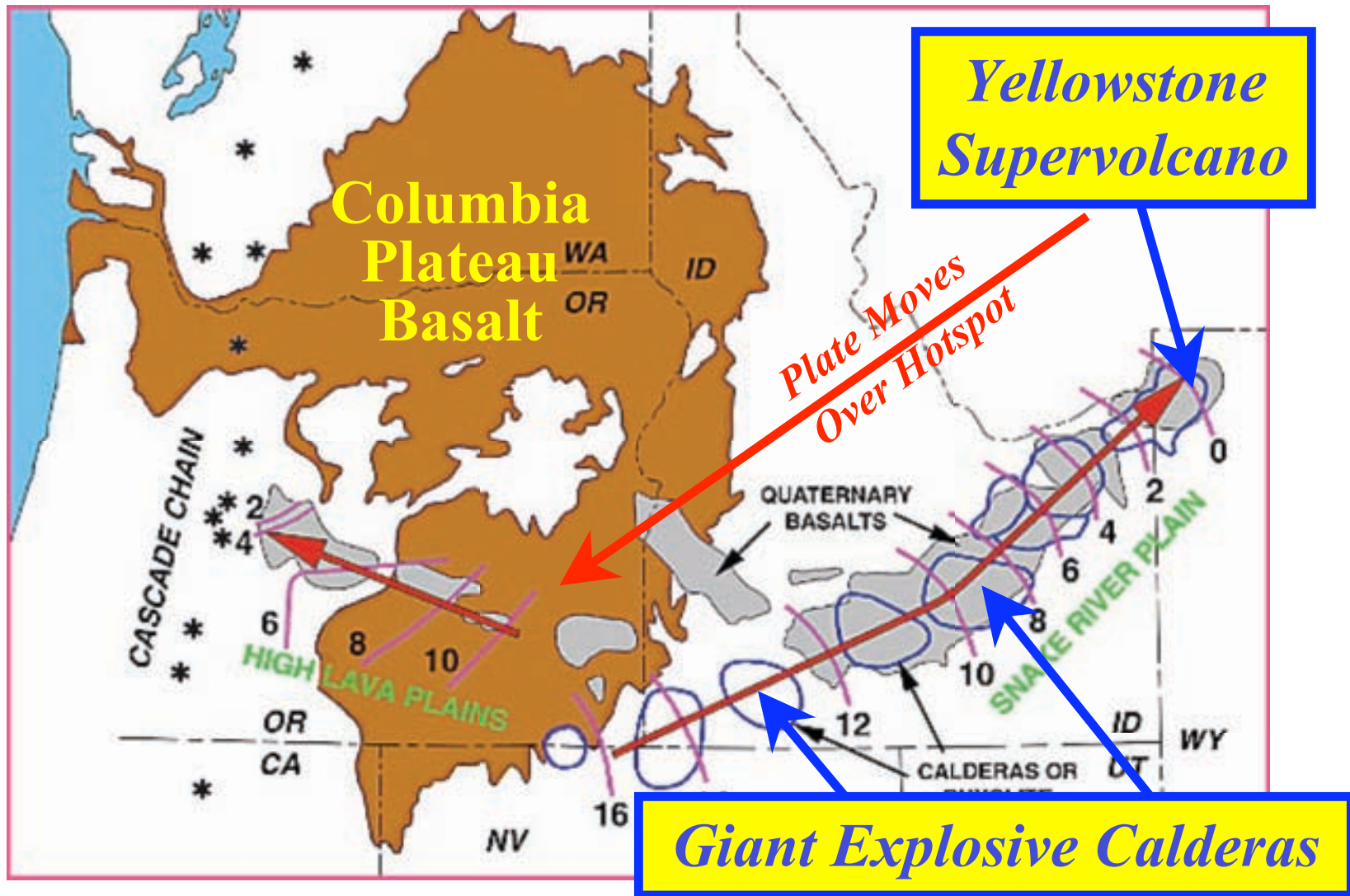
bbc.co.uk/supervolcano

This BBC production brought great global awareness of Yellowstone as an active volcano



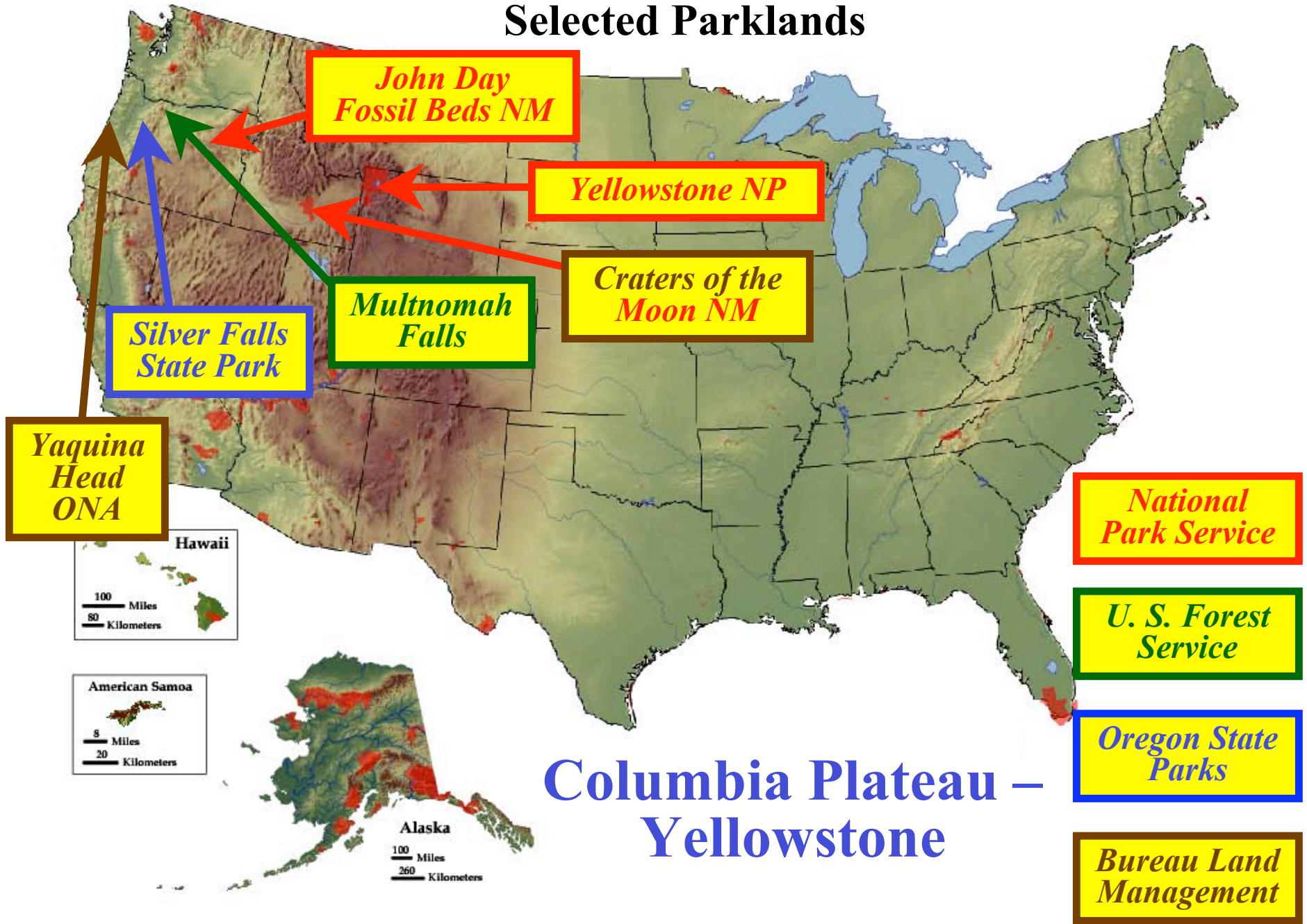
Flood Basalts and Hotspot Tracks

Numbers are age of initial lava eruptions (millions of years)



From Camp and Ross, JGR 2004

Selected Parklands





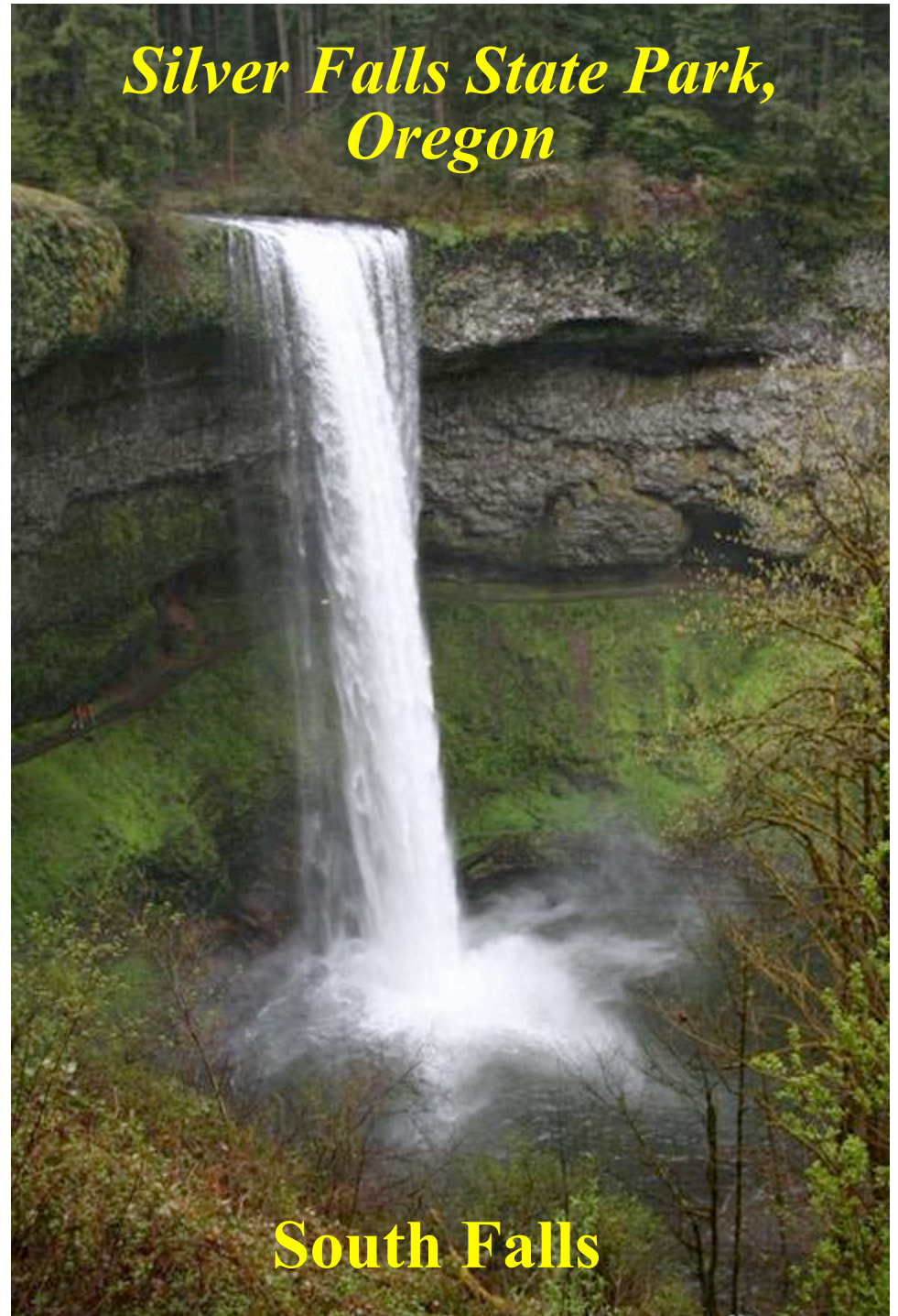
**Many of Oregon's
majestic waterfalls flow
over resistant
Columbia Plateau
Basalt**

***Columbia Gorge National
Scenic Area,
Oregon/Washington***

U. S. Forest Service



**Many of Oregon's
majestic waterfalls flow
over resistant
Columbia Plateau
Basalt**



***Silver Falls State Park,
Oregon***

South Falls

Robert J. Lillie

Yaquina Head Outstanding Natural Area, Oregon

**Many of Oregon's coastal headlands are also resistant
Columbia Plateau Basalt**





**Many of Oregon's coastal headlands are also resistant
Columbia Plateau Basalt**

Robert J. Lillie

Looking South from Cape Fowlweather, Oregon

A photograph of a coastal landscape. In the background, a modern house with a flat roof sits atop a grassy hill. Below the house, a steep cliffside shows exposed, light-colored soil or rock. The middle ground features a rocky beach with dark, jagged rocks and a sandy area. The ocean is visible in the foreground, with waves breaking on the shore. The sky is overcast.

Other coastal headlands are much older basalt formed in the ocean realm.

Basalt Lava Flows

- Manufactured in Ocean Realm**
- About 35 million years ago**

Cape Perpetua Scenic Area, Oregon

Basalt from Columbia Plateau (15-9 Million Years Ago)

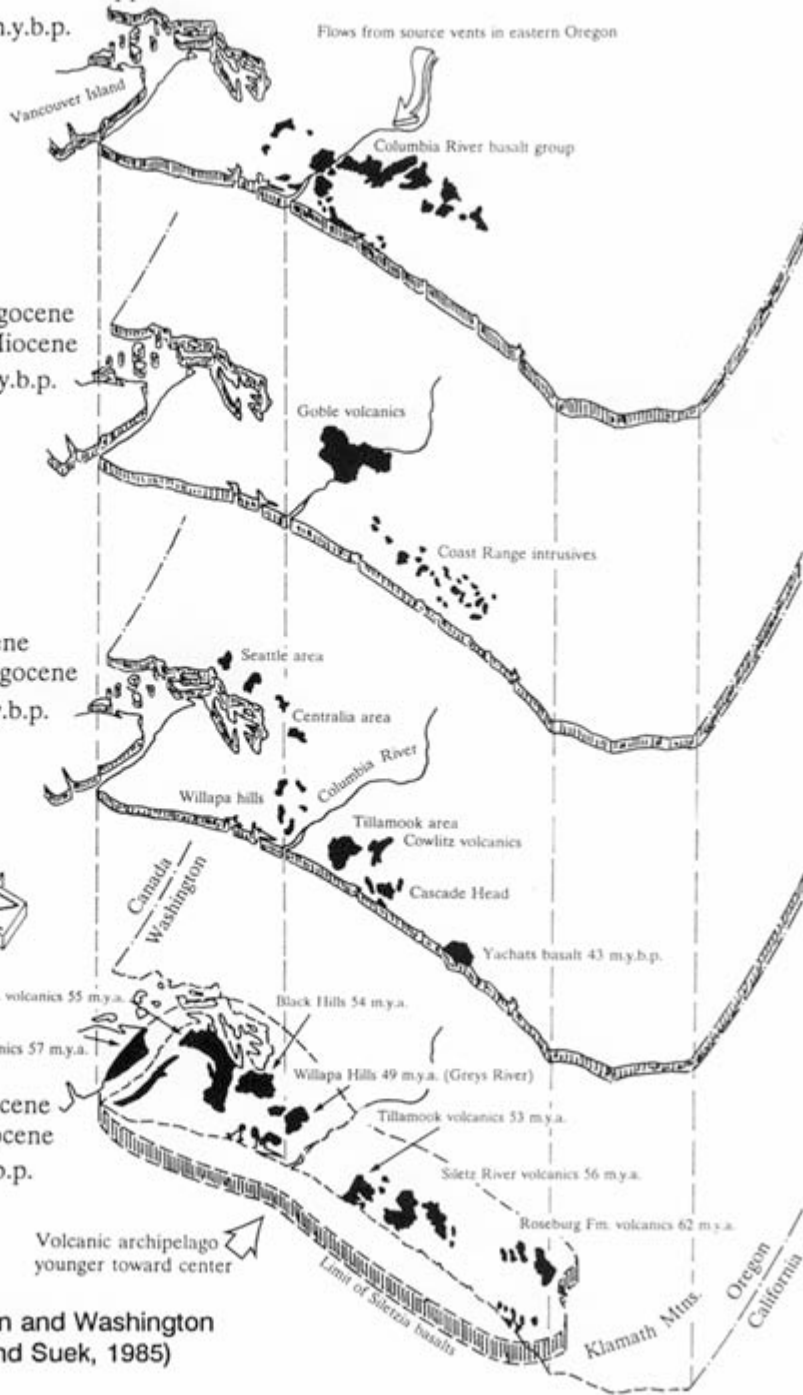
Basalt from Ocean Realm (63-29 Million Years Ago)

Middle Miocene To upper Miocene
15-9 m.y.b.p.

Upper Oligocene to lower Miocene
38-29 m.y.b.p.

Upper Eocene to lower Oligocene
43-38 m.y.b.p.

Upper Paleocene to middle Eocene
63-46 m.y.b.p.



Age of Basalt along Oregon and Washington Coasts

Volcanic rocks of the Oregon and Washington Coast Range (Armentrout and Suek, 1985)

Orr, Orr, and Baldwin, "Geology of Oregon," 4th Edition, 1992