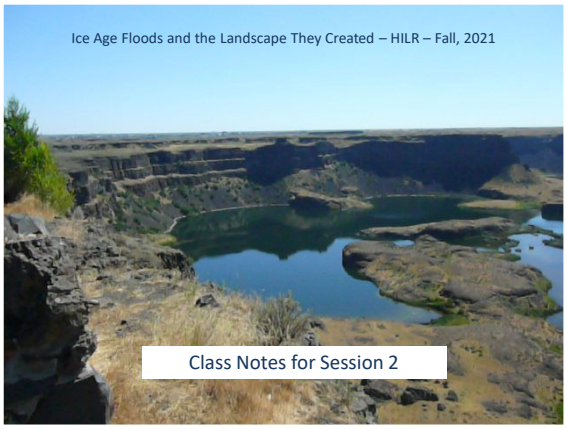


Topics for Today

- The Geology of the Pacific Northwest Before the Floods
  - Plate Tectonics 001
  - Basaltic volcanoes 001
  - Chunks of continents welded together
  - The Yellowstone hot-spot volcanoes
  - The Columbia Plateau flood basalts
  - The courses of the Snake and Columbia Rivers
- Glacial Lake Bonneville and its Flood
  - The Great Salt Lake Basin
  - Water levels in Glacial Lake Bonneville
  - Red Rock Pass and the Snake River Plain
  - Hell's Canyon
  - Gravel deposits

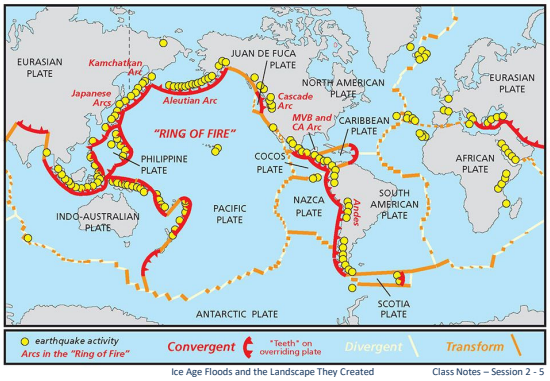
Plate Tectonics 001

- The earth's crust is formed from semi-rigid thin plates that move on a platform of viscous, deformable rock, the mantle.
- New earth's crust is created at mid-ocean ridges
- The earth stays the same size
- Therefore, crust must be destroyed somewhere:
  - Subduction zones
  - One plate dives beneath another
- Volcanoes happen in multiple ways as a result of these processes

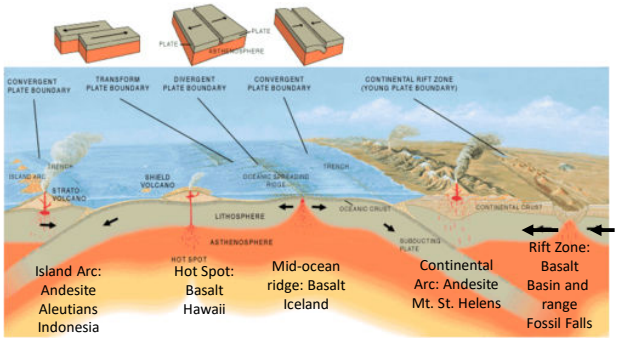
Basaltic Volcanoes 001

- Heat from the earth's core creates slow convection currents in the mantle, the layer beneath the crust.
- Near the surface, the combination of reduced pressure and rising heat can create a melt: MAGMA
- When magma bursts through onto the surface, it is called LAVA
- The most common form of lava is BASALT, a dense black rock, rich in minerals
- Basaltic lava is hot and highly fluid – Hawaii
- When mantle magma mixes with continental rock, the magma incorporates more silica, and gets stickier. Pressure builds up before an eruption.
  - Moderate silica – andesite – explosive – Mt. St. Helens
  - Even more silica – rhyolite – super-explosive -- Yellowstone

Major Plate Boundaries



Major Volcanic Origins



Island Arc: Andesite Aleutians Indonesia

Hot Spot: Basalt Hawaii

Mid-ocean ridge: Basalt Iceland

Continental Arc: Andesite Mt. St. Helens

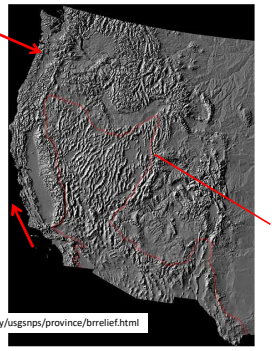
Rift Zone: Basalt Basin and range Fossil Falls

Major Geologic Features

Juan de Fuca Plate: Subduction

The Cascade Range volcanoes are the result of this subduction

San Andreas Fault Motion



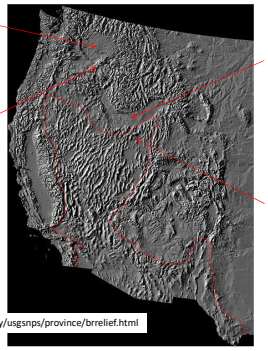
Basin and Range outlined in red: Normal faulting of the North American plate produced by the subduction of the Farallon plate, now long gone

http://www.nature.nps.gov/geology/usgsnps/province/brrelief.html

But What About These Features?

Columbia River Plateau: flood basalts from vents in northwestern Oregon and southwestern Washington

Hells Canyon: an eroded pathway for water to reach the sea



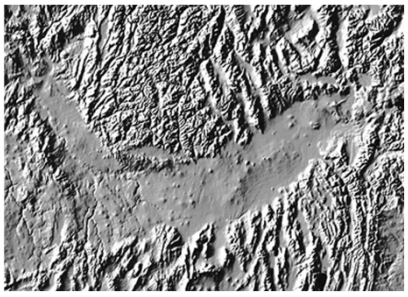
Snake River Valley: from the motion of the North American plate over the Yellowstone hot spot

Salt Lake Basin: part of basin and range

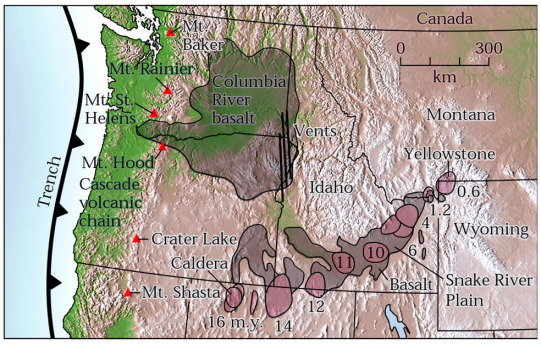
http://www.nature.nps.gov/geology/usgsnps/province/brrelief.html

The Snake River Plain

- Created by the Yellowstone Volcano as the North American plate moved over the hot spot



Pacific Northwest Volcanic History



Columbia Plateau Flood Basalts

- These flood basalts erupted 15-17 Mya
- They cover all of southeastern Washington, much of eastern Oregon, the entire Columbia River drainage to the sea, and even into the Willamette Valley toward Salem
- The basalts are up to 3 km thick in places
- That's a lotta basalt!

Some characteristics

- Slow cooling of flow basalts leads to columnar basaltic formations
  - Shrinkage during cooling produces fracture blocks
  - Within fracture blocks, the basalt forms columns
  - Cooling from the top and the bottom are incommensurate, so there is a rubble zone in the middle.

The edge of the flood basalt

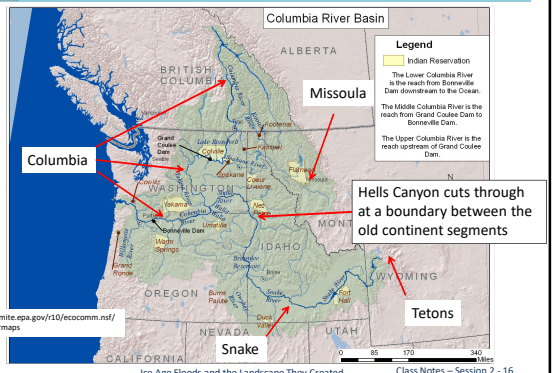
- Exiting the Northern Cascades and seeing the first evidence of the flood basalt (having just crossed the Columbia River)

Flood Basalts

- Basalts in the Columbia River Gorge:

A Closer Look at the Basalts

The River Courses



The Columbia River in Washington

Why does the Columbia River cut across the middle of the flood basalt field?

Hint:
https://www.nwcouncil.org/reports/columbia-river-history/columbiariver

http://vulcan.wr.usgs.gov/Volcanoes/ColumbiaPlateau/Maps/map_columbia_river_flood_basalts.html

Topics for Today

- The Geology of the Pacific Northwest Before the Floods
  - Plate Tectonics 001
  - Chunks of continents welded together
  - The Yellowstone hot-spot volcanoes
  - The Columbia Plateau flood basalts
  - The courses of the Snake and Columbia Rivers
- Glacial Lake Bonneville and its Flood
  - The Great Salt Lake Basin
  - Water levels in Glacial Lake Bonneville
  - Red Rock Pass and the Snake River Plain
  - Hell's Canyon
  - Gravel deposits
  - The Columbia River Gorge

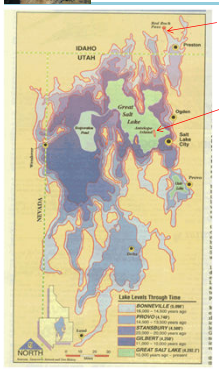
The Great Salt Lake Basin

- We begin with a satellite view of the state of Utah:

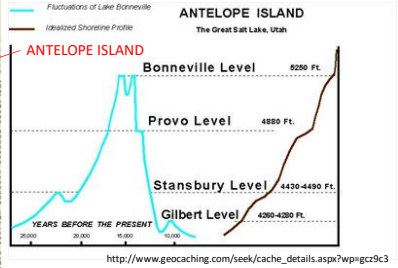
http://geology.com/satellite/utah-satellite-image.shtml

http://iceagefloods.blogspot.com/2010_11_01_archive.html

Lake Levels



RED ROCK PASS



http://www.geocaching.com/seek/cache_details.aspx?wp=gcz9c3

http://fopnews.wordpress.com/2010/01/

Evidence of Ancient Lakes

http://www.geo.cornell.edu/geology/classes/Geo101/101images.html

Antelope Island

Wave-cut platforms from Lake Bonneville preserved on Antelope Island, Great Salt Lake, Utah. (Mark A. Wilson Image), http://hugefloods.com/Bonneville.html

Antelope Island Video

Now Try to Imagine the Bonneville Flood

- Water levels up hundreds of feet
- Boulders, cobbles, gravel, sand and silt being carried along, tumbling and eroding both themselves and the canyon walls

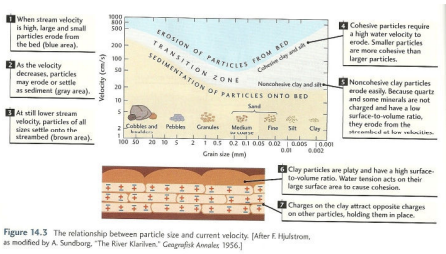
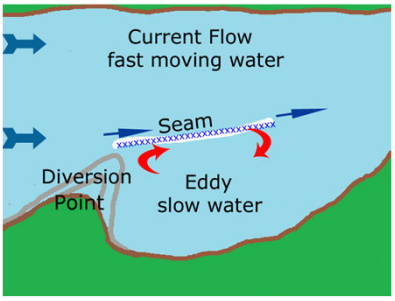


Figure 14.3 The relationship between particle size and current velocity. [After F. Hjulstrom, as modified by A. Sundborg, "The River Klarälven." *Geografiska Annaler,* 1956.]

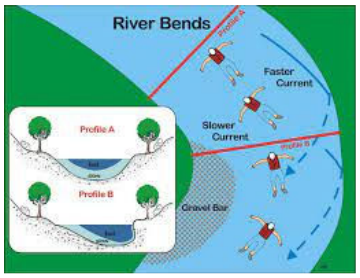
Eddies Lead to Gravel Deposits

- Whenever the flow slowed due to curves or junctions, eddies can form, and the stream drops a load of
  - Boulders
  - Cobbles
  - Gravel
  - Sand
  - Silt



Bends Lead to Point Bars

- The slower flow is where gravel deposits. At the opposite bank, there can be erosion



What Happened at Red Rock Pass?

- OVERFLOW followed by MASSIVE EROSION
- The water scoured the topsoil off the basalt in the Snake River Canyon and dumped residue all along Hell's Canyon and beyond.
- We look at the Lake Bonneville Website and Video
  - http://hugefloods.com/Bonneville.html

Hell's Canyon

- Hell's Canyon is the deepest canyon in the US.
- At present, it extends from the Hell's Canyon Dam to just south of Lewiston, Idaho.
- It carried all of the water from the Bonneville Flood

http://www.gonorthwest.com/Idaho/Hells_Canyon/areamap.htm

Hat Point from the Snake River

Snake River from Hat Point

Let's Take a Jet Boat Ride (Upstream)

Gravel Bar at the Hell's Canyon Exit

At Tammany Bar south of Lewiston, Idaho - Bonneville Flood gravels (B) are capped with Lake Missoula Floods rhythmites (M) 2-20 feet thick. The Missoula sand and silt deposits were backflooded to this location when Ice Age floodwaters temporarily reversed the Snake River's course.

The Columbia River Gorge

- The floodwaters coursed down the Snake River to where it joins the Columbia River near Pasco, Washington
- It then poured through the Wallula Gap and down the Columbia River Gorge to the ocean
- We will look more at this waterway when we examine the flood from Glacial Lake Missoula