

ED51B-0751 Teaching Seismic Methods Using Interactive 3-D Earth Globe

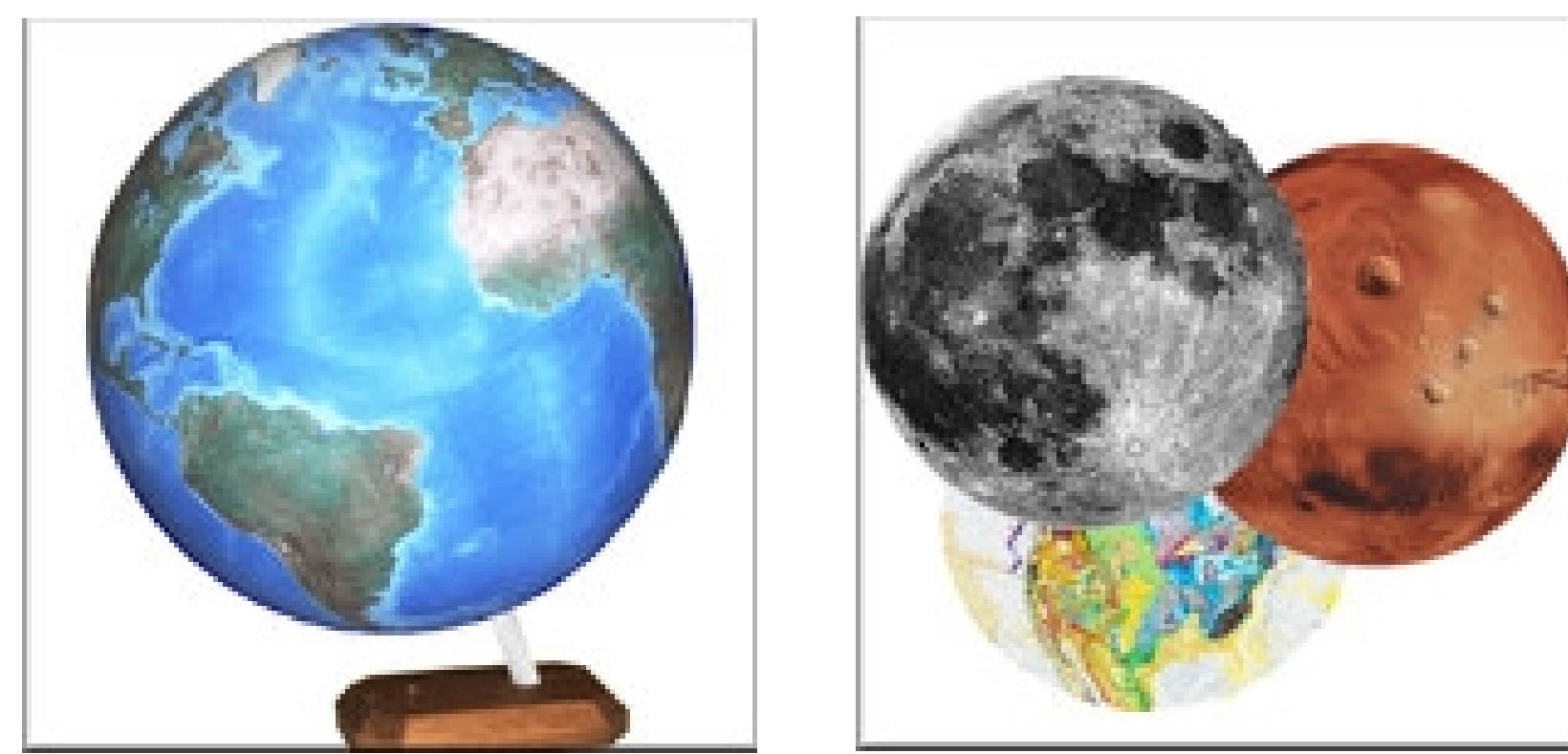
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Abstract

Instructional techniques for study of seismology are greatly enhanced by three dimensional (3D) visualization. Seismic rays that pass through the Earth's interior are typically viewed in 2D slices of the Earth's interior. Here we present the use of a 3D Earth globe manufactured by Real World Globes. This globe displays a dry-erase high resolution glossy topography and bathymetry from the Smith and Sandwell data archives at its surface for interactive measurements and hands-on marking of many seismic observations such as earthquake locations, source-receiver distances, surface wave propagation, great circle paths, ocean circulation patterns, airplane trajectories, etc.. A new interactive feature (designed collaboratively with geoscientists) allows cut away and disassembly of sections of the exterior shell revealing a full cross section depicting the Earth's interior layers displayed to scale with a dry-erase work board. The interior panel spins to any azimuth and provides a depth measurement scale to allow exact measurements and marking of earthquake depths, true seismic ray path propagation, ray path bottoming depths, shadow zones, and diffraction patterns. A demo of this globe and example activities will be presented.

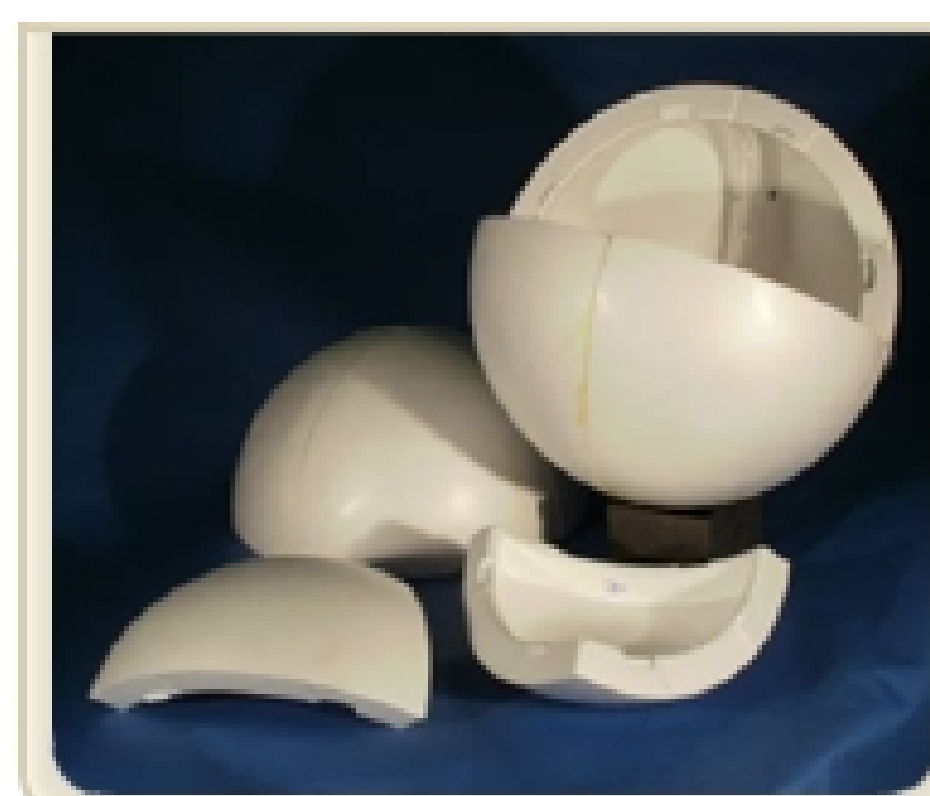
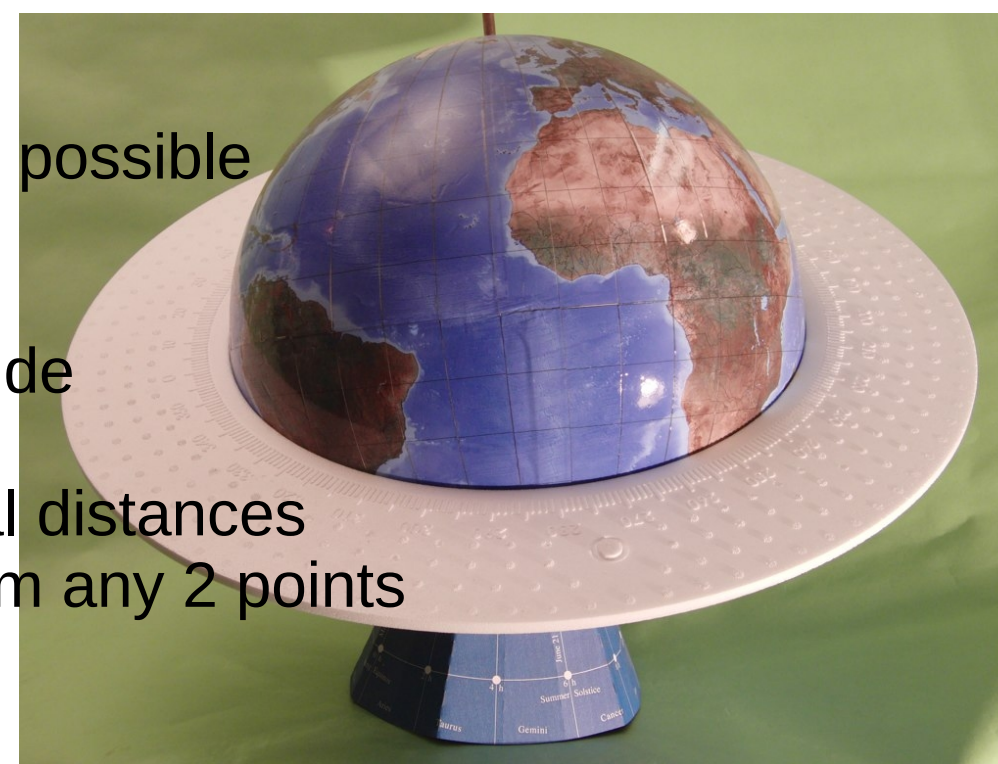
www.realworldglobes.com



We design and use a three dimensional globe from c Real World Globes for Earth Science activities. This globe must be assembled from 8 arc segments which hold together by magnets. Activities using surface locations of any geological feature or earthquake can be mapped on a 3D surface. An interior work board can be used for lessons of the Earth's interior layers.

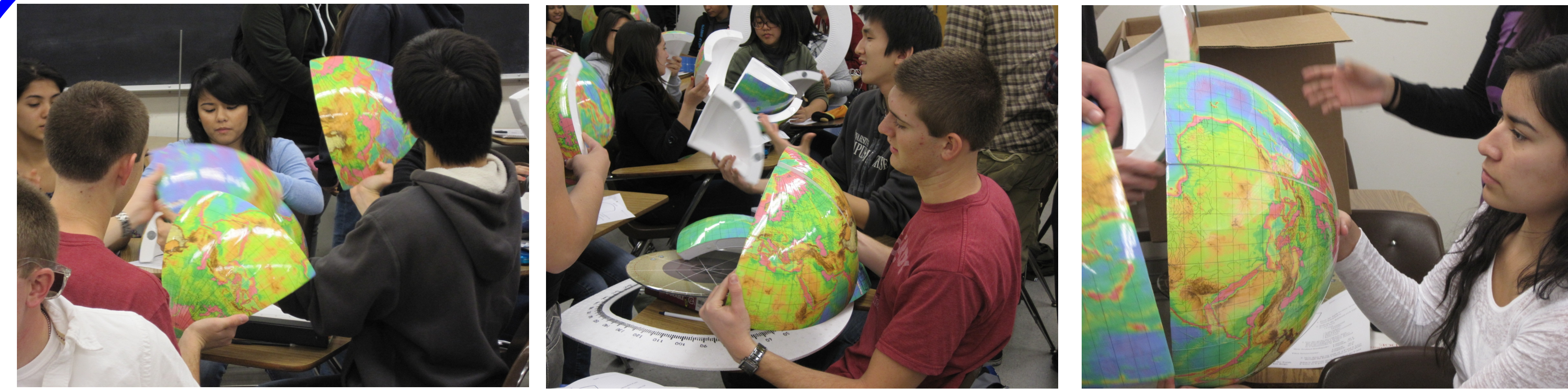
Globe and Materials

- Thick hardened styrofoam shell (Remains stable during repeated student activities)
- Arc pieces hold together by magnets along edges
- Dry Erase map surface
 - Earth's surface, ocean water and land cover
 - Elevation and bathymetry map
 - Other planets, moons
 - Any digital global data sets are possible
- Dry Erase interior work board
 - Interior Earth Layers
 - Blank white board on reverse side
- Equatorial ring
 - Measures longitudes, equatorial distances
 - Measures great circle paths from any 2 points
 - Width similar to Saturn rings
- Azimuth orientation compass
- Wooden stand with 1/4 " threaded axis rod
- Cardboard bowl base



Earth Science Activities

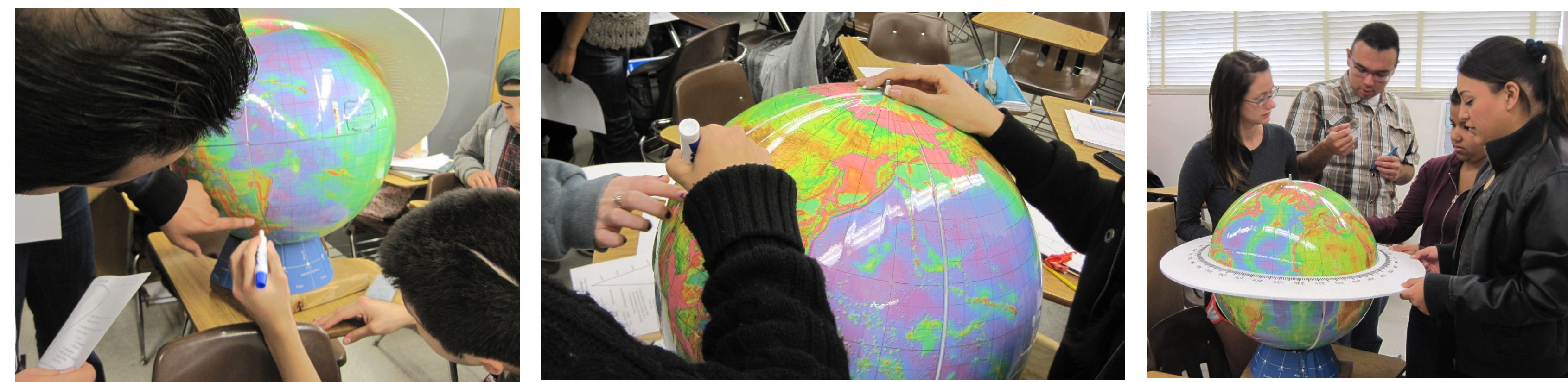
Assemble Globe



- The first lesson is basic assembly of the Earth's surface continents and ocean basins. This is a fun way for students to test basic geography and global setting. The pieces join by magnets embedded at the edges for quick assembly.
- Students are quickly engrossed in the Earth and its surface and adopt a sense of pride after assembly of the complete globe.

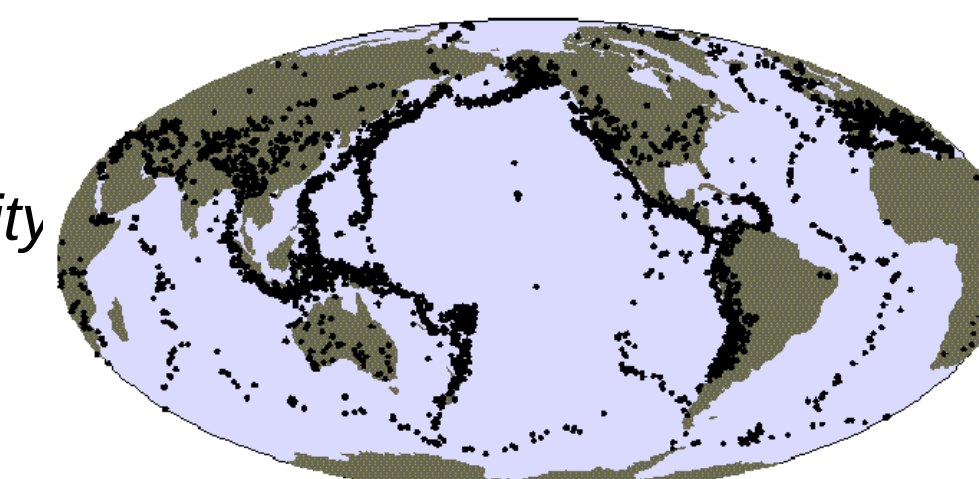


Draw and Write, Dry Erase on the Earth's Surface



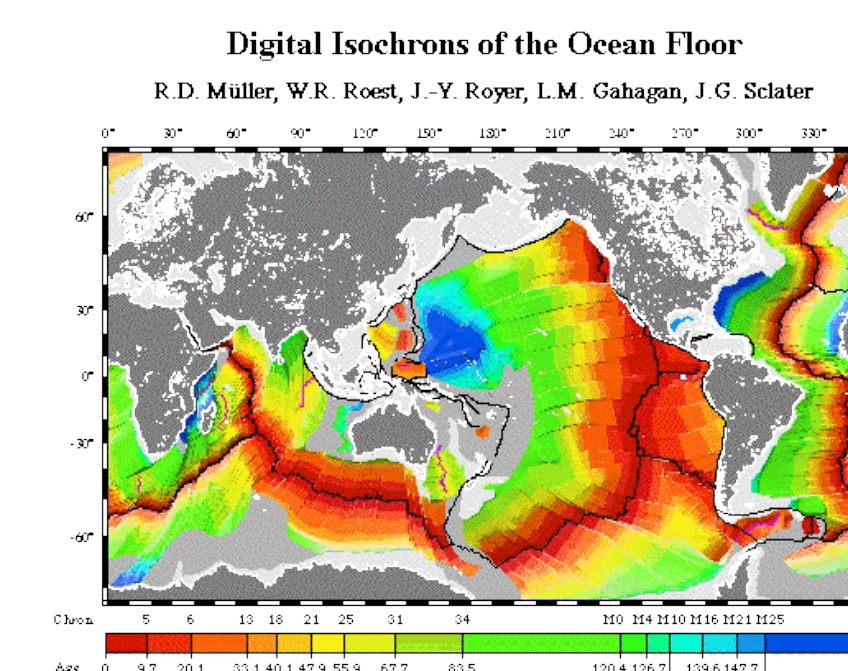
Seismology

- Find and mark **earthquake locations** using Latitudes and Longitude
- Plot all the earthquakes that occurred during your birthday, (*group activity*)
- "Connect the dots" of earthquakes and draw **plate boundaries**
- Find and mark seismometer locations
- Draw **great circle paths** between and 2 points
- Determine **distance** between 2 points in arc distance (km) and/or degrees-



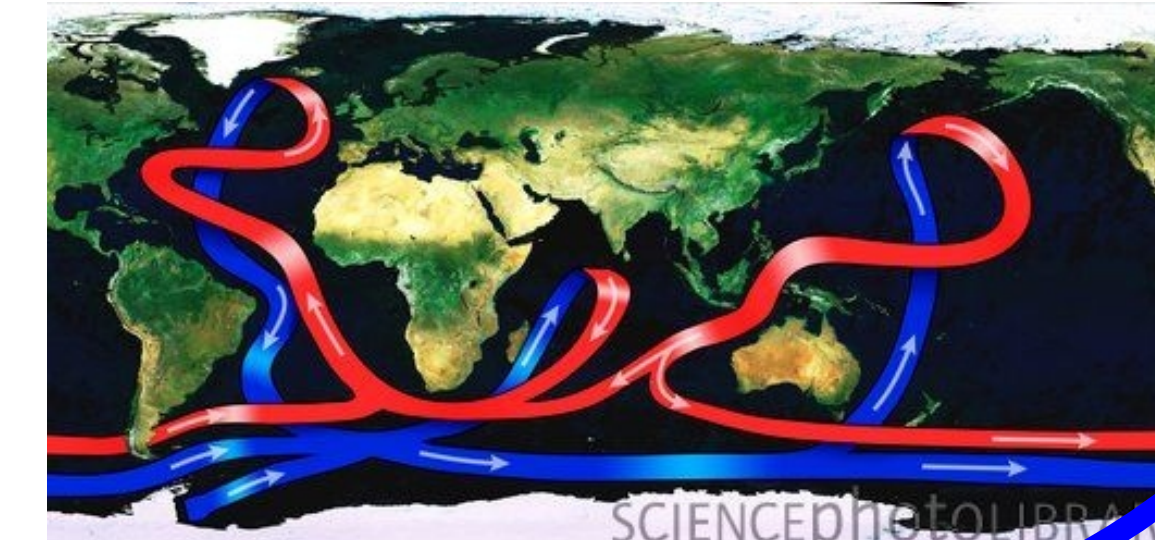
Tectonics

- Plot, measure, calculate **plate motion** direction and velocity
- Use seafloor age maps to estimate plate ages
- Use globe to measure distance plates have moved
- Calculate plate velocity and changes with age/geologic history
- Measure land elevation and seafloor depth directly from the global map
- Measure and plot seafloor depth with age, for lessons on lithospheric formation
- "Connect the dots" of earthquakes and draw **plate boundaries**
- **Subduction zones:**
 - Plot the location of volcanoes along a subduction zone arc (e.g. Cascade Volcanoes)
 - Plot earthquakes along the Benioff zone of a subducting plate using interior work board (e.g. Juan de Fuca, Tonga, etc.) - calculate subduction angles of different plates
 - Draw the connection between alignment of volcanic arcs and 3D plate subduction

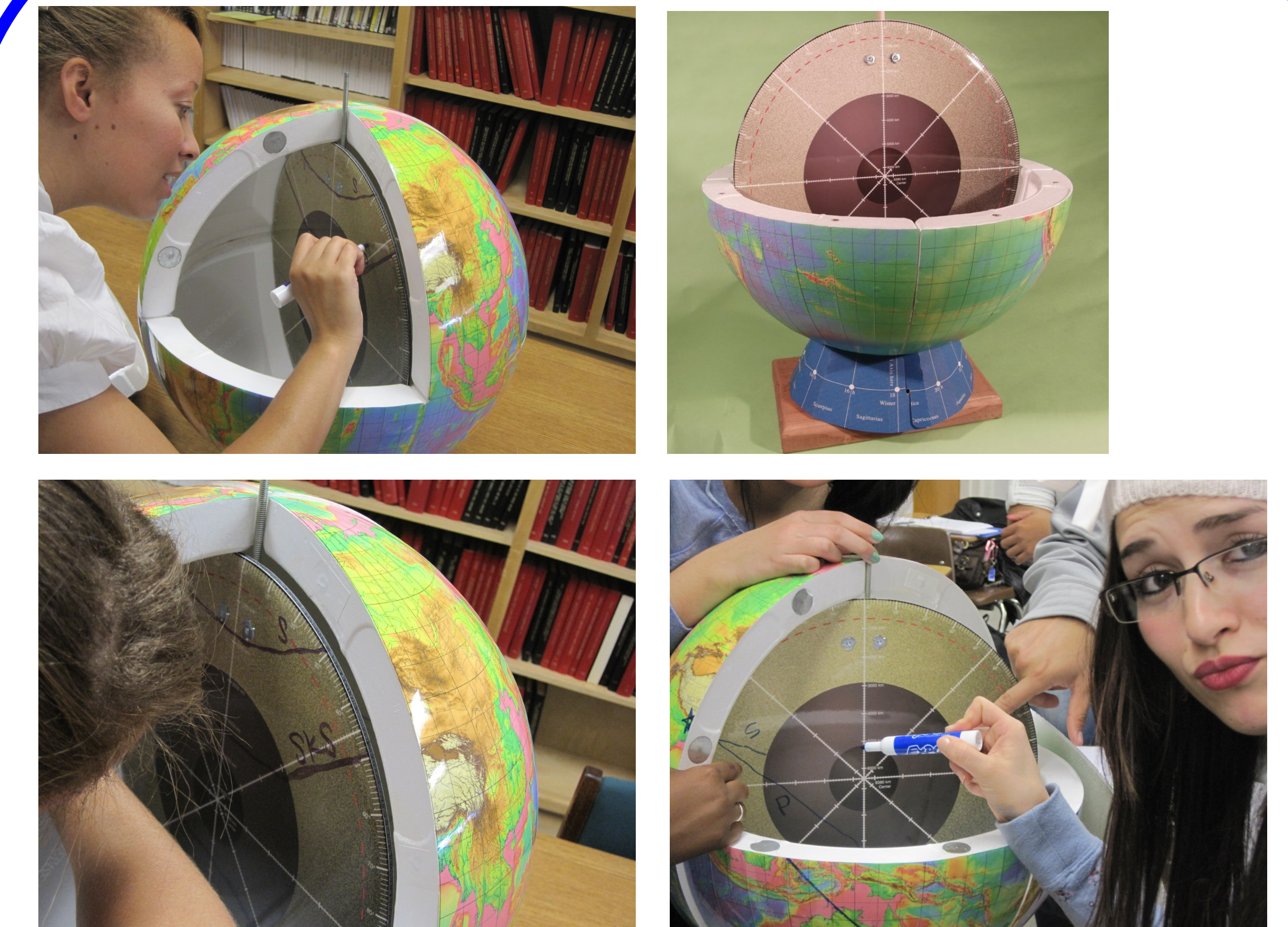


Oceanography / Atmospheric Science

- Draw ocean circulations patterns in ocean basins
- Draw temperature or salinity variations in ocean basins
- Design map surfaces with atmospheric/ocean circulation patterns
- Use elevation and seafloor depth variations to draw, plot, and measure temp/salinity/geochemistry variation patterns.

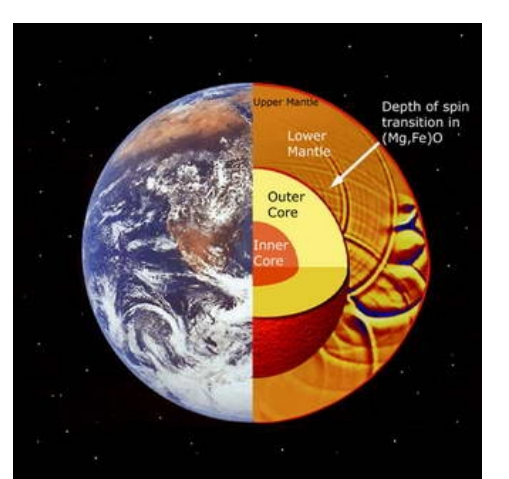
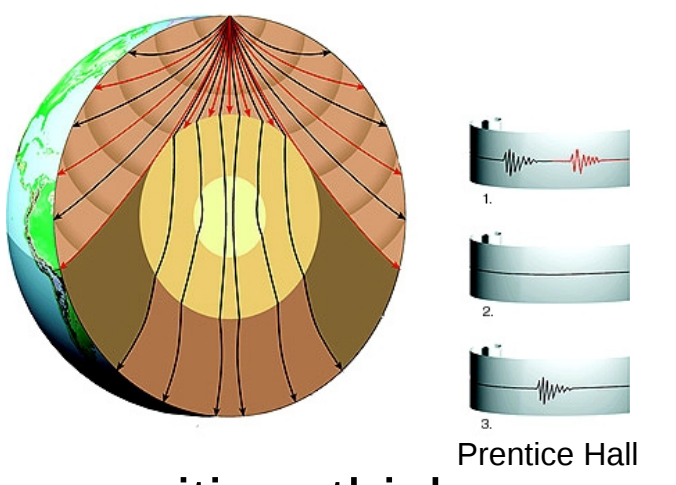


Earth Interior Work Board



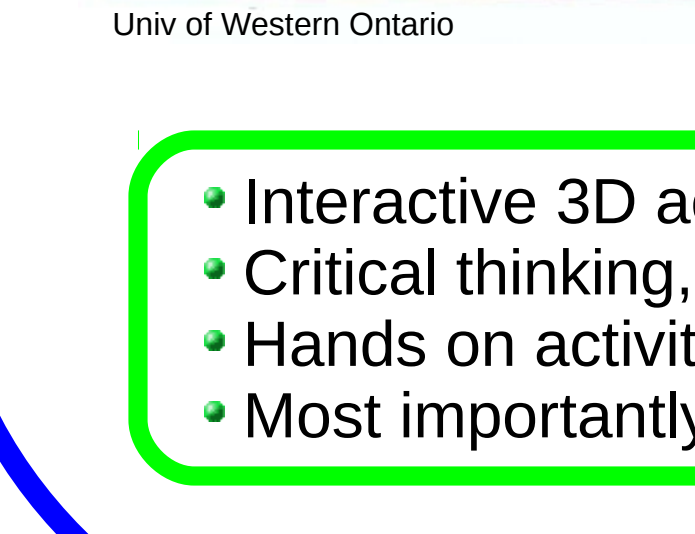
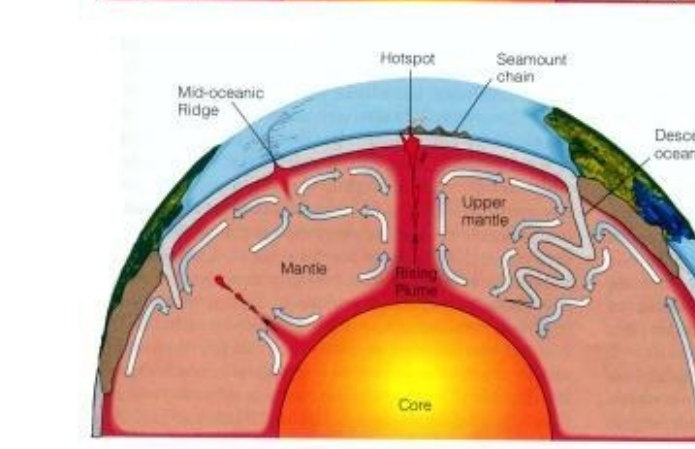
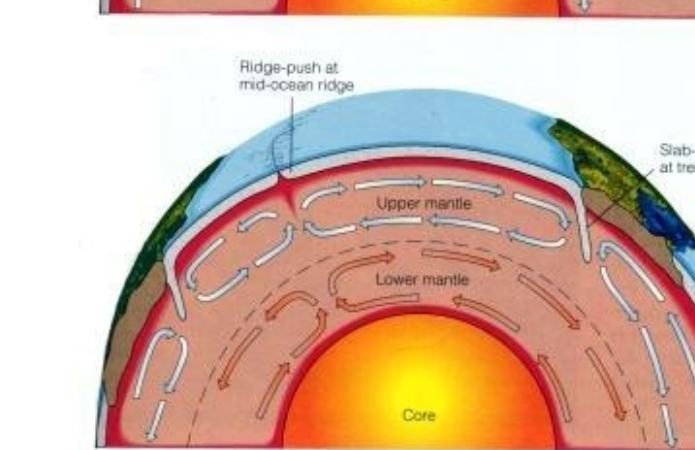
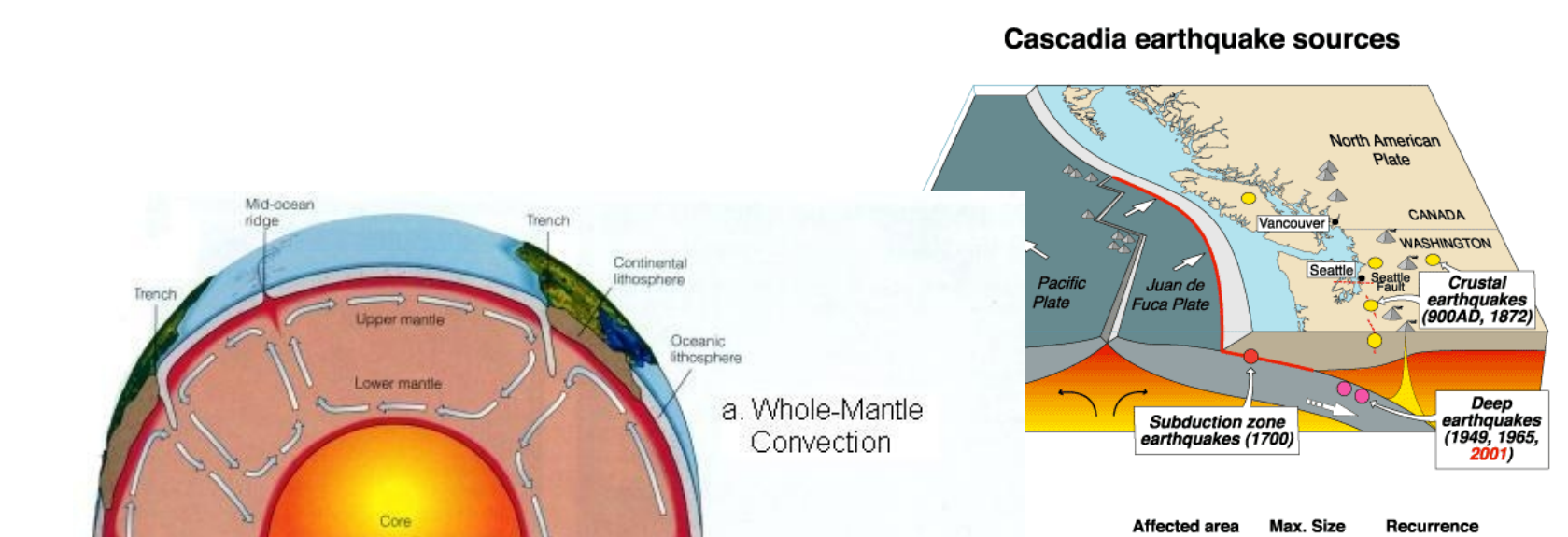
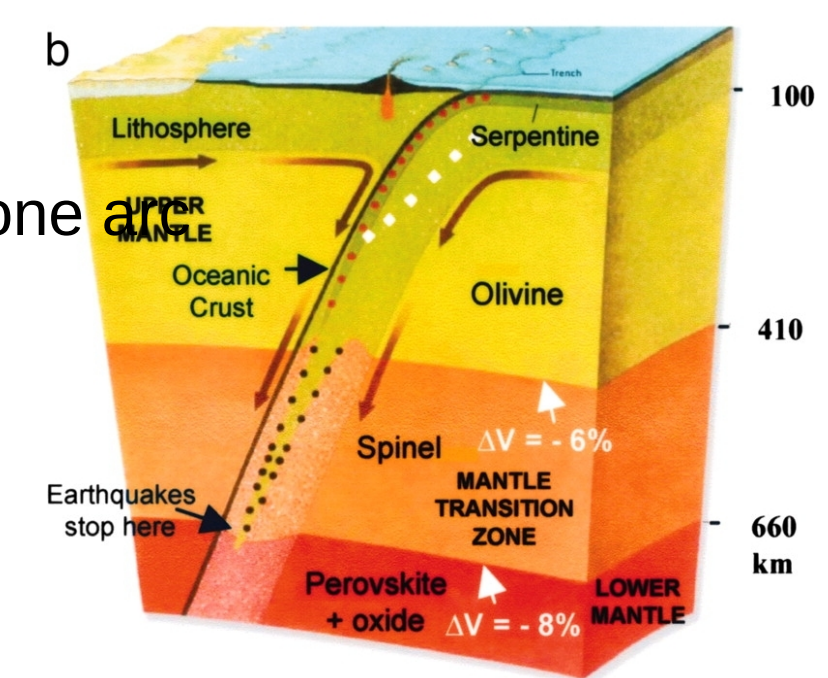
Seismology

- Draw seismic ray paths through the Earth's interior
- Compare S and P wave paths through the core
- Define the outer core and inner core
- Draw and measure S and P waves shadow zones
- Draw the layers in the earth and define their depth, composition, thickness
- Compare different raypaths of P, PKP, PKKP, SSS, SKS, SKKS waves
- Calculate and draw
 - Incidence angles
 - Ray parameter
 - Bottoming depths
- Draw surface waves & body waves paths



Tectonics

- Plot earthquakes in the subducting zone
- Compare subducting plate angles across the globe
- Plot the location of volcanoes along a subduction zone arc (e.g. Cascade Volcanoes)
- Plot earthquakes in Juan de Fuca subducting plate
- Draw the connection between alignment of volcanic arcs and 3D plate subduction
- Draw Earth's interior layers, depths, composition



Geodynamics

- Mantle plumes
- Subducting plates
- Whole and partial mantle convection

Oceanography

- Ocean circulation patterns in the ocean
- Temperature, salinity concentrations

- Interactive 3D activities with the Earth's surface and interior
- Critical thinking, putting ideas together in a big picture planetary scale
- Hands on activities that draw in students
- Most importantly, It's Fun! (Try it!)