

Plate Tectonics Through Time

The Shape of Today's Sea

Plate Tectonics and Ancient Oceans

Graphic: CNN, Jan 23, 2003. Photo by the Associated Press.

Review - How Does Plate Tectonics Work?

Plates move relative to one another

Lithosphere is formed where plates pull apart

Lithosphere is destroyed where plates come together at subduction zones

Graphic: See Garrison, Fig. 3.13.

What Drives Plate Motion?

The force of gravity on the downward moving edge of a plate pulls it down ("Slab pull")

Creation of new plate material by volcanic eruption at the mid ocean ridges and the downward pull of gravity on their flanks forces plates apart ("Ridge push")

Mantle convection moves plates via friction with the underside of the plate

Graphics: (top) Garrison, 4th Ed. Fig. 3.1
pg 59, 5th Ed. See Fig. 3.21 pg 72,
(bottom) Garrison, 4th Ed. Fig. 3.13, pg 71,
5th Ed. Fig. 3.14 pg 67.

Divergent and Convergent Plate Boundaries

Divergent –birthplaces of new oceans, locations of mid-ocean ridges

Convergent – plates come together, mountain building

The Shape of Today's Sea

Graphic: Garrison, Fig. 4.32.

Continental Margins

Shelf - submerged edge of continent

Slope - transition between continental and oceanic crust

Rise - area at the base of the continental shelf covered by sediment deposited from the shelf

Graphics: (left) California, as viewed from space, image courtesy of the SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE, (right) Computer-generated visualization of the continental shelf, slope and rise off the coast of Los Angeles, courtesy of the USGS Pacific Sea-Floor Mapping Project, see Garrison, Fig. 4.11.

Passive Margins

- far from plate boundaries
- common around the Atlantic Ocean
- broad continental shelves
- little tectonic activity

Graphic: Garrison, Fig. 4.8.

Active Margins

Coincide with plate boundaries

Common around the Pacific Ocean

Narrow continental shelves

Significant tectonic activity

Graphic: See Garrison, Fig. 4.10.

Deep Ocean Trenches

Are 3-6 km deeper than surrounding ocean

Tectonically active

Graphics:(top) Garrison, Fig. 4.31, (bottom) Garrison, Fig. 4.30.

Volcanoes, Earthquakes and the Ring of Fire

**“Ring of Fire” - a zone of intense volcanic activity around
the Pacific basin**

Most “Ring of Fire” volcanoes are formed as a result of processes at plate boundaries

Graphics: (top) Locations of active volcanoes, from worldatlas.com, (bottom) Earthquakes around the Pacific basin, courtesy USGS.

Plates on the Move

Lithospheric plates move 2-15 cm/yr

Over long times, these motions significantly rearrange continents and oceans

Graphic: See Garrison, Fig. 3.14.

How Do You Grow a Continent?

As plates move, continents grow by accretion of microcontinents, island arcs and old oceanic plateaus

These smaller pieces of continental material are not subducted because they are not sufficiently dense

Graphic: Garrison, Fig. 3.34.

North American Terrains

The Wilson Cycle

Earth's crust is rearranged and recycled as plates move:

- **Rifting of continents**
- **Seafloor spreading forms new ocean basins**
- **Subduction of old seafloor**
- **Building of continental platforms via accretion**
- **Suturing of continents to form mountain ranges**
- **Erosion of mountains**

Graphic: Garrison, Fig. 3.37.

Plate Motion Through Time

Modern geography can be traced back millions of years using

- fossil plants and animals
- rock assemblages
- magnetic properties of oceanic and continental rocks

Changes in climate occurred in conjunction with reorganizations of land and ocean

Graphic: Garrison, Fig. 3.20. ([animation](#))

Plate Tectonics and Climate

Some influences on climate:

- Amount of land at various latitudes (poles vs equator vs midlatitudes)
- Circulation of the ocean
- Numbers and locations of mountain ranges
- Dust in the atmosphere from volcanic activity

Graphic: Garrison, Fig. 3.20.

Order from the oldest to the most recent...

356 Ma - Converging Continents

About 300-350 million years ago, ancient continents moved together to form a vast supercontinent, Pangea

Graphic: Courtesy of C.Scotese, see <http://www.scotese.com/newpage4.htm>

237 Ma - A Supercontinent and a Great Ocean

Graphic: Courtesy of C.Scotese, see <http://www.scotese.com/newpage8.htm>

94 Ma -Formation of New Oceans

50 Ma - A Widening Atlantic Ocean

14 Ma - Connecting North and South America

Plate Tectonics and Today's Ocean Basins

Plate Tectonics and the Future?

Exam 1 – Sept 23

Worth 20% of your grade

Be on time! Bring two pencils and an eraser!

You will need your Banner ID number for the exam sheets

Format: Multiple choice

May include interpretation of maps and diagrams

Content: Lectures 1-6 (inclusive)

Intro to Oceanography – Plate Tectonics through time