Earthquakes and Tectonics

Earthquake occurrence:
Earthquakes occur all over the world. They are concentrated along linear trends across the earth. Many earthquakes occur around the Pacific Rim; the margins of the Pacific Ocean. Other linear trends of earthquakes run along the middle of the Atlantic Ocean and across South Asia.

Global seismicity map from the USGS (12 Mb) can be found here:

Earthquakes occur every day. Most earthquakes are too small to feel or do any damage, but they are recorded by sensitive seismic instruments. Up-to-date maps of today’s earthquakes are available here:

Volcano occurrence:
Volcanoes also occur all over the world, and are also concentrated along some of the same lineaments as earthquakes. Status of US Volcanoes from the USGS can be found here:

Plate Tectonics: The driving mechanism for most major geologic processes.
The surface of the earth is broken into about a dozen major tectonic plates.
Plate: refers to the shape of the strong moving sections of Earth’s outer surface
Tectonics: refers to the large scale movement and deformation of Earth’s outer surface

The Earth’s layered structure.
Earth structure as characterized by composition:
• Crust: buoyant, rich in silicate rocks: Very thin (6 km in the oceans, 35 km in the continents.)
• **Mantle**: Made up of solid silicate rocks, but with a different composition than the crust. Thickness is about half the radius of the Earth (2900 km)

• **Core**: Metal: Mostly iron and nickel, with smaller amounts of other elements. The core is the source of the Earth’s magnetic field.

Described in terms of strength of the material, Earth’s layered structure looks a little different:

• **Lithosphere**: strong, outer layer. Consists of crust and some of the upper mantle. It’s this that makes up the tectonic plates.

• **Asthenosphere**: Hotter, and weaker, than the lithosphere. Although it is solid, crystalline, under the elevated temperatures of Earth’s deep interior, it flows like a fluid.

• **Core**: consists of a solid inner core and a liquid outer core.

**Plate tectonics causes earthquakes, volcanoes, mountain-building, and other geologic activity.**

A map of the major tectonics plates is available here:

3 types of plate boundaries:

Divergent: two plates pull apart; new plate forms at this type of boundary.
Convergent: two plates collide; one plunges into the interior and the other overrides it. Plate is destroyed at this type of boundary
Transform: two plates slide by one another; plate area is conserved – neither formed nor destroyed - at this type of plate boundary

Divergent plate boundaries:
Mid-ocean ridges: oceanic plates pull apart (example: the mid-Atlantic Ridge); mantle wells up to fill the gap, and as the hot material rises it melts and erupts. Many earthquakes and a great deal of volcanic activity occur at mid-ocean ridges. The earthquakes tend to be shallow and not very large. They do not represent a major natural hazard because people do not live at the bottom of the ocean.

Convergent plate boundaries
Subduction zone: Where an oceanic plate collides with another plate, one plunges into the interior and the other overrides.  
  o Examples: Japan trench, Alaska, Peru-Chile trench (S. America), Sumatra, Cascadia (Western US).
  o Wadati-Benioff zone of earthquakes marks the path of the subducted slab
  o The plate bends as it turns into the interior, creating a deep trench in the ocean.
  o The largest earthquakes ever recorded have occurred at subduction zones.
  o Major mountain belts (the Andes) and volcanic chains (the Aleutians, Mt. Fuji) occur in this tectonic setting.

Collision zone: Where continents converge, the buoyant continental crust builds up, creating mountain belts.
  o Example: Indian plate colliding with Eurasian plate to create the Himalayas.

Transform plate boundaries
Examples: San Andreas fault system (California, USA); North Anatolian fault system (Turkey)
Offset features can provide information about the recurrence interval.

Some seismic and volcanic activity takes place far from plate boundaries Hotspots (locations of anomalous volcanic activity and earthquakes not associated with a plate boundary). Example: Hawaii, Galapagos, Iceland. Intraplate seismic activity (example: New Madrid fault zone).