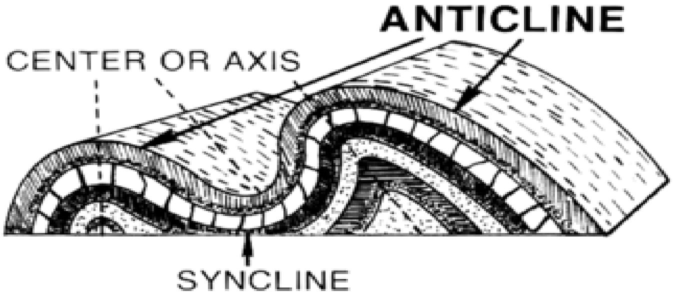
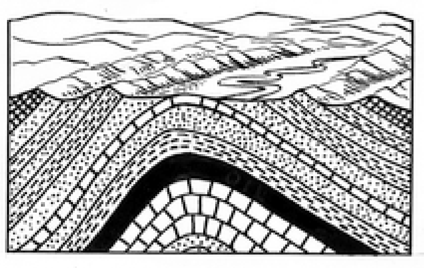
Folds and Faults

Structural geology is the study of the three-dimensional distribution of rock units with respect to their deformational histories. The primary goal of structural geology is to use measurements of present-day rock geometries to uncover information about the history of deformation (strain) in the rocks, and ultimately, to understand the stress field that resulted in the observed strain and geometries.

The shape of a rock can be changed by **plastic deformation**. There are two common types of **folds** in folded rocks. A **syncline** is typically a downward fold, with younger layers closer to the center of the structure. If the fold pattern is circular or elongate circular, the structure is a **basin**.





An **anticline** is a fold that is convex up (arching up) and has its oldest beds at its core. On a geologic map, anticlines are usually recognized by a sequence of rock layers that are progressively older toward the center of the fold because the uplifted core of the fold is preferentially eroded to a deeper stratigraphic level relative to the topographically lower flanks. The strata dip away from the center, or crest, of the fold. If the fold pattern is circular or elongate circular, the structure is a **dome**.

The term is not to be confused with *antiform*, which is a purely descriptive term for any fold that is convex up. Therefore if age relationships (i.e. younging direction) between various strata are unknown, the term antiform must be used.

Folds typically form during crustal deformation as the result of compression that accompanies orogenic mountain building.

Aside from Mid-Ocean Ridges, subduction zones, and collision zones, there are areas where the stretching or compression of plates causes slight **fractures** in the earth's crust. These areas of crustal stress are called **faults** and there are essentially two types. **Normal faults** occur where tension within the Earth stretches the crust to form a basin, or range, with **fault-block mountains** flanking the basin. The southern Rockies include a basin and range area formed as a result of normal fault. **Reverse faults** occur where compression squeezes the crust together as one block of land slides over another forming **overthrust mountains**.

Another type of fault occurs where plates are sliding, shearing, or grinding past each other, folding mountains and producing earthquakes in the process. These plate boundaries are called **lateral**, or **transform faults**, and they are found where significant movement occurs along a fracture in the earth's crust.

The San Andreas Fault

Clearly, the most famous and most visible transform fault in the world is the San Andreas Fault. This enormous fault stretches for over 1,000 miles from northern California, through western California, to the East Pacific Rise beneath the waters of the Gulf of California.

The Pacific Plate lies to the west of the San Andreas Fault and the North American Plate lies to the east. Scientists have determined that the Pacific Plate moves northwest at the rate of about two inches every year relative to the North American Plate. The western half of California lies on the Pacific Plate while the eastern half of California lies on the North American Plate.

Besides the short term effects of being an earthquake 'hot zone', western California will, in about one million years, be part of Alaska, as the Pacific Plate continues its north-westerly trek. Much crushing and grinding takes place as these two enormous plates move past each other. When sections of the plates become locked, stress builds up until the friction is relieved by a minor tremor, or major **earthquake**. The point of origin , where stress energy changes to wave energy, is a **focus.** The area on the earth´s surface directly above the focus is an **epicenter.** Most earthquakes occur at a shallow depth, somewhere between the surface an 70 km depth. Earthquake vibrations produce two major kinds of waves - **primary waves** (**P-waves**) which are longitudinal, and **secondary waves** (**S-waves**), which are transverse waves.
The relative amount of energy released by an earthquake, its **magnitude**, can be measured by an instrument called a **seismograph**. An earthquake's magnitude is translated into a measurement on a numerical scale, called **the Richter scale**. Major earthquakes usually measure between 6.0 and 9.1 (the highest recorded) on the Richter scale. Each increase of one unit on the Richter scale represents a 32-fold increase in the intensity of the earthquake. For example, a magnitude 8.5 earthquake is 32 times more intense than an earthquake with a measured magnitude of 7.5. Earthquakes are quite a common occurrence on our planet. Several per day are detected by **seismologist**s, but because of their relative weakness, they are not made known to the global public.
On April 18, 1906, the stress and friction built up for over one hundred years along the San Andreas Fault was released during a cataclysmic tectonic event. In less than a minute, one plate jumped 7 m northward along a 270-mile stretch of the fault. The result was the infamous San Francisco earthquake of 1906. The quake, which lasted only one minute and measured 8.3 on the Richter scale, claimed over 700 lives and left 250,000 homeless, as fire consumed almost five square miles in the heart of the city.
In 1989, a San Francisco earthquake measuring 6.9 on the Richter scale killed 67 people, and in a few short moments of crustal realignment, billions of dollars were lost in the damage. But that damage paled in comparison to the damage incurred by the people of Armenia that same year when Armenia also suffered a tremor measuring 6.9 on the Richter scale. But because of the poor building construction methods and standards in Armenia, the death toll rose to over 30,000. And in 1993, 28,000 people perished in an instant when an earthquake measuring 6.4 on the Richter scale leveled several small towns in south-central India, near the Deccan Plateau.
With all of our accumulated knowledge regarding the forces that shape our planet, scientists are still unable to foresee an impending earthquake or predict cataclysmic tectonic events. There is much yet to know.

After Japan´s 1995 earthquake, high-tech sensors were placed around the country to observe even the slightest movements, which is why scientists are able to calculate the quake's impact down to the inch. "The 9.0 magnitude quake in 2011 is overwhelmingly the best-recorded great earthquake ever," says the chief scientist for the Multi-Hazards project at the U.S. Geological Survey.
(By Liz Goodwin – Mon Mar 14, 9:56 am ET)

Sources: Adapted from Wikipedia and Fariel, R. - Hinds, R. - Berey, D.: Earth Science, Addison-Wesley 1987 by Věra Hranáčová

Check yourself
1. What are the differences among synclines, anticlines, basins and domes?
2. What kinds of stresses can create faults?
3. What can you say about San Andreas fault?
4. What natural earth processes can cause earthquakes?
5. How is the energy in an earthquake measured?