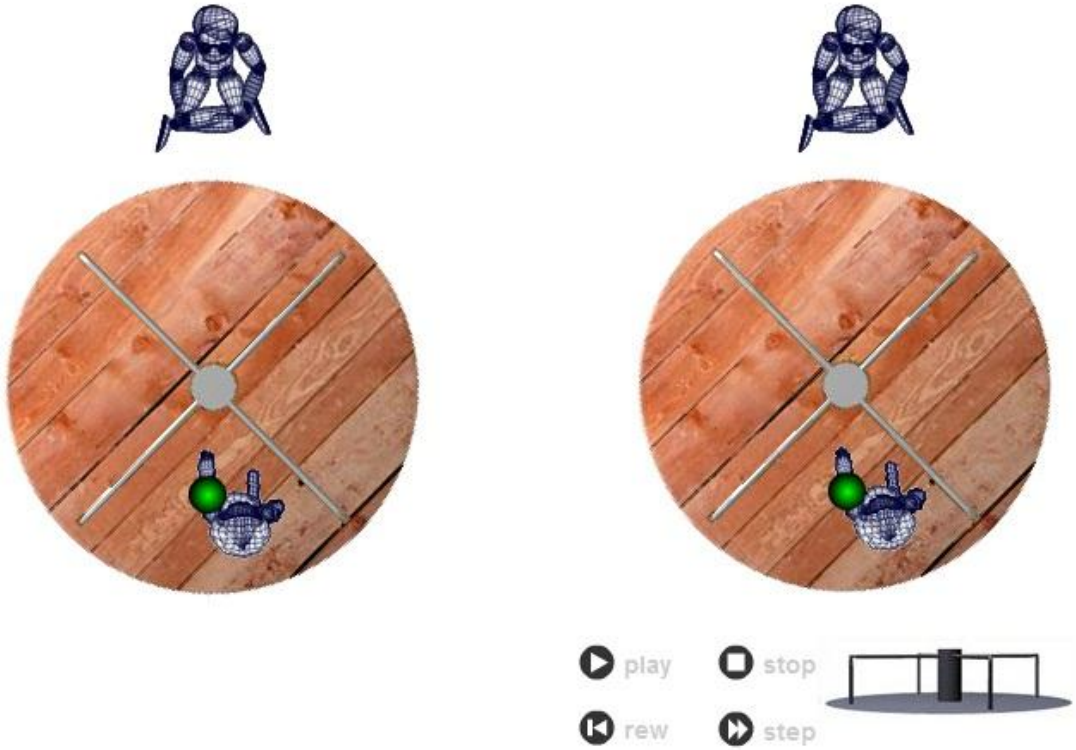
Reference Frames

Overview of Reference Frames

When describing changes in position, it's important to establish one's point of observation, the "frame of reference".



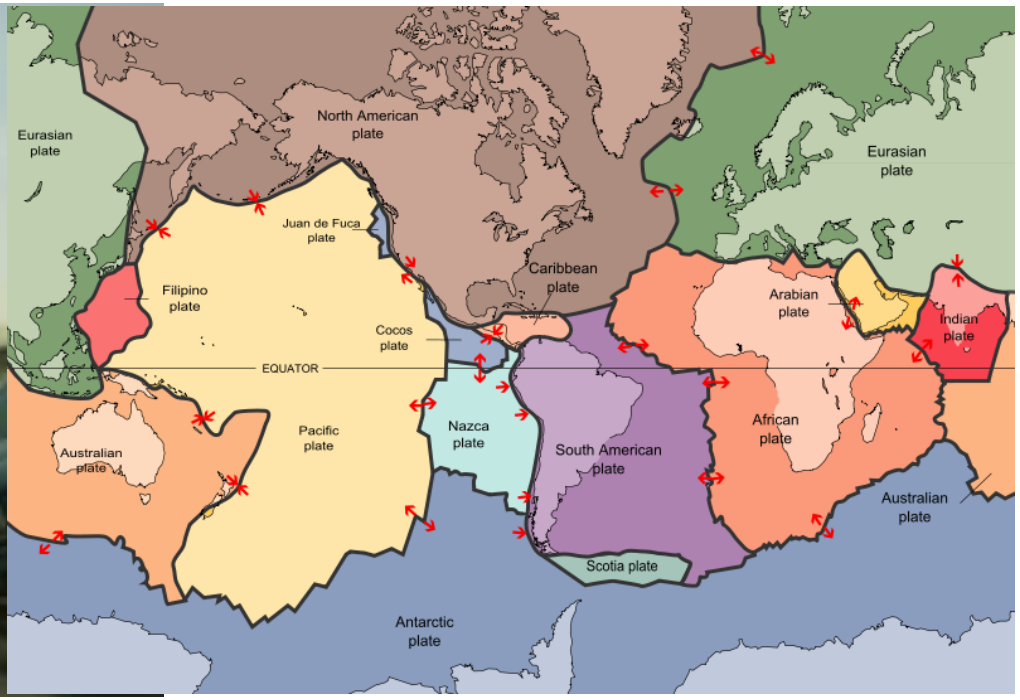
To use this animation, go to:
http://ei.lehigh.edu/eli/tectonics/support/referenceframes/referenceframes1.html

Press play to run the animation. Notice that on the left, the reference point is the thrower on the merry-go-round, while on the right the reference point is the seated observer. Depending on frame of reference, the relative motion of the ball is very different.

Plate Motion: Boundary Reference Frame

When describing relative plate motion, several different reference frames are possible. The simplest one, used by most science textbooks is the boundary reference frame. With this reference frame, the relative motion of plates is observed from the plate boundary.

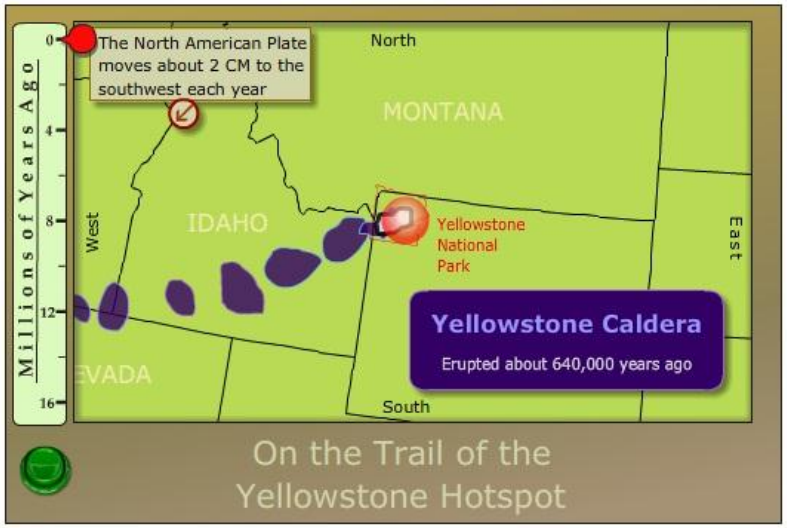
When you are standing at the side of a road, you are in a fixed location. Cars move relative to you.



Imagine you are a fixed observer standing at the boundary between two plates. As indicated by the red arrows, plates might be moving towards you, away from you, or past you.

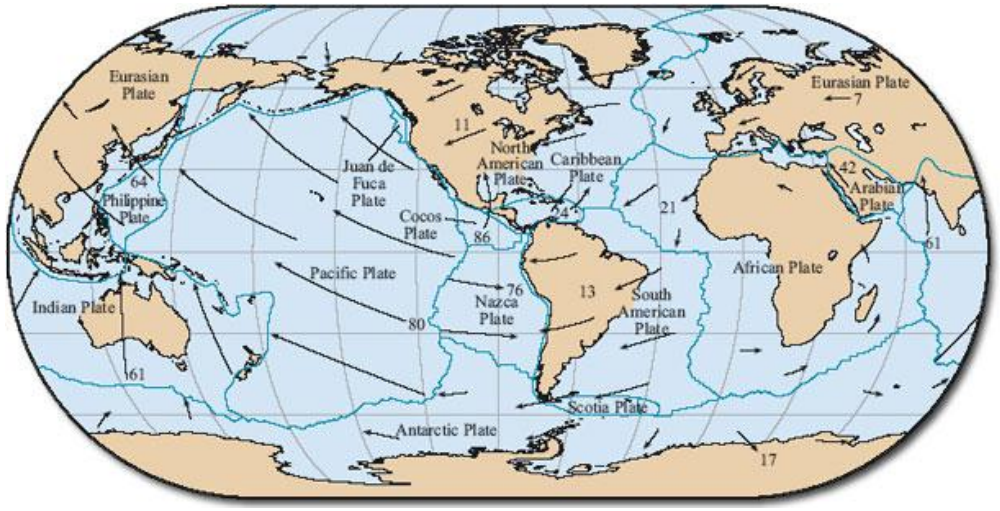
Plate Motion: Hot Spot Reference Frame

Heat plumes rising from the core – mantle boundary cause volcanoes at the Earth's surface. We call these regions *hot spots*. The tracks made by hot spots as they create volcanoes on the Earth's surface enable scientists to approximate plate motion relative to the mantle.



Press the green button to see how the Yellowstone Hotspot has moved relative to the lithospheric plate.

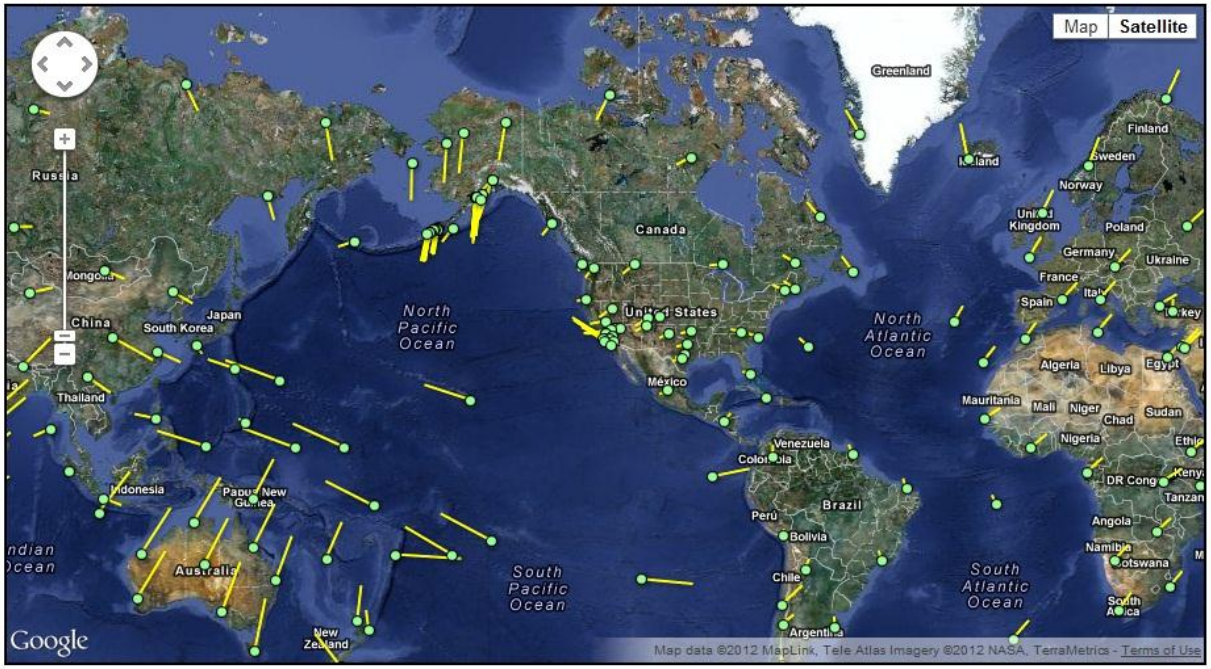
To use this animation, go to:
http://ei.lehigh.edu/eli/tectonics/support/referenceframes/referenceframes3.html



Because the hot spots move slowly relative to one another at a rate 10 times slower than lithospheric plates move, they can be used to analyze the relative motion of the overlying plates. The length of each arrow indicates the amount of movement over 50 Ma. The numbers indicate plate speed.

Plate Motion: Absolute Reference Frame

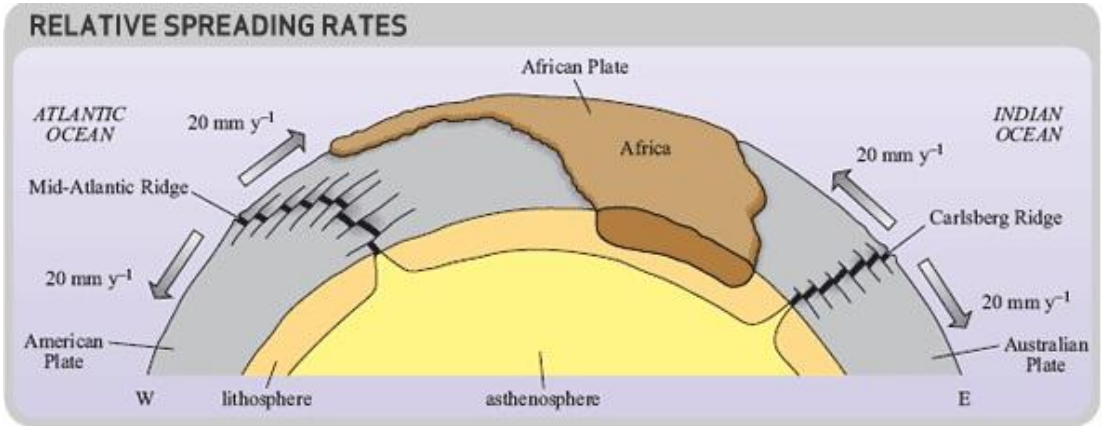
Scientists use the Global Positioning System (GPS) to plot precise measurements of plate position. Over 2,000 transmitters from around the world emit data to the satellites. Tracking the changes in positional data enables scientists to approximate plate motion relative to a network of geostationary satellites.



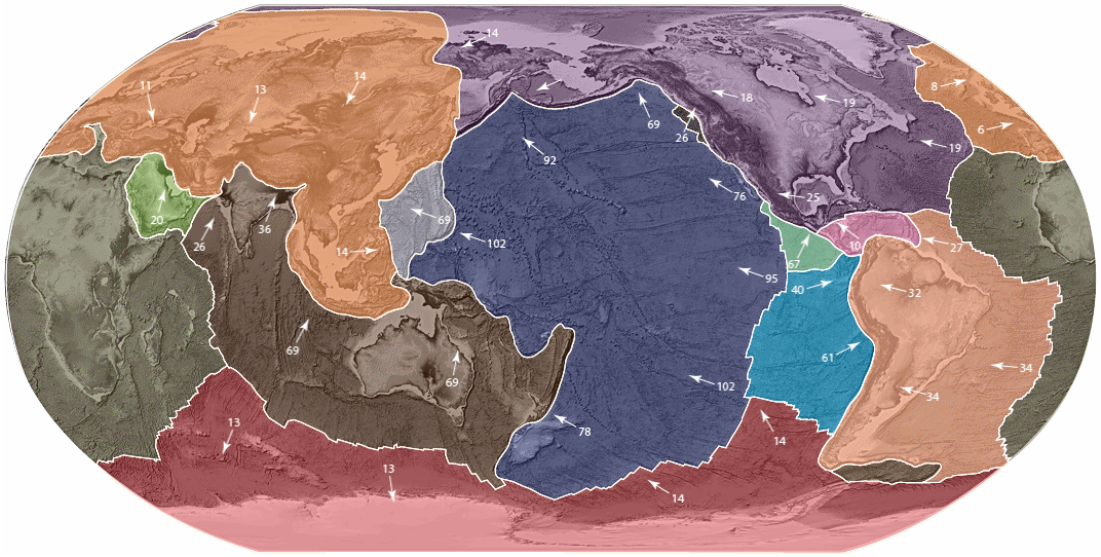
In this map, each of the green circles represents a transmitter. The yellow line indicates how that transmitter has moved over time. Longer lines represent more movement.

Plate Motion: Plate Specific Reference Frame

For plate tectonic studies, scientists sometimes choose to use a specific plate as a fixed reference frame. Because it is surrounded by ridges and moves slowly relative to the hot spot reference frame, Africa is often used in this capacity. Alternatively, any other plate could be used.



This diagram illustrates the motion of the American plate and Australian plate relative to the African plate.



The African Plate is shown here in light brown. It wraps around the map with part of the plate on the left side, and part on the right side. This map illustrates all of the plate motions relative to the African plate.