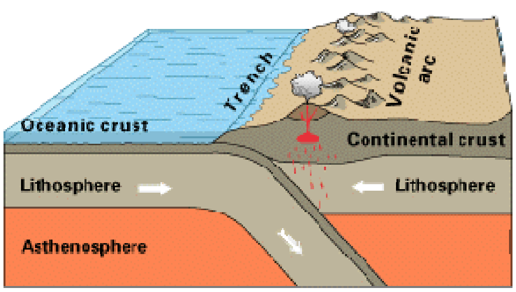
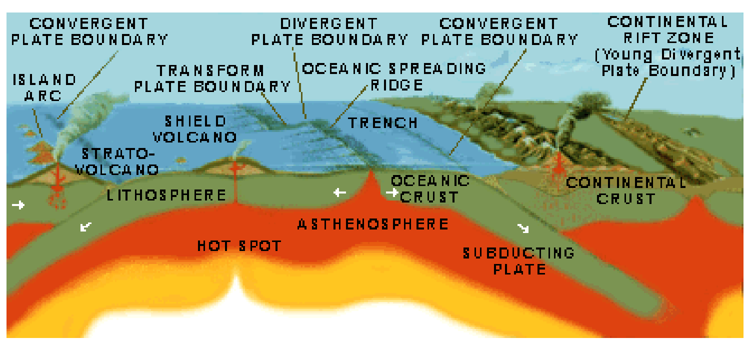
Granite

Perception is reality … not. Our perception of how things really are is often misleading, and we depend on the methodical tactics of science to explain correctly the nature of the world. Understanding the dynamics of the earth's crust and of mountain building is a good example of this. The solid rock of the planet’s surface is in constant motion. Continental land masses rise high above the ocean floor and mountains above the underlying mantle because of the Archimedes principle as it affects granite. Being less dense than the underlying components of Earth's crust, granite masses float according to the physics of volume displacement. The operation of these simple forces is hidden from our view because of our difficulty in perceiving the geologic time scale in which these events occur.

The geologic cartoons depicted below are accurate representations of how the earth works and how the crust and mountain ranges are formed. To put the images in motion, however, would require our ability to appreciate the 3-foot per decade spreading of the 2,500 mile-wide Atlantic Ocean as robust geologic movement, demonstrating the active nature of rock at the earth’s surface. We simply cannot intuitively appreciate this. Human perception is totally blind to such slow motion.



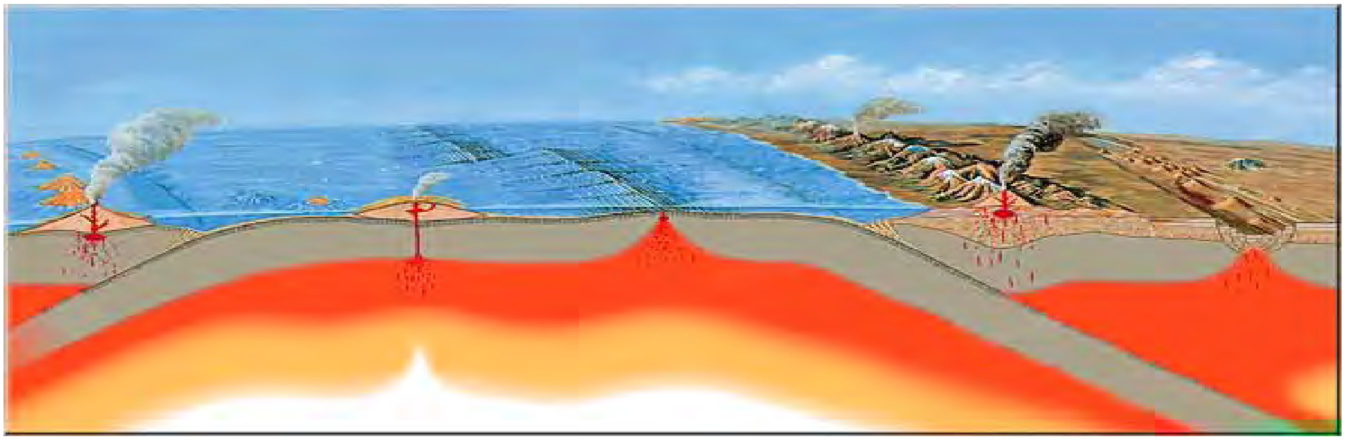
Oceanic-continental convergence

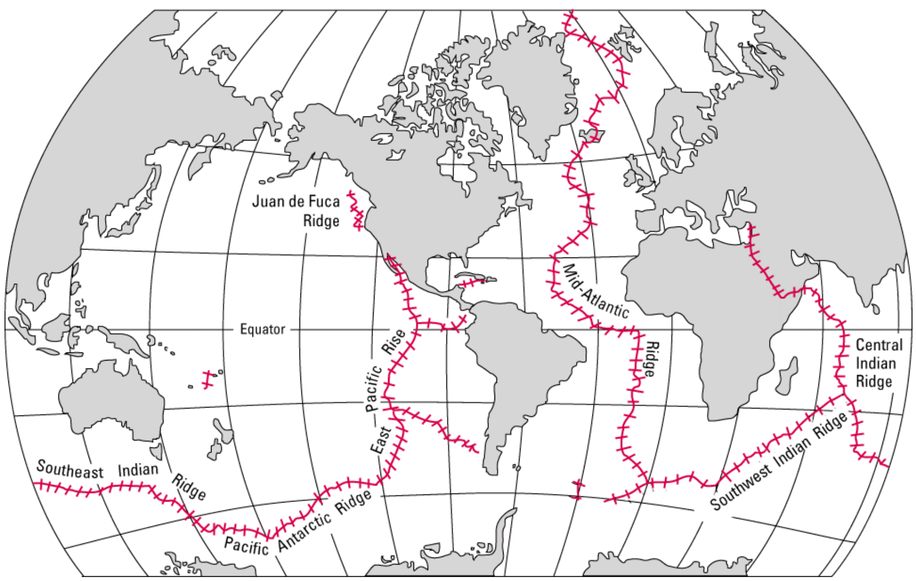


images credit: U.S. Geological Survey (USGS)

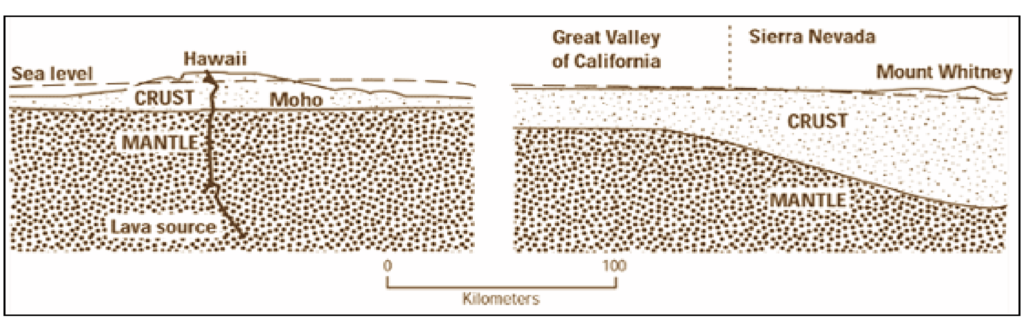
Plate tectonics has been accepted geoscience only since 1967. The observation of tectonic activity transformed our thinking of how the earth works much as description of the mechanism of species diversification (by variation and natural selection) revolutionized biology a century earlier. The tremendous explanatory power of this concept has established its central role in geology, and serves well to give an understanding of the origin of granite and of continents and mountains.

Newly-formed oceanic crust moves away from the spreading center at a mid-ocean ridge. Upon collision with an adjacent crustal plate, the younger, denser oceanic crust is subducted at the convergent boundary and descends toward the mantle. Moving downward, at depths of 60 miles or so, the upper portion of the subducting crust begins to melt and then rise as magma. Moving upward, the magma melts and mixes to various degrees with surrounding rock. If it makes its way to the surface, this molten rock may form volcanoes and erupt as lava. If the magma plume slows and solidifies (crystallizes) far below the surface, granite is the rock that is formed. Granite, which – with its derivative rock forms - comes to make up the bulk of the crust of continents, is only slightly less dense (2.7 g/cm^3) than oceanic crust (2.8 g/c m^3). Nonetheless, this slight difference is enough to allow mountains (whose deep portions are granite) to be buoyed up (float) within the surrounding and underlying rock by the Archimedean principle - called *isostasy* when applied to rock.





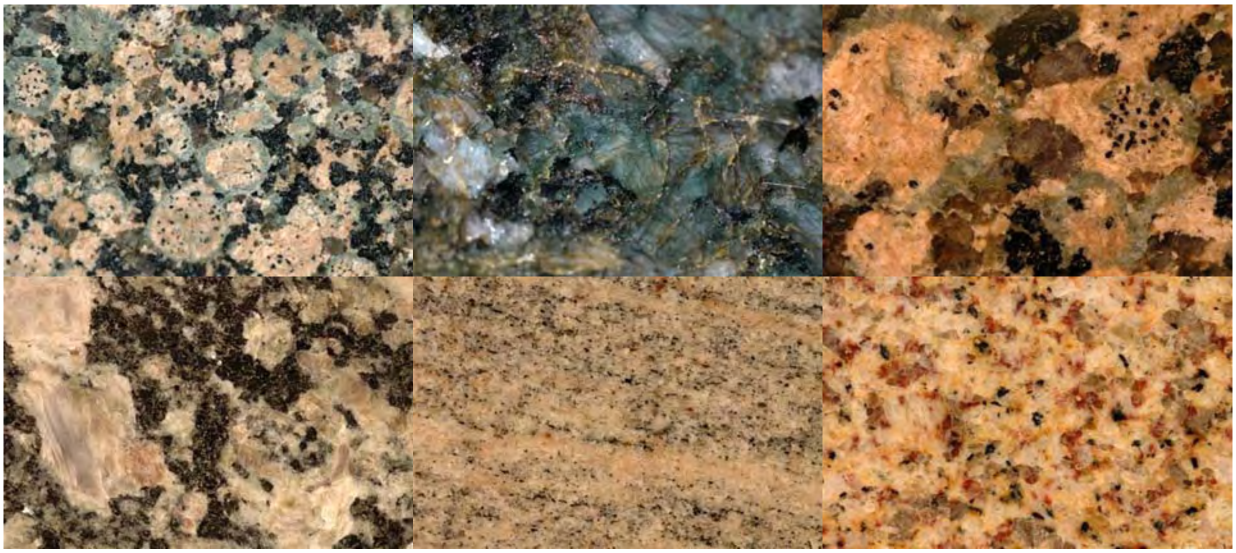
The mid-ocean ridges (shown in red) wind between the continents much like the seams on a baseball.



USGS

Oceanic crust at the island of Hawaii is about 5 km (3 mi) thick.
Continental crust under eastern California ranges from 25 km (15 mi) under the Great Valley to 60 km (36 mi) under the Sierra Nevada.

Under appropriate conditions (which usually exist 6 to 10 miles beneath the surface), rising magma cools sufficiently to become solid, forming interlocking crystals of feldspar, quartz, and biotite … granite. Once emplaced and no longer moving relative to the surrounding “country rock”, an enormous solid granite mass (called a *batholith* – “deep rock” - or *pluton* – after Pluto, god of the underworld) is hidden from surface view. As erosion of overlying crustal rock occurs, the emplaced granite pluton slowly rises (floats) to the surface [rate of rise often 1mm per year]. An imperceptible rate of rise, yet 1mm/year X 1000 y = 1 m/1000 y, … X 1000 = 1km / million y, … X 10 million y = 10 km elevation (10 km = 6 mile rise) … and the massive granite batholiths of the Sierra Nevada break into the light of day and a Yosemite is born.



Granite comprises much of the volume of the continental crust, though it is most often hidden from surface view by overlying metamorphic and sedimentary strata. Close examination of granite specimens reveals both common structural elements and diverse chemistry, reflected in variations in color and pattern. Specific depth, pressure, and temperature of crystallization, as well as chemical composition of the specific source magma and of the adjacent admixing melt of country rock all contribute to the appearance of the resulting granite.