Plate Tectonics: How it works
All material contained here are figures from Understanding Earth by Grotzinger, Jordan, Press, and Siever.
Or they are original figures by Harold Gurola.

Convection:

• A means for moving heat from deep in the Earth to the surface by means of flow of rock.
• This flow of rock establishes large cells the tectonic plates ride on.

Convection in a boiling pot of water

How convection may drive plate motion
Two possible types of convection:

a) Whole mantle

b) Layered convection

The different types of plate boundaries

- Normal fault: Riffs or ridges are characterized by normal faults which are extensional.
- Reverse fault: The major fault that accommodates the motion between the plate in subduction is a thrust or low angle reverse fault. These faults are compressional.
Passive margins are the transition from continental to oceanic crust remaining after rifting but it is not a plate boundary.

How these plate boundaries are distributed with relation to mantle convection.
Divergent Boundaries
Oceanic Plate Separation
Volcanoes and earthquakes concentrate.
How rifting works on a continent

A) Hot mantle causes crustal uplift and stretching accommodated by 1) normal faults in the brittle upper crust and 2) ductile flow in the lower crust.

B) If a successful rift forms, new rock is injected into the crust by cooling of mantle rock.

C) This results in an ocean basin and passive continental margins where the continental crust binds to the oceanic crust. This is not a plate boundary; the ridge is the plate boundary.

A triple junction of rifts is the typical configuration of rifts. In order for the continent to break apart two of the rifts must succeed in developing oceanic crust. The third rift may continue to break up the continent or it may stop in which case a rift is left behind. These usually become the location of a future significant river valley (i.e. the Mississippi river, the Amazon ...).
Divergent Boundaries
Continental Plate Separation
Parallel valleys; volcanoes and earthquakes.

East African Rift Valley

The fate of the rifts are:
1) Future ocean basins
2) Failed rifts which typically become major river valleys.

Red River (from an older event)
Mississippi
Future ocean basins
Congo
Amazon
Convergent Boundaries
Ocean-Ocean Convergence

Deep-sea trench; volcanic island arc.
Mariana Islands
Marianas Trench

Philippine Plate
Pacific Plate
Convergent Boundaries
Ocean-Continent Convergence

A volcanic belt of mountains forms.
Convergent Boundaries
Continent-Continent Convergence

Crust crumbles, creating high mountains and a wide plateau.

Himalaya
Tibetan Plateau
Indian-Australian plate
Eurasian Plate
Transform-Fault Boundaries
Mid-Ocean Ridge Transform Fault

Spreading centers offset.
As plates move past each other...
...creek beds are offset.

San Francisco
San Andreas fault
Los Angeles

Transform-Fault Boundaries
Continental Transform Fault

Offset continental crust.

Accretion: Building a continent is accomplished by accretion. Accretion is the process by which new material is added to the edges of continents. This material may be new rock material added by subduction, island arcs developed away from the continents, or fragments of old continents.
Craton:
A craton is the ancient core of the continent. (Archean, older than 2.5 billion years, and Proterozoic, older than 550 million years). It is made up of metamorphic rock.
Continents are accreted from the middle outward.
North America is the best example of this because it has only one craton.
Virtually all the other continents are currently composed of several cratonic fragments.

Accretion by the addition of a buoyant fragment of crust.
This fragment may be:
1) An island arc (an older one not related to current subduction)
2) A fragment of another continent
3) Hot spot island
4) ?

Accretion of an island arc related to current subduction event.
Accretion by continent-continent collision followed by rifting. The Llano uplift, which is the hill country around San Antonio and Austin, may be a fragment of Africa which was attached to North America in this fashion.

Accretion by a transform fault. Much of Central America and the Yucatan may have been accreted in this manner.

The age of accretion of the continents. North America has a single craton. Most of the other are assemblages of many cratons.
The following frames show the assembly of the supercontinent Pangaea from a North American perspective.

**Assembly of Pangaea**

RODINIA Late Proterozoic, 750 Ma

Formed about 1.1 billion years ago; began to break up about 750 million years ago.

**Assembly of Pangaea**

Late Proterozoic, 650 Ma

The pre-Pangean pattern of continental drift.
Laurentia is an old continent that includes North America and Greenland.

**ASSEMBLY OF PANGAEA**
Middle Ordovician, 458 Ma

The pre-Pangean pattern of continental drift.

Baltica is now part of Eurasia.
Gondwana is an ancient supercontinent that was made up of most of the modern-day southern continents.

ASSEMBLY OF PA NGAEA
Early Devonian, 390 Ma

The pre-Pangea pattern of continental drift.

Late Mississippian (340 Ma)
Shelf and submerged continent
ASSEMBLY OF PANGAEA
PANGAEA (a) Early Triassic, 237 Ma

Assembled by 237 Ma.
BREAKUP OF PANGAEA
(b) Early Jurassic, 195 Ma

Signaled by the opening of rifts from which lava poured; relics can be found today in volcanic rocks from Nova Scotia to North Carolina.

BREAKUP OF PANGAEA
(c) Late Jurassic, 152 Ma

BREAKUP OF PANGAEA
(d) Late Cretaceous, Early Tertiary, 66 Ma
The modern world has been produced over the past 65 million years.

50 million years in the future