



19.4 Continental United States Geology

READ

You have learned about the plates that make up the surface of Earth. You have also learned how plates are formed at mid-ocean ridges and are destroyed at subduction zones. Here is a very brief look at how plate tectonics formed the land mass that we call the United States. It covers only the last chapter of the Earth history of the 48 contiguous states.

The full history of the surface of Earth is a very long and complicated story. To give you an idea of the difficulty of understanding the full story, imagine this: A young child is given a new box of modeling clay. In the box are four sticks of differently colored clay. The child plays with the clay for hours making different figures. First a set of animals, then a fort, and so on. Between each idea, the child balls up all of the clay. Now imagine that it's the next day and the ball of swirled clay colors is in your hand. Your task is to figure out what the child made and in what order.

That sounds impossible, and it probably is. The amazing thing is that geologists have figured out a lot of the equally difficult story of Earth's surface. We have a pretty good idea about how the early crust was formed. And we know that there was a super continent called Rodinia that formed before Pangaea, the last super continent. But like the child's clay figures, the further back we look, the more the clues are mixed up.

The last chapter

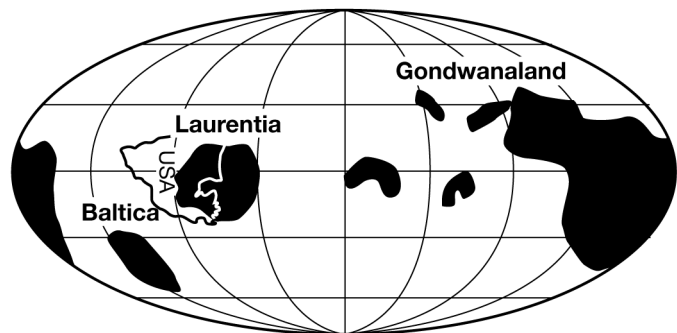
Our story begins late. Most of the history of Earth has already passed. During this time rift valleys formed that split continents into smaller pieces. First the land moved apart on both sides of a rift valley. Then, once the rift valley opened wide enough, water flooded in and a new ocean was born. Underwater, the rift valley then became a mid-ocean ridge.

At the same time, subducting plates acted like conveyor belts. Anything that was part of a subducting plate was carried toward the subduction zone. In this way continents were carried together. Collisions between continents welded them together. Mountain ranges formed at the point of contact.

The combination of rifting and subduction worked together to form, destroy, and reform the early continents. You can see that the result is very much like playing with modeling clay.

The craton

Even though most of Earth's history had passed, it was still an incredibly long time ago. Rifting had broken up Rodinia, but subduction had not yet formed Pangaea. The break-up of Rodinia left six continents scattered across the world oceans. These continents were not the continents that we see today. One of these, Gondwanaland, was larger than the others put together.



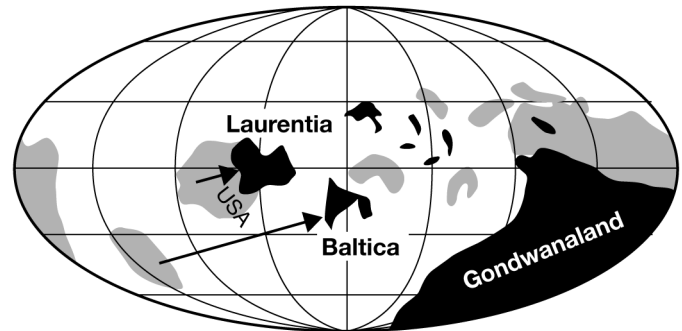


Two other continents are important to our story. They are called Baltica and Laurentia. At the center of Laurentia was a core piece that was very old even then. This core piece is called the craton. The craton had been changed again and again, but it was stable inside Laurentia. Today the craton of Laurentia forms the central United States.

You may wonder where these names came from. After all, these continents were gone many millions of years before humans appeared on Earth. They are modern names proposed and adopted by geologists.

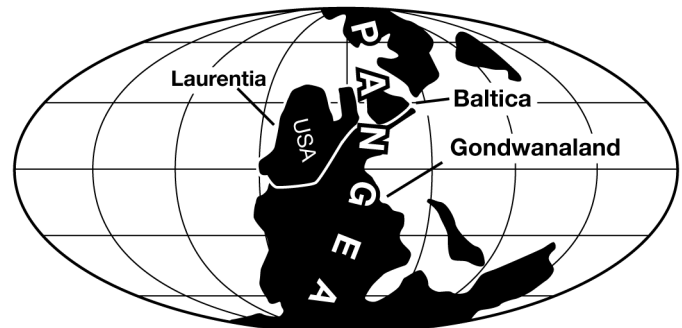
The first collision

Rifting and subduction caused Baltica to move in a jerky path. Eventually, Baltica collided with Laurentia to form a larger combined continent. This new continent is called Laurasia. A high mountain range formed where the colliding continents made contact. This mountain range lay deep inside Laurasia. Today the remains of this high mountain range form our northern Appalachian Mountains.



Gondwanaland collides

Subduction continued to bring continents together. Next mighty Gondwanaland was drawn ever closer to Laurasia. Gondwanaland collided just below where Laurentia and Baltica collided with each other. This new collision raised another set of mountains that continued the northern Appalachians into what are now the southern Appalachians. The combined Appalachians were as high as the Himalayans of today! The super continent Pangaea was then complete and the lofty Appalachian Mountains stood near its center.



Pangaea breaks up

Pangaea did not remain together for very long, only a few tens of millions of years. The same rifting process that broke up Rodinia split the new super continent into smaller pieces. Our future East Coast had been deep inside the central part of Pangaea. But in the break-up, a rift valley split our eastern shore away from what is now Africa. Instead of an inland place, our East Coast became an eastern shore.

The East Coast after Pangaea

One of the amazing things in geology is how quickly mountain ranges are eroded away. After Pangaea broke up, the Appalachians completely eroded away. All that was left was a flat plain! The sediments produced from this erosion formed deep layers on the eastern shore and near-shore waters. These coastal margin sediments make up most of the eastern states today. But wait a minute; today we see rounded mountains where there had been only flat plains. What formed the rounded Appalachian Mountains of today?



When a mountain is formed, some of it is pressed deep into the mantle by the weight of the mountain above. It's like stacking wood blocks in water. As the stack grows taller, it also sinks deeper. Erosion takes a tall mountain down quickly. With the top gone, its bottom rebounds back to the surface. In this way, the Appalachian Mountains that we see today are actually the rebounded lower section of the mountains that once had been pressed deep below Earth's surface.

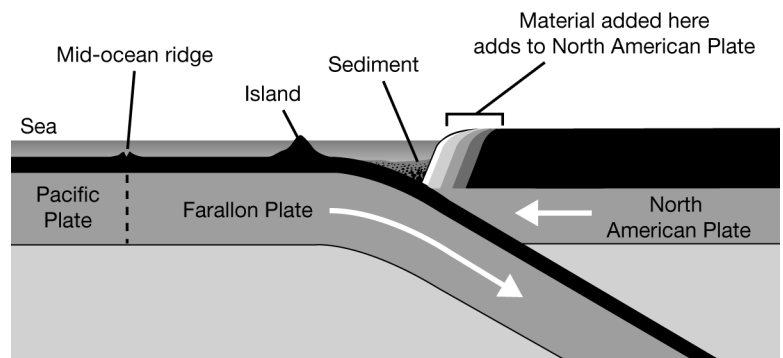
The West Coast and the Ancestral Rocky Mountains

There are two Rocky Mountain ranges. The first is called the Ancestral Rocky Mountains. The Ancestral Rocky Mountains were formed when subduction caused an ancient collision with Laurentia. The collision struck Laurentia on the side that would become our western states. In other words, the Ancestral Rocky Mountains already existed before Pangaea formed. The Ancestral Rockies were then heavily weathered and the sediment deposited on the surrounding plains. Today the Front Range of Colorado is part of the exposed remains of the Ancestral Rocky Mountains.

Pangaea and the West Coast

Our West Coast did not exist as Pangaea began to break up. The shoreline was near the present eastern border of California. What would become our West Coast states were sediments and islands scattered in the ocean to the west.

North America began to move westward as it was rifted apart from Pangaea. A subduction zone appeared in front of the moving continent. As the ocean floor dove under the westward-moving continent, these sediments, islands and even pieces of ocean floor became permanently attached to the continent. Our western shore grew in this way, forming the shape that we see today.



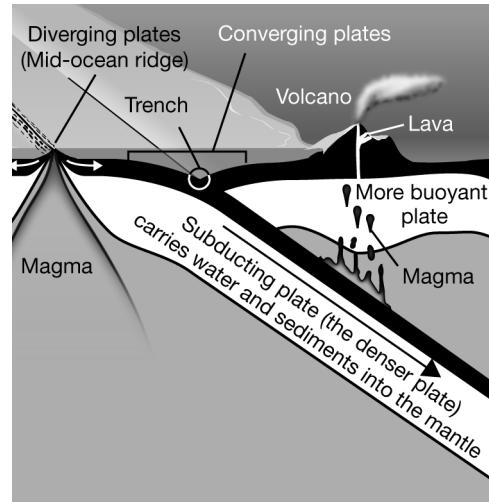
The modern Rocky Mountains

The mid-ocean ridge that was forming the subducting ocean plate was not too far away to the west. As the plate subducted, the mid-ocean ridge got closer and closer to the edge of the continent. This changed the way that the plate subducted. The result was that stronger push pressure caused the continent to buckle well back from its edge. In this way, the modern Rocky Mountains were formed near the remains of the Ancestral Rocky Mountains.



Inland volcanoes

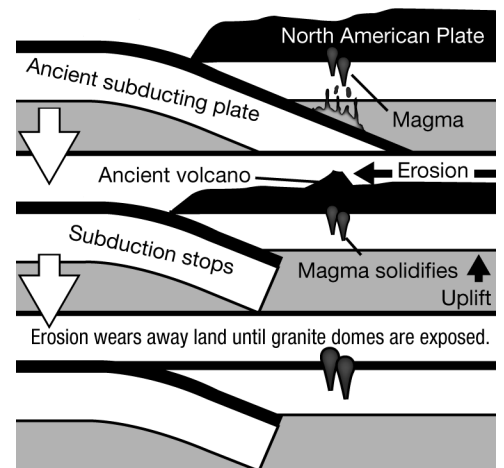
The subducting plate also caused volcanoes to form and erupt inland. These eruptions produced the Sierra Nevada Mountains to the south and High Cascades to the north.



A small plate disappears

The plate that had been subducting along the southern West Coast was small. Eventually it disappeared when its mid-ocean ridge was subducted. This changed the western edge of the United States from a converging boundary to a transform boundary. Now instead of one plate diving under another, the remaining Pacific Plate slides by the West Coast. Today this slide-by motion is well known as the San Andreas Fault.

When subduction stopped along the lower West Coast, the Sierra volcanoes became extinct. Magma cooled and solidified below the surface. Today this cooled magma is exposed as the domes of Yosemite National Park. Further north, the Pacific Plate is still subducting under the West Coast. That subduction continues to drive the volcanoes of the High Cascades.



The United States today

In geologic terms, the East Coast is quiet and the West Coast is active. The contiguous United States are part of the North American Plate. The active eastern boundary of the plate lies in the middle of the Atlantic Ocean, far from our East Coast. But the active western boundary is also our western shore. The San Andreas Fault slowly moves slivers of California northward. Baja California will eventually be attached to San Diego. Map makers won't have to redraw New England, but they will have to watch for West Coast changes. The good news is that they'll have plenty of time to make those changes.