Based on the presentation “Rise of the Colorado Plateau: Insights from recent geodynamic studies” by Scott Tarlow.

The rise of the Colorado Plateau has long baffled scientists. How do hundreds of square miles of rock, chronicling over a billion years of earth’s history, rise to be almost a mile above sea level? The key seems to lie in a process called “mantle induced uplift.”

First, a quick overview of everyone’s high school earth science course: the mantle is the extremely hot layer between Earth’s lithosphere, which includes the surface crust, and its core. The temperature difference between the cold lithosphere and hot core drives a circulation current in the mantle, much the same way that the temperature differences between the poles and the tropics drive some of the ocean’s currents and the atmospheric jet streams. When the mantle moves, Earth’s crust moves, albeit over millions of years. Keep in mind that the lithosphere under the oceans is denser than that which makes up the continents and, when oceanic and continental lithosphere collide, the ocean lithosphere will usually move beneath the continents in a process known as subduction.

Now that we all remember plate tectonics, let’s return to the Colorado Plateau. By bouncing sound waves under the continental plates, scientists can determine the relative densities of the rocks far beneath the surface and infer which regions originated from oceanic lithosphere and which are made up more of continental lithosphere. It turns out that deep beneath the region of the Colorado Plateau is extremely dense, thought to be the ancient remnants of an oceanic plate that moved beneath the continental lithosphere.

With this new-found knowledge that an ancient oceanic plate lies beneath the Colorado Plateau, scientists created a model that combined knowledge of the temperatures in the mantle with basic principles of physics. The model allowed them to calculate the velocities at which the oceanic plate likely moved beneath the continental plate. They determined that the velocity of subduction was initially fast, causing the continental crust to be dragged down. Then subduction slowed and the sinking oceanic plate flattened out, relieving pressure on the continental plate and causing it to bounce up (as much as gigantic slabs of lithosphere can bounce).

Eventually the oceanic plate moved entirely under the continental plate and the cold, dense hunk of crust sunk into the hot mantle. As it sunk and warm mantle moved in to replace it, the continental crust was buoyed up even more. This would explain the last bit of uplift that would bring the Plateau to its current elevation of 1.9km (more than a mile) above sea level. This entire process ended around 100 million years ago.

Seems like a fine enough story, right? Well, science is strongest when comparing multiple theories against each other. Another possible explanation for that last bit of uplift lies in the temperature differences between the cold, thick lithosphere of the Colorado Plateau and the relatively thinner and warmer lithosphere of the regions next door, known as the Basin and Range provinces. This difference in temperature could have caused the mantle to rise and replace the cold lithosphere under the Colorado Plateau with hot mantle, which would push up the continental crust even further.

UC Davis graduate student, Scott Tarlow, is more inclined to believe the first theory, citing the fact that this second explanation relies too heavily on overly simplistic 2-dimensional models and does not account for the three dimensionality of movement in the mantle.

The story of the rise of the Colorado Plateau remains an active area of research. Luckily for the rest of us, enjoying the big skies and natural beauty of the area does not require a graduate degree in geology and mantle physics. Though there is a certain power in imagining the grandiose processes of giant chunks of Earth’s crust sinking and rising right beneath your feet.