

## The “How” Behind the Geologic Uniqueness of the Grand Canyon and Colorado Plateau

The Grand Canyon is arguable one the United States’ most scenic wonders and a geologic paradise. Most people are quite familiar with its red-hued rock layers and its awe-inspiring depth and age. Less well known is the story of why these perfect striations are visible, mostly untouched by forces like mountain-building or massive erosion that would deform most rock layers. Although we think of this geologic abnormality as a feature of the Grand Canyon, it’s actually the Colorado Plateau, the huge area around the Four Corners of the Southwest, of which the Grand Canyon is just a part, which has escaped distortion and has survived through the millennia with its layers mostly intact.

What is the Colorado Plateau and how did its rocks escape the destructive tectonic forces that have shaped much of the visible geological landscape of the United States? This question was at the heart of Elaine Young’s presentation about the tectonic history underlying the structural and tectonic evolution of the Colorado Plateau. She began by outlining the setting the situation for the audience. In essence, the Plateau is a piece of Earth’s crust between the Rocky Mountains, the Great Basin of Utah and Arizona, the Mogollon Rim of Central Arizona and the Rio Grande valley in New Mexico. While these surrounding areas have been subject to fierce tectonic shifts, the 2 km high Colorado Plateau has an almost perfectly horizontal layers of rocks from 2 billion to 250 million years old. The rock layers of the Colorado Plateau began as sediments and lava flows deposited in shallow, coastal waters at sea level. When the Farallon Plate, a piece of Earth’s crust, began to dive under the North American Plate (near the current West Coast of the US) about 100 million years ago, the Colorado Plateau began to rise.

While it is not exactly known how this area was lifted, according to Young there are two possible hypotheses- either rocks were lost from the top or the bottom of the layers. If some rock layers were taken off the bottom, the remaining rock layers would rise in elevation, which Young described as similar to how “an iceberg rises if a section of it that was underwater breaks off”. This could happen if there was a “roll back” of the diving Farallon Plate or some “delamination”. If it was a roll back, the Farallon Plate took a steep dive towards the Earth’s molten interior which allowed hot, buoyant magma to flow under the North American Plate and drive it up. This hot magma could be likened to “boiling water that pushes up a piece of floating wood” said Young to the class of non-geologists. Alternatively, delamination involves the diving Farallon Plate and some of the lower crust of the North American detaching or “dripping off”, causing the remaining crust to buoy upward.

Alternatively, the second hypothesis is that the Colorado Plateau might have risen when the youngest layers of rock eroded away and the area shifted upward to compensate. This “unroofing” of the plateau may explain the absence of rocks younger than 250 million years old that are found in nearby Zion National Park. Somehow the Colorado Plateau rose, either from the erosion of these young rock layers or the breaking off of heavy lower plates that buoyed the land upward.

So we know the ways the Plateau might have rose, but how did the Grand Canyon come to be, revealing its geologic bounty? According to Young, scientists think that the Colorado

River may have begun cutting a channel through the rocks 70 million years ago or 6 million years ago, or maybe both. These estimates are based on the dating of certain crystals found in the rock layers that only form at specific temperatures. And although most of the rock layers are well-preserved horizontally, some rocks are offset due to slipping or sliding at active fault lines that bisect the area. This can be easily seen in the canyon, where rock layers are offset on a canyon wall.

Elaine was quick to point out that though these geologic shifts have drastically altered the region, humans are shaping the Grand Canyon at a rate unprecedented in geologic history. The damming of the Colorado River at various points is altering the landscape in ways that took nature millions of year to do, Elaine described.

While most tourists are awed by the size, color and beauty of the Grand Canyon, its unique history and the events that led to its intact layers is perhaps even more interesting. Hopefully the modifications humans are making to the region do not distort the natural beauty of the canyon that's billions of years in the making.