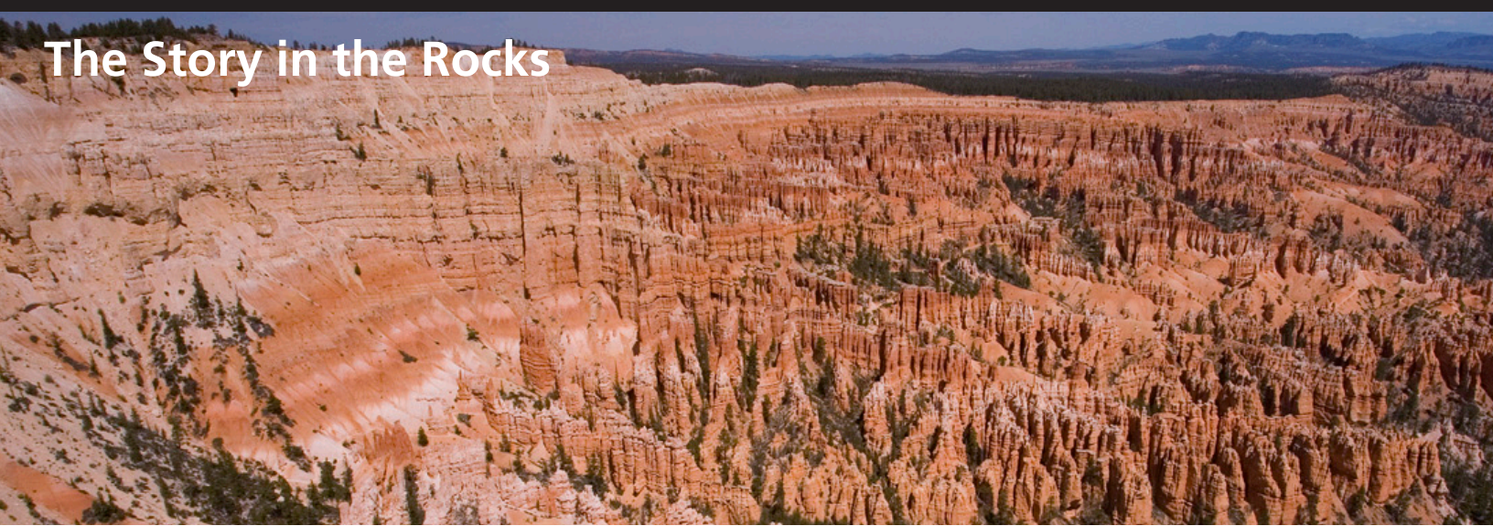
Bryce Canyon

National Park Service
U.S. Department of the Interior

Bryce Canyon National Park



The Story in the Rocks

The geology of Bryce Canyon is a story rich with change and the exciting interaction between nature's forces. The creation of the unique landscape that makes Bryce Canyon famous began between 35 and 55 million years ago, when much of southern Utah was covered by braided rivers and streams, and later by a system of lakes. However, the story really begins millions of years before.

The Top of the Stairs

In the preface to Clarence E Dutton's *Report on the Geology of the High Plateaus of Utah* (1880), John Wesley Powell wrote "These cliffs are bold escarpments hundreds and thousands of feet in altitude - grand steps by which the region is terraced." Powell was describing a series of cliffs we now know as the Grand Staircase, visible from the Kaibab Plateau north of the Grand Canyon. Each of Powell's steps represents a different period of geologic history, beginning 260 million years ago in the Permian. A low lying set of cliffs of Lower Triassic-aged marine sediments make up the first riser in the staircase, the Chocolate Cliffs. The Vermilion Cliffs are the second step and consist of Middle to Upper Triassic marine, river, and swamp sediments. The third step has its origins in a vast desert from the Lower Jurassic, larger than the present day Sahara, known as the White Cliffs and dominated by the Navajo Sandstone formation.

The oldest rocks exposed at Bryce Canyon are from the Lower Cretaceous, when most of North America was under water. The Dakota Formation, Tropic Shale, and Straight Cliffs Formation are marine sediments associated with the Western Interior Seaway. These rock layers, along with the slightly younger Wahweap Formation, are the Gray Cliffs, covering a span of time from 100 to 75 million years ago, are the fourth step in the staircase. The Pink Cliffs of the Claron Formation are the fifth and final step.

Four of the Grand Staircase's five steps

Setting the Scene

One of the most significant factors in the creation of many of the landscapes seen in western North America is the subduction of the Pacific Oceanic Plate (originally the Kula and Farallon Plates) beneath the North American Continental Plate. For millions of years the western portion of the continent had been at or below sea level, and the forces of this ongoing collision between plates are responsible for the west's higher elevations that exist today. Beginning in the middle to late Jurassic a mountain building event took place, the Sevier Orogeny, in what is now eastern Nevada and western Utah. As this period of uplift was winding down, interaction between the plates continued and the Laramide Orogeny began during the Cretaceous, uplifting the mountain chain we call the Rockies. Between these mountain ranges a large basin formed, creating a perfect place for snowmelt and rain runoff to collect.

Watery Beginnings

With well formed mountain ranges lying to the west and east, rivers and streams flowed into the basin below and, from what is now southern Utah up to Wyoming, a chain of lakes formed. The southernmost of these lakes has been named Lake Claron, the name having been derived from a mountain in western Utah - Mount Claron - where the *Claron Formation* was first described (in geologic terms, the *type locality*). Water is one of the most powerful forces on Earth, and as rain fell and snow melted, it began to take apart those mountain ranges, grain by grain. These grains became the sediments that would collect on the lake's bottom.

Early on, as water first began to flow into the basin, what existed here was probably more marsh-like than an actual lake. Silts and muds were carried into the basin by the rivers and streams, along with minerals like iron and manganese. The roots of plants living in this marsh help to oxidize these minerals, contributing to the spectacular colors visible today. The Lower Pink Member of the Claron Formation gets its

Watery Beginnings
(continued)

distinctive pink color from iron oxides, with veins of dark blue to purple caused by manganese oxides. In addition, the waters were also rich in calcium carbonate, which comes from dissolved limestone and, once the sediments dry out, becomes the glue that bonds the grains together, forming rock.

Within the Pink Member there are also thin layers of gray rock that are not continuous, suggesting there were periods where this marshy landscape had dried and was instead dotted with many ponds. Indications are that these ponds were salty or highly mineralized, with nothing able to survive in them except cyanobacteria (blue-green algae). By enriching the sediments with magnesium the algae extracted from the water, they helped to create dolostone, an important piece of the puzzle in the formation of hoodoos.

Later, as the basin began to fill, a large lake with fresher water appears to have formed. The Upper White Member of the Claron Formation is not iron-rich like the Lower Pink Member and lacks the distinctive color.

Utah region 50 million years ago. Sediment eroded from mountains in Northwestern Utah was deposited in a lake and lithified (turned to stone).

Geologists are not certain exactly when the lake, ponds, and marshes were here, but can date the underlying and overlying layers with great precision. Around 55 million years ago the Claron Basin began to fill and, by 35 mya, the lake disappeared. While rocks can tell many stories, one left untold is whether Lake Claron drained out of the basin, or it simply dried up. That part of the geologic record eroded away, and has left the question unanswered.

Uplifting Experiences

With the lake dry and sediments solidifying to become rock, another event must take place before hoodoos can begin to form. Around 15 Mya the same plate tectonics responsible for mountain building begin to act on the land. Over the next 10 million years the land would rise nearly a vertical mile, creating the 140,000 square mile Colorado Plateau. In this portion of the Colorado Plateau the underlying bedrock would break and form deep faults that split the plateau apart, creating seven blocks separated by these faults. As the tectonic forces that were pushing up the Colorado Plateau continued to act, these seven blocks were pushed up even further, creating Utah's High Plateaus Region. One of these blocks became what we call the Pausaugunt Plateau, and it is along this plateau's eastern edge that Bryce Canyon is being formed.

How to Make a Hoodoo

The Paria River and its tributaries have eroded away several thousand feet of bedrock between Bryce Canyon and the Table Cliff, 15 miles to the east, exposing the rocks of the Gray Cliffs that lie below. Running parallel along the eastern edge of the park boundary is the Paunsaugunt Fault, and the colorful hoodoos and badlands that make the park famous are being formed as the plateau's edge erodes westward from this fault.

During periods of uplift, earthquakes created fractures and joints within the bedrock. More than 200 days each year temperatures at Bryce Canyon rise above freezing during the day, then drop to well below freezing at night. With annual snowfall totals of up to 8 ft./2.6 m, snow will melt and find its way into those fractures and joints. When the melted snow refreezes at night, the ice begins to break the rock apart. Summer monsoonal rains then carry away the debris. The rain also eats away at the plateau's edge until it encounters one of the harder dolomitic limestone layers. Rather than carry this rock away, it flows around this layer, eventually forming a fin. Within these fins, freeze-thaw cycles continue to carve the rock, forming openings in the fins called ice windows. As the seasons come and go, these windows eventually become so large that the top of the window collapses – along with its protective layer of harder dolomitic limestone. Additional windows form in the fin and also ultimately collapse until the long, flat topped fin becomes a row of hoodoos. Most hoodoos are still capped by this protective layer of dolomitic limestone, helping to preserve them for thousands of years.

An ice window (circled) has formed along a joint in a fin near Sunset Point; to the left is a collapsed window along another joint - the beginnings of a new hoodoo.

All Good Things Must Come to an End

The relentless force of water never stops carving away at the Claron Formation. Each year many tons of rock are cracked and broken away during the winter, then the summer monsoons dissolve the calcite bonding them together. The Paria River and its tributaries carry these sediments to the Colorado River, where they will become new sedimentary layers down river. The eastern edge of the Pausaugunt Plateau marches steadily toward the East Fork of the Sevier River, currently draining the upper reaches of the plateau. In approximately 3 million years the plateau's edge will breech the river, its waters carrying away what remains of Bryce Canyon in a relatively short period of geologic time. The water will then begin to attack the Gray Cliffs that lie below, the next victim in the never ending cycle of deposition and erosion.