The Landscape

The grandeur of Grand Canyon lies not only in its size, but also in the beauty of its landscape. In this respect, Grand Canyon shares many characteristics with its neighbors—Zion, Bryce, Canyonlands, Arches, and Capitol Reef national parks. Like Grand Canyon, these neighboring parks lie within the geologic province known as the Colorado Plateau, a region characterized by mostly flat-lying sedimentary rocks that have been raised thousands of feet above sea level, then carved by erosion.

Landforms here are beautifully sculpted and well exposed due, in part, to climate. The semi-arid climate that predominates in the Southwest means that instead of tree-covered slopes and thick soils, bedrock is at the surface. Therefore, rain does not soak into the ground; instead it runs off in huge floods carrying away grains of rock. Cycles of freezing and thawing in the winter widen cracks in the rocks, eventually producing rockfalls. Soft layers erode more rapidly undermining the hard layers above. Bit by bit, flash flood by flash flood, and rock fall by rock fall, the canyon continues to grow.

Each of the rock units in the canyon erodes in its own manner, yielding the characteristic stepped-pyramid look of the canyon. Shales erode to slopes, while harder sandstones and limestones tend to form cliffs. The extremely hard metamorphic rocks at the bottom of the canyon produce the steep-walled and narrow Inner Gorge, as these rocks are more resistant to erosion than the softer sedimentary rocks above.

Color is also an important feature of this landscape. Many of these colors are due to the presence of small amounts of iron oxides and other minerals that are either in the rock itself or stain the surface and mask the true color of the rock.

The River Below

The Colorado River flows 277 river miles (446 km) from Lees Ferry to the Grand Wash Cliffs, the accepted beginning and end of Grand Canyon. Hidden in the narrow Inner Gorge, the river is visible from only a few spots along the rim.

Toroweap Overlook in western Grand Canyon offers visitors a stunning view of the Colorado River.

From the rim, the river looks puny, yet it averages 300 feet (90 m) wide and features a series of fierce rapids. From its origins high in the Colorado Rockies, the river drops more than 12,000 feet (3,700 m) and passes through a series of canyons, including Grand Canyon, on its 1,450-mile (2,300 km) journey to the Gulf of California.

The name Colorado is derived from Spanish for reddish, reflecting the heavy sediment loads the river once transported. Dams now bracket Grand Canyon—Glen Canyon Dam (Lake Powell) upstream and Hoover Dam (Lake Mead) downstream. As a result of these dams, the dynamics of the Colorado River through Grand Canyon changed dramatically. Gone are the large annual floods that carried hundreds of thousands of tons of sediment through the canyon each day.

Today, the Colorado is seldom its natural muddy red-brown color. Only when tributaries downstream from Glen Canyon Dam, such as the Paria and Little Colorado rivers, contribute significant amounts of sediment during flash floods or spring snowmelt, does the river change from clear blue-green to its natural reddish-brown.

The North Rim

The North Rim and the South Rim are only separated by ten miles (16 km) as the raven flies. Although it is not apparent, the north wall of the canyon rises a thousand feet (305 m) higher than the South Rim, giving the North Rim nearly twice the annual precipitation as South Rim. This considerable difference in elevation results from the fact that the apparently flat-lying rocks of the Kaibab Plateau are dipping gently to the south.

Expansive views from Cape Royal on the North Rim

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National Park Service
U.S. Department of the Interior

Grand Canyon National Park

Journey Through Time:
Grand Canyon Geology

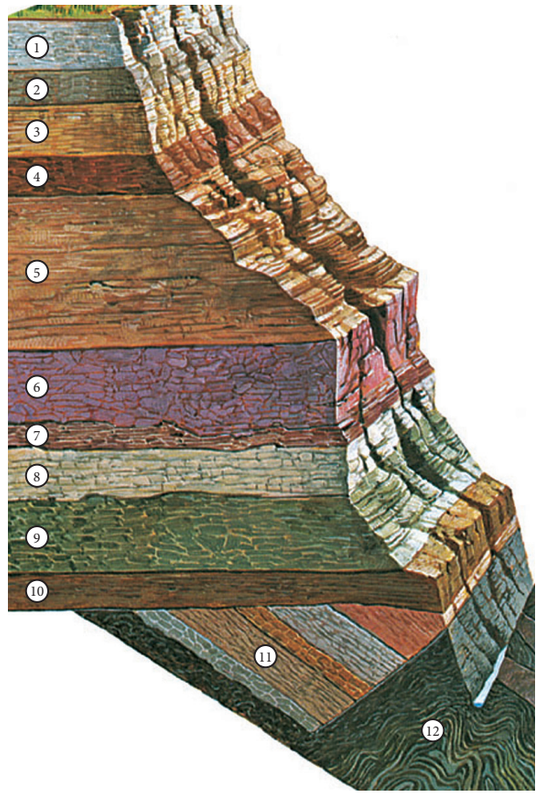
The Geologic Record as Told by the Rocks

Nowhere on this planet are the scope of geologic time and the power of geologic processes as superbly and beautifully exposed as in these canyon walls. Rocks equivalent to many of these strata may be found scattered throughout the United States and flowing water has sculpted other landscapes. Yet, at Grand Canyon, a remarkable geologic assemblage is exposed in sequence and intact in an amazing erosional landscape.

The canyon walls reach about 5,000 feet (1,500 m) below the rim to the river. The thickness of all Grand Canyon rocks, if present in one spot, would total more than 15,000 feet (4,600 m). Some rock units, however, appear only in some parts of the canyon. The strata of Grand Canyon do not present a continuous record of Earth's history. Some rock layers eroded away before newer layers were deposited on top, producing unconformities, millions of years of missing time, and unknown geologic stories.

Each rock layer represents a period when a particular environment of deposition prevailed. For example, the Kaibab Formation, the rock that makes the canyon rims, is the youngest of Grand Canyon's layers. The Kaibab Formation formed in shallow, warm seas about 270 million years ago, a bit before dinosaurs roamed the Earth. Below the Kaibab Formation caprock, the strata become progressively older.

The oldest rocks lie more than 3,000 feet (900 m) beneath the rim in the walls of the Inner Gorge. The Vishnu basement rocks consist of ancient igneous and metamorphic rocks that formed deep in the Earth when island arcs collided with the continental mass. These crystalline rocks—schist, gneiss, and granite—are very different in origin and structure than the sedimentary rocks above them. The Vishnu basement rocks, including Vishnu Schist, are between 1,840 and 1,680 million years old.



Geologic Cross Section of Grand Canyon

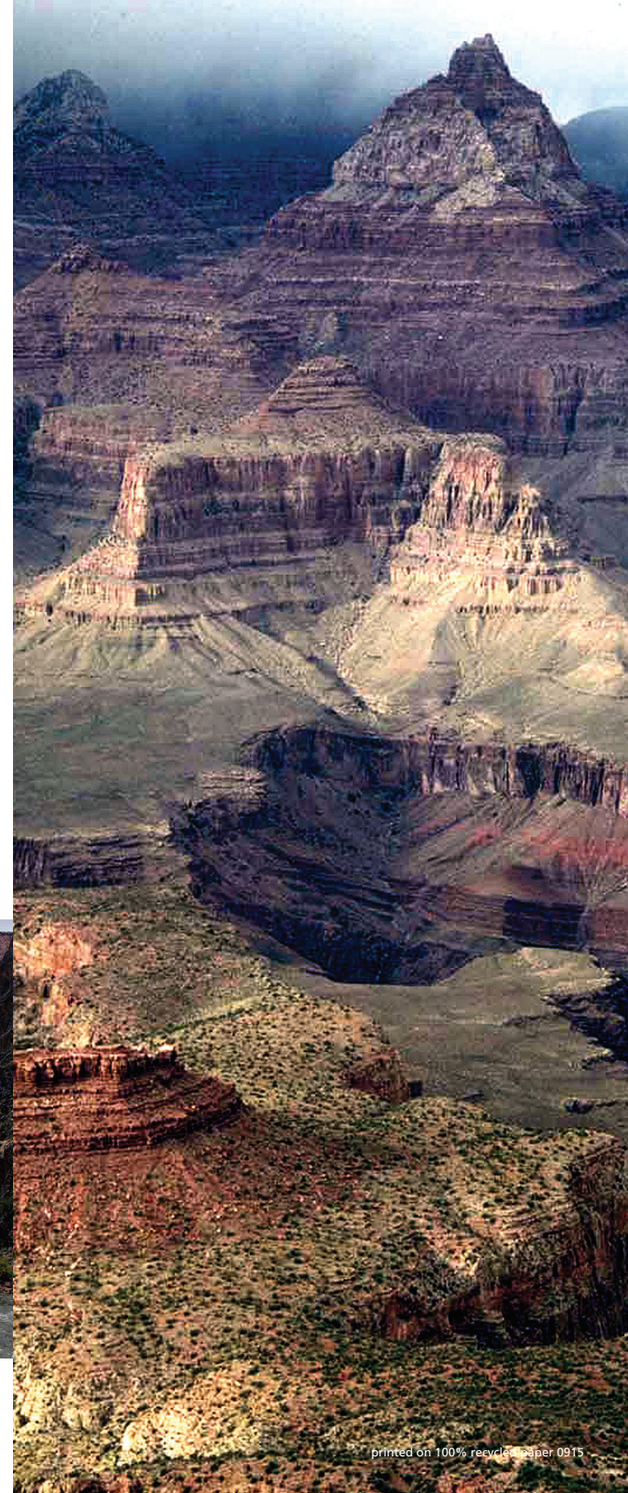
1 . Kaibab Formation . . . . . 270 my
2 . Toroweap Formation . . . . . 273 my
3 . Coconino Sandstone . . . . . 275 my
4 . Hermit Formation . . . . . 280 my
5 . Supai Group . . . . . 315–285 my
6 . Redwall Limestone. . . . . 340 my
7 . Temple Butte Formation . . . . . 385 my
8 . Muav Limestone. . . . . 505 my
9 . Bright Angel Shale . . . . . 515 my
10 . Tapeats Sandstone . . . . . 525 my
11 . Grand Canyon Supergroup. . . 1,250–650 my
12 . Vishnu basement rocks . . . . . 1,840–1,680 my

Canyon Origins

Although the origin of Grand Canyon is complex and not totally deciphered, the forces that shaped it are well understood. Grand Canyon is the result of erosion, specifically incision by a river into a high, arid plateau. The Colorado River carved the depth of the canyon as it cut its way through the Kaibab Plateau which is more than 7,000 feet (2,100 m) above sea level. Side canyons, scoured by summer thunderstorms and winter snow melt, produce much of Grand Canyon's 10–16-mile (16–22 km) width.

Compared to the rocks exposed in its walls, Grand Canyon is geologically young. Excavation of the canyon occurred within the last six million years or so. The question of how the Colorado River evolved its present course is still unresolved, even though geologists have hypothesized for years about how the river first established its path across the plateau and carved this immense chasm. Much of the uncertainty regarding the exact age and history of the canyon centers on the reality that we have only scattered bits of evidence to reconstruct its history and to precisely date its origin. The history of the Colorado River is complex and will be the subject of geologic research for years to come.

Vishnu basement rocks line the walls of the Inner George.



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