

GRAND CANYON

The Grand Canyon is a steep-sided canyon carved by the Colorado River in the United States in the state of Arizona. It is contained within and managed by Grand Canyon National Park, the Hualapai Tribal Nation, and the Havasupai Tribe. President Theodore Roosevelt was a major proponent of preservation of the Grand Canyon area, and visited it on numerous occasions to hunt and enjoy the scenery. It is considered one of the Seven Natural Wonders of the World.

The Grand Canyon is 277 miles (446 km) long, up to 18 miles (29 km) wide and attains a depth of over a mile (6,000 feet or 1,800 meters). Nearly two billion years of the Earth's geological history has been exposed as the Colorado River and its tributaries cut their channels through layer after layer of rock while the Colorado Plateau was uplifted. While the specific geologic processes and timing that formed the Grand Canyon are the subject of debate by geologists, recent evidence suggests the Colorado River established its course through the canyon at least 17 million years ago. Since that time, the Colorado River continued to erode and form the canyon to its present-day configuration.

For thousands of years, the area has been continuously inhabited by Native Americans who built settlements within the canyon and its many caves. The Pueblo people considered the Grand Canyon ("Ongtupqa" in Hopi language) a holy site and made pilgrimages to it. The first European known to have viewed the Grand Canyon was García López de Cárdenas from Spain, who arrived in 1540.



How was the Grand Canyon formed? The truth is that no one knows for sure though there are some pretty good guesses. The chances are that a number of processes combined to create the views that you see in today's Grand Canyon. The most powerful force to have an impact on the Grand Canyon is erosion, primarily by water (and ice) and second by wind. Other forces that contributed to the Canyon's

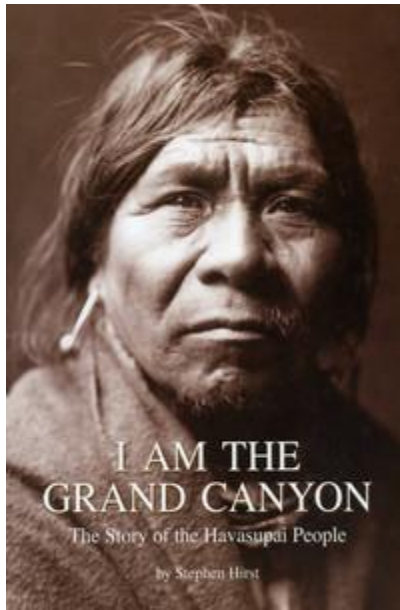
formation are the course of the Colorado River itself, vulcanism, continental drift and slight variations in the earth's orbit which in turn causes variations in seasons and climate.

Water seems to have had the most impact basically because our planet has lots of it and it is always on the move. Many people cannot understand how water can have such a profound impact considering that the Canyon is basically located in a desert. This is one of the biggest reasons that water has such a big impact here. Because the soil in the Grand Canyon is baked by the sun it tends to become very hard and cannot absorb water when the rains come. When it does rain the water tends to come down in torrents which only adds to the problem. The plants that grow in the Grand Canyon tend to have very shallow root systems so that they can grab as much water as possible on those rare occasions when it does rain. Unfortunately these root systems do nothing to deter erosion by holding the soil in place. Now you've got lots of water, no place for it to go, but down to the Colorado River, and nothing holding the soil and rock in place. The result is frequently a flash flood roaring down a side canyon that can move boulders the size of automobiles, buses and even small houses.

After erosion by liquid water the next most powerful force is probably its solid form, ice. In the colder months, especially on the north rim, water seeps into cracks between the rocks. These cracks can be caused by seismic activity, or by the constant soaking and drying of the rocks. When the water freezes it expands and pushes the rocks apart and widens the cracks. Eventually rocks near the rim are pushed off the edge and fall into the side canyons. These rocks sometimes hit other rocks and are stopped but on occasion one fall by a large rock will cause a cascading effect and create a rock fall that will alter the landscape drastically in the side canyon. Debris from rock falls piles up at the bottom of the side canyons and is then carried down to the Colorado River the next time there is a flash flood. Rock falls frequently take out sections of trail in the Grand Canyon requiring the Park Service to close these trails until they can be repaired.

Once the ice had pushed the rocks off the edge and the water in the flash floods has carried them down to the river, then the Colorado itself takes over. The erosive action of the Colorado has been severely constrained by the building of the Glen Canyon Dam, which ended the annual spring floods, but there is still a lot of water flowing relatively quickly through a very narrow gorge. Before building the dam the Colorado River had spring floods that would exceed a flow rate of 100,000 CFS. All of that snow melting in the Colorado Rockies came pouring down through the Grand Canyon in May and June, every year, like clock-work. These spring floods were considerably larger than today's "trickle" of 8,000-10,000 CFS at low water and even the 20,000 CFS peak flow rates.

The Colorado's spring floods used to carry away all of the debris that was deposited in the main channel by the flash floods, but today's mediocre flow rates have a tough time doing the job. It still gets done to some extent, it just takes a lot longer. In the process of moving the rocks and sediment down the river to the Pacific Ocean the bed of the river is scoured by all of this fast moving debris which slowly eats away at the banks and bed of the river. This causes the river to widen and cut down deeper into the lower rock layers. Another cause for the slowing of the erosive force of the Colorado River is the fact that it is now trying to cut through harder granites and schists found at the bottom of the Canyon instead of the softer limestones, sandstones and shales near the top. This rock takes a lot longer to erode and a slower moving river means it takes even longer.



The Havasupai, like all indigenous groups impacted by tourism, have been forcibly displaced and allotted only a small portion of traditional lands. By 1919 with the establishment of the Grand Canyon National Park, the tribe was restricted to 518 acres, five miles wide and 12 miles long in a side canyon. At that point, the Havasupai were rounded up and driven out of their ancient homeland. Havasupai houses were destroyed and the U.S. Forest Service filled in their water wells. Many Havasupai died as a result of this traumatic experience. After years of court battles, in 1974 the Havasupai were returned a portion of their former homelands.

Four million visitors come to the Grand Canyon each year, and 20,000 venture the six-mile deep canyon to the Havasupai Reservation. Most of those people who go to the bottom are hikers, scout groups, adventurers, and the very curious. There is a \$15 per person hiking fee that goes into the tribal coffers and is used for the entire community.

The Havasupai continue to deal with the heavy impacts of tourism, primarily noise pollution from the many helicopters and planes that fly over the canyon. They have joined other tribes and environmental groups to oppose the noise and its effects on the canyon and nearby lands. Liquid waste, especially during the tourist season, is an enormous problem with campsite toilets. Recently the National Park Service installed solar toilets, but tourists damaged them by using them for garbage. Erosion on the trail from the village to the campground is increasing. Wildlife on the mesa and in the canyon is affected by increased tourism. A major area of concern focuses on what is termed "prehistoric Havasupai" sites that are in the nearby government forest areas. Currently, the Havasupai Elders are working to determine which of these are sacred areas and must be kept from outsiders.



The most serious management issue is that of tourism. Visitation increased dramatically in the late 1980s causing traffic congestion and crowding at popular daytime attractions. The present four to five million annual visitors, their vehicles and wastes, are gradually degrading the Park's resources both natural and cultural. Alien flora and fauna which compete with and sometimes exclude native plants are being systematically extirpated although they number 171 species; and campaigns have been needed to eliminate the feral burros and introduced trout. Destructive fires are reduced by thinning the forests which will allow the beneficial use of controlled burns. The air quality is affected by coal-powered plants in the region and copper smelters in Northern Mexico; regional haze results which can cut visibility by two thirds. The construction of Glen Canyon dam upstream noticeably reduced the rate of water flow and the amounts of silt and sediment carried down the Colorado, lowering the rate and pattern of sediment aggradation and the camping beaches used by river-runners; it has also affected the breeding of sediment-adapted native fish and reproduction of flood-dispersed cottonwoods, favoring invasion by exotic clearwater fish and the proliferation of tamarisk. Other intrusions have included trespassing cattle, now fenced out, commercial interests, mining, and aircraft overflights which are now limited.

