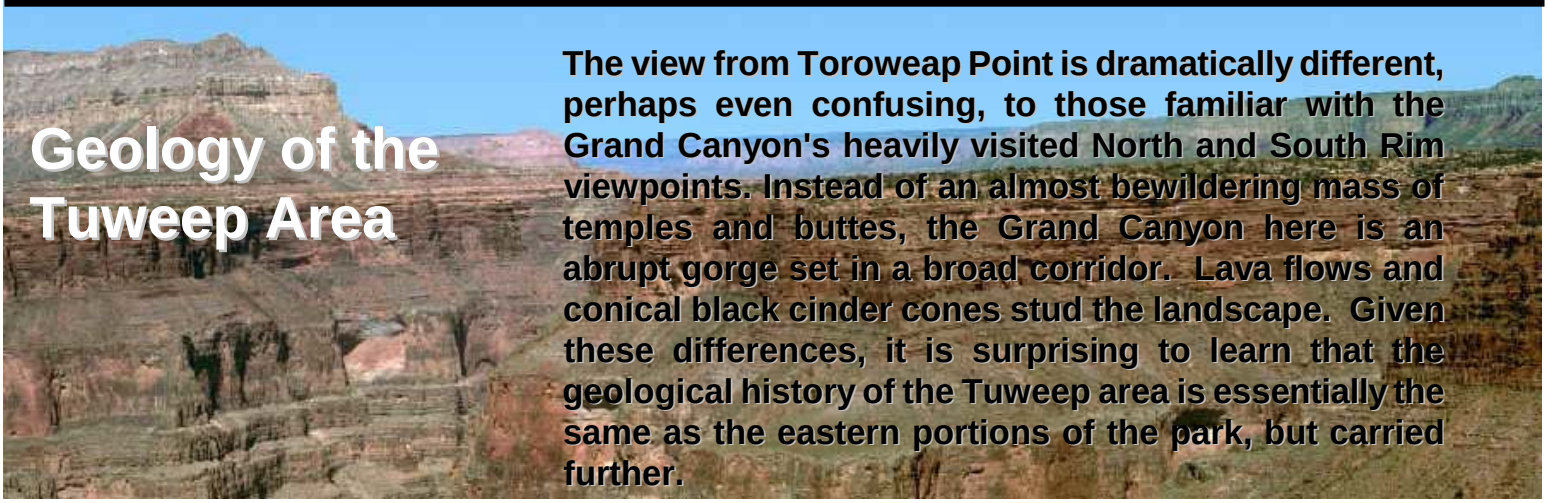
# Grand Canyon

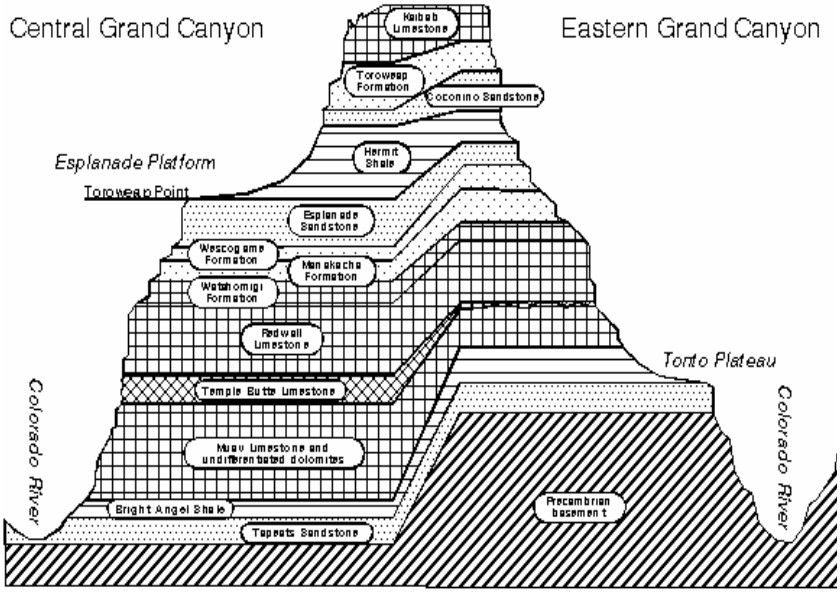
National Park Service
U.S. Department of the Interior

Grand Canyon National Park
Arizona



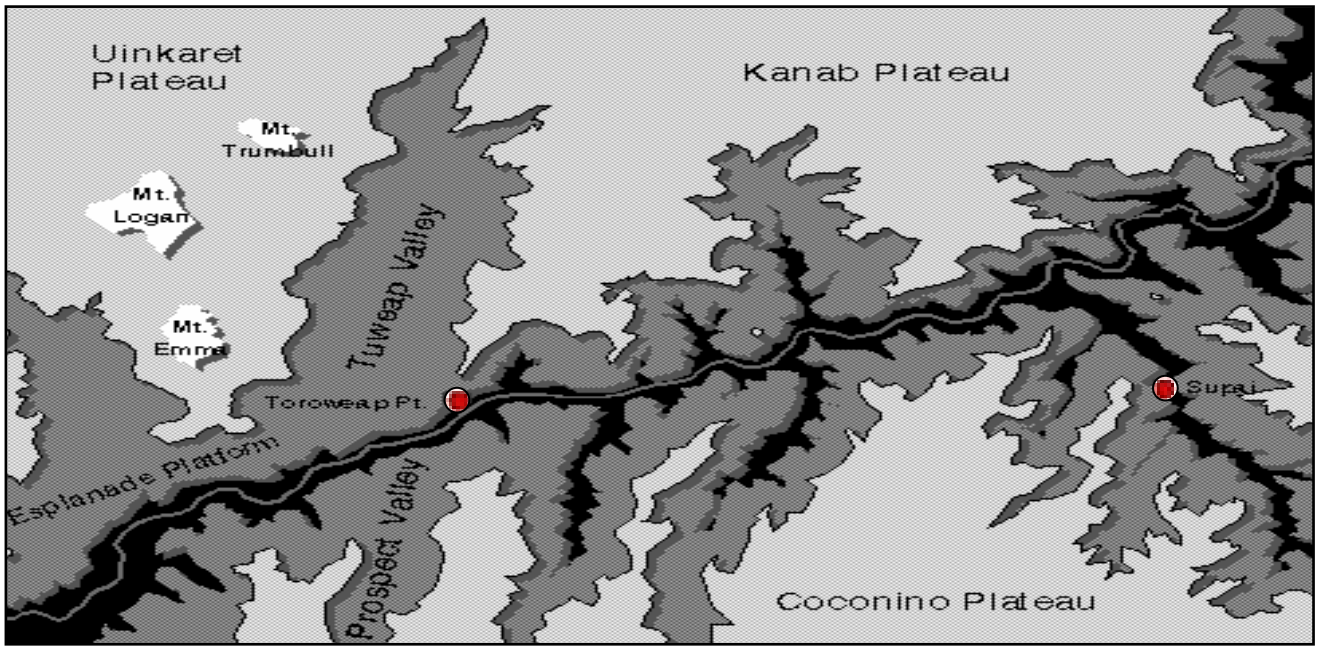
## Geology of the Tuweep Area

**The view from Toroweap Point is dramatically different, perhaps even confusing, to those familiar with the Grand Canyon's heavily visited North and South Rim viewpoints. Instead of an almost bewildering mass of temples and buttes, the Grand Canyon here is an abrupt gorge set in a broad corridor. Lava flows and conical black cinder cones stud the landscape. Given these differences, it is surprising to learn that the geological history of the Tuweep area is essentially the same as the eastern portions of the park, but carried further.**




Below Toroweap Point, the Colorado River has not yet cut into the Canyon's oldest rocks. They disappear 43 miles upstream at the foot of the Middle Granite Gorge, and do not reappear for another 11 miles downstream. However, the Layered Paleozoic rocks that compose the temples of the eastern Canyon are here at Tuweep. From 525 million years ago until 270 million years ago, the forerunner of today's Pacific Ocean alternately advanced and retreated from northwestern Arizona. Low-lying landscapes dominated: deltas, lagoons, swamps, shoals, and shallow seas. Since the seas advanced from the west, the Tuweep area was more likely to be under these seas. Thicker layers of marine limestone formed here, while coastal mud and sand were deposited to the east. As a result, limestone cliffs dominate the Canyon walls near Tuweep, replacing many of the terraces seen in the east. The major exception to this pattern lies in the deep red mudstones of the Hermit Shale. Less than 100 feet thick near Grand Canyon Village, the Hermit thickens dramatically to the west. In the Tuweep area, it is 800 feet thick. Erosion of this thick, soft layer has formed the broad Esplanade Platform (just as erosion of the soft Bright Angel Shale forms the Tonto Plateau of eastern Grand Canyon). Although hints of the Esplanade can be seen from the North and South Rims, it grows to dominate the Canyon's profile about 65 miles upstream from Toroweap Point. The Esplanade Platform continues downstream to the Canyon's mouth at the Grand Wash Cliffs.

The volcanoes dotting the landscape around Tuweep are features unique to this section of the Grand Canyon. Beginning eight million years ago[1], molten lava erupted from hundreds of vents. Some lava erupted before the Grand Canyon existed. Rather than flowing south, into what is now the Canyon, these early lavas flowed north. As the flows cooled into basalt, they preserved fragments of the ancient landscape under a hard cap. Today, these old flows cap Mounts Trumbull, Logan and Emma, the highest peaks of the Uinkaret Mountains to the west. Younger eruptions occurred as the Canyon was carved. Lava filled side canyons, flowed down the Grand Canyon, and created huge dams across the Colorado itself.




The flat floors of the Toroweap Valley and Prospect Valley south of the Colorado, are themselves the result of these eruptions. Millions of years ago, deep side canyons drained into the Colorado through both valleys. Lava flows followed the same downhill paths, and gradually filled both side canyons with flow after flow of lava. Between eruptions, lake mud and windblown silt and sand accumulated in the basalt-choked canyons. Eventually, sediments and lava flows filled both canyons to the level of the Esplanade Platform. Today, Toroweap Valley is still broad and flat, but erosion has begun to re-excavate Prospect Canyon. A short steep canyon now cuts from the Esplanade Platform down to the Colorado River. Indeed, this new Prospect Canyon is so steep that the occasional flash flood or debris flow can carry huge boulders down to the Colorado. This fan of debris creates Lava Falls, the biggest of the 360 rapids in the Grand Canyon. The forces of erosion are still hard at work here. On March 6, 1995, geologists camped at Lava Falls witnessed a debris flow in Prospect Canyon that filled half of the Colorado's channel with rocks and boulders. Within a day, the River had removed about half the constriction. Constant renewal of Lava Falls by these debris flows will maintain its fierce reputation with river runners for a long time!

As lava spilled from volcanoes on the Plateau, there were times it completely blocked the Colorado's course. Geologists have identified at least 13 lava dams across the Colorado. The highest and oldest of the dams formed 518 ± 22 thousand years ago[2]. Today, scraps of basalt from this "Prospect Dam" still cling to the Canyon walls below the Toroweap. At its maximum, "Prospect Lake" may have extended upstream hundreds of miles, well past Moab, Utah (the crest of modern Glen Canyon Dam would have been 250 feet underwater)! Twelve more lava dams blocked the river, but none were as high as the Prospect Dam. The Colorado eroded the dams quickly, generally in the order of a few thousand years. At least a few of the dams failed catastrophically, sending floods of water and boulders hundreds of feet deep surging through the western Grand Canyon. However, one dam remains athwart the River's old course, four miles downstream from Lava Falls. Instead of carving away the dam, the Colorado excavated a new gorge around it to the south. The dam remains in place, a memorial to these massive structures, and a reminder of the Colorado's incredible carving ability.

Today, the landscape looks quiet. But the fresh appearance of the lava flows cascading down the Canyon walls is no illusion. The youngest eruptions in the area are only 1,000 years old[3] - an eye blink in geologic time! In all, the volcanoes of the Tuweep area add a fascinating, and much younger chapter to the Grand Canyon's geologic story.

---

1 Establishing a beginning of volcanism in the western Grand Canyon is problematic - there are volcanic rocks as much as 19 million years old. In the Tuweep Valley, the oldest is the basalt flow capping Mount Trumbull, dated at 3.67 ± 0.07 million years.

2 Crowe, R.S. et al., 2008 "History of Quaternary volcanism and lava dams in western Grand Canyon based on LIDAR analysis, $^{40}Ar/^{39}Ar$ dating, and field studies: implications for flow stratigraphy, timing of volcanic events and lava dams" *Geosphere* Vol. 4 pp 183-206

3 Young, R.A. (editor), 2000, "Abstracts for a Working Conference on the Cenozoic Geological Evolution of the Colorado River System and Erosional Chronology of the Grand Canyon Region", p. 101