



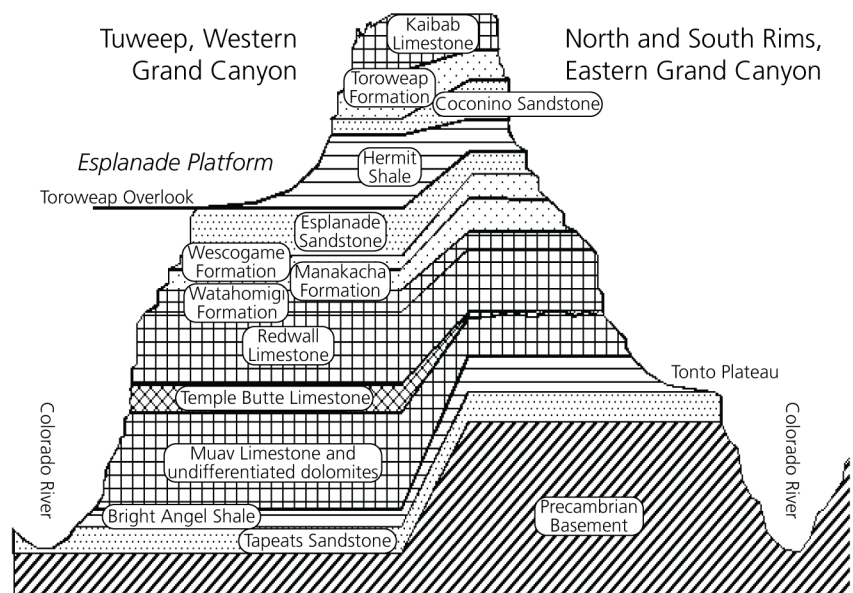
## Geology of the Tuweep Area



The view from Toroweap Overlook is dramatically different from more familiar views at the park's North and South Rims. Here you will find two canyons—a broad outer canyon, where lava flows and conical black cinder cones grace the landscape, and a much deeper and narrower inner canyon. But this view is just another part of a huge area; Grand Canyon extends 180 miles (290 km) upstream and nearly 100 miles (161 km) downstream from Tuweep.

### Back in Time

Below Toroweap Overlook, the Colorado River has not yet carved into Grand Canyon's oldest rocks. These ancient formations dip beneath the river about 43 miles (69 km) upstream and reappear again about 11 miles (18 km) downstream. The layered Paleozoic rocks present in the walls of eastern Grand Canyon are exposed at Tuweep. From about 508 million years ago until 270 million years ago, ancient seas advanced and retreated across northern Arizona. The layers of marine limestone found in the inner canyon document the most extensive occurrences of these ancient seas. The rocks of the outer canyon walls in the Toroweap cliffs sometimes record more terrestrial times, like periods of sand dunes and rivers.



### The Esplanade Platform

The broad Esplanade platform rises above the inner canyon. The Toroweap cliffs over Tuweep Ranger Station lie atop this landform. The Esplanade formed when softer red mudstone of the Hermit Formation retreated away from the river corridor, undercutting the harder layers above it. The Esplanade is an important landform in Grand Canyon. It provides a spacious feeling in an otherwise sheer canyon.



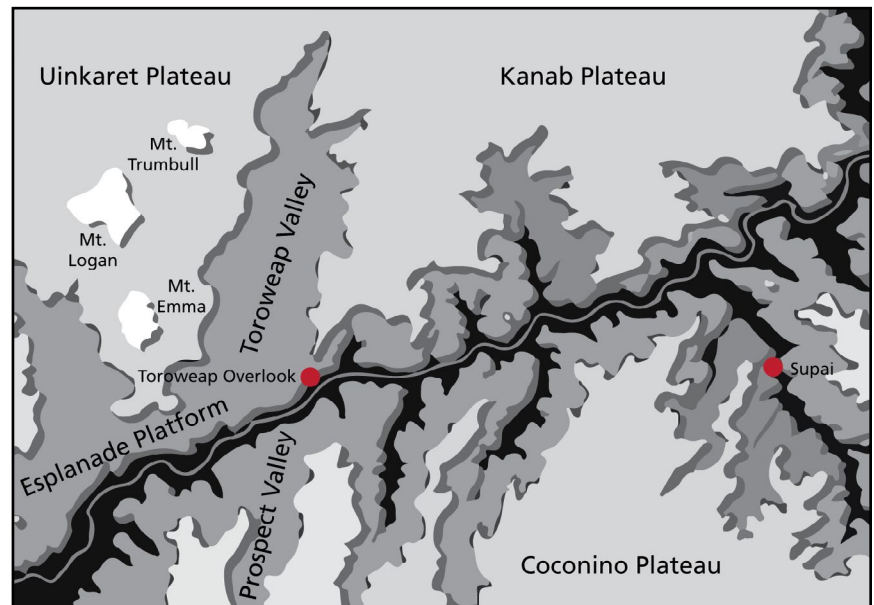
## Volcanism

The volcanic rocks around Tuweep are a fascinating part of Grand Canyon's geologic story. Starting about 3.5 million years ago, enormous eruptions created Mount Trumbull (elevation 8,009 feet, 2,441 m) and Mt. Logan. These are the highest peaks in the Uinkaret volcanic field, which has approximately 200 volcanoes.

These eruptions produced a type of lava called basalt. Black in color, basalt is more durable than the sedimentary rock that is common in Grand Canyon. Beginning about 830,000 years ago, lava erupted on the rim, on the Esplanade, and within the canyon. The flows often filled deep side canyons to the level of the Esplanade. The flat floors of Toroweap and Prospect Valleys formed as a result of these sizeable eruptions. Although Toroweap Valley remains broad and flat, erosion has begun to re-excavate Prospect Canyon. A short and steep canyon now slashes down to the Colorado River. The current Prospect Canyon is so steep that occasional flash floods or debris flows carry huge boulders to the river. This process created Lava Falls, the largest of the over 100 named rapids in Grand Canyon.

## Lava Dams

Below Toroweap Overlook is a remnant block of hardened basalt that was part of the interior "plumbing" of a volcano within the river. Lava flows from this and other volcanoes traveled as far as 84 miles (135 km) downriver. Many of these flows created lava dams across the Colorado River. Geologists have identified at least 17 dams that once blocked the river. The highest of these dams was between 1,000 and 2,000 feet (305 to 610 m) above the river, including Prospect Dam across the canyon from Toroweap Overlook. The reservoirs behind them would have backed up the river through Grand Canyon and perhaps beyond.



## Erosion

Cold river water made parts of these lava dams inherently unstable. Therefore, many of the dams eroded quickly, within a few hundreds to thousands of years. At least five of the dams failed catastrophically, creating huge outburst floods that drained the lakes in hours or days. Boulders up to 100 feet (30 m) in diameter and other deposits from these tremendous floods have been found over 600 feet (183 m) above the river. In a few places the dams were resistant to removal and the river simply excavated a new path adjacent to the obstruction.

The forces of erosion are still hard at work at Tuweep. On March 6, 1995, geologists camped at Lava Falls witnessed a debris flow in Prospect Canyon that sent rocks and boulders to the midpoint of the river channel. Within a day, the river had removed about half the debris. The constant renewal of Lava Falls by debris flows will maintain the rapid's fierce reputation with river runners far into the future.

Today the landscape looks quiet, but it is no illusion that the lava flows look fresher than the rest of the canyon. The most recent eruptions in the area are only about 1,000 years old, the blink of an eye in geologic time. The volcanoes of the Tuweep area add a fascinating, and much younger chapter, to Grand Canyon's geologic story.