Red Rock Canyon State Park

Photo: Will Harris

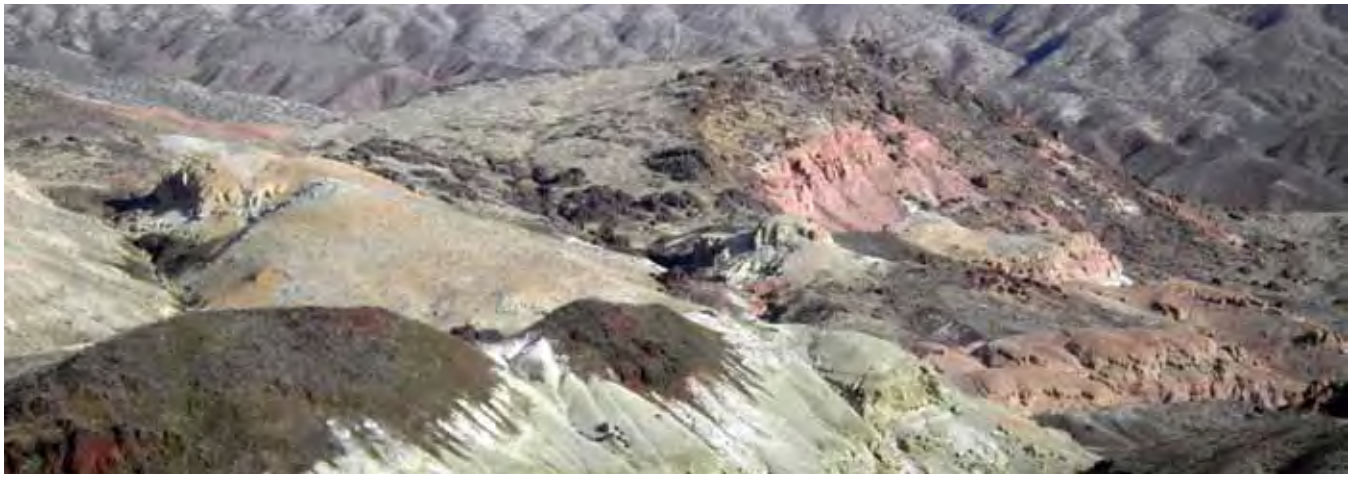
Geomorphic Provinces and Boundaries

Process/Feature:
Basin sedimentology along province boundaries, Paleocene and Miocene fossils, and scenic cliffs

Red Rock Canyon lies in the Basin and Range geomorphic province which features large north-south trending mountains and valleys. This park is just east of the southern Sierra Nevada and north of the Mojave Desert geomorphic province. Features and rocks from the neighboring geomorphic provinces can be found around the park. The east–west trending Garlock Fault, just south of the park, separates the Mojave Desert from the Basin and Range. The El Paso Fault, a branch of the Garlock Fault, traces northeast through the park, near the crest of the El Paso Mountains. During two periods (55 to 65 and 5 to 20 million years ago) this area subsided and over 5,000 feet of sediments and volcanic materials accumulated. Later movement along the El Paso Fault uplifted the sediments, exposing them to erosion that formed the badland topography.

Faults

The Garlock Fault is an active left-lateral fault (one side of the fault moves to the left relative to the other side). The Garlock Fault runs northeasterly from its intersection with the San Andreas Fault in the Tehachapi Mountains to the Avawatz Mountains south of Death Valley. The amount of displacement on the Garlock Fault is estimated at 40 miles.



Why it's important: Red Rock Canyon's rugged beauty has been the scene in western and science fiction films such as Stagecoach with John Wayne (1939), The Mummy with Boris Karloff (1933), 20,000 Leagues Under the Sea (1954), and Jurassic Park (1993).

The colorful badlands, cliffs and canyons provide more than pretty scenery and a backdrop for movies. Hidden behind the scenes in the layers of rock is what amounts to paleontologists as a treasure trove. For almost a century, paleontologists have been combing through these layers and making important discoveries about the history of mammalian life in these parts.

The El Paso Fault formed in response to the tearing caused by the Garlock Fault. Strain just north of the Garlock's trace pushed a block of terrain upward, causing the landscape to break along the northeasterly oriented El Paso Fault thus uplifting the El Paso Mountains—a typical "fault block." Most of the uplifted rock has since been eroded away. The tilted layers of rock revealed on the fault's up-thrown block, north of the trace of the El Paso Fault, are displayed with younger layers atop older layers in the colorful sidewalls of the southeast-draining canyons of Red Rock Canyon.

Rock Formations

The strata are divided into two major groups: the Goler Formation (55 to 65 million years old) and the overlying Ricardo Group (5 to 20 million years old). A portion of the Ricardo Group is the famously fossiliferous Dove Springs Formation.

The Goler Formation is more than 3,000 feet thick. It is best viewed in Last Chance Canyon. Long before the El Paso Mountains existed, about 65 million years ago, the detritus from the weathering uplands (long vanished) began to accumulate and the first coarse of sediments of the Goler Formation were deposited on eroded outcrops of basement rock. Boulders and cobbles tumbled onto the eroded surface first, followed by coarser sands and cobbles indicative of alluvial fans deposits near a mountain flank. Since the 1990s, researchers have systematically unveiled a wealth of vertebrate fossils (unrivaled west of the Rockies) in these 55 to 65 million year-old layers.

What you can see:

Colorful cliffs and canyons made up of layers of sediments and volcanic deposits. Classic desert landforms such as alluvial fans, slot canyons, dry waterfalls, and erosion pedestals are beautifully displayed.

The present topography began to form about 18 million years ago as movement initiated on the Garlock Fault and its related splays like the El Paso Fault. Major drainages for the area, such as Red Rock Canyon and Last Chance Canyon, were established shortly before this time, though they looked much different then. As the El Paso Mountains were uplifted, the drainages were able to maintain their courses across the fault block by eroding the uplifted rock as it rose incrementally over millions of years.

The uplift along the El Paso Fault further tilted the Goler Formation to the northwest. Concurrently, the initial sediments of the Ricardo Group were deposited in a basin atop the eroded Goler Formation.

The Ricardo Group contains the red sandstone beds for which this region is famous. It consists of nearly 7,000 feet of coarse volcanic ash, lava flows, sandstones, lake-deposited silts and clays, and sandy gravels. Most of these deposits contain or consist entirely of volcanic ash, and some are inter-layered with lava flows. This is fortuitous as geologists can determine the ages of these deposits with good precision, providing an unusually well-defined timeline for the Ricardo Group.

Deposition of the Ricardo Group spanned 8 to 18 million years, ending about five million years ago. The pink and white ash beds and lava rock record the evolution of the Basin and Ranges geomorphic province, when many volcanic vents and fissures were erupting within and near the expanding (rifting) province.

Although the Ricardo Group is the thickest geologic deposit found in the Red Rock area, it was originally much thicker. The upper portion of the formation was eroded due to renewed uplift on the El Paso Fault. The fault movement also caused the formation to be tilted back to the northwest, allowing the southeast-draining desert washes to cut down through the soft strata of the Ricardo Group, dramatically exposing the colorful sediments on the canyon sidewalls. The formation's dramatic flare has been

increased by water from periodic rainfall that flows down over the exposed layers, eroding away the softer beds leaving the effect of fluted columns.

Much of the red and pink hues of the Ricardo Group derived from oxidization of iron-bearing minerals. The white layers consist dominantly of volcanic ash.

Within the upper part of the Ricardo Group lies the famous Dove Springs Formation which contains over 100 types of fossils of extinct plants and animals, including woody plants, giraffe-like camels, elephants, three-toed horses, rhinoceros, saber-toothed cats, primitive dogs, skunks, and rodents. Deposited between 7.5 and 12.5 million years ago, the Dove Springs formation offers a unique four million-year-long record of life in a well-defined timeline.

Final Thoughts

The fossil treasure troves of the Goler and Dove Springs Formations are being compared with fossils found elsewhere in North America and even Asia, to help understand the evolution of mammals (including early primates) and their migration across continents. For example, Anza-Borrego Desert State Park contains an amazing assemblage of more recent mammal fossils dating back less than five million years.

Written by Will Harris, California Geological Survey, 2010
Photos: Mike Fuller (except where noted)

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