



## Anza-Borrego Desert State Park



### Badlands

The badlands at Anza-Borrego Desert State Park result from multiple phases of both erosion (easily envisioned from any of the sweeping vistas) and sediment deposition (indicated by each layer). After deposition, the sandy and silty sediments were buried under sheets of gravelly alluvium shed from the rising mountains. The gravel cap protected the underlying sediments from erosion for a period of time. Eventually the cap itself eroded, exposing the weaker underlying sediments to rapid erosion. Water is the primary agent of erosion in this parched region. Rainfall sufficient to produce erosion is relatively rare—occurring as periodic flash floods. Through time, however, the effects have become profound.

Three individual areas of badlands occur within the park: Borrego, Vallecito Creek-Fish Creek, and Carrizo Badlands. These areas represent ancient lake basins in which the sediments were deposited. The Colorado River drained a large portion of the southwestern continent, excavated the Grand Canyon, and deposited the sediments as deltas where it emptied into these basins over the last five million years. The sediments range from very fine sand to coarse gravels and have a combined thickness of 19,000 feet. To accumulate such thick deposits the basins must have been continually subsiding during deposition.

### Feature(s):

Badlands, fossils

**Why it's important:**

In California, badlands are an unusual and intriguing landscape. The origin of the badlands in the park is especially fascinating. It is mind-boggling to think that much of these sediments are the waste products of the Grand Canyon and Colorado River because the idea is so contrary to the current topography. Of course some of the deposits were locally derived. The river no longer runs this way. The landscape was very different when the river sediments were deposited but has changed rapidly due to widespread deformation along major faults such as the San Andreas and San Jacinto Faults.

The assemblages of fossils are very important because they compose the most complete record of the animals (fauna) and plants (flora) that existed in this region before and during the Ice Ages. The reconstructed skeletons of large creatures (megafauna) such as mammoths, giant sloths, saber toothed cats (the official State fossil), and giant bears are very impressive museum pieces. These species like so many others that once roamed the area are now extinct. The fossil record informs us of the transience of life and what to expect from geologic and environmental changes.

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The Colorado River migrated significantly through time as indicated by the distribution of the badlands. To a lesser degree, earthquake movements along faults have shifted things around. Very gradually, earthquake movements have lifted the deposits to their current elevations and tilted the beds. The change from subsiding basins to uplifted basins marks a significant change in fault activity and is what geologists call “basin inversion.”

The park occupies one of the most seismically active regions in the country. The multitude of earthquakes continue to uplift, fold, and re-organize the rocks and modify the landscape. Historically, strong earthquakes (magnitude 6 or more) occur on average once every five years in the vicinity. Large historic earthquakes include the Borrego Mountain (magnitude 6.6) quake in 1968. Without the earthquakes and basin inversion, the area's wealth of fossils would remain deeply buried and unknown.



**What you can see:** Because the badlands are deeply eroded and devoid of vegetation, it is easy to see the dipping layers of siltstone and sandstone. The strata contain the debris eroded from the surrounding area as well as by the Colorado River as it carved its course through the Colorado Plateau, forming canyons including the Grand Canyon, and deposited the eroded debris here between one and five million years ago. The mud hills conceal a rich assemblage of fossils, which are periodically exposed along the washes.

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### **Fossils**

Any evidence of an organism, plant, or animal that is preserved in rocks constitutes a fossil. Identifiable fossils of known lineages can be used to date the age of the rocks in which they are found. However, fossils are imperfectly preserved and truly diagnostic features can be rare. Lineages are built from large collections of fossils, from which evolutionary patterns are deduced by paleontologists. Typically, there are many key pieces missing from fossil record. These factors illustrate the need for careful archiving, preservation, and protection of fossil resources.

These badlands contain the fossil remains of approximately 550 types of plants and animals that once lived here. The environment was quite different then. Woodlands

bordered large lakes. Grasslands covered rolling hills and plains. Marine fossils occur in other rock formations within the park. Collectively, the various fossil assemblages constitute the most continuous archive of the history of life for the past seven million years in the west.

By examining the various layers of rock in the badlands, geologists identify beds that formed along rivers and in floodplains. These beds contain the most significant and abundant vertebrate fossils in the park. The beds date from just after the time (three million years ago) that the Isthmus of Panama joined North and South America. That land bridge made possible major migrations and mixing of North and South American faunas in what is called “the Great American Biotic Interchange.” The park contains fossils of animals that originated from South America mixed with North American fauna including llamas, tapirs, horses, camels, the largest flying bird in the Northern hemisphere (16 foot wingspan), and a giant (five to six feet long) tortoise.

### **Final Thoughts**

This extreme landscape is the product of past landscapes upon which odd fauna roamed. At times, a sinking sediment basin at the mouth of Colorado River where animals were deeply buried, it has been pushed up by hidden forces into stark-looking hills that (through erosion) gradually reveal the secrets of the past.

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