Big Bend

National Park Service
U.S. Department of the Interior

Big Bend National Park
Rio Grande Wild & Scenic River

Geology

The physiographic order of the Big Bend is somewhat like the order of a great city built of stone and brick—wrecked by an earthquake. Perhaps order once prevailed there, but some mighty force wrecked the place, shook it down, turned it over, blew it up, and set it afire. Evidences that all this happened exist on every hand, making the land the finest example of earth-wreckage in Texas.

~Walter Prescott Webb, 1937

The lay of the land

The chaotic appearance of this jumbled landscape no doubt presented substantial challenges to the first geologists who attempted to explain and then map the very complex geologic history of the area that is now Big Bend National Park. It should be of little surprise to anyone that initial hypotheses explaining geological events here have been subjected to challenge and revision as the area has undergone continuous study by professional and amateur geologists since the park was established.

Sharing responsibility for the evolutionary nature of the Big Bend geology story is the fact that the science of geology itself has evolved significantly over time. Present day geologists have enjoyed great technological advantages over those who have gone before them.

With the emergence of new and improved technologies there seems to be one certainty: the geological history of Big Bend will continue to evolve as we make new discoveries and are able to more accurately piece together this magnificent story.

Big Bend National Park has often been described as a "geologist's paradise," but it has also been called a "geologist's nightmare" by some field geologists. The visitor can readily observe rock strata exposed at odd angles, standing vertical, or turned completely upside down. Rocks often appear to be completely displaced and do not appear to "fit" within the areas in which they are found. Clearly there have been many geologic processes and forces at work here over a vast expanse of time. This makes interpretation of geologic history very difficult.

Following is a brief summary of the complex geologic history of Big Bend National Park. Again, it is expected that as we continue efforts to study the geology of the park using new technologies and methods our interpretation will also continue to evolve.

Most of the visible surface of Big Bend National Park is relatively young when compared to the age of the earth, which most geologists accept as being approximately 4.6 billion years. There are materials present that date from about 500 million years ago; however, most exposed rock throughout the park is 100 million years or less in age.

Early mountain building in North America

From 500 million years ago (mya) through approximately 300 million years ago the Big Bend area was near the western portion of a deep-ocean trough that extended from present-day Arkansas and Oklahoma to West Texas. From highlands in the north, eroded gravels, sand, and clay gradually accumulated in layers within this trough and, in time, became beds of sandstone and shale.

About 300 mya pressure exerted by continental movement from the south forced these beds upward forming the Ouachita Mountains, the western roots of which extended to the northern part of Big Bend. Once thought to rival the elevation of the present day Rockies, about 160 million years of erosive forces have reduced the uplifted material. Worn remnants may be seen today to the north of the park, extending from the Marathon area to near Persimmon Gap in Big Bend National Park. Distinctive white bands of rock seen along Highway 385 to the north of the park represent beds that were tilted by the Ouachita mountain-building episode.

Joined at birth with the Appalachian mountains to the east, the remnants of the Ouachita we see in this area were thus part of the first of several mountain building plate collisions that culminated in the construction of Pangea, the supercontinent that existed before each of the component continents moved to their current configuration.

Shallow seas over Big Bend

In many ways the Cretaceous Period (144-65 mya) can be considered to be the beginning of our modern world. Flowering plants and pollinating insects both evolved during this period. Continental land masses moved closer to the positions and arrangements that we see today, and modern weather patterns began to be established. Perhaps the most obvious difference in the Cretaceous world was the wildlife, because this was the end of the Age of Reptiles, and dinosaurs, mosasaurs, and pterosaurs dominated the landscape.

Around 135 mya, during the Cretaceous Period, a warm shallow sea invaded the Big Bend area, as part of a vast, shallow seaway that divided the western portion of North America from the eastern portion. Cretaceous seas are thought to represent a high point in the evolution and abundance of calcium-rich organisms, the deaths of which resulted in deposition of thick lime muds that contain remains of sea-dwelling animals. Limestone layers that formed from these muds are highly visible in the vertical cliffs of the Sierra Del Carmen.

The shallow Cretaceous sea began a retreat to its present location, the shore of the Gulf of Mexico, approximately 100 mya. Shallow sea sedimentary rocks, sandstone and shales, are seen in lowlands surrounding the Chisos Mountains and exhibit fossil remains of oysters, giant clams, ammonites, fishes, and marine reptiles.

Near the end of the Cretaceous Period, a massive west-to-east compression of North America led to the second mountain building period in the Big Bend area. Progressing from north to south, ancient sediments at the compression boundary were forced upward to form the Rocky Mountains; the southernmost extension of the Rockies in the United States can be seen at Mariscal Mountain. Broad periods of uplift, punctuated by upward folding, exposed massive erosion-resistant early Cretaceous limestones along with less erosion-resistant sandstones and clays. The imposing limestone cliffs throughout Big Bend continue to be eroded as we view them today.

The age of mammals

In a number of locations within Big Bend National Park one can view the actual exposed boundary between the Cretaceous and Tertiary Periods. The end of the Cretaceous Period, dated at 65 mya, marks the most famous of the mass extinctions that have taken place in the history of our planet. By the end of the Cretaceous, the great land dinosaurs had disappeared, but flowering plants, mollusks, amphibians, lizards, snakes, crocodililes, insects, and mammals all traversed the Cretaceous-Tertiary time boundary and continued, despite the loss of some species, to thrive to the present.

The time interval represented by the Tertiary Period is often called the “Age of Mammals” because of the proliferation of mammal species during this period. In Big Bend, non-marine sediments formed in the ten million years following the end of the late Cretaceous uplift provide a fossil record of early mammals that once occupied the Big Bend landscape. Found here are fossilized remains of early horses, rhinoceroses, camels, and various species of rodents; fossils also reveal the plants which they likely consumed.

Volcanism in the Big Bend

Rock of volcanic origin dominates much of the visual landscape in Big Bend National Park. The first of a series of volcanic eruptions occurred approximately 42 mya near the present northwest boundary of the park. Upward-moving magma lifted the area that is now the Christmas Mountains and resulting fractures of surface strata allowed lava to spread in great sheets across the land.

Between 38 and 32 mya a series of volcanic eruptions occurred within the park. Initial activity began in the appropriately named Sierra Quemada, meaning “burned mountain range” in Spanish, located below and south of the present South Rim of the Chisos Mountains. Volcanic activity that followed in the areas of Pine Canyon, Burro Mesa, and Castolon gave rise to colorful volcanic ash and layered lavas in lower park elevations and for most of the mass of the Chisos Mountains.

Volcanic activity within the park was far from continuous and the thousands to millions-of-years intervals between periods of peak activity featured constant exposure of surfaces to the forces of erosion along with perpetual attempts by life forms to occupy areas as they became habitable. Erosive forces continue to the present time.

Beginning approximately 26 mya, the central area of Big Bend National Park was subjected to development of fracture zones as the continental plate that covers the western part of the US was stretched between the west coast and a point east of the park. Large blocks making up much of the central mass of the park between the Sierra Del Carmens on the east side of the park and Mesa de Anguila on the west dropped downward along active faults. Limestone layers at the base of both east and west ranges thus match layers found at the tops of the mountains!

Present-day Big Bend

Mountain building by forces of compression, volcanism, and tension over a vast amount of time provided the foundation for present day Big Bend. The last 10 million years or so have been dominated by erosion sculpting the modern Big Bend landscape. As the highlands eroded, gravel and boulders formed a blanket of sediments around the base of the mountains. In the lowlands, sediments filled in the low places and erosion wore down the high places, forming a relatively flat, gently sloping surface called a pediment. Remnants of the pediment can be easily seen along park roads, for example, to the east of the Maverick Entrance Station.

At first, the mountains were surrounded by closed basins, called bolsons. As the sediments filled the bolsons, the higher basins started to spill into the lower basins, creating drainage systems that got progressively larger as they linked more basins.

Eventually basins from El Paso to Big Bend became filled with eroded material, then linked by the Rio Grande. Within the last two million years, the Rio Grande has broken through to the Gulf of Mexico, carving the magnificent canyons found within the park and throughout the entire river drainage.

Geologic forces continue to shape the Big Bend landscape to the present day. Today the various forms of erosion represent the primary forces that continue to shape the park as one sees it. Wind and water, often aided by suspended abrasive materials, minerals, or acids, have combined their efforts with the effects of organisms that live here, to produce landscapes and features we see today. The one thing that is certain, as is demonstrated by the geologic history of the park, is that which is observed today by the visitor will be somehow different when the park is again visited in the future.

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