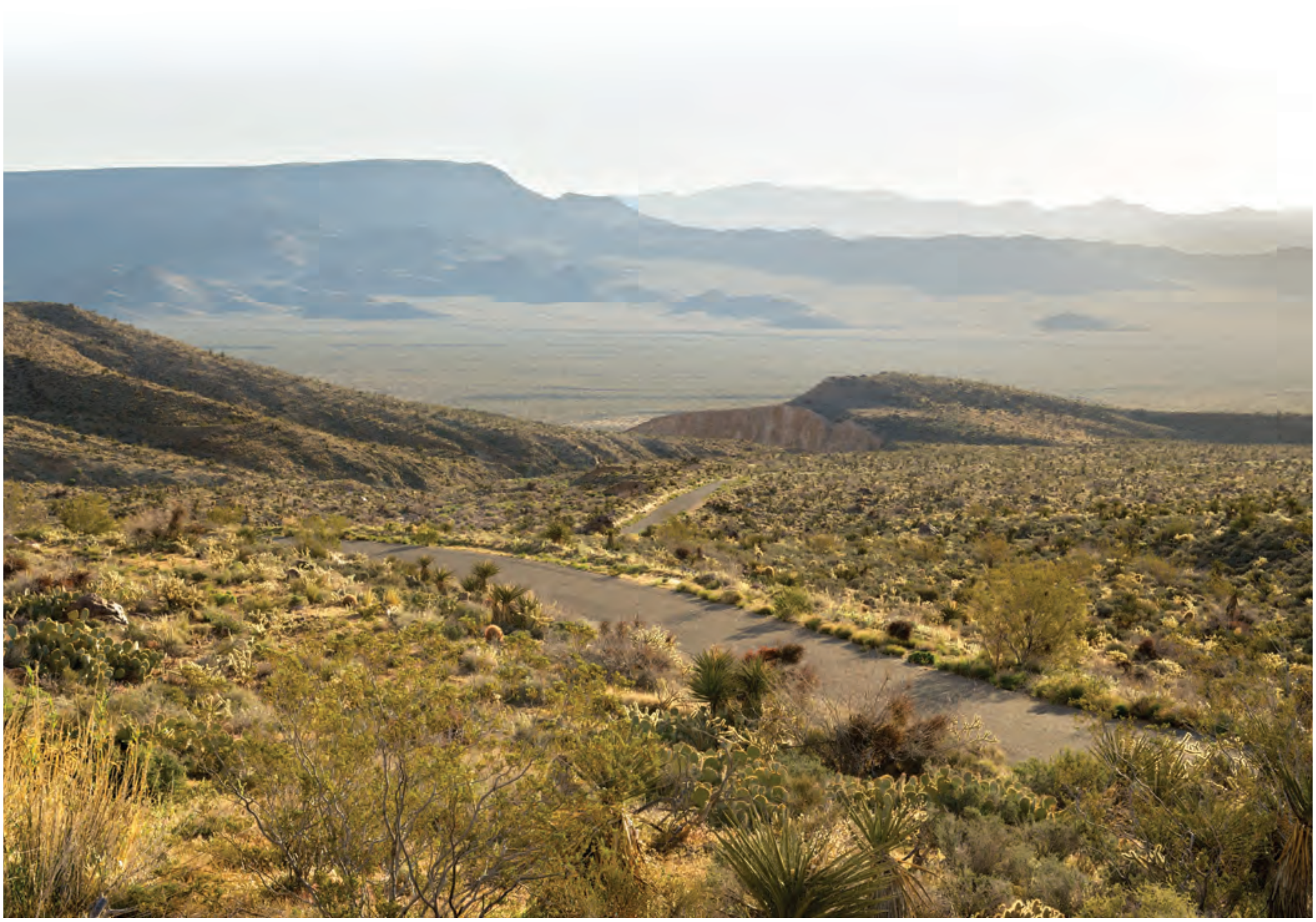
Providence Mountains SRA

National Natural Landmark 1975 | State Recreation Area



Oldest Rocks in the State Park System?

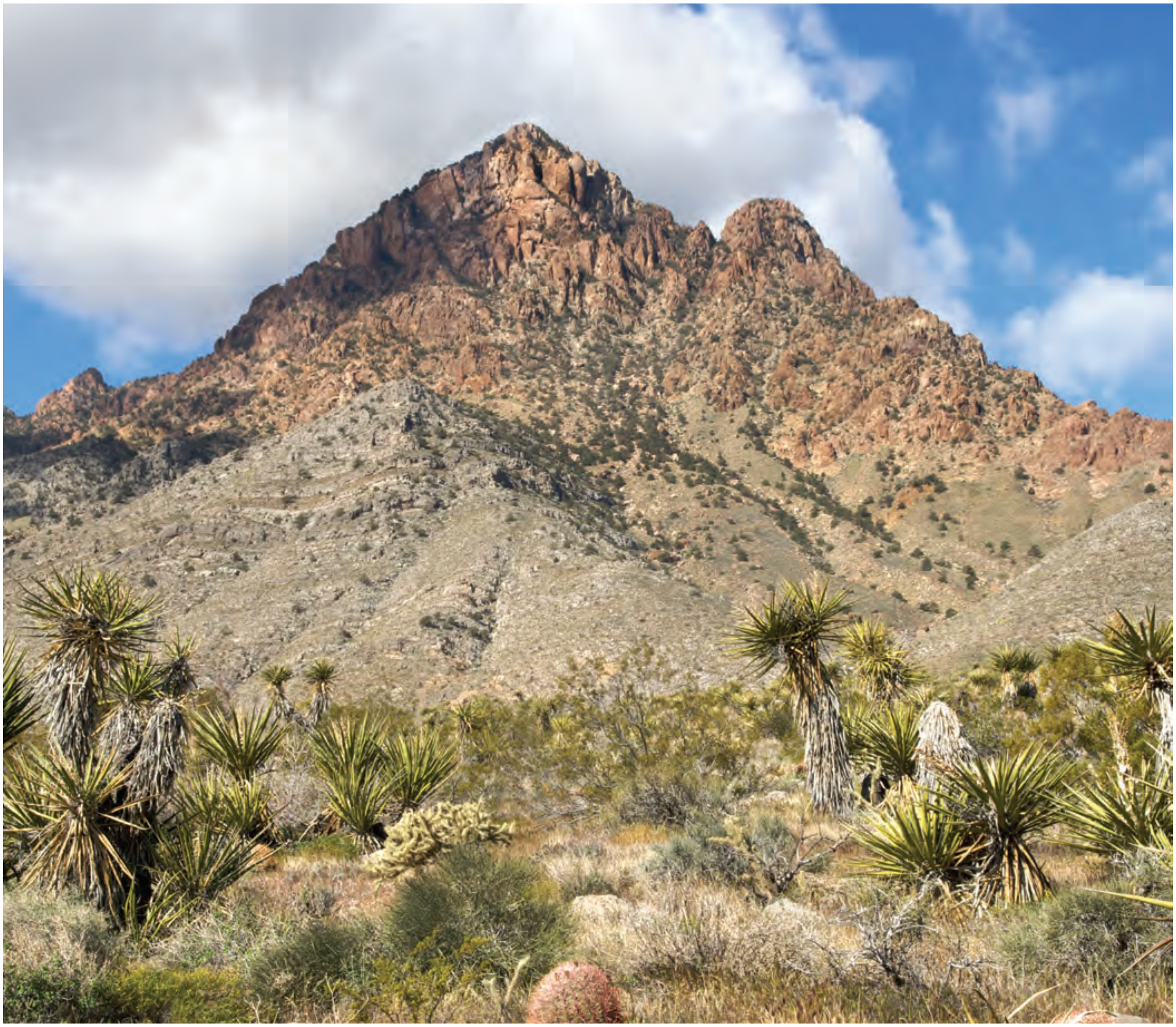
The Providence Mountains State Recreation Area lies within the Mojave Desert geomorphic province of southern California, characterized by a series of isolated mountain ranges with intervening valleys and desert plains. In the eastern portion of this province, the rocks are much older than in the west. In the recreation area, the oldest rocks are called gneiss, a highly metamorphozed rock, and they are the oldest rocks in the California State Park system. They are Precambrian in age and have been dated at approximately 1.7 billion years old, nearly one-third the age of the earth itself!

Features:

Geologic beginnings of California, caverns, and speleothems

What you can see:

- Limestone and gneissic metamorphic rocks
- Limestone caves and dripstone formations (speleothems), a record of the region's past climate



Why it's important: The Providence Mountains State Recreation Area contains the oldest rocks in the state park system and some of the most spectacular limestone caves in all of California. The caves are important to visitors for their spectacular beauty, but they also provide abundant information about the geologic and climatic history of the region.

What Gneiss Represents

Gneiss is a rock that has been subjected to immense heat and pressure in the earth's crust. During metamorphism, minerals partially melt and re-crystallize, orienting themselves in response to pressure. It is the orienting of light and dark minerals that appears as banding or layering. The depth in the earth's crust required to cause rocks to metamorphose into gneiss is on average about 15 miles deep, with a temperature of roughly 1,000° Fahrenheit.

The gneissic rocks of the State Recreation Area represent the metamorphism of sedimentary and igneous rocks during a mountain-building event that occurred on the ancient western continental margin of what is now North America. Because of the depth required to metamorphose the pre-existing rocks, we know that 15 miles of overlying sediment and rocks have been uplifted and removed by erosion to bring these rocks to the surface.

How Long Did This Take?

In the area that is now the Providence Mountains, the gneiss was exposed at the earth's surface and sediments were deposited on top of it during the Paleozoic Era (570 to 245 million years before present). A contact between the gneiss and the overlying Paleozoic sedimentary rocks represents an enormous gap of time in the geologic record, an unconformity. This particular unconformity is termed the "great unconformity." It represents 1.2 billion years of erosion (all the material overlying the gneiss was eroded away) and it extends across much of the western United States.

In the vicinity of Mitchell Caverns, the contact between the gneiss and Late Paleozoic Bird Spring Formation is not an unconformity, but is a fault contact created by the East Providence Fault.

Limestone and Limestone Caves

The limestone caverns occur in the Late Paleozoic (~299 to 251 million years ago) Bird Spring Formation. The Bird Spring, composed chiefly of limestone, represents a period of stability along the western edge of the continent where a warm and shallow sea contained abundant calcium carbonate shelled organisms that fell to the bottom of the ocean, eventually forming limestone.

Many tectonic events have affected the area since the deposition of the Bird Spring, such as the break-up of the supercontinent Pangaea, mountain building during the Mesozoic and Early Tertiary, and extensional faulting and volcanism during the Tertiary. Today, we see the oceanic deposits of the Bird Spring capped by Miocene volcanic rocks, hundreds of miles away from, and elevated above our modern Pacific Ocean.

Cave Formation

Being composed of calcium carbonate, the Bird Spring limestone is slightly soluble in water. Dissolution is accelerated by the addition of carbonic acid from rainwater and decaying vegetation found in the soils overlying the caves. Taking place in the arid desert, this process is very slow.

During the Ice Ages (~1.6 million to ~11.7 thousand years before present), this region was likely much colder and wetter. The beginning of the formation of the solution caves at Mitchell Caverns was even earlier and is thought to be as much as 12 million years ago, during prevailing warm and wet tropical climate conditions. The increased precipitation would have percolated into the mountains along fractures and gradually dissolved the limestone, forming cavities and dripstone. After thousands of years, the openings became large enough to allow for increased flow of groundwater and accelerated cave growth. It took many thousands to a million years for that accelerated flow to form 3-foot-wide solution cave passages.

Dripstone—Beauty and Scientific Value

Without question the dripstone formations or speleothems are beautiful and pleasing to the eye, but for scientists who study past climates, they are also a gold mine of information. Each layer contains chemical clues to the climate during which it formed. Analyses of speleothem growth rates and chemical composition can show past patterns of climate change.

Elsewhere, in more recently active speleothem deposits, laminations that form along the growth axes of stalagmites have been measured, isotopically analyzed, and dated. From the analyses, scientists have been able to differentiate wet from dry periods and cold from warm periods. From these studies, past climate change events have been traced back as far as 250,000 years. The resulting data from the studies have also been calibrated by comparison with historically recorded periods of cold, such as the "little Ice Age," and the "medieval warm period."

Final Thoughts

Eventually, the analysis of speleothem deposits in Mitchell Caverns and the surrounding region may contribute to modern climate change models and help us to respond and adapt to future climate change.

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Prepared by California Geological Survey, Department of Conservation | www.conservation.ca.gov/cgs
for California State Parks | www.parks.ca.gov

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