Great Basin

National Park Service
U.S. Department of the Interior

Great Basin National Park

Geology

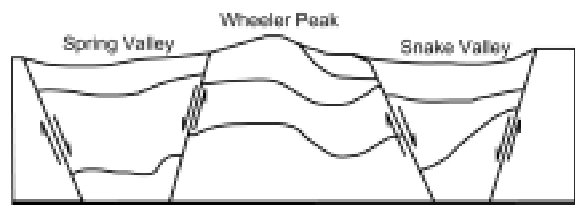
Great Basin National Park lies within the Basin and Range physiographic province. The entire region has experienced crustal thinning and deformation that produced extensive faulting. Along these roughly north-south-trending faults, mountains uplifted and valleys down-dropped, producing the Basin and Range topography.

Geologic Description

The Great Basin physiographic region is characterized by basin and range topography

Great Basin National Park covers a majority of the southern Snake Range, a mountain range with a maximum elevation of 13,063 feet (3,982 m) at the summit of Wheeler Peak. The southern Snake Range is primarily composed of quartzite, shale, and limestone intruded by small bodies of granite. **Quartzite** is sandstone that has been metamorphosed by heat and pressure. This extremely hard rock is resistant to erosive forces, explaining why the high peaks and cliffs in the park are primarily quartzite.

Limestone forms in warm water rich with calcium carbonate and is easily eroded by water into exotic geologic features such as Lexington Arch and Lehman Caves. **Shale** forms with the accumulation of silt and clay particles in relatively calm water. **Granite**, with its salt and pepper appearance, forms when magma intrudes the earth's crust and slowly cools. A variety of small granite intrusions are located in Johnson Cirque, one of many glacial features in the upper elevations of the park.



As the earth's crust stretched, faults formed along which valleys down-dropped and mountains uplifted.

Geologic History

The majority of the rocks in Great Basin National Park formed during the Cambrian, a time when western North America was located near the equator as part of a continent called Laurentia. Thick layers of limestone, shale, and sandstone accumulated along a passive margin, where warm shallow seas lapped at the edge of the continent, similar to regions like islands of the modern Caribbean.

These rock units have survived numerous episodes of mountain building (orogenies). These included the Antler Orogeny during the Devonian era, the Sonoma Orogeny during the Permian era, and the Sevier Orogeny during the Cretaceous era (Figure 2). The Sevier Orogeny pushed or "thrusted" thick layers of rock on top of one another that doubled the thickness of the earth's crust. This caused the metamorphism that turned the sandstone into quartzite, shale into slate, and limestone into marble. The Cretaceous is the same time when magma, molten rock formed within the earth's interior, intruded or pushed its way into the overlying rock layers. This magma cooled, forming the bodies of granite found throughout the park.

The modern basin and range topography is relatively new, forming in the last 30 million years, during which time the crust of the Great Basin has been subjected to extensive stretching and thinning. The result of this stretching caused the crust to break up into blocks. Some of these blocks slid down past one another along faults forming the valleys, and those blocks that remained intact formed the mountains of today.

ERA	TIME PERIOD	AGE
Cenozoic	Quaternary	1.8 MA
	Tertiary	65 MA
Mesozoic	Cretaceous	144 MA
	Jurassic	208 MA
	Triassic	245 MA
Paleozoic	Permian Pennsylvanian	320 MA
	Mississippian	360 MA
	Devonian	408 MA
	Silurian	438 MA
	Ordovician	505 MA
	Cambrian	540 MA
	Precambrian	

Glaciation

The mountains in Great Basin National Park have been shaped by a variety of erosional and depositional processes. The most influential of these was Pleistocene glaciation, that occurred during several distinct "Ice Ages" over the last 1.5 million years. The modern landscape of the park provides evidence for extensive glaciation from 40,000 to 60,000 years ago and again from 14,000 to 25,000 years ago.

As the glaciers grew in response to cooler summers and snowier winters, they moved downslope, eroding canyon walls and replacing v-shaped valleys (typical of stream erosion) with u-shaped valleys characteristic of glaciated areas. These glaciers carved out several cirques (features with steep ridges and shaped like a horseshoe). When the ice retreated, it left behind beautiful alpine lakes such as Johnson Lake, Baker Lake, and Teresa Lake.

Each glacial episode left behind moraines (deposits of debris shaped like ridges) that indicate where the edge of the glacier was. Examples of moraines are the ridge of cobbles above Brown Lake where the Bristlecone Pine Grove is located, the pile of debris impounding Stella Lake, and the prominent tree-covered ridge seen looking towards Wheeler Peak from Mather Overlook. Using these features we can infer the extent of the glaciers during each glacial advance.

Rock glaciers are large masses of boulders cemented together by ice. Lehman rockglacier is a large tongue-shaped feature that you can either view by hiking up the Glacier Trailor the Summit Trail. Another smaller and less accessible rockglacier can also be seen from the summit in the cirque above Teresa Lake.

One remnant glacier is all that remains of the giants that carved the alpine landscape then melted out around 10,000 years ago. It resides in Lehman Cirque just above the Lehman rockglacier. Earlier in the summer the glacier is a bright clean white, but as the season progresses rocks and debris fall onto its surface, making it appear dark gray. This debris is dislodged from the steep walls of the cirque when water freezes and expands along cracks in the rock. You may even hear rocks falling from the steep walls as you hike up into the cirque.

Lehman Caves Formation

The formation of Lehman Caves began approximately 550 million years ago during the Cambrian when thick deposits of limestone, the rock type where the caves are found, formed in a warm, shallow ocean. Limestone forms when the shells of dead sea creatures sink to the floor of the ocean and accumulate. Over time, these layers solidify in response to the weight of overlying sediments and become limestone. The limestone in the park was subjected to a metamorphic event (increased heat and pressure that changes the minerals in a rock) turning some of the gray limestone into a whiter and harder rock called marble. The limestone was eventually brought to the earth's surface in response to numerous geologic events. These same events were responsible for fracturing the limestone. During the Pleistocene, water was more abundant throughout the southwestern United States. This caused more water to seep into the ground and eventually into the fractured bedrock. As the water passed through the soil and air it absorbed carbon dioxide forming carbonic acid. This acidic groundwater is responsible for dissolving large rooms and cavities in limestone and marble. The groundwater level slowly dropped leaving behind empty cavities in the limestone, but the slow trickle of acidic water continued. Limestone and marble that was dissolved above the cavities remained in solution and eventually precipitated on the ceilings, walls, and floors of empty cavities. These processes created the beautiful formations we see in Lehman Caves today. Such as stalactites, stalagmites, helictites, popcorn, and shields.

Text and diagrams by John Van Hoesen, UNLV, 2001