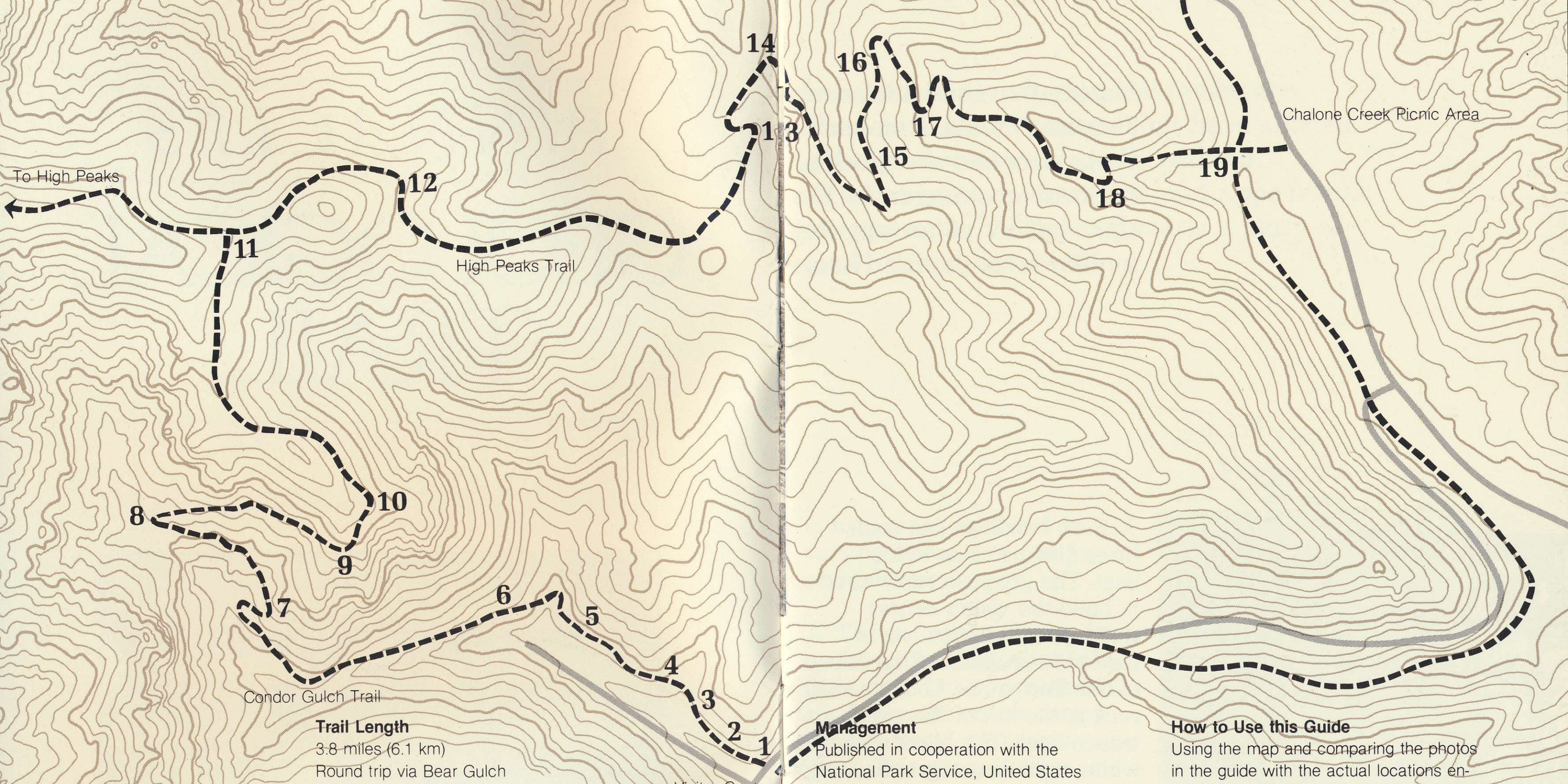
PINNACLES

GEOLOGICAL TRAIL



Trail Length
3.8 miles (6.1 km)
Round trip via Bear Gulch Trail 5.5 miles (8.8 km)

Duration
2-4 hours

Terrain
Average to rugged

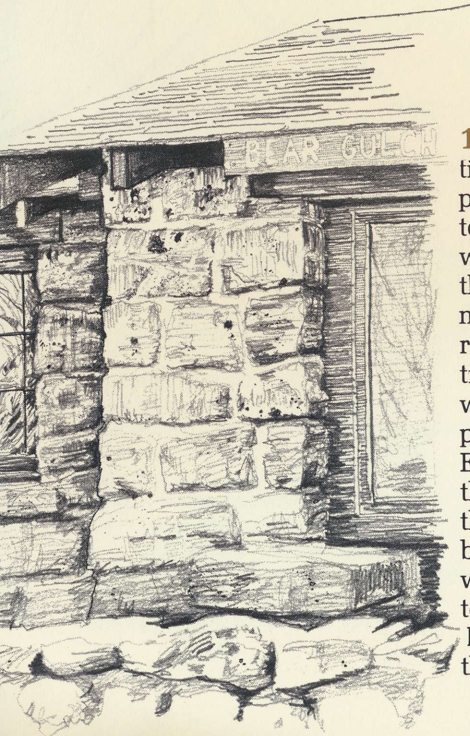
Rules
While hiking, remember that Pinnacles, like all national parks, is an extremely fragile and protected area. Nothing may be taken or disturbed in any manner.

Warnings
Carry water with you.

Management
Published in cooperation with the National Park Service, United States Department of the Interior, by Southwest Parks and Monuments Association, a non-profit organization devoting all its proceeds to support historical, scientific and educational activities of the National Park Service.

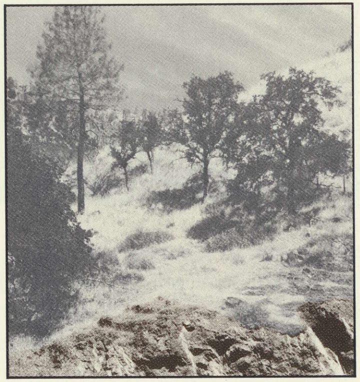
How to Use this Guide
Using the map and comparing the photos in the guide with the actual locations encountered, you will be able to identify outcrops along the trail. Stop 1 is the Bear Gulch Visitor Center. This self-guiding trail starts here and continues along the Condor Gulch Trail, winding upwards towards the high peaks, then east, descending to Chalone Picnic Area. At the first junction, Stop 11, the route continues to the right, ending near the Chalone Creek Picnic Area.

Nature moves at a leisurely pace, constantly altering the landscape. Despite Pinnacles' violent and fiery past, the processes that have shaped these canyons are gradual. A thousand years may pass with no noticeable changes in the rocks, yet by their structure and appearance, they tell us of an ongoing story spanning millions of years; a story of molten lava, gaping fissures, and a trembling earth.



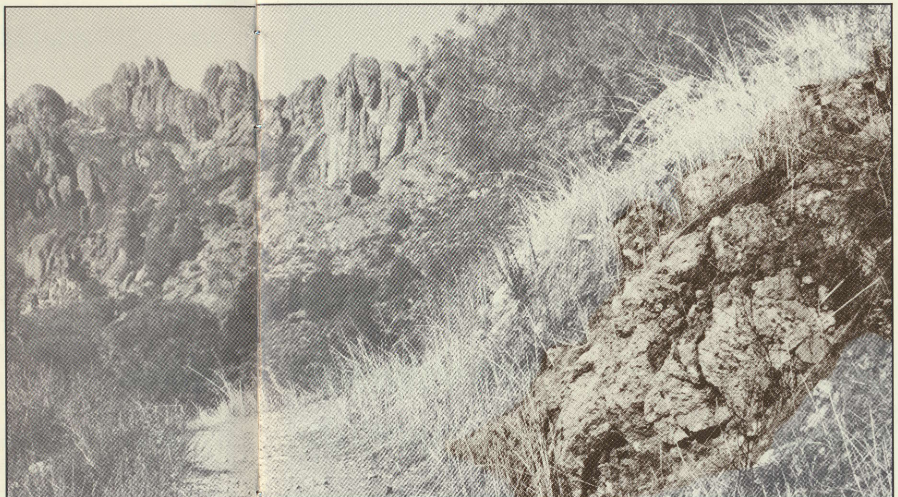
1 Even buildings can sometimes give us clues to the past. The greenish rocks used to build the visitor center were quarried from one of the lower sections of the Pinnacles Formation. Look at the rock to the left of the entrance door. The black and white crystals are **granite,** part of the original bedrock. Explosions ripping through the granite threw pieces into the air. As these chunks fell back to earth they were mixed with pumice and volcanic ash to form the light green **pumice lapilli tuff** that now surrounds the granite. The color of gray to light green is caused by varying amounts of **quartz** and **feldspar.**

2 Things are not always recognized when they appear in unfamiliar forms. Across the road from the visitor center is an outcrop of volcanic glass. This opaque, olive-green glass, called **perlite,** probably formed when fissures beneath a shallow sea belched molten lava into the water where it quickly cooled. **Obsidian** was the initial product, but water was absorbed into its structure, causing it to swell



and crack into the numerous horizontal fractures common in this outcrop. Perlite is named for the long curved cracks in the glass, called **perlitic cracks.**

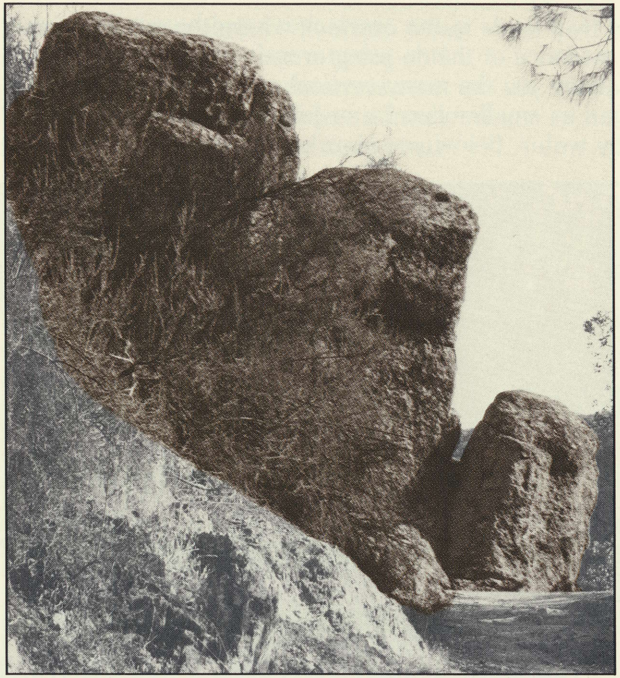
3 As you start up the Condor Gulch Trail you will see a number of rounded rocks. The nature of the rock deposit reveals something about what happened to these rocks since their formation. These volcanic rocks were rounded by the erosive action of a swift moving stream. The stream deposited the rocks at the edge of an ancient sea where a slide brought them downhill with other debris, forming **agglomerate** of large rounded boulders and smaller pieces of material. Evidence from nearby rocks indicates that the mudslide probably occured while the area was still submerged. Obviously, the land and the sea looked considerably different than they do today.



4 Two hundred and fifty feet (76 meters) after the trail crosses a small gully you will see what appear to be clusters of rocks held together by cement. This light colored outcrop is actually a volcanic rock called **tuff.** Violent volcanic explosions formed the small grains of volcanic ash which settled to form tuff. Microscopic ocean fossils have been found in this type of rock, indicating that the volcanoes which created Pinnacles were submerged for at least a portion of their life.

5 Along the trail just before and after these two double trees, you will find dark gray to chocolate brown colored rocks called **andesite.** The white flecks are a mineral called **plagioclase,** a calcium-sodium feldspar, and are not usually found in andesite. If you look closely between here and the next stop, you will see andesite alternating with agglomerates and other rocks. It is believed that this was the result of a series of mudslides such as mentioned at stop #3.

6 One quarter of a mile (.4 kilometers) past stop #5 is a ten to fifteen foot (3 to 4.6 meters) wall of gray rock, much lighter in color than the andesite. The rock, **dacite,** is a paler color because it contains less iron and magnesium than does the andesite. Dacite is easy to identify here because of the white crystals of **plagioclase,** a mineral that was even found on the moon by the Apollo 12 astronauts. This dacite is **porphyritic,** meaning that it is a volcanic rock in which larger crystals are surrounded by finer textured material.

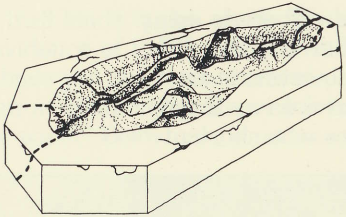


7 The looming outcrop of rock at the top of the first switchback is composed of **breccia,** which covers about 60 percent of the monument. Sharp angular edges of its fragments contrast with the smooth, rounded agglomerate rocks. The angular fragments are of just one rock type; **rhyolite.** Much of this rock may have been deposited in marine waters since some poorly preserved micromarine fossils have also been discovered here. This would indicate that the land was above water part of the time and submerged part of the time.

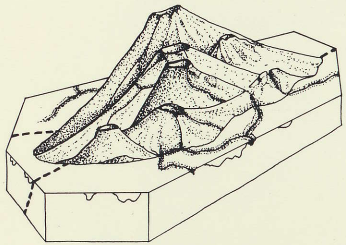
8 A short trail leads to the overlook where there is considerable evidence of the on-going erosion processes. Notice in the cliffs above you the many vertical cracks in the rocks. These began as smaller cracks, or **joints,** and have since been widened by water. Below you is an example of water's cutting power. Winter rains flow down these rocks creating a temporary tumbling cascade of water that carries debris and gravel with it, gouging out the rock to form these potholes.

Eventually the potholes will erode away as the water cuts further into the cliff.

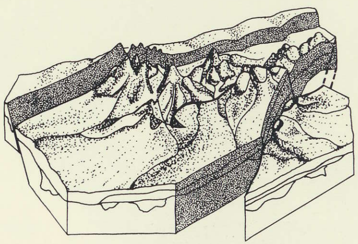
Unnatural erosion, however, is extremely damaging to an area as fragile as the Pinnacles. Hikers who shortcut off the trails damage both plants and soil, as well as risk serious injury to themselves.



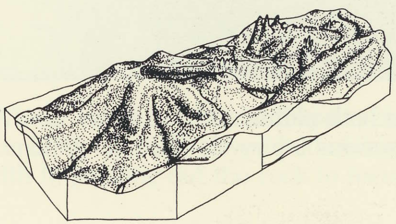
A large north-south fissure developed in the early stages of the Pinnacles formation. The lava issuing forth plugged most of the cracks but left a few open vents from which several volcanic cones developed.



Over a long period of time intermittent lava flows and a series of explosive eruptions caused the small volcanic cones to enlarge and merge with one another.



At the close of volcanic activity two north-south faults developed. The block between these faults slowly subsided and tilted to the east. Thus the features of this central block were well shielded from the elements by a protective bulwark of rock on either side.



The protective bulwarks eventually wore away. The elements attacked the now unshielded rock on full force. Water running down the steeply titled eastern slope cut two deep narrow gorges into the rock to form the upper end of Bear Gulch and the West Fork of Chalone Creek. The cracks between the rocks were widened into the Pinnacles we know today.

9 Is that really a lava flow? Past the brush-covered ridge to the south, you can see a mass of solid rock with great curving lines through it that is often mistaken for a lava flow. It is actually breccia which has eroded along curved joints. So much rock has eroded from the original 8,000 foot (2440 meter) volcano that most of the features of the lava flows and cones have been washed away.

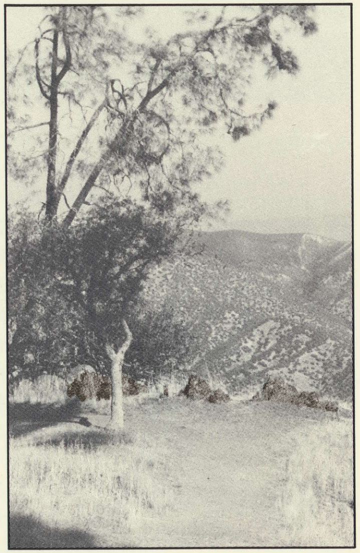
10 Looking east, you can see the San Andreas Fault. The Pinnacles formation originated 195 miles (314 kilometers) south of here, near Gorman and Lancaster, and continues to move northward at a little over 1 inch (2.5 centimeters) per year. You can also see two areas where the white sandstone has "slumped." This rock was once part of the Continental Plate, but it became jammed and broke off. It now moves northward on the Pacific Plate along with the rest of the Pinnacles.

11 From here you can get an excellent view of the surrounding countryside. Looking northward, you see a large hill in the near distance which appears to have been cut in half. At the base of the hill is a line of trees. These clumps of trees appear where springs occur along the Chalone Creek Fault. The hill with the large white scar lies between the Chalone Creek and the San Andreas Faults. It is the result of "slumping", which will be discussed at stop 18. The Chalone Creek Fault was part of the San Andreas Fault until a large chunk of sandstone jammed the San Andreas, and caused it to move 5 miles (8 km) east, to the approximate location of present day highway 25. The Chalone Creek Fault is the only clear indication we have to show the former location of the San Andreas.

Take the right fork of the trail to continue the geology trail; the left fork goes through the heart of the rugged high peaks.

12 A person with a trained eye for geology and a good knowledge of botany can often tell what rock types are in a given area by the kinds of plants growing there. As you look down towards the grassy hillside notice how the pines are concentrated near the edge of the hill while the oaks grow in a cluster closer to where you stand. The pines grow better in soils derived from andesite; oaks in soils derived from dacite; and chaparral in soils derived from rhyolite or rhyolitic breccia. These plants are called **indicators** since they tell us what soils are to be found in an area.

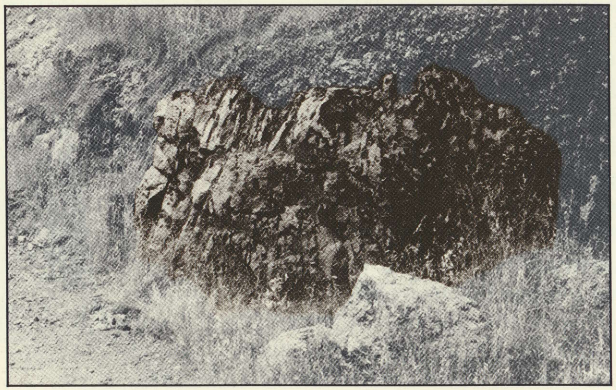
13 The outcrop found on the edge of the hill is similar to the andesite seen earlier on the trail. Andesite is named for the Andes Mountains of South America. The Andes are part of the "Ring of Fire" which encircles the Pacific ocean and includes California. This ring is an extremely active area geologically and suffers more earthquakes and volcanic activity than any other area in the world. Andesite is found more frequently in this ring than anywhere else.



14 You will have to look closely near this switchback to see where an andesite **dike** cuts through a section of pumice tuff. The molten rock forced its way through the tuff, flowing up to feed the andesite outcrop at stop 13, and eventually hardened. Notice how the rock next to the dike has been discolored by "baking." You should recognize the pumice tuff as the same rock from which the visitor center was constructed. The reddish fragments in the tuff are rhyolite. You will see more of the pumice tuff as you start walking downhill.

15 Here on the left you see perlite similar to the outcrop across from the visitor center. The perlite was originally the top of a lava flow that cooled quickly to form a volcanic glass. The flow-banded rhyolite at stop 18 was the lower section of this flow. The greenish perlite has broken down chemically in many areas to take on a waxy rather than glassy appearance. Many lighter colored veins of quartz can be found which cut through the perlite.

16 While the dike at #14 was composed of andesite, this formation is a **porphyritic dike**, formed of **porphyry.** Porphyry is essentially a "frozen" rock mush, with isolated crystals of some mineral, usually feldspar, embedded in the finer-grained surrounding igneous rock. Dikes such as this are usually younger than the rocks into which they intrude, their molten contents squeezing into cracks in older rocks or being carried by water between different rocks. This dike extends northward about a mile, and though we don't know its exact age, it is younger than most of the rock you have seen so far. The rhyolitic breccia and other rocks of Pinnacles have been potassium-argon dated and are thought to be about 23½ million years old.



17 Look for the unusual pinnacle on the hill above to help locate this stop. **Flow-banded rhyolite** such as you see here is often mistaken for petrified wood. The likelihood of finding petrified wood in volcanic deposits is slight, however, since the tremendous heat associated with volcanic activity usually completly consumes any organic material. To understand how this rock becomes banded, imagine yourself at an old fashioned taffy pull. When the piece belonging to you is cool enough you begin to pull it, and any dirt that happens to be on your hands mixes with the taffy. The result is taffy streaked with grime. A similar process has happened with this rhyolite. As the molten rock cooled, small crystals began to form. The rock was then stretched, or pulled, creating the banded effect.

18 As you near the picnic area, notice the buff colored areas in the hills behind it. These are on the opposite side of the Chalone Creek Fault and are called **slumps.** These are areas where weak, unconsolidated sandstone is eroding rapidly and falling in before vegetation can take root and hold it together. The loose, dry soil is easily washed away by the winter rains and abrasive winds.

19 Though this streambed appears to be dry most of the year, there actually is an abundance of water here, underground. The coarse, gravelly soil retains water very poorly. When the winter rains come, the runoff flows rapidly down hillsides and into the ground at the bottom of these canyons. Now far underground it runs into an impermeable layer of volcanic rock, and then flows laterally as a permanent water source. Many springs are located throughout the park where ground water, meeting this impenetrable bedrock, is forced to the surface.

Many things, like water, appear to be hidden when we first look for them. But by taking the time to look closely we begin to understand some of the secrets. We hope that you have been able to unlock some of Pinnacles' secrets through this walk, and that you have received a greater understanding of why this is a protected place where natural processes are allowed to continue their ever-so-slow changing of our world.

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