Picacho Peak State Park Self-Guided Geology Tour

Introduction

Picacho Peak State Park offers a snapshot of the crustal extension, faulting, volcanism, mineralization, and erosion that occurred in this area over the past 23 million years.

For millions of years, southern Arizona was compressed as a slab of ocean rock wedged its way under the surface, resulting in widespread uplift and a thickening of the crust.

Between 15-35 million years ago, the nature of the ocean slab's downward movement changed. The rate of descent slowed, and the dip steepened. The result was volcanic eruptions and a thinning of the crust. Many geologists believe that the surface in southern Arizona doubled in size and the crust halved in thickness during this period.

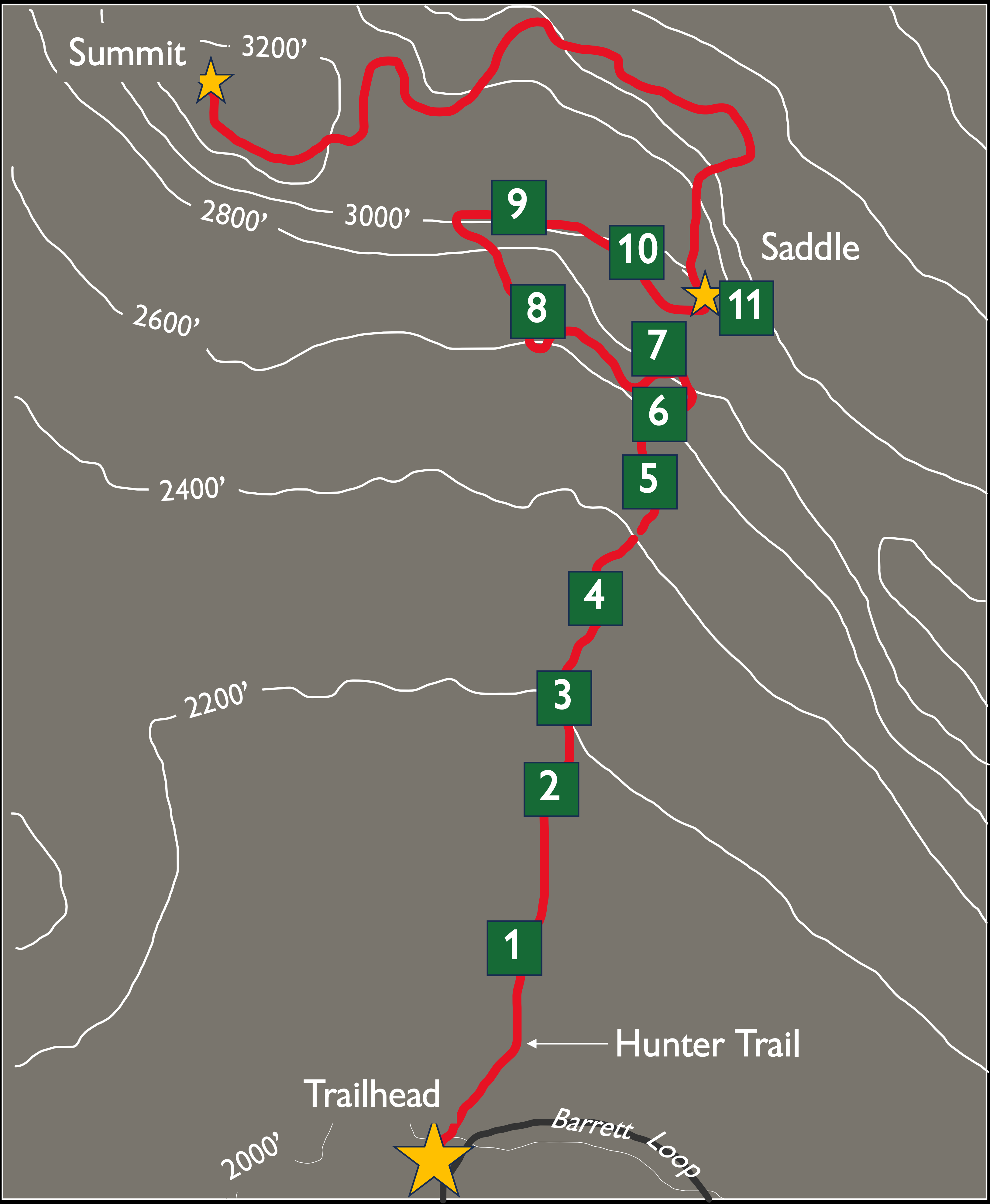
The Self-Guided Geology Tour provides visitors with examples of the events that defined this area. It follows the Hunter Trail for 1 mile from the Trailhead to the Saddle, with a 900' elevation gain. GPS coordinates and mileage estimates are provided for each geologic marker.

Next Page

Trailhead

(32.64263, -111.40245)

There are 11 geologic points of interest (markers) along the Hunter Trail between the Trailhead and the Saddle. For each location, we have provided distances between markers plus GPS decimal degree coordinates.



From the Trailhead proceed 0.1 miles, just past the green water tanks, to Marker #1

Marker #1

(32.64142, -111.40315)

Alluvial Fan

At this location, the trail crosses a gentle slope of sand, gravel and scattered cobbles arranged on a fan-shaped surface extending outward from the ridge. The feature is called an *alluvial fan*. This fan was created by streams and debris flows that deposited eroded rock about 1 million years ago. More recently, streams exiting the range have cut into the fan, exposing the layers of fragments carried by ancient storms (200' left of trail).

Desert Pavement

Here you will see a natural rock surface called *desert pavement*. It consists of various sized rock fragments tightly clustered. There is scarce fine sediment between the fragments; removed by wind over 1000s of years. The pavement is an indication that the ground has been undisturbed for a considerable time.

Desert Varnish

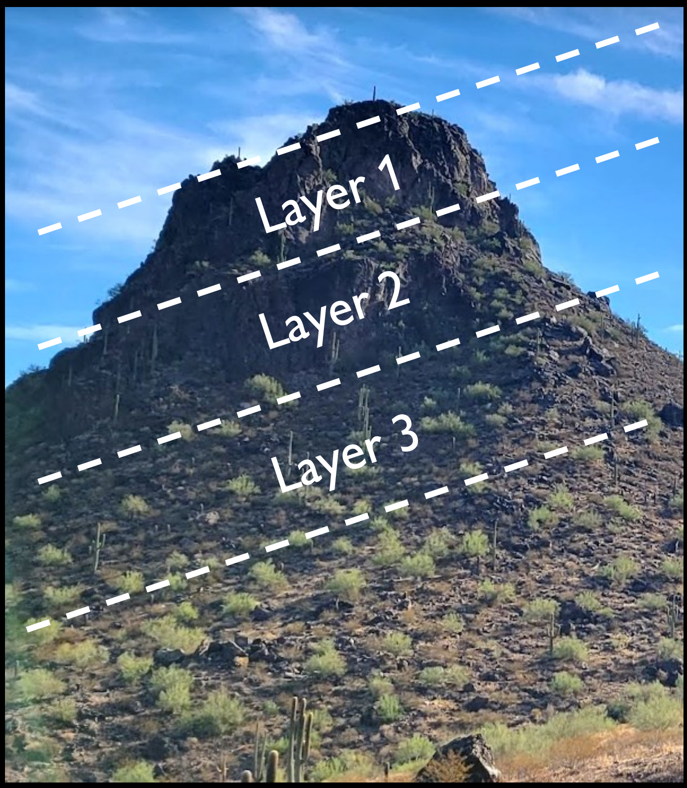
Many rocks of the Sonoran Desert are covered with a brown or black coating, referred to as *desert varnish*. It grows on the surface as bacteria and wind-borne clays, manganese, and iron interact.

From Marker #1 proceed about 0.1 mile to Marker #2

Marker #2

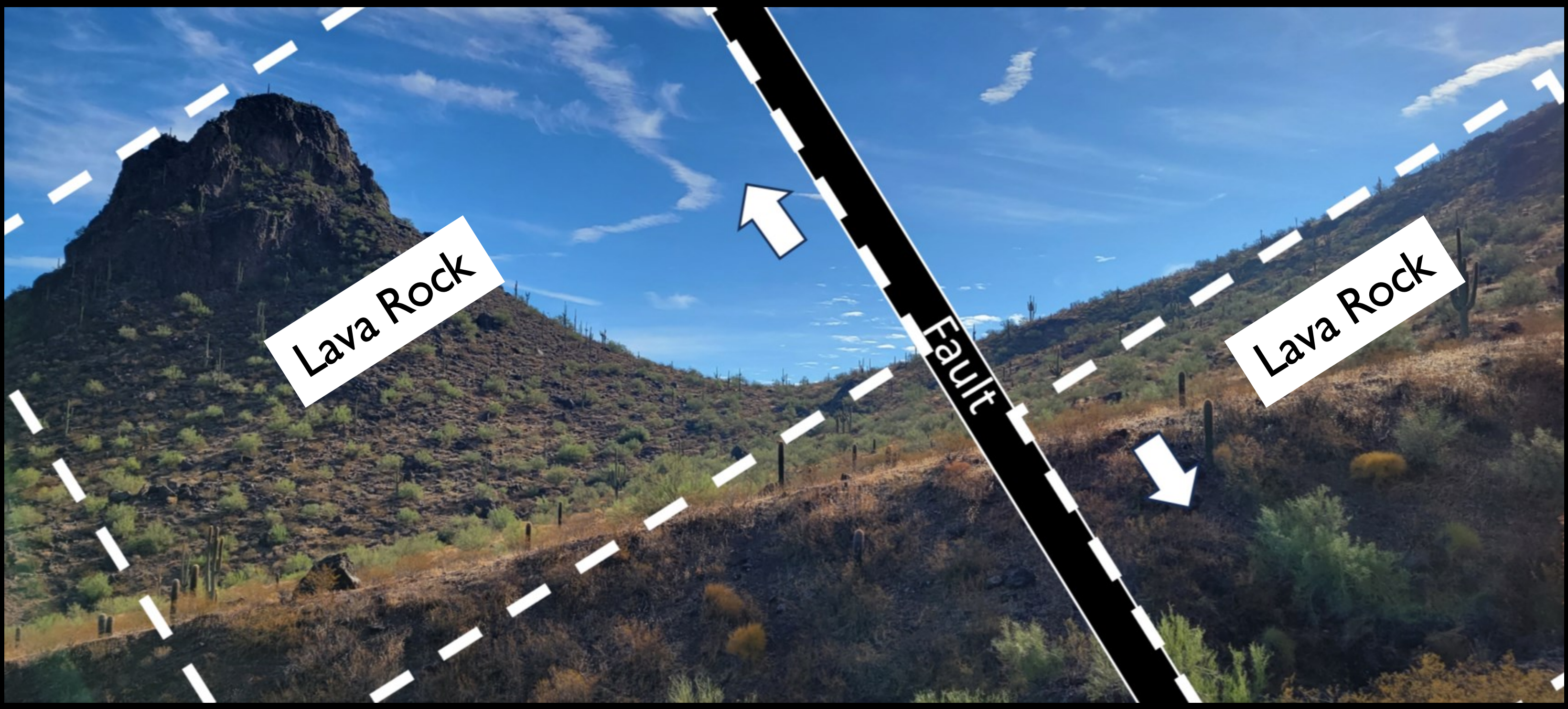
(32.64031, -111.40337)

Tilting



About 22 million years ago, volcanoes produced lava that flowed along a relatively flat surface. Bugler Peak on your left consists of stacked lava. However, the layers are not horizontal but rather *tilted* to the northeast.

The entire park was tilted along a large fault that was active for millions of years before, during and after the volcanic eruptions, it is called the *Picacho Mountains Detachment Fault*, located deep beneath the park.



Faulting

After tilting, more faults trending northwest-southeast activated and dismembered the lava rock. One of the faults crosses the trail at this marker. Bugler Peak is on the side of the fault that ascended while rock on the right side dropped.

From Marker #2, proceed about 200′ to Marker #3, which is at a rock outcrop on the right side of trail

Marker #3

(32.63973, -111.40357)

Volcanic Rock

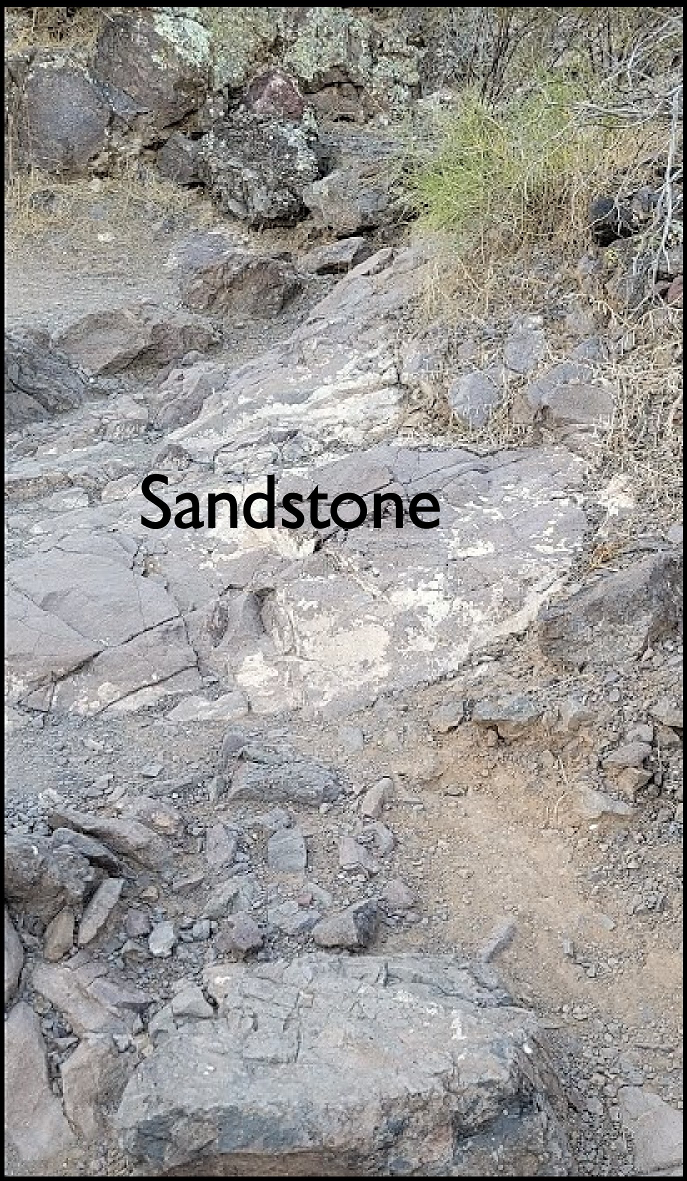
Most of the rock at the park is volcanic. Several volcanoes, in a *volcanic field* (example photo below) once existed here.

They erupted for several 100s of thousands of years, ending about 22 million years ago. The eruptions produced thick layers of *andesite* and *dacite* rock. At this location is the youngest lava layer at the park. Faults have dismembered the layer so that portions are found here, at the summit, and at the campground.

From Marker #3, proceed about 250′ to Marker #4,
a light gray rock that crosses the trail

Marker #4

(32.63912, -111.40369)

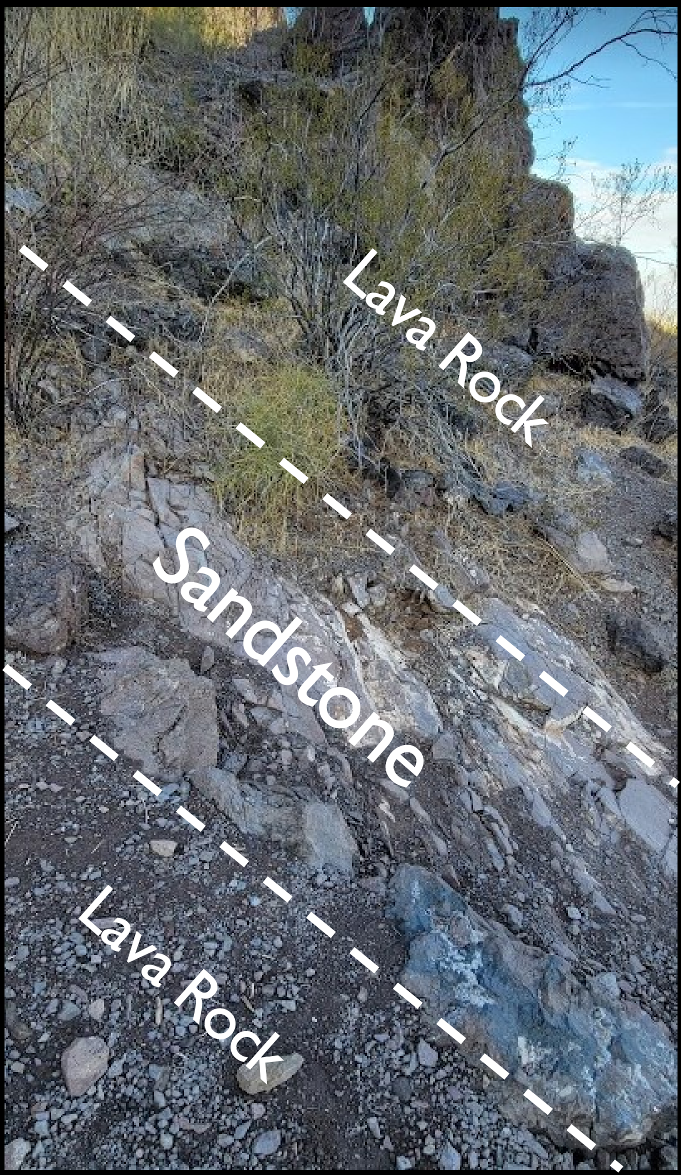


Volcaniclastic Rocks

Crossing the trail here is a light gray rock that is not volcanic. Rather, it is a *sandstone* made of small volcanic rock fragments and sediment. The closeup photo shows the pebbly composition of this rock.

Origin

Look closely and you will see the basalt-andesite lava layers above and below the sandstone. It is likely that after the lower lava layer cooled, there was a period of *erosion* and deposition which created the sandstone. Then eruptions resumed and the upper lava layer was produced. This indicates that volcanic activity here was not continuous, permitting ample time for erosion.



From Marker #4, follow 4 cable sections. Near the end of the 4th cable (.16 mile) is Marker #5

Marker #5

(32.63815, -111.40427)

Hydrothermal Veins

Near this location, the lava rock is cut by another fault running northwest-southeast. After faulting, hot fluids, called *hydrothermal solutions* carried dissolved minerals along the faults and openings in the rock.

Base and Precious Minerals

Minerals like quartz, calcite, barite, hematite, and copper accumulated, as hydrothermal solutions circulated about 22 million years ago.

Pictured here is a sample of *chrysocolla* (copper) with *hematite* (iron).

Several prospect pits can be spotted on the hillsides of the park, but most failed in their attempts to locate significant deposits.

From Marker #5, proceed about 350′ to Marker #6, a switchback and outcrop before the ½ mile sign

Marker #6

(32.63774, -111.40412)

Breccia

At this trail switchback, is a prominent outcrop of rock comprised of angular rock fragments that are cemented in a finer grained matrix. This is called a *flow breccia*.

This breccia was created as lava began to flow (photo below). As it moved, the outer edges cooled and crystallized above the semi-liquid interior. The lava tumbled down the side of the volcano and churned the cooler fragments into the melt. Once movement stopped, everything cooled, and the tumbled fragments were preserved.

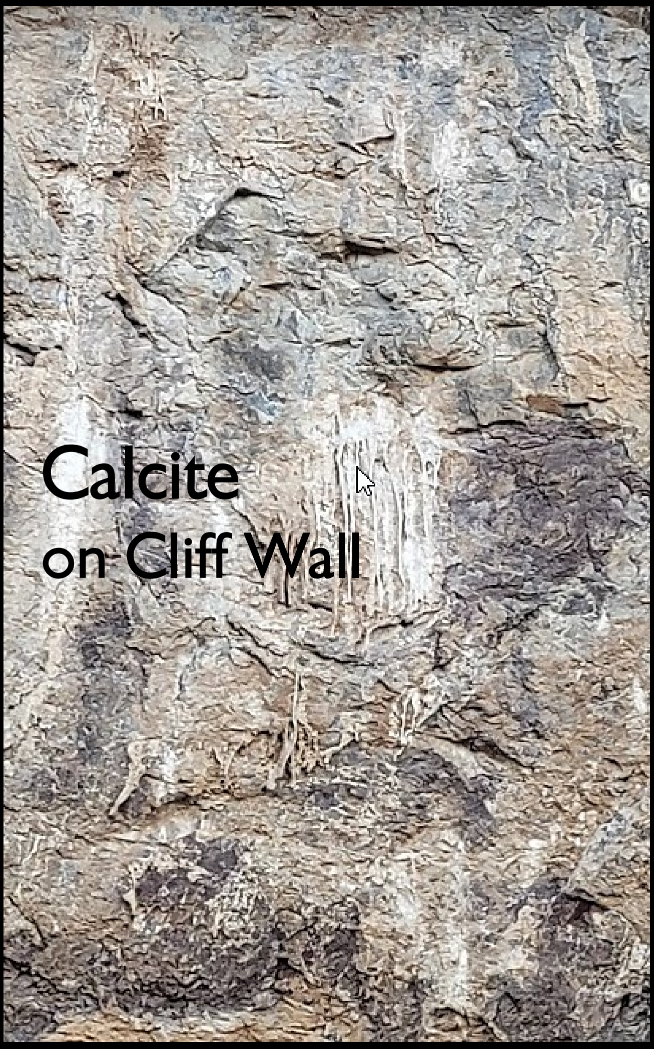
From Marker #6, proceed 400′ to Marker #7, an open cave below the overhang of the cliff

Marker #7

(32.63736, -111.40428)

Calcite Coatings

As you approach the prominent basaltic-andesite cliff, you will notice flow structures on the rock face, like those found in caves. They are called *calcite coatings.*



Calcite coatings form on cliff faces when meteoric waters travel through the rock dissolve calcite minerals. The dissolved calcium-rich water travels slowly down

between the lava layers and fractures. Eventually, it reaches the surface of the cliff. There, the saturated mixture exits and solidifies as calcite when subjected to evaporation.

This process has likely occurred for some time. Here, you will see *stalactites, columns, and stalagmites.* The stalagmite is the result of calcium accumulating from a seep located 20' above it.

From Marker #7, proceed about 0.1 mile to Marker #8, just before a sharp switchback that turns east

Marker #8

(32.63690, -111.40334)

Weathering & Lichens

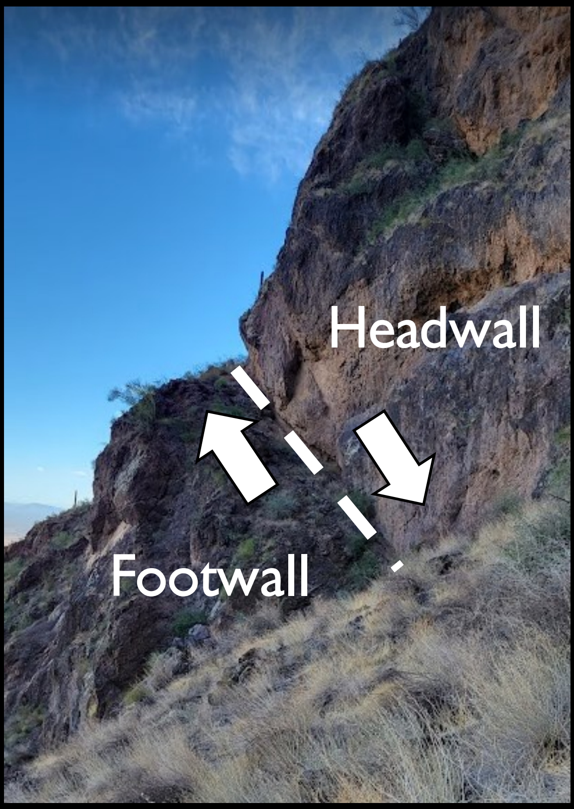
All rocks and minerals break apart, or *weather*. Without weathering, soil would not exist. Weathering occurs by physical and chemical means. Physically, wind, rain, and plants weaken minerals as they penetrate cracks in the rock. Chemical weathering happens when air, water, or hydrothermal fluids weaken the rock at a molecular level.

At this location is an organism comprised of fungus and algae (or cyanobacteria) called *lichens*. Lichens play an important role in the weathering of rock. They send anchors of fungal filament between the rock's minerals, physically weakening them. They also produce oxalic acid which acts like a bleach, breaking up minerals chemically.

From Marker #8, proceed .15 mile to Marker #9, at the base of the cliff as trail turns back west

Marker #9

(32.63613, -111.40278)



Fault

Along the cliff wall heading west towards the saddle are several features. Looking back to the east is a ledge and escarpment. The ledge is on the *footwall* of a normal fault, and it has ascended while the *headwall* on the right has descended towards the south.

Shear Zones

Near major faults, like that described above are smaller parallel faults like this one in a broader shear zone. Notice the smaller rock fragments accumulating in the fault plane as the rocks move past one another, it is called *fault gouge*.

Fault Breccia

A short walk further up the trail you will see a fracture filled with angular rock fragments from movement along this surface. It is a *fault breccia*. Later, the fragment were cemented by calcium-rich solutions that intruded.

From Marker #9, proceed .10 mile to Marker #10,
a small cave located just before the Saddle

Marker #10

(32.63643, -111.40421)

Fault and Breccia Wedge

Just before the saddle, along the cliff, is a small cave. A fault is visible here and runs from above right to lower left. Above the cave, you can see a wedge of rock that has been fragmented or brecciated by movement of rock along the fault.

Slickensides

Inside the cave on the left side is a smooth surface called a *slickenside*. It is caused by friction between rocks as they moved past one another along this fault. Striations of the slickenside indicate the direction that the rock moved (down and to the left).

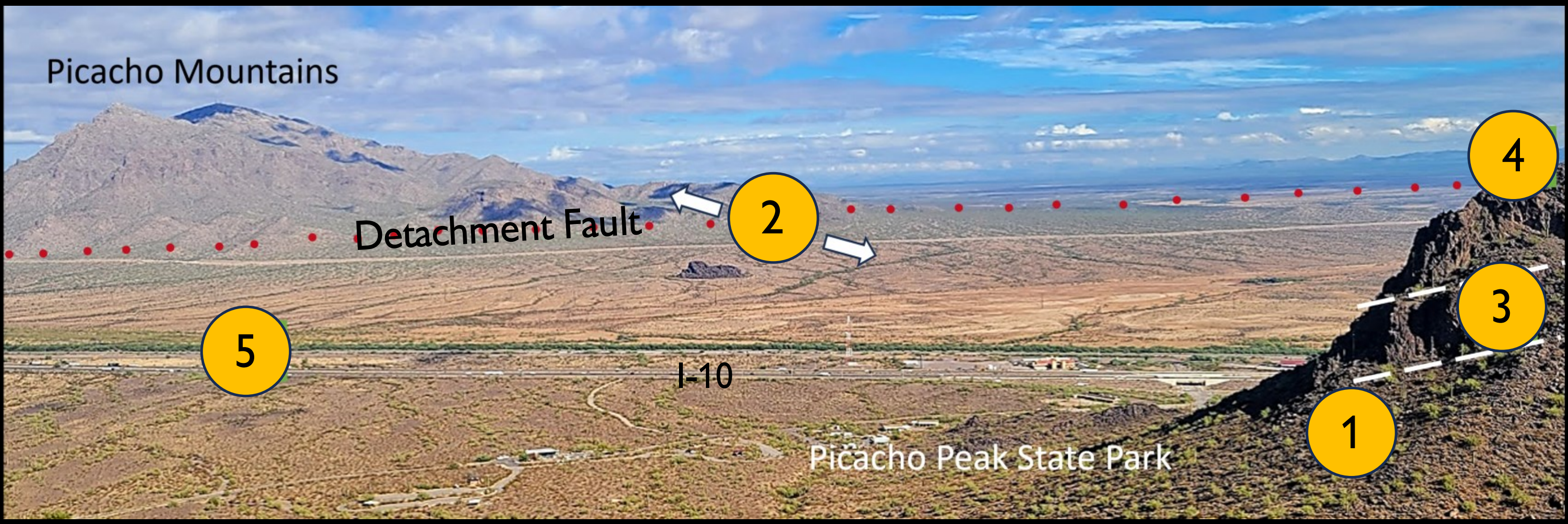
Hematite-Stained Fracture Face

Up ahead, you will see additional signs of fracturing and faulting. Here, a fracture formed in the rock that was later invaded by hydrothermal solutions carrying an iron mineral called *hematite* that coated the surface that turned red as it oxidized.

Follow the trail about 250′ to Marker #11,
the Saddle

Marker #11

(32.63669, -111.40479)



The Geologic Evolution of the Park

The Saddle, about 1,000' above I-10, provides a vantage point to visualize the geologic events that created the rocks and landforms we see today.

1

Between 22-23 million years ago, a *volcanic field* comprised of several volcanoes formed near the park and erupted periodically for several 100s of thousands of years. They produced 1000s of feet of rock.

2

Before, during and after volcanic eruptions, the crust of the earth was regionally stretched creating a large *detachment fault*. Along the fault, the volcanic rock moved from its originating position further northeast. Additionally, the fault exhumed long buried *basement rock* at the surface of what is now the Picacho Mountains, across I-10..

3

As the park landmass was displaced, the volcanic rock layers were *tilted* by more than 40 degrees.

4

After the rock was tilted, a series of *normal faults* running northwest-southeast activated as the crust continued to stretch. This caused the once contiguous, stacked volcanic rock layers to be fractured and separated. This also opened avenues for *hydrothermal fluids* to flow and deposit minerals like copper.

5

Over the past 17 million years, the valley below deepened and then filled with sediment as Picacho Peak and Picacho Mountains *eroded*.

Thank you for taking the Picacho Peak State Park Self-Guided Geology Tour!