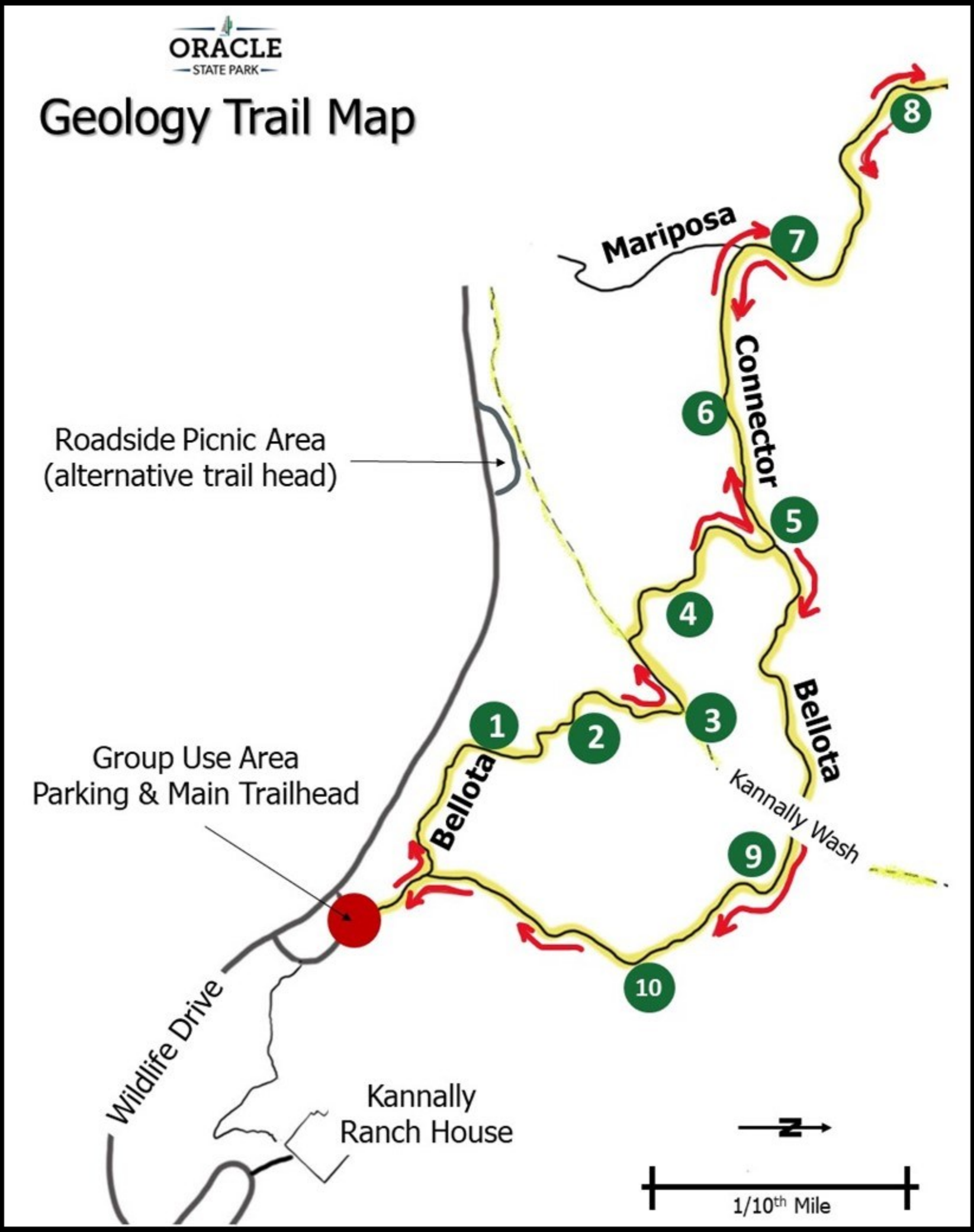
Oracle State Park
Self-Guided Geology Tour

The Self-Guided Tour begins at the Group Use Area Trailhead. Follow the Geology Trail signs to each of the numbered markers (#1 - #10). *Alternatively, you can start the Tour at the Roadside Picnic Area where you follow the wash to the markers (beginning with #4).*



Proceed for 1/10th of a mile to Marker #1

Marker #1

The bedrock here is Oracle Granite. It formed from molten rock that flowed and crystallized miles beneath the surface 1.4 billion years ago.

After it solidified, magma of a different composition continued to flow upward and intruded Oracle Granite. These intrusions are called **igneous dikes**. Being more erosion-resistant than Oracle Granite, a dike such as this one remains elevated as a ridge.

This dike was accompanied by hydrothermal solutions rich in Boron. As these hot solutions filled rock openings, black **tourmaline** minerals grew. Tourmaline, at gem quality, can exhibit various colors and worth more than $1000 per karat.

Proceed 400’ to Marker #2

Marker #2

Notice what appears to be blue-green moss on the rocks. Although they look like plants, they are not. They are called **lichens**.

Lichens are a composite organism resulting from a partnership between fungus and algae. The algae provides food, while the fungus offers shade and shelter.

Lichens are found in diverse areas, from Arizona deserts to Alaskan forests. They have long life spans of 100+ years. Their color is determined by the underlying algae.

Lichens have a role in geology. They physically break down rocks by expanding as they hydrate. They also chemically weather rocks by excreting oxalic acid, that bleaches and weakens minerals.

Proceed 300’ to Marker #3

Marker #3

The third marker is in the Kannally Wash. This dry stream bed originates southwest of the Park and continues northeast for several miles, merging with other washes at the San Pedro Valley.

Washes like this one fill with flowing water and debris during seasonal storms.

Notice the black streaks running through the sandy bed. These are created by heavier, iron-rich, magnetic minerals that settle as storm waters flow. The mineral is called **magnetite**. It is one of the two most important iron ores used in steel production.

Storm waters erode the hillsides and expose buried rocks. About 1 mile north, this wash cut steep banks revealing the 20 million year old sedimentary rock


Kannally Conglomerate

called **Kannally Conglomerate**. It formed from streams carrying debris when the Catalina Mountains first rose and eroded. It contains small rock fragments that span much of our 1.7 billion year geologic history.

Proceed 500’ to Marker #4

Marker #4

Oracle Granite Outcrop

Marker 4 provides you an opportunity to examine the bedrock of Southern Arizona, called Oracle Granite.

Oracle Granite is the most common rock found at the Park. It is igneous, coarse-grained, with minerals clearly visible to the naked eye. Faulting and extensive erosion, have exposed the bedrock surface, leaving 100s of isolated boulder piles like this one, scattered throughout the southern half of the Park. There are 3 common minerals that comprise Oracle Granite:

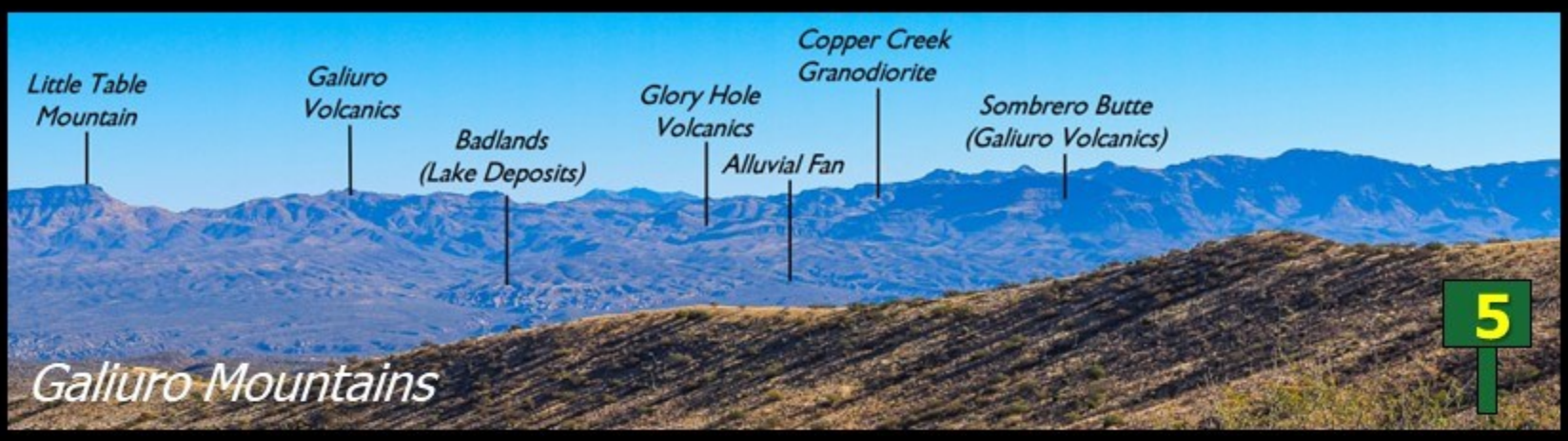
Orthoclase (K-Feldspar): pink color, weathers to a clay that is used in brick making and ceramics

Mica-Biotite – silver-black color, minerals grow in sheets, used in cosmetics and auto paint providing sparkle

Quartz – colorless, very hard mineral, used in glass-making

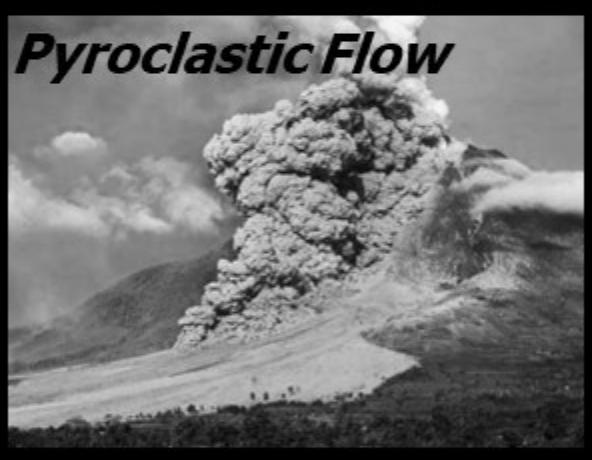
Proceed 300’ up to Marker #5

Marker #5



Marker 5, is located at a high elevation on the trail at a shade structure. It offers you views of the Galiuro Mountain Range along the eastern horizon.

The most noticeable feature of the Galiuros are the steep cliffs along the crest and flanks. They were created from eruptions, 70 million and 25 million years ago.

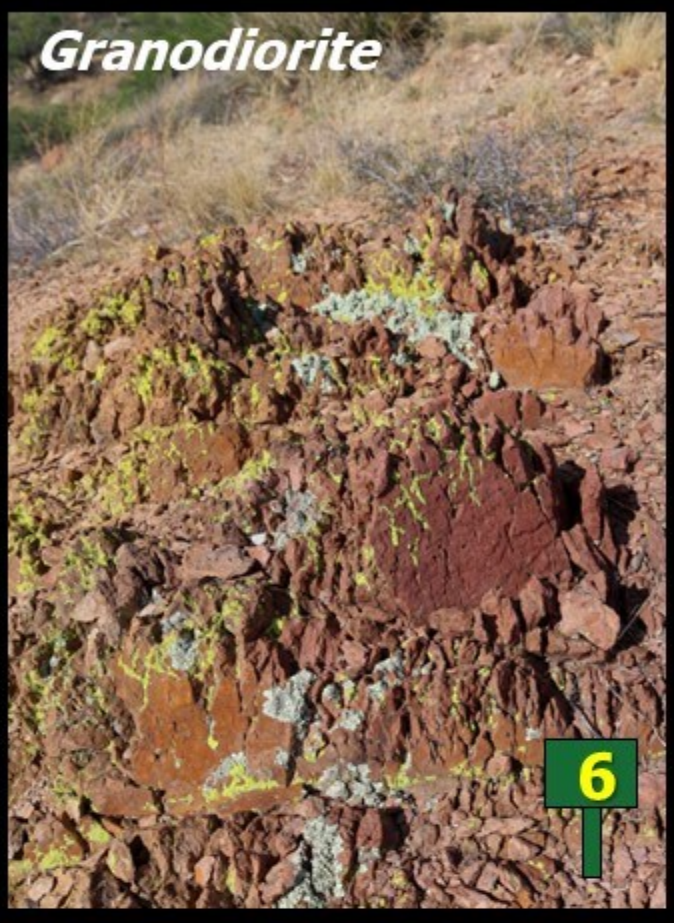


The eruptions were explosive, moving 1,000° F mixtures of rock, ash, and gas 100s of miles per hour down the slopes of volcanic domes. The rock created is a cliff-builder called **ash flow tuff**.

Look for the light-colored cliffs near the base of the range. These cliffs are not volcanic, but rather are the 7 million year old remains of a lake once located here. The fossilized bones of camel, horse, and mastodon are buried within these lakebed deposits. Eventually the lake evaporated and minerals like gypsum formed. Gypsum is mined and used in the production of cement and drywall.

Proceed 300’ up to Marker #6

Marker #6



Geology Trail Marker 6, is located on the left side of the trail that connects Bellota to Mariposa. When you walk on to this pink-gray rock outcrop, notice how it is oriented west to east.

It is an igneous intrusion, or dike, that crystallized along a trend that extends several miles across the Park.

The rock is a **Granodiorite Porphyry** that intruded Oracle Granite about 65-70 million years ago. The magma that produced it was accompanied by hydrothermal solutions that deposited valuable minerals like copper, gold, silver, and molybdenum throughout this area.

Just to the north of the Park, copper mineralization was economically concentrated. By the 1980s, the San Manuel-Kalamazoo Mine, was recognized as one of the world's largest copper mining operations.

Copper was mainly extracted by an underground operation with shafts up to 4,000' deep. Shallow copper ore deposits were extracted via an open pit method.

The mine was open for over 45 years. Over its life, it is estimated that nearly $8 billion of copper was produced.


San Manuel Mine

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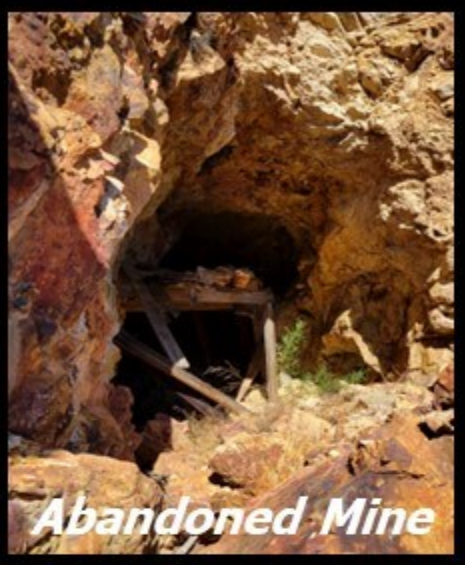
Marker #6 (continued)

In the Catalina Mountains to the south, copper formed in a similar manner (via precipitation from hydrothermal solutions). But the host rock in the Catalinas that received the copper, was often **limestone** that lay adjacent to the intruding granodiorite porphyry.


Abandoned Mine

In the Galiuro Mountains to the east, lies the Copper Creek Mining District. Copper has been mined in that area since the early 1900s. Geologically, the host rock for copper has a unique history in the Galiuros. When the granodiorite magma advanced vertically through the overlying rock, it would sometimes subsequently retreat.


Copper Creek Breccia

The retreat left a vacant cavity. The cavity filled with rock fragments from the roof and sides as they collapsed. Hydrothermal solutions then entered and cemented the fragments while depositing copper.

The copper-filled rock is called a **Breccia Pipe.** 100s of these 'pipes' have been discovered, and many have been mined.

Proceed 600' to Marker 7

Marker #7

Geology Trail Marker 7 is located on the Mariposa Trail section at a cluster of Oracle Granite boulders.

Scattered throughout the granite surface are 1-5" dark rock fragments. They are not Oracle Granite. When molten rock was flowing upward, it broke through other rocks and typically melted them. Occasionally, the intruded rock did not melt and instead fractured and joined the flowing magma. These foreign fragments are called **xenoliths**. They provide us a rare opportunity to examine rocks from the earth's deep crust and mantle.

Notice the rounded hills dominating the Park's north side. The rounded hills, called **alluvial fans**, formed as the Catalina Mountains eroded. Eroded fragments were carried by debris flows and streams and deposited on these alluvial hills that extend to the San Pedro Valley. Amongst the fragments are remnants from shallow seas that covered this land 300 million years ago.

Proceed 700' to Marker 8

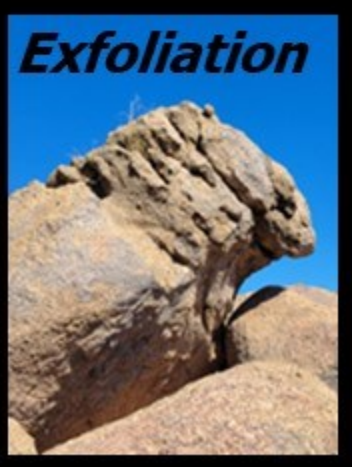
Marker #8

At Marker 8, you are at the trail's highest elevation. Here, you can observe from a distance or follow the narrow path leading up into this geologic feature.

This group of Oracle Granite boulders is not random, and the rocks did not roll here. The feature is an **inselberg**. It initially formed deep in the earth as part of the Oracle Granite mass. As faults lifted it towards the surface and the overlying rock eroded, cracks formed. Over millions of years the cracks widened as groundwater percolated downward. Once fully exposed at the surface, rainwater, ice, and plant life continued to widen the gaps.

Features you will discover in the inselberg include the following:

Once a granite reaches the surface, pressure is released, and the rock expands. As it expands, external layers delaminate. This is called **exfoliation**.

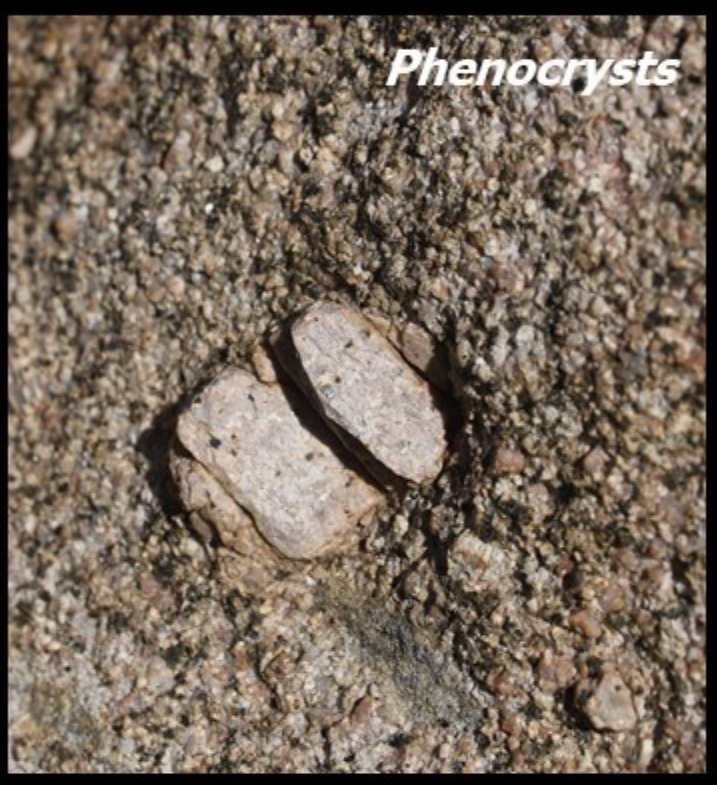


Next page for related information

Marker #8 (continued)

Notice the dark stains on the Oracle Granite surface. It is called **desert varnish**. It is due to iron and manganese oxides released from inside the rock. It takes 1000s of years for it to form.

As you follow the path through the inselberg, you may see oversized, pink-white colored minerals amongst the Oracle Granite. These are called **phenocrysts**. They are feldspar minerals. These crystals grew faster than the surrounding minerals.



The presence of phenocrysts usually indicates that the magma remained hot for a period, followed by a sudden cooling phase that prevented other minerals from continuing their growth.

Partially hidden in the inselberg is an exposed quartz-feldspar vein. This is the result of magmatic fluids, rich in minerals, that entered a gap in the granite.

Retrace steps & follow signs for ½ mile to #9

Marker #9

At Marker 9, you are standing on a 1 billion year old rock called **diabase**. This rock is part of an igneous dike running northward through the Park.

1 billion years ago, the earth's crust was thin from millions of years of extension. A rift formed, and an iron-rich magma flowed into the overlying rocks.

Diabase has several unique properties. It is typically black or dark brown, extremely durable, with a salt and pepper appearance. The most recognizable characteristic is that it is magnetic.

Its durability has been realized throughout history. About 5,000 years ago, masons used diabase as the building material for the pillars at Stonehenge!

Proceed 400' to Marker 10

Marker #10

Silty Clay Soil from Diabase

Marker 10 is a good place to examine soil. The grey-black soil at this marker is the result of diabase weathering.

Since diabase has little quartz, the soil produced is a very fine silty clay. Some plants have adapted to this soil. But many find it too fertile carrying too much retained water.

Diabase-born soil is relatively scarce at the Park. The most common soil you will find here is called **Grus**. It is derived from the weathering of Oracle Granite. Grus soils are typically well drained but can also have a good amount of clay from the decomposition of feldspar. Native plants are well adapted for Grus soil.


Grus Soil from Granite

This is the last stop along the Self-Guided Geology Trail Tour. We hope you enjoyed this tour and walked away with a better understanding of our unique geology. Please visit the rock and mineral collection on display in the Ranch House. Also, please inquire about the scheduled guided geology tours offered. We hope to see you again! Thank you.

Proceed 1/10th mile back to the Trailhead