



Geology Tour Road

an 18-mile motor tour



White Tank
Monzogranite
and Pinto Gneiss
Lost Horse Valley

This is your guide through some of the most fascinating landscapes in Joshua Tree National Park. The numbers appearing in the left margin correspond with markers along the tour route. Mileage starts at the intersection of Geology Tour Road and the main park road. The 16 stops along the 18-mile tour will require approximately two hours and will return you to this point.

Soft sand and steep grades make it a challenging trip. Recreational vehicles are not recommended, but two-wheel sedans and trucks may access the route as far as Squaw Tank, marker number 9. After Squaw Tank the road gets rougher and is only recommended for 4-wheel-drive vehicles.

Please help us protect this natural environment so that others may enjoy it as you have.

Geology and the Park

The face of Earth at any one time represents only a fleeting phase of a very long and dynamic history. Geologic change goes on all around us, all the time. The way the landscape looks today is a result of the geologic processes that have occurred throughout most of Earth's 4.5-billion-year past.

The landscape we see today in Joshua Tree National Park is the product of at least two widely separated episodes of mountain building. The latest of these episodes was followed by uplift and very deep erosion and then by further uneven uplift along faults. Erosion

exposed two rock bodies originally formed deep below Earth's surface: the 1.7-billion-year-old Pinto gneiss and the 85-million-year-old White Tank monzogranite, which intruded the gneiss as molten magma.

Many other geologic events occurred in this area, however the rock record has been lost through erosion. What remains are primarily the roots of old and very ancient mountains. The rocks that we see in the park have been faulted, jointed, weathered, and eroded to produce the geologic scenery of Joshua Tree National Park.

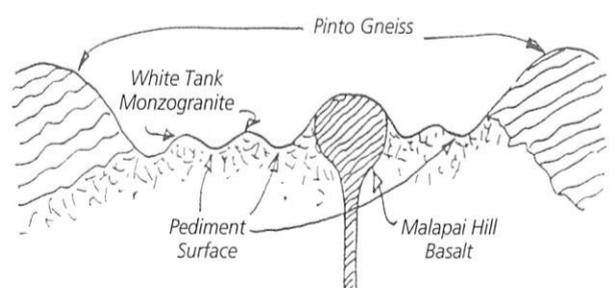
1 Why a Valley?

Mountain-rimmed Queen Valley and Lost Horse Valley to the west are formed by a difference in the rate of erosion between the rock underlying the valley itself and the rock composing the surrounding mountains.

The rock making up these valleys is generally less resistant to weathering and erosion than the rock forming the surrounding mountains and disintegrates more rapidly to form low-lying plains.

Pleasant Valley, seen later in the tour, is the result of faulting and consequent uplift and down-drop, or subsidence.

CROSS-SECTION OF QUEEN VALLEY



2 A Raindrop Divides

This knoll is the north-south drainage divide for the park. Water drains either to the northwest via Quail Springs Wash or to the southeast via Fried Liver Wash into Pinto Basin. The Queen Valley area, as viewed from a distance, actually has the shape of a broad, irregular dome eroded on bedrock by running water, the most important agent in the shaping of desert landscapes.

3 Nature's Gutter

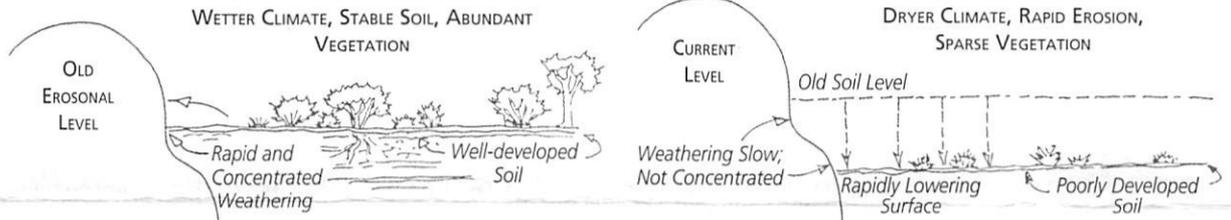
Just ahead is a wash. During summer, intense rainstorms can produce flash flooding along desert washes. Mineral grains, loosened from their parent rocks by weathering, are moved downslope through

the wash system. Several storms may be required to transport a mineral grain down a system of washes onto an alluvial fan, or, if it is a very small grain, onto a playa or dry lake bed.

4 Old Erosional Level

Many of the granite boulders to the left (east) of the road bear a distinct groove or line about seven feet above current ground level. Above the line, the boulder surface is generally steeper than below it. The line indicates the soil level in the past during a wetter climate. With the soil surface remaining constant for a

long time, weathering at soil level, where moisture was concentrated, loosened mineral grains and formed steep slopes on the boulders. During the later, drier climate, the soil surface eroded more rapidly, so the boulder surfaces below the old soil line are not so steep.

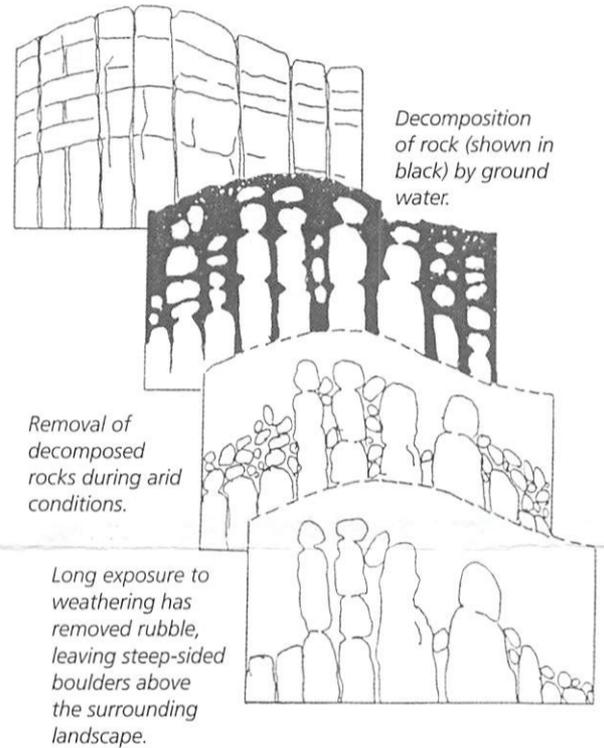


5 Rock Piles

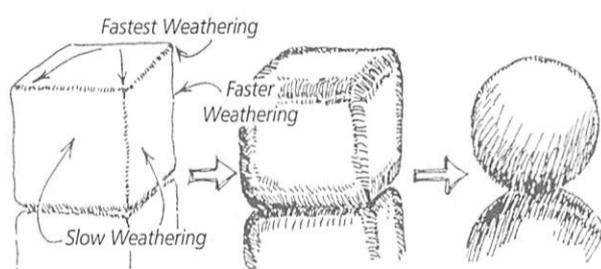
The monzogranite forming the rock piles on both sides of the road was once a molten mass that was forced upward into the overlying Pinto gneiss. The magma cooled at a depth of about 15 miles below the surface and crystallized to form solid rock.

Erosion over the ages has stripped away the overlying Pinto gneiss, exposing the monzogranite outcrops as you see them. The mountains to the right (west) are composed primarily of the darker gneiss, which is more resistant to erosion than monzogranite. Within the monzogranite, those areas with more widely-spaced joint cracks weather more slowly than others and form the high rock piles called inselbergs. In some piles, well-defined joint systems are obvious; in other piles, smaller boulders have collapsed and obscured the underlying joint pattern.

Vertical section with varied spacing of joints some 20 million years ago.



6 Rock Sculpture



White Tank monzogranite commonly displays sets of cracks, called joints, that intersect at roughly right angles. The nearly vertical cracks probably occurred when the rock mass contracted while cooling—

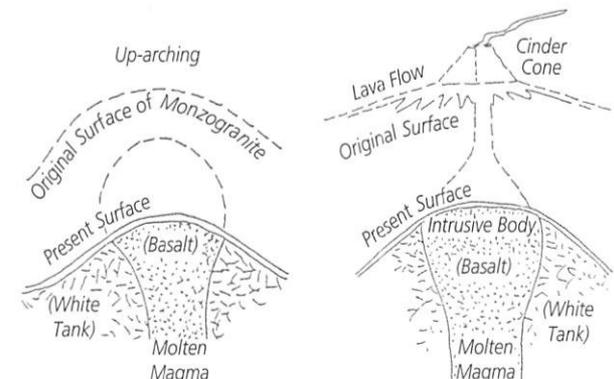
movement along fault lines may also have contributed. Then, as erosion removed the overlying rock, nearly horizontal cracks were created as the monzogranite expanded upward. These intersecting joints created more or less cube-shaped blocks of rock.

While the monzogranite was still below the surface, water, containing carbon dioxide, moved through the joint cracks. Little by little the rock was dissolved into individual mineral grains. Since this process is more effective on corners and edges, as there is more surface area than on faces, the cubes slowly changed into rock spheres—sort of like ice cubes melting.

7 Malapai Hill

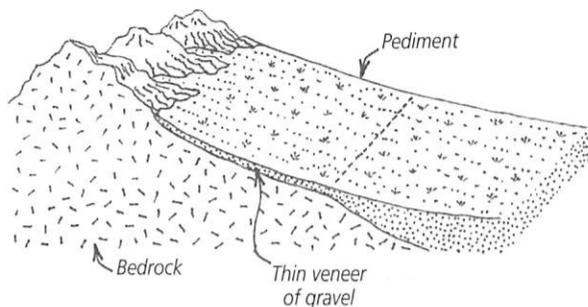
Three-quarters of a mile west of this point the twin peaks of Malapai Hill rise about 400 feet above the valley floor. The hill is composed largely of black basalt, which is more resistant to weathering than monzogranite, and most likely resulted from a shallow intrusion of molten magma that did not quite reach the surface. If it did reach the surface, any cinder cone or lava flow that was produced has eroded. The basalt intrudes the monzogranite and is probably relatively young, though the true age is unknown. It could have formed within the last two or three million years, which is quite recent compared to the monzogranite at 85-million years of age and the gneiss at 1.7-billion years old.

MALAPAI HILL CROSS-SECTION TWO POSSIBLE INTERPRETATIONS



8 Pediment Surface

You are now descending a pediment surface: a gently sloping erosional surface carved into bedrock on the edge of a mountain.



The pediment is formed by broad continuous sheets of water flowing over the gently sloping bedrock, which evenly removes surface rock material, rather than downcutting as by stream erosion.

A thin layer of fluvial gravel, derived from the mountains above, covers the bedrock. Periodically, during episodic rain storms, this gravel layer moves downslope across the bedrock surface.

9 Squaw Tank

The large mineral grains evident in White Tank monzogranite are a product of the slow cooling of the magma at 15 to 20 miles below the surface. This allowed more time for crystals to grow.

Notice the light-colored bands of rock cutting across many of the monzogranite boulders in this area. These bands of rock, called dikes, were formed when molten magma filled opening joints in the monzogranite. These dikes are composed either of aplite (light color) or pegmatite. They are more resistant to weathering and erosion than monzogranite and tend to protrude above it as low walls.

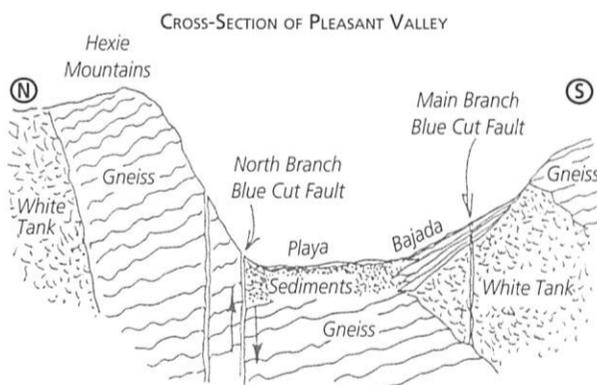
The pits and hollows on rock surfaces in this area are a product of cavernous weathering. This process begins with irregularities on the rock surface that trap water. The water promotes chemical breakdown of the rock to clay, which in turn holds more moisture and promotes more breakdown of the rock. As a pit becomes larger it can produce shade, which helps to increase moisture and foster lichen growth, increasing the chemical breakdown of the rock even further.

About 100 feet farther to the southeast, in the wash, is a concrete dam which forms Squaw Tank. Cattlemen built such dams to catch runoff water for their cattle during the early 1900s. Many of these dams are located where water collected in natural "tanks" or pools after rains.

Stop here in wet weather.

10 Pleasant Valley

The Blue Cut fault is one of a number of earthquake faults found in and around the park. Extending for



about 50 miles through the Little San Bernardino Mountains, under Pleasant Valley, and into the Pinto Basin, this fault is named for the blue granodiorite that is exposed on the mountainside to the southwest and marks the main branch of the fault.

Activity on a branch of this fault uplifted the steep, straight, southern edge of the Hexie Mountains to the left, while dropping Pleasant Valley on the right.

To your left you can see a dark coating or patina on some rock surfaces. Clay, iron, and manganese oxides accumulate over thousands of years to form patina layers which reflect, in their chemical composition, the story of past climate change.

11 Debris Flow

At the mouth of the steep canyon to the left there are irregular mounds of Pinto gneiss rock-debris without a patina. A number of times during heavy rains debris has oozed in slow-moving, viscous masses down the canyon and come to a halt near the mouth.

12 Mines

The mountain slopes in front and to your left (north) are riddled with tunnels and shafts dug by miners in search of gold and other precious metals. There was extensive mining activity throughout the area during the late 1800s and early 1900s, but very few of the mines were profitable due to limited high-grade ore.

Gold, silver, copper, lead, and other metals of economic importance are believed to be deposited when intruding magma cools and crystallizes, and various gasses and liquid solutions rise from the magma. In this area the fault zone has provided fractured rock pathways through which solutions migrated to precipitate metal-bearing quartz veins.

Shafts and tunnels part way up the slope to the east are probably on smaller branches of the fault zone along which quartz vein formation has occurred.



13 Dry Lake

This dry lake, or playa, which you are now crossing is evidence of a wetter climate during which a periodic lake existed in Pleasant Valley. Sediments consisting of clays and silts were deposited in this lake to a depth of hundreds of feet. As the lake water dried up, salts were crystallized out and deposited. Unlike many other dry lakes throughout the desert, salt deposits are not at all obvious here, but fairly high salt content is revealed by the presence of salt-tolerant plant species. After heavy rains many “dry” lakes become temporarily “wet” lakes.

14 Pinto Gneiss & Lichens



The banded and folded Pinto gneiss to your left, probably the oldest type of rock in the park, is approximately 1.7 billion years old. Gneiss is a metamorphic rock, whereas the basalt of Malapai Hill and the monzogranite are igneous rocks, the product of cooled and crystallized magmas.

Geologists believe that the Pinto gneiss was formed from preexisting sedimentary and igneous rocks. At some point the rocks were subjected to a deep burial where they underwent changes in mineral composition, grain size, and orientation due to increases in pressure, heat, and chemical activity. Directed pressure causes certain mineral grains to segregate and band together; it is the alternate banding of light and dark minerals that defines a gneiss.

The bright splotches of color found on many rocks are primitive forms of plant life called lichens, consisting of a mutually beneficial relationship, or symbiosis, of algae and fungi. The different colors indicate different species. Some species form a weak carbonic acid, which is the main agent in chemical weathering—the breakdown of rock to form soil.

15 Pinyon Junction

You are now at the upper end of an alluvial flow that makes up part of the bajada that you viewed from stop #8. The road to the left, now closed to vehicles, leads up a canyon to the site of a well that once provided water for gold ore processing and for watering cattle.

16 Panoramic View

For the past several million years, uplift of park land has been occurring along the San Andreas fault system to the south. Continuous erosion of this uplift has created hills and valleys.

We can only speculate on what future appearance the park landscape will take. However, it is certain that the processes of mountain building and erosion, shapers of the park for almost two billion years, will continue to mold the Joshua Tree region.