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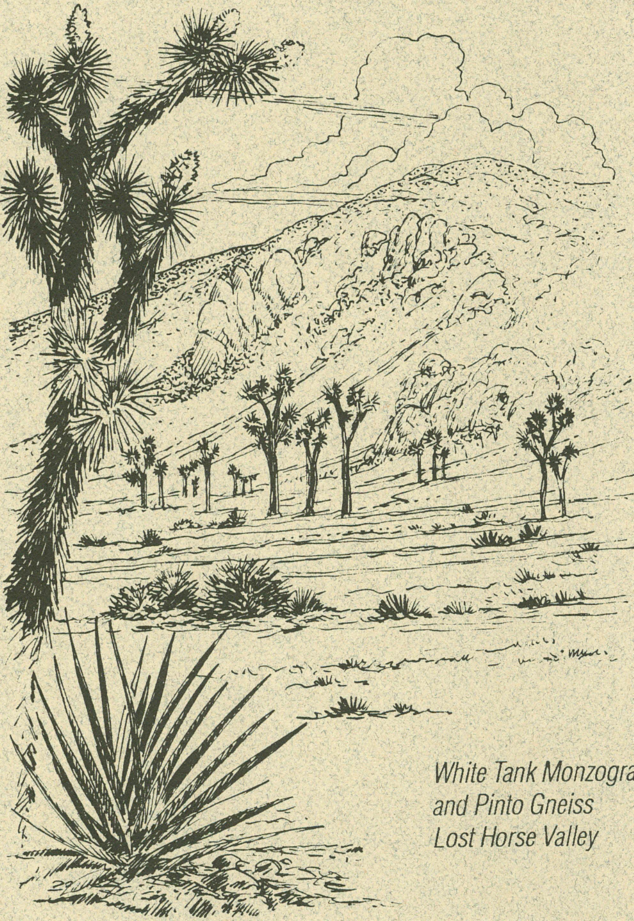
Joshua Tree National Park



White Tank Monzogranite
and Pinto Gneiss
Lost Horse Valley

Geology Tour Road Guide

An 18 Mile Motor Tour

This 18-mile motor tour (round trip) leads through one of Joshua Tree National Park's most fascinating landscapes. The numbers appearing in the left margin of this guide correspond with markers along the tour route. There are 16 stops along a dirt road and it takes approximately two hours. At Squaw Tank, 5.4 miles from the beginning, a chemical toilet is provided and there is adequate turn-out space for returning to Park Blvd. Or you can precede on the one-way portion (numbered stops 10-16) to continue exploring Pleasant Valley.

Vehicle restrictions: Four-wheel drive is recommended. Two-wheel sedans and trucks may access the route as far as Squaw Tank, marker number 9. Due to rough road conditions, recreational vehicles are not recommended. Please stay on established roads.

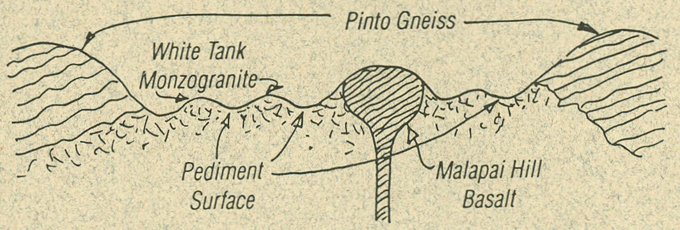
GEOLOGY AND THE PARK

The face of the earth at any time represents only a fleeting phase of a very long dynamic history. Significant changes are going on all around us, and the way the earth looks now is a product of these changes through time. The science that deals with these changes is called geology. More precisely, geology may be defined as the study of processes operating on and within the earth at the present time and, as revealed by the rock record, throughout most of its 4.5 billion year past.

The area encompassed by Joshua Tree National Park has been restless for at least 1.5 billion years. What we see today is the product of at least two widely separated episodes of mountain building. The later of these episodes was followed by uplift and very deep erosion and then by further uneven uplift along faults. Exposed by this erosion were two rock bodies originally formed deep below the Earth's surface, the 1.7 billion year old Pinto gneiss and the 85 million year old White Tank monzogranite which intruded the Pinto gneiss as molten magma.

Many other geologic events probably occurred in this area throughout the vast time before and after the formation of gneiss and intrusion of the monzogranite. However, the rock record of these events has been lost through deep erosion. What remains are primarily roots of old, ancient mountains. The rocks we see in the park have been faulted, jointed, weathered, and eroded to produce the unique geologic scenery of Joshua Tree National Park.

Cross-Section of
Geology Road Tour Area
Queen Valley



1. WHY A VALLEY?

Mountain-rimmed Queen Valley (elevation 4,450 feet,1356 meters) is one of two types of valleys found along the tour. Both Queen 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 a low-lying plain, or "valley". Within Queen Valley, rocky hills are more resistant than the areas around them. Pleasant Valley, seen later in the tour, is the result of faulting and consequent uplift and subsidence.

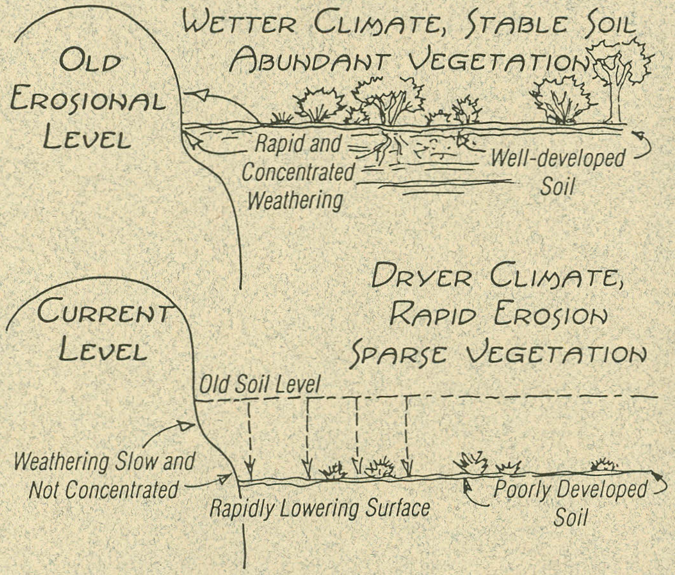
2. A RAINDROP DIVIDES

It is interesting to note that here on this knoll is the north-south drainage divide for the park. One would normally expect such a divide to occur on the crest of a mountain range to the north or south. Actually, water drains from this point 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. It was eroded on bedrock by running water, the most important agent in the shaping of the desert landscape.

3. NATURE'S GUTTER

Just ahead is a dry, intermittent stream channel, called a wash. During the summer months, intense rainstorms can produce flash flooding along many desert washes. Mineral grains, loosened from their parent rocks by weathering, are moved downslope by heavy rains. During flooding, these grains are moved further downslope through the wash system. It may require a number of storms to transport a mineral grain down a system of washes to where it is finally deposited on an alluvial fan, or, if it is a very small grain, beyond the fan onto a playa, or dry lake bed.

The increased soil moisture along these washes allows certain plants, such as the California juniper, to grow here more readily than on the drier surrounding desert.

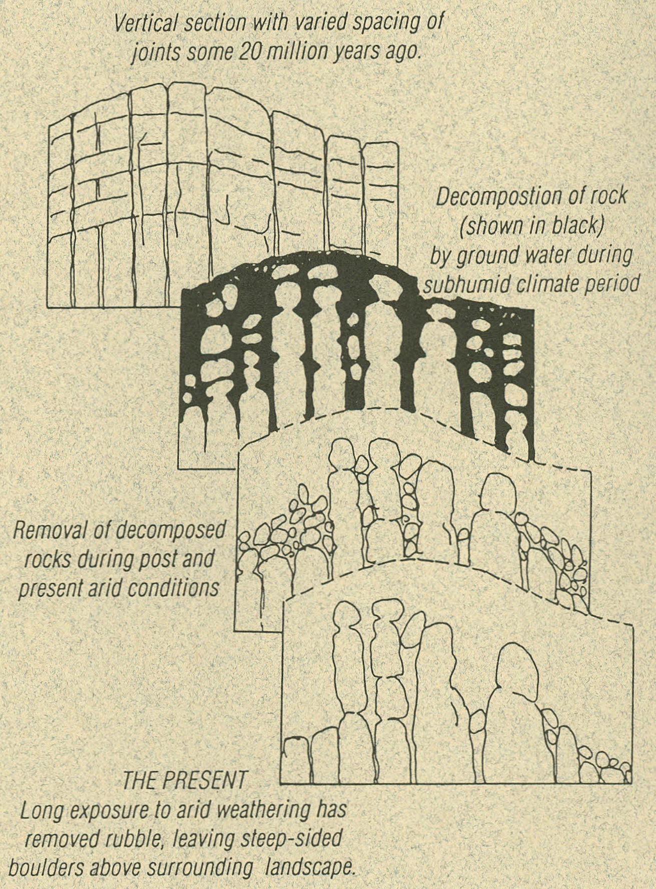


4. OLD EROSIONAL LEVEL

Many of the White Tank monzogranite 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 probably shows where a stable soil level existed in the past during a wetter climate. With the soil surface remaining constant for a long time, weathering processes, particularly at soil level where more moisture was concentrated, had plenty of time to loosen mineral grains and form steep slopes on the boulders. Subsequently, during a drier climate, the soil surface has been lowered rapidly by erosion. There has not been time for much weathering at the lower soil level to occur, 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 which was forced upward, or intruded, into the overlying, older Pinto gneiss (pronounced "nice"). The magma cooled at a depth of about 15 miles (25 km) below the surface and crystallized to form solid rock. Erosion over the ages has stripped away the overlying 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.



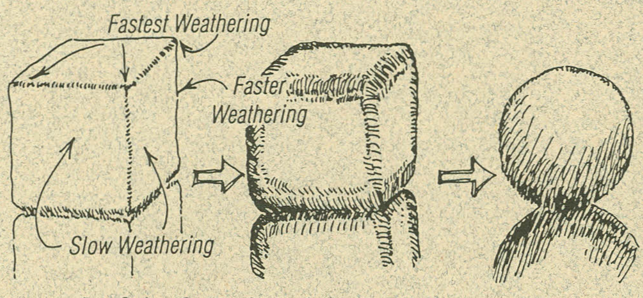
6. ROCK SCULPTURE

The rounded rock masses found in the White Tank monzogranite are probably more extensive and better displayed at Joshua Tree National Park than anywhere else in the world. What is the story behind these rock sculptures?

Massive rock bodies like this monzogranite commonly display 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. As erosion removed the overlying rock, nearly horizontal cracks were created when the rock mass expanded upward.

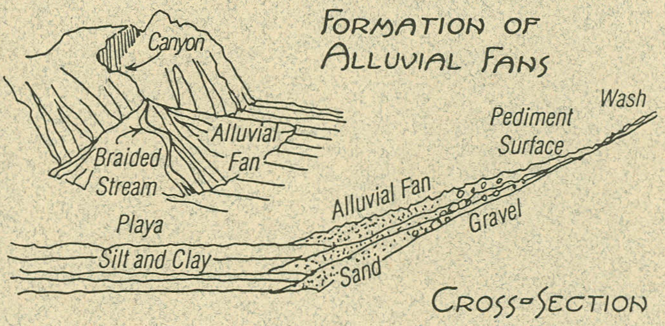
Jointing produces more or less cube-shaped blocks of rock. Why, then, are most of the rock masses quite rounded? (The rectangular rock at this stop is rather unusual.) While the monzogranite was still below the surface, water containing carbon dioxide moved through the joint cracks. Little by little the rock was broken down along the joints by this solution 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. (Imagine some ice cubes melting in the sun.)

ROCK STRUCTURE: CUBES TO SPHERES



7. MALAPAI HILL

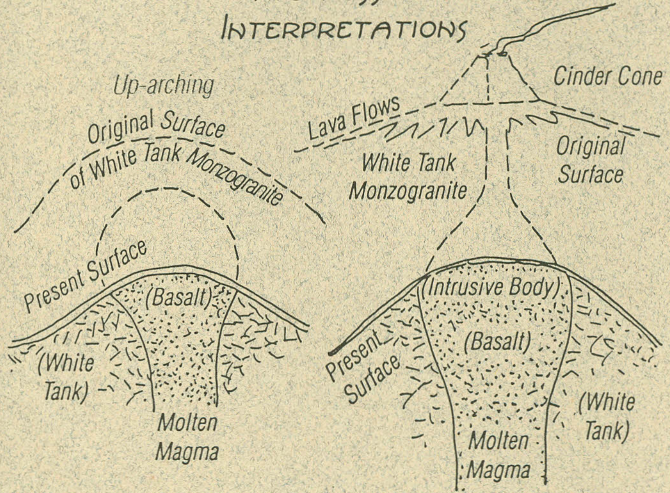
Three-quarters of a mile west of this point the twin peaks of Malapai Hill rise about 400 feet (122 m) above the valley floor. The hill is composed largely of black basalt, which is more resistant to weathering than monzogranite, and most likely resulted from a shallow intrusion of molten magma which did not quite reach the surface. If it did reach the surface, any cinder cone or lava flow that was produced has eroded by now. 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 (85 million years old) and the gneiss (1.7 billion years old).



8. ALLUVIAL FANS AND BAJADAS

You are now descending a slope called a bajada. A bajada is formed when neighboring alluvial fans merge into one long, wide slope. Directly across the valley you can see a bajada extending from the mountains into the valley. Alluvial fans are composed of sand, gravel, and rock produced by the weathering and erosion of rocks at higher elevations. This material is carried by gravity and flood waters to lower levels. Here it is deposited, the larger, heavier rocks being dropped first, and the lighter sands and gravel being carried farther out into the valley and deposited in a fan shape. Alluvial fans and bajadas illustrate the constant change that is taking place. Mountains are being carved and material being deposited in new places. Some might be deeply buried and consolidated into sedimentary rock which could be uplifted into mountains in the future.

MALAPAI HILL CROSS-SECTION
TWO POSSIBLE INTERPRETATIONS



9. SQUAW TANK

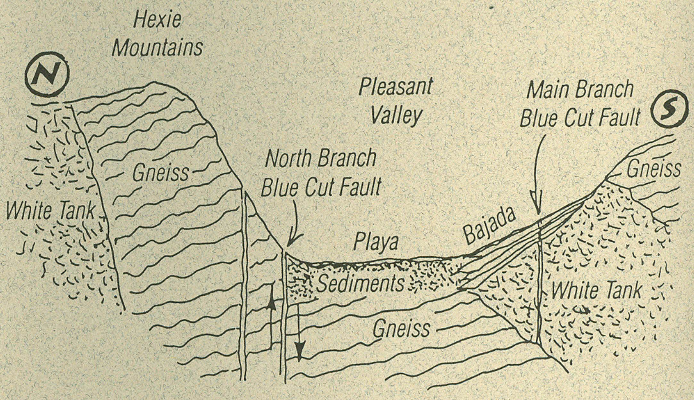
Here is a good place to observe firsthand some interesting geological features and also some ways that man has made use of the natural environment.

WHITE TANK MONZOGRANITE The White Tank monzogranite formed originally as magma deep below the earth's surface and rose as great balloon-like masses to a depth of around 15-20 miles below the surface, where the magma cooled and crystallized. The large mineral grains are a product of slow cooling, which allows more time for crystals to grow.

DIKES 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.

CAVERNOUS WEATHERING In this area are pits and hollows on rock surfaces, which 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, thus increasing chemical breakdown of the rock.

USE BY MAN Other holes in rocks may be bedrock mortars. Archaeological investigations show that semi-nomadic Native Americans used this area for about 1000 years, grinding seeds in these ever-deepening stone mortars. Several of these bedrock mortars can be seen just south of the large rock in front of you. About 100 feet farther to the southeast, in the wash, is a concrete dam which forms Squaw Tank. Cattlemen built this and other similar dams to catch run-off water for their cattle during the early 1900's. Many of these dams are located where water collected in natural "tanks" or pools after rains. Native Americans used this area for camping because of the water found in the pools.



PLEASANT VALLEY CROSS-SECTION

10. PLEASANT VALLEY

The Blue Cut fault is one of a number of earthquake faults found in and around Joshua Tree National Park. The Blue Cut fault extends 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 behind you to the southwest and marks the main branch of the fault.

Through activity on a branch of this fault, the land was uplifted to form the steep, straight, southern edge of the Hexie Mountains to the left; to the right the land was dropped, or subsided, to create Pleasant Valley, the second type of valley that you have seen (the first being Queen Valley, a result of differential erosion).

PATINA AND PETROGLYPHS To your left you can see a dark coating or patina on some rock surfaces. This is called "desert varnish" and is composed of clay, iron and manganese oxides. It accumulates at an incredibly slow rate over thousands of years, and as it accumulates, the chemical composition changes. Each patina layer is a page in the story of past climate records that can be read and interpreted by scientists. Petroglyphs, or Indian rock carvings, can be seen chipped into the desert varnish on rocks about 150 feet to the left. Many of the carvings may be hundreds or even thousands of years old, because the patina has reformed on some of them. Please help protect this prehistoric rock art.

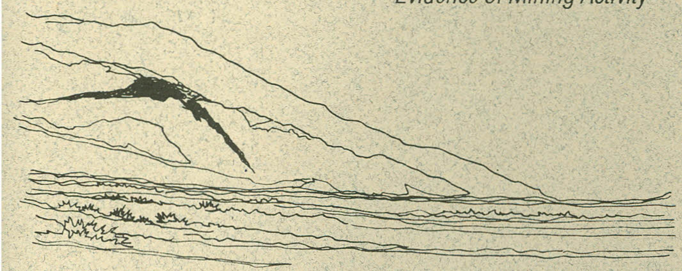
11. DEBRIS FLOWS

At the mouth of the steep canyon to the left there are irregular mounds of Pinto gneiss rock debris without 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. A debris fan has not yet developed, but several individual flows can be seen. One flow went as far as the edge of the playa and is immediately adjacent to the road on the left.

12. MINES

The mountain slopes in front and to your left (north) are riddled with tunnels and shafts dug by miners 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. The Lost Horse Mine is one of the exceptions. 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.

Evidence of Mining Activity



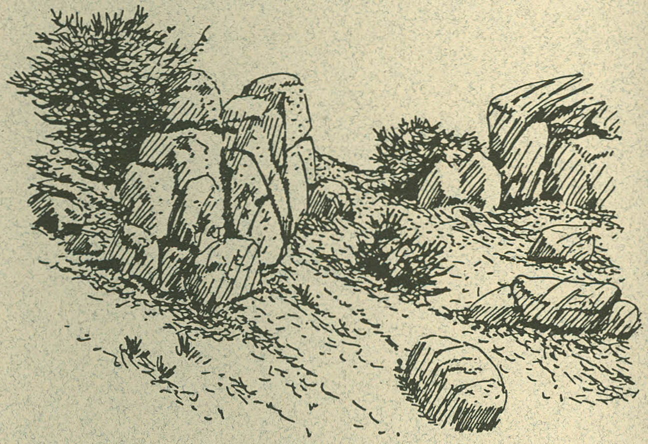
13. DRY LAKE

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 dried up, salts in solution 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 of the dry lakes become temporary "wet" lakes.

14. PINTO GNEISS

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 pre-existing sedimentary and igneous rocks. At some point the rocks were subjected to a deep burial where they underwent metamorphism to the present state. Metamorphism consists of 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.

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



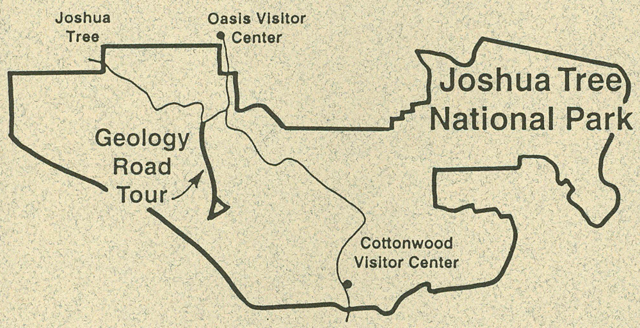
Pinto Gneiss

15. PINYON WELL JUNCTION

You are now at the upper end of an alluvial fan 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

The rock record along the Geology Tour Road reveals a dynamic past characterized by periodic episodes of mountain building. For the past several million years, uplift of most of the park area has been occurring along the San Andreas fault system to the south. Along with this uplift, there has been further erosion creating hills and valleys. We can only speculate on what future appearance the park landscape will take. However, it's 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.



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