Geologic Features in The Jewel of the Creek: An Armchair Tour

Thomas McGuire, August 23, 2022

This is a colorful burst of annual “autumn” leaves on Cottonwood Trees in The Jewel of the Creek, January, 2021.

The Jewel of the Creek is a jointly owned preserve of the Desert Foothills Land Trust (DFLT) and the Maricopa County Spur Cross Ranch Conservation Area.

”The Jewel” and the Conservation Area are dedicated to enable visitors to learn about and to enjoy the High Sonoran Desert, and to protect this unique riparian area and the adjacent desert.

This presentation will show major geological, hydrological and related features along the loop of the Dragonfly Trail.

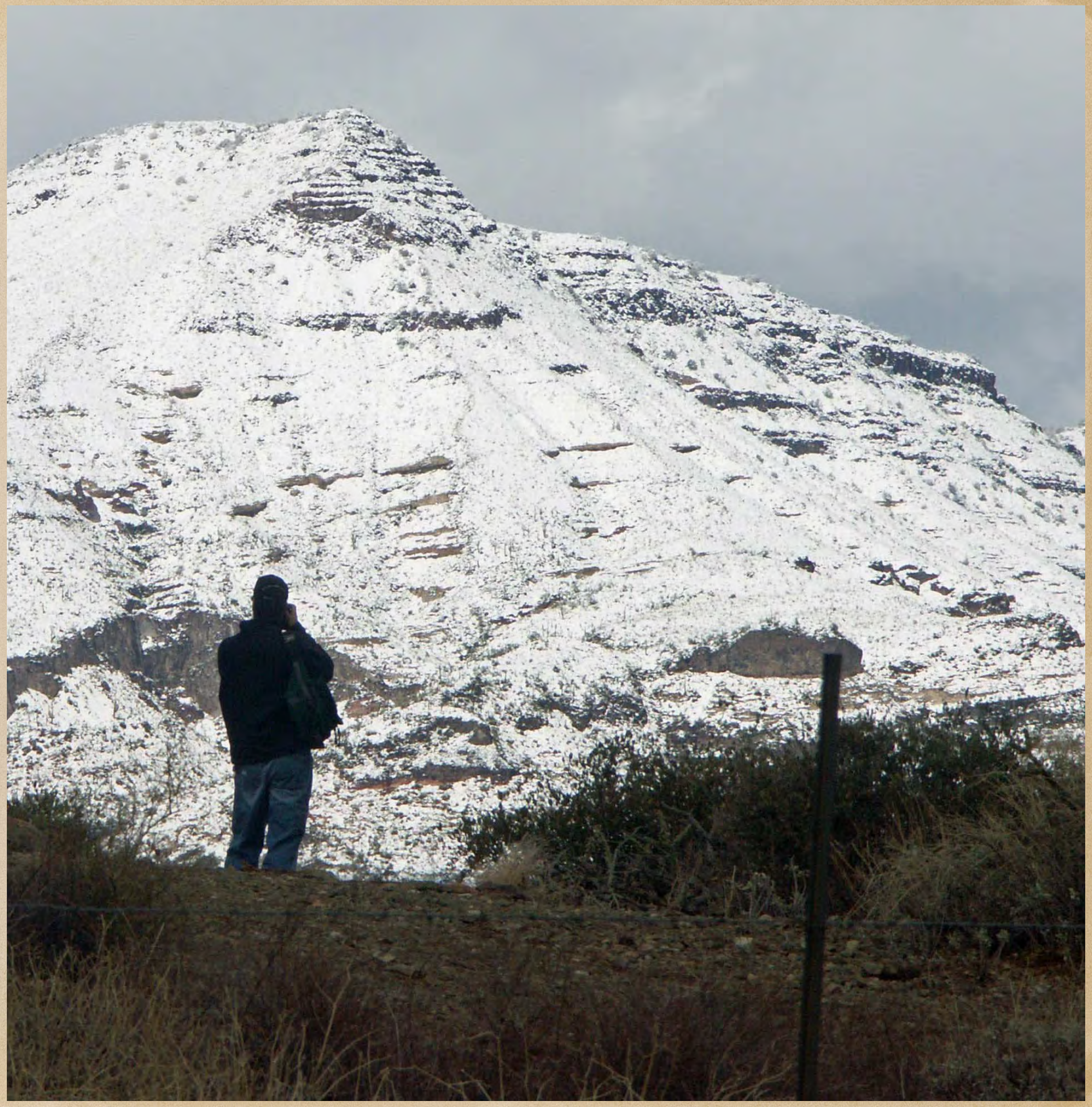
There are several ways to use this presentation.

1. Just enjoy it, instead of walking the trail.

2. Read it before or after your walking tour.

3. Load the presentation onto your cell phone. Then walk the route using the slides like information sign posts.

Snow is a rare event at the Conservation Area. This a photographer standing on the ridge above The Jewel of the Creek. He is photographing Black Mesa shortly after a snow storm in 2006.



The tour begins near the north end of Spur Cross Road in Cave Creek. Parking is limited, so you may need to park at the main parking lot of the Spur Cross Ranch Conservation Area just ahead. Most of the features in this tour are shown in the order you can see them if you walk the trail.

Many scientists perform experiments to see the results. But being a geologist is the opposite. A geologist is a detective. The geologist looks at the final results (Earth and its features) and tries to deduce what happened (what was the “crime”) to create what we now observe.

This tour will stress how we can interpret the clues to figure out what happened to the rocks.

In addition, you will see how (and why) geologists can differ in their interpretations of the rocks.

The Jewel of the Creek is an ideal place to see evidence (the clues) and understand how and why different scientists reach different conclusions.

So which one is right?

You can decide. I will try to give you enough observations to justify the conclusions of other geologists as well my own interpretations.

The science is not what you know, it’s how do you know what you know.

Jewel of the Creek

DESERT FOOTHILLS LAND TRUST


Great Blue Heron


Cactus Wren


Red-tailed Hawk

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W E
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PRESERVE RULES

- Remain on designated trails.
- Do not enter closed areas.
- Take only pictures and leave only memories.
- Pick up after your pet.

Hours of Operation
Jewel of the Creek Preserve is open daily.
Sun - Thurs: 6a.m. to 8p.m. and Fri & Sat: 6a.m. to 10p.m.

Saguaro Blossom

Cottonwood

❶ Barrier Free Section of Harry Dalton Trail Loop

Easy, hikers only

The portion of this trail is barrier free and is accessible to people of all abilities. Please note the hill contains some steeper slopes. Therefore, motor assisted wheelchairs are recommended. This trail was built in loving memory of USA SGT, Travis Warren and in honor of those who serve our country. (0.32 mi)

❷ Harry Dalton Trail Loop

Easy, hikers only

This trail circles through an incredible mesquite bosque, crosses Cave Creek and passes through a towering stand of giant saguaros. (0.62 mi)

❸ Dragonfly Trail Loop

Easy, hikers only

A beautiful trail that traverses the unique riparian area surrounding Cave Creek. This trail also connects to other trails throughout Spur Cross. To reach these trails, take the spur off to the north at Boca Grande Wash. (Loop trail 1.03 mi)

Always remember to bring plenty of water, use protection from the sun and let someone know where you are going and when you plan to return. Please enter the Maricopa County Sheriff's Office phone number of 602.876.1000 into your phone prior to hiking. In case of emergency dial 911.

DESERT FOOTHILLS LAND TRUST

For further information please contact:
Desert Foothills Land Trust
480.488.6131
www.dflt.org

A DFLT plaque is posted near the parking area. While you can observe plants, birds and other wildlife, this presentation will stress the physical environment. It will follow mostly trails 1 and 3.

The town of Liscum provided housing and services for miners at the adjacent gold mines. It was founded in 1897 and lasted about 10 years. Now it’s a “ghost town” where no structures are left.

When molten basalt lava cools and solidifies, the rock shrinks. This causes cracks in the solid basalt. In some places the cracks have created 5 or 6-sided vertical columns extending down through the layer.

Basalt columns can be seen in Iceland (right), the Palisades Sill across the Hudson River from New York City (below) and Devils Postpile in California.

Columnar jointing can also be seen in many lava flows to the north of us in the Tonto National Forest.

Near the entrance of The Jewel you can see 15-20 million year old lava flows near the top of Sugarloaf Mountain, about two miles north. The columnar basalt is relatively young. It’s only about 1% of the age of the ancient meta-basalt bedrock you will soon see down in The Jewel.

Along the trail ahead are many boulders that show the polygonal pattern of basalt columns. The boulders sometimes split along these cracks that created the former vertical columns.

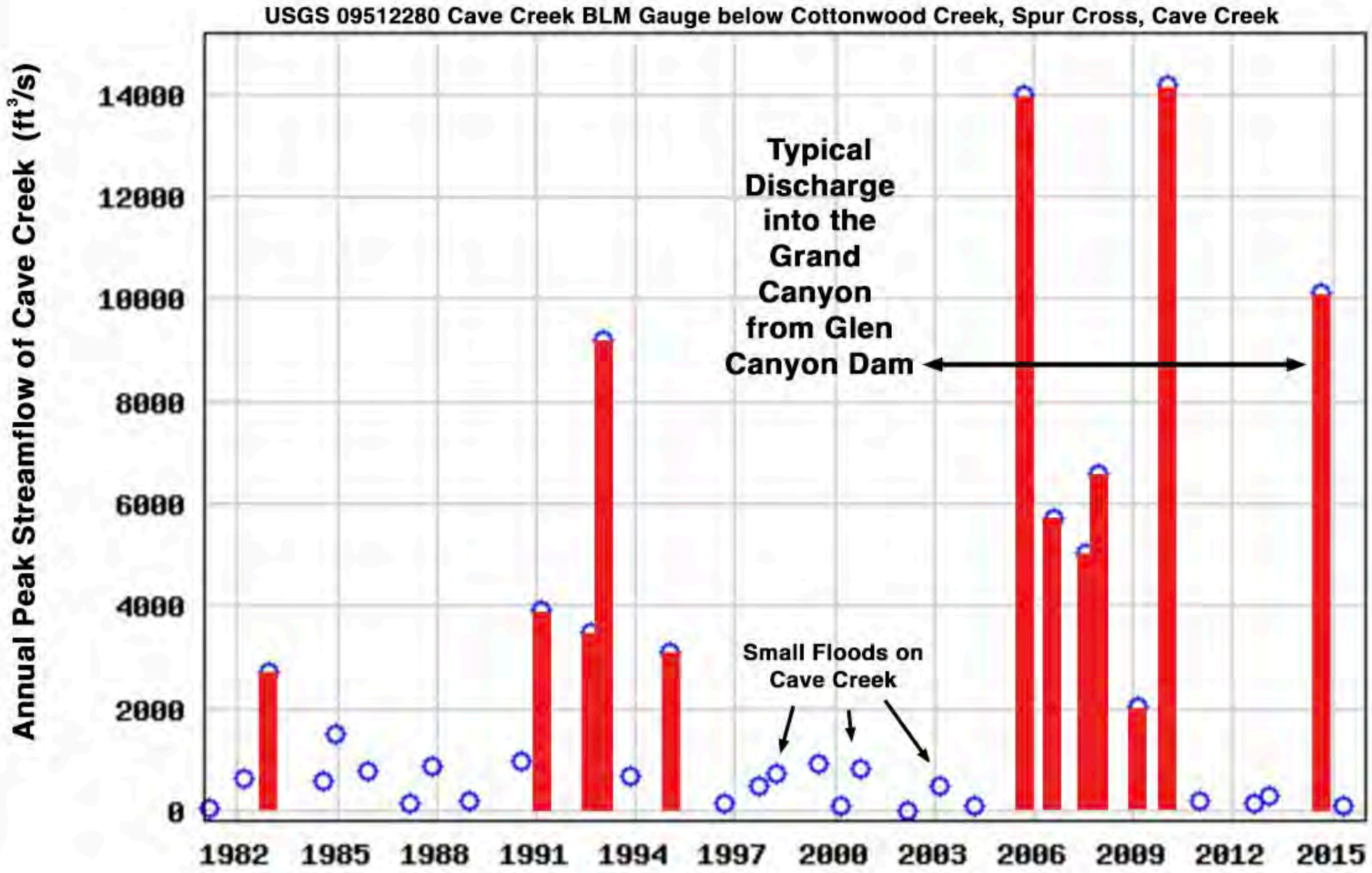
The flat area below is the riparian floodplain of Cave Creek. It’s called the floodplain because it is covered with water in major floods. Normally the creek flows only through the trees to the right.

The soil tends to be moist in these stream-side areas. So the riparian zone supports cottonwood trees and relatively dense vegetation. Note that tall saguaros, desert shrubs and other cacti occupy the dry slopes above the flood plain, but tend not to grow down in the moist soil.

Cave Creek, like many desert streams, is “flashy.” It is usually dry about 6-8 months of the year when water flow sinks underground. But torrential storms cause floods that overtop the banks.

Some recent floods have briefly carried more water than the Colorado River as it flows through the Grand Canyon. This is a flood of 10,000 cubic feet per second in 2014. (USGS data)

Cave Creek floods greater than 2000 cubic feet/second1980-2016. Four of them were greater than normal water releases at the Glen Canyon Dam that flows through the Grand Canyon.



USGS/TMcG 2020

Flooding is especially common during the summer monsoon season, July-September. Major floods, such as those that occurred in 2006, 2010 and 2014, flatten most of the vegetation.

The path of Cave Creek is easy to follow on a satellite image as a zone of green riparian vegetation.

The creek generally flows south, but here it takes a sharp bend to the west where the creek erodes into weak rocks in the Continental Mountain Fault Zone. This fault is one of several that separates the low Sonoran Desert, from the rugged transition zone, that leads up to the Colorado Plateau.

Different minerals form in different geologic conditions. This green rock is composed of the mineral epidote, a metamorphic mineral that forms under conditions of high heat and pressure, deep below Earth's surface. The light colored material is caliche, a natural limestone cement that is deposited by evaporating groundwater. Caliche can make digging holes in nearby desert soils very difficult.

Next, in the rock cut along the path are dozens of “lava pillows.” They formed when molten lava flowed into water, and the lava solidified very quickly to make round pillow-shape structures.

You can find videos on the ‘net of lava flowing into water in Hawaii, as it makes lava pillows. These lava pillows show that an inland sea probably existed here 1.68 billion years ago when North America was located south of Earth’s equator. This rock started an igneous rock. But the pillows here have been elongated by metamorphic stretching of the rock deep underground.

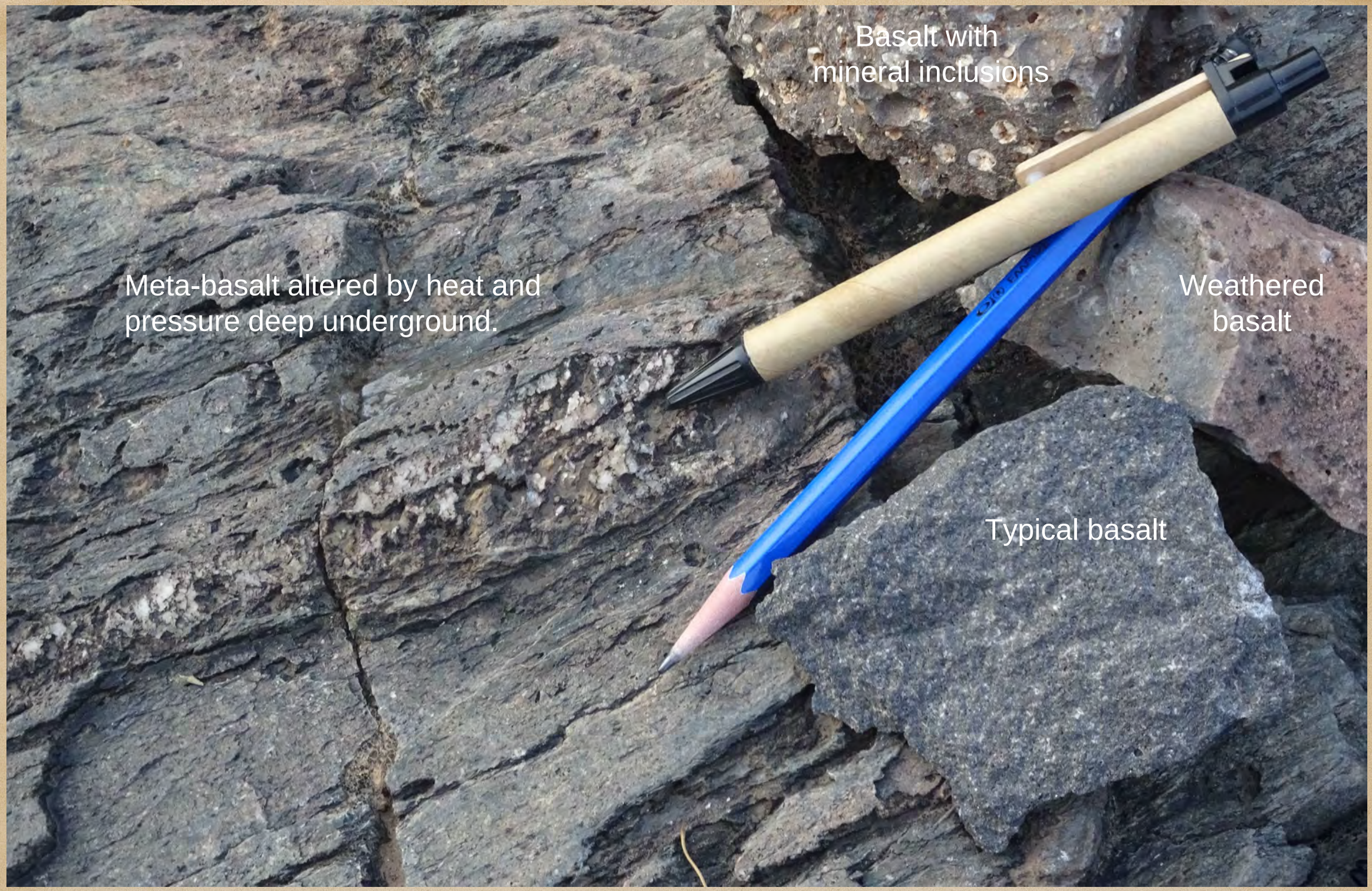
Bedrock is the solid rock that extends from the surface deep into Earth. You saw a cut into bedrock along the path at the last stop.

This bedrock outcrop has dozens of rounded lava pillows that can be found by carefully observing exposed surfaces of the bedrock.

The angular steps of this bedrock exposure reminds me of the outdoor seating of a classical Roman or Greek amphitheater.

So this location will be identified in this tour as “The Greek Amphitheater.”

Movement within Earth causes rocks to crack, forming joints. These joints intersect at nearly right angles. This is not common in basalt. Nevertheless, the professional geologists who mapped this area call it basalt. A combination of the right angle jointing, deformed lava pillows, quartz intrusions and thin layering lead the author to differ. Here, we'll call it meta-(metamorphic) basalt.



Layering along with white quartz pods looks very different than the far younger, typical basalt rocks on the right. Those rocks were not metamorphosed by deep burial within Earth. The three rocks on the right are typical samples of the basalt you saw on the high mesas to the north.

At one end of the same outcrop is a small, rounded flume created by floods on Cave Creek. Water alone doesn’t wear down the rock, but when it carries sand and other sediment, it’s a very effective agent of erosion. This little flume is evidence of floods far above the usual water level. You should turn left just before the creek crossing to follow the path up the north-facing slope.

Like the bedrock at the “amphitheater”, this position was mapped as basalt by the USGS geologists. Here, the rock is so layered it looks to me more like a typical metamorphic schist.

High across the canyon is a mine pit that a hiker fell into in 2019. Unable to climb out, she called for help on her cell phone and was rescued by first responders. After the accident, the county fenced off and posted the sign here, as well as dozens of other nearby open mine pits and adits.

A sign marks the boundary between Desert Foothills Land Trust property and the Spur Cross Ranch Conservation Area, managed by Maricopa County. Unlike other county parks, by charter, the “conservation area” is for preservation and education. It will never have outdoor recreation facilities.

Note that the ground is sometimes wet here. It seems an unlikely place for a natural spring. And it is.

The Cave Creek Water Company extended a water line to a place above us to prepare for a large resort community planned on the mesa across the creek. When Cave Creek voters purchased the resort site in 2000, a dead end water line was left.

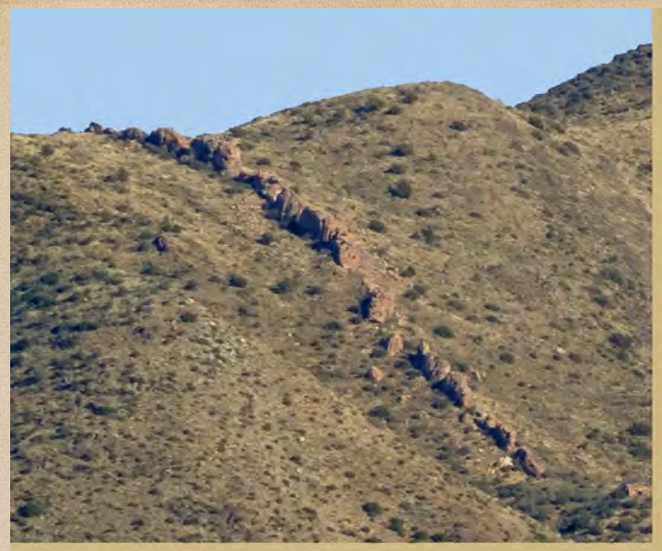
To prevent stagnant water in the pipe, it must be “bled out” periodically. That excess town drinking water flows down here.

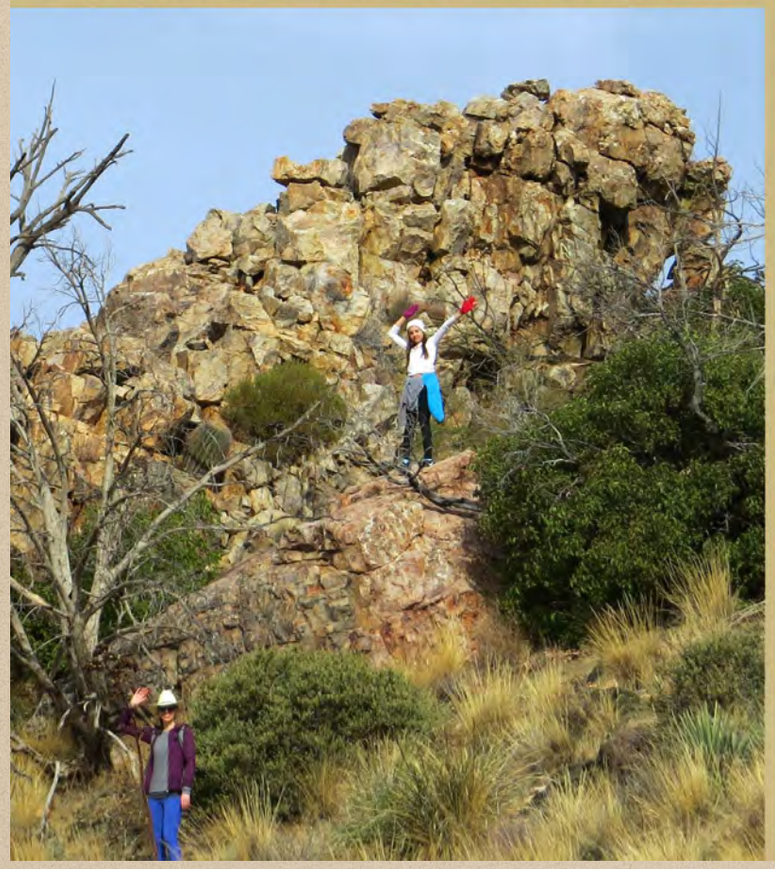
50 yards ahead, wheeled traffic from the Maricopa Mine probably created these parallel ruts in the bedrock.

The Cave Creek Mining District was most active between 1890 and 1910. But the gold soon became too scarce to continue mining.

While mines subsequently changed hands several times, they never found enough gold, or secondly minerals (including minor amounts of copper, silver and others) to make mining profitable.

The rock clearly has the layered character of metamorphic slate or schist, but even here it is mapped as the original 1.7 billion year old basalt.





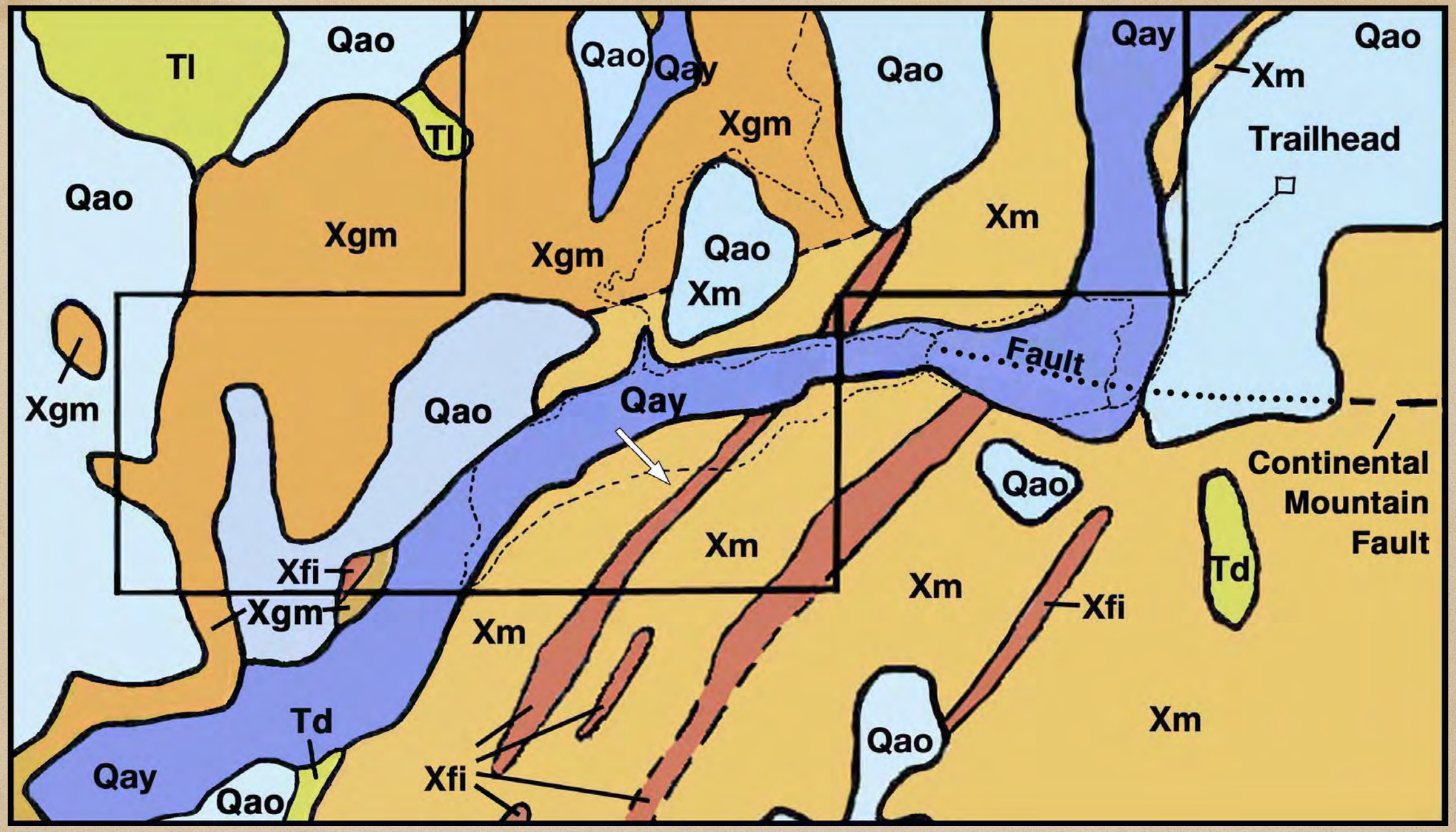
Soon “China Wall” comes into view on the highest mountain about 4 miles to the east. It is named China Wall because it looks like the ruins of the Great Wall of China, as the close-up images show. It was hot, molten rhyolite injected along the rock layers. Rhyolite is a light colored, sugary rock composed of the same minerals as granite. But rhyolite cooled before large crystals could form.

Next to the camera bag you can see the boundary between meta-basalt and rhyolite. Geologists use interfaces like this to plot geologic maps.

Prospectors use contacts to indicate the edge of productive ore deposits.

According to mining reports, porphyry rhyolite was the primary gold ore at the Maricopa Mine. Porphyry is a rock composed of large crystals in a matrix of much smaller crystals.

The next slide is a part of the geologic map of the New River
Mesa quadrangle made by USGS professional geologists. These maps help them assemble a geologic history.

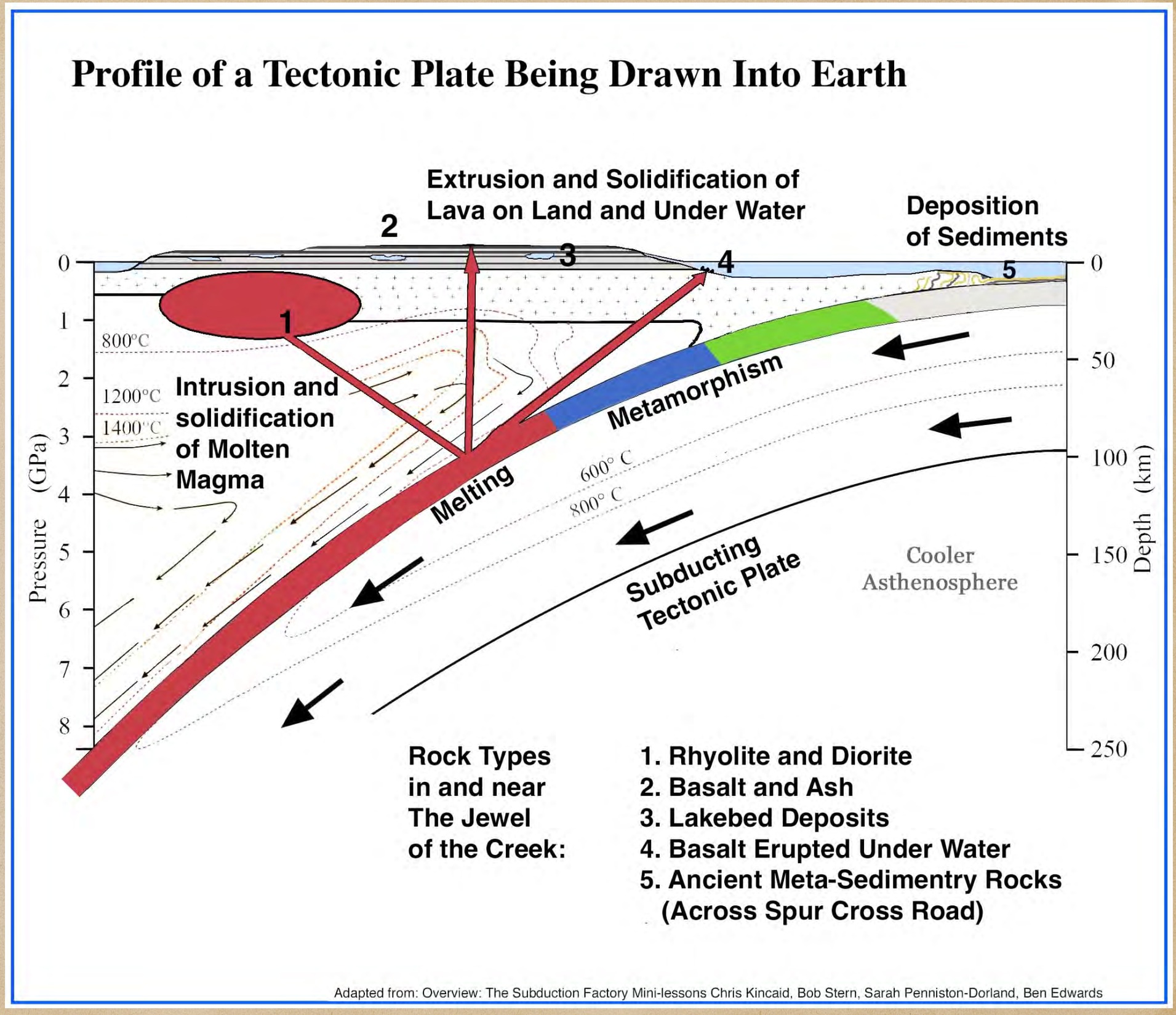


This is a small portion of the USGS New River Mesa geologic map that is around The Jewel. It is based on field observations and mapping by Ferguson, et al. Thin dotted lines show the paths you have been following. The trailhead is on the right. The white arrow locates the Maricopa Mine.

Blue Qay and Qao are Quaternary (less than 2 million years old) stream and rockfall deposits. Formations labeled “X” are Proterozoic rocks 1.68 billion years old; the same age as rocks at the bottom of the Grand Canyon. Xm is the (meta) basalt at the “amphitheater.” Xfi is “China Wall” rhyolite.

To produce the great variety of rock types we see within, and adjacent to The Jewel, requires a plate tectonic environment such as the subducting (diving) tectonic plate off the coast of Japan.

Numbers 1-5 are environments where the rock types found in The Jewel and the Spur Cross Conservation Area might form.



Numbers 1-4 show the rock record revealed in The Jewel of the Creek in time sequence.

Events in Earth's history of which there is no record in The Jewel or visible from here are in red.
In The Jewel, the rock record of the vast majority of geologic time has been lost to erosion.

(No record of Dinosaurs 200 million years ago)

1.
Deposition of sedimentary rocks, lava flows on land and into water and magma intrusions that were later metamorphosed occurred nearly 2 Billion Years ago

(Formation of Earth and the solar system 4.6 billion years ago)

2.
Very long period of deep burial and metamorphism by heat and pressure underground over millions of years

3.
Euption of volcanoes that left the flat lava flows on the high mesas to the north and white ash layers containing fossils: 20 million years ago

4.
Weathering, erosion and deposition still going on today

Modified from a USGS diagram

We can take the whole history of Earth back to its origin 4.6 billion years ago and make a spiral. The rocks in The Jewel span an amazing 2 billion years. But the portion recorded in these rocks is a tiny part of that 2 billion years. There are huge gaps in the time line caused by erosion.

Across and high above The Jewel are Elephant Mountain and Elephant Butte. There is an Indian fortress above the steep cliff. It was a retreat and protection from Apache Indian raiders.

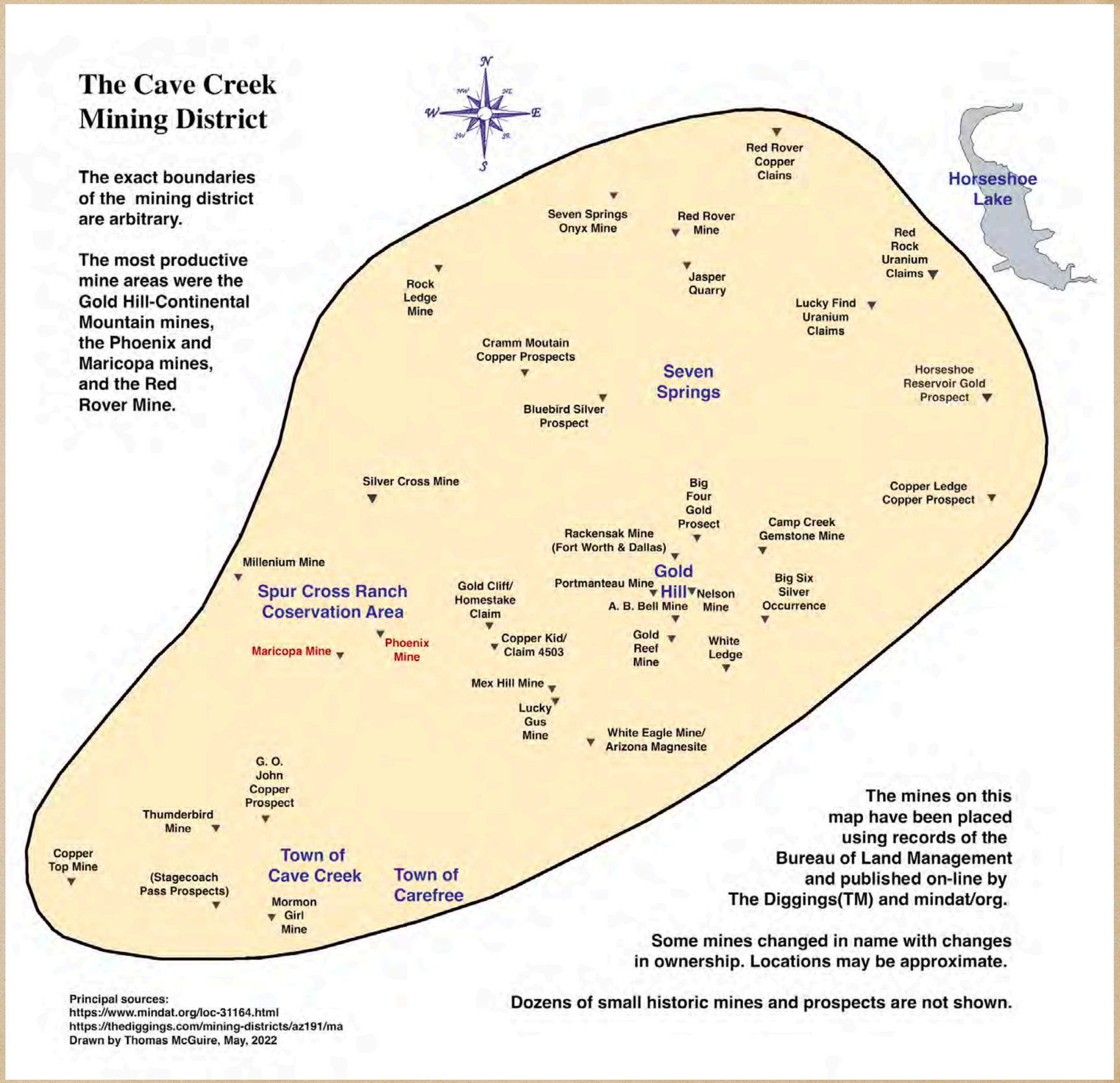
Blue and green copper minerals like chrysocolla along the upper mine road are “indicator minerals.” Gold is usually hard to see in the rocks at most mines. But these minerals can be used to locate gold ore. You are now at the Maricopa Mine, as you will see in the next five slides.

Rhyolite porphyry is the primary ore at the mine site. It’s composed of large crystals surrounded by smaller crystals. Porphyry bodies are a primary source of gold and copper throughout Arizona.

The region including many of the local mines became known as the Cave Creek Mining District.

Many explorations were made, but none of these small mines produced much return for the prospectors or the investors.

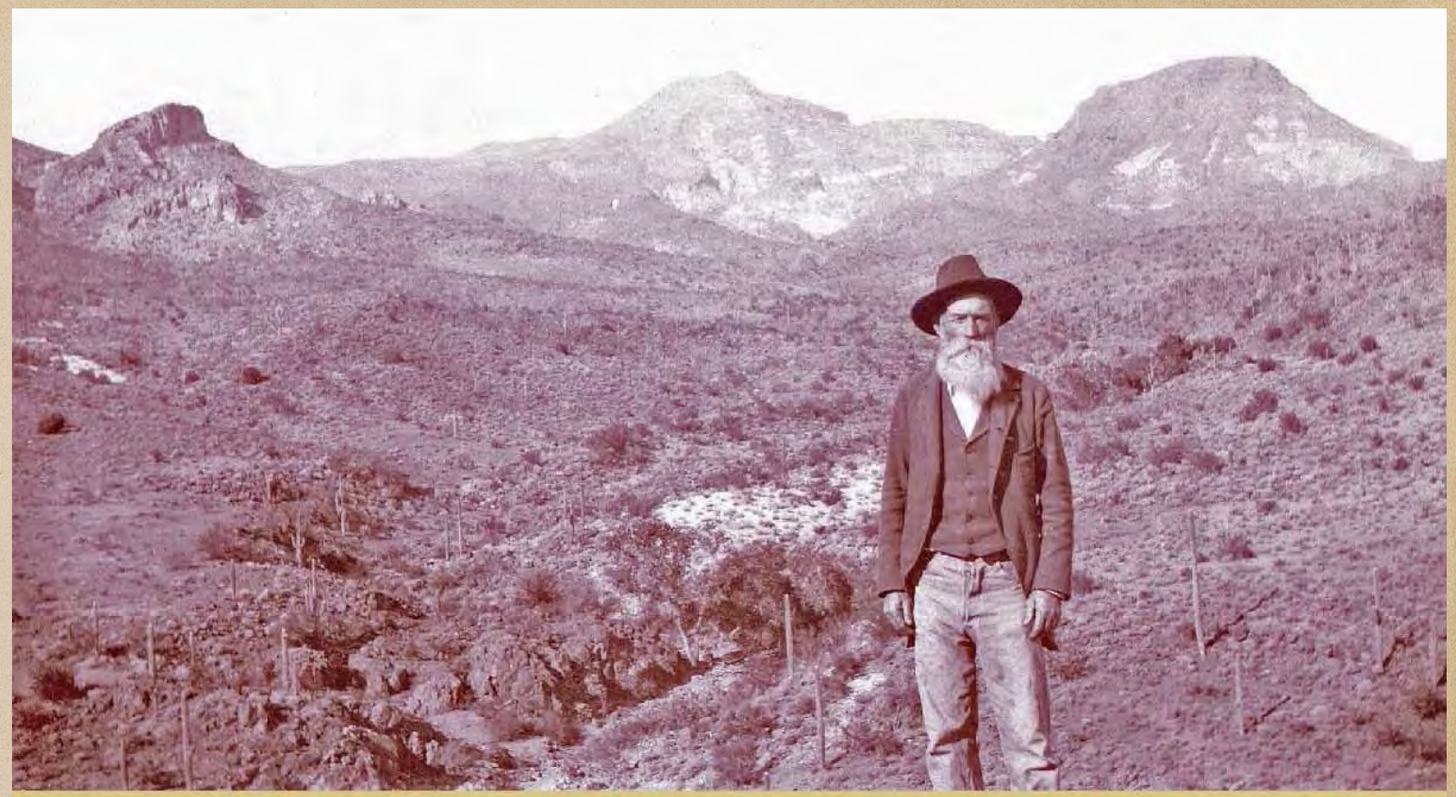
Modern mines can make a profit from low grade ore, but they need a big ore body.



Gold was discovered by William Rowe in 1864, about 4 miles east of here near Continental Mountain and China Wall. Our area is known today as the “Cave Creek Mining District.”

The upper image shows Francis Shaw in 1905, one of the Maricopa Mine owners. Below is the same view in 2020. Note the lack of trees in the top image. The bigger trees were cut for steam powered rock crushers.

There are no reliable records of the value of gold the Maricopa and Phoenix mines produced. But a reasonable guess is $10 million. They were most productive from 1890 to 1900. Given the cost of mining equipment, mine structures, supplies and labor, local mines were never a financial success.

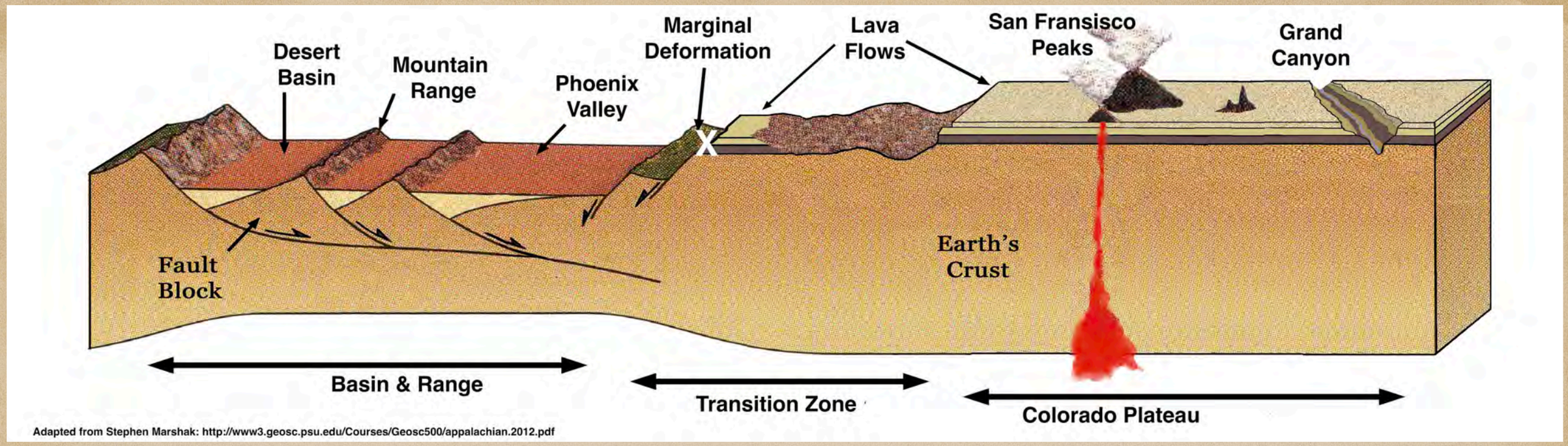


Weathered wood posts and the concrete foundation were a part of the Maricopa Mine structure.

Broken concrete footings, timbers and cables can still be seen on the bank below the trail. The title slide in this tour is a view of the mine and tailings from the creek bed below.

There are no historic images of the Maricopa or Phoenix Mine buildings. But this mine in Eureka, Utah, could be similar to a mining structure at the Maricopa Mine.

The last commercial mining activity in the Cave Creek District ended in the 1950s. But in 2020 an amateur prospector used a metal detector to find a pea-size gold nugget near the mine.



Arizona has three major landscape provinces as you can see on the diagram above; Basin and Range, Transition Zone and Colorado Plateau. The "X" on the top diagram shows that The Jewel of the Creek is located near the boundary between the Basin and Range and the Transition Zone.

Notice how the tilted layers below on Elephant Mountain on the left side of the photo, and flat lava layers on Sugarloaf, near the right side, relate to the position of the X on the top diagram.

After the Maricopa Mine, the trail descents into The Jewel. There, the path is fine clay that has been deposited by floods on the creek. The bank is above most floods and receives no clay to cover the rocks. The clay initially forms a harder crust on top, but it breaks up with foot traffic.

An ephemeral pool is next. From late December until May surface water may be seen here. But the pool dries up in summer and autumn months except during or right after floods.

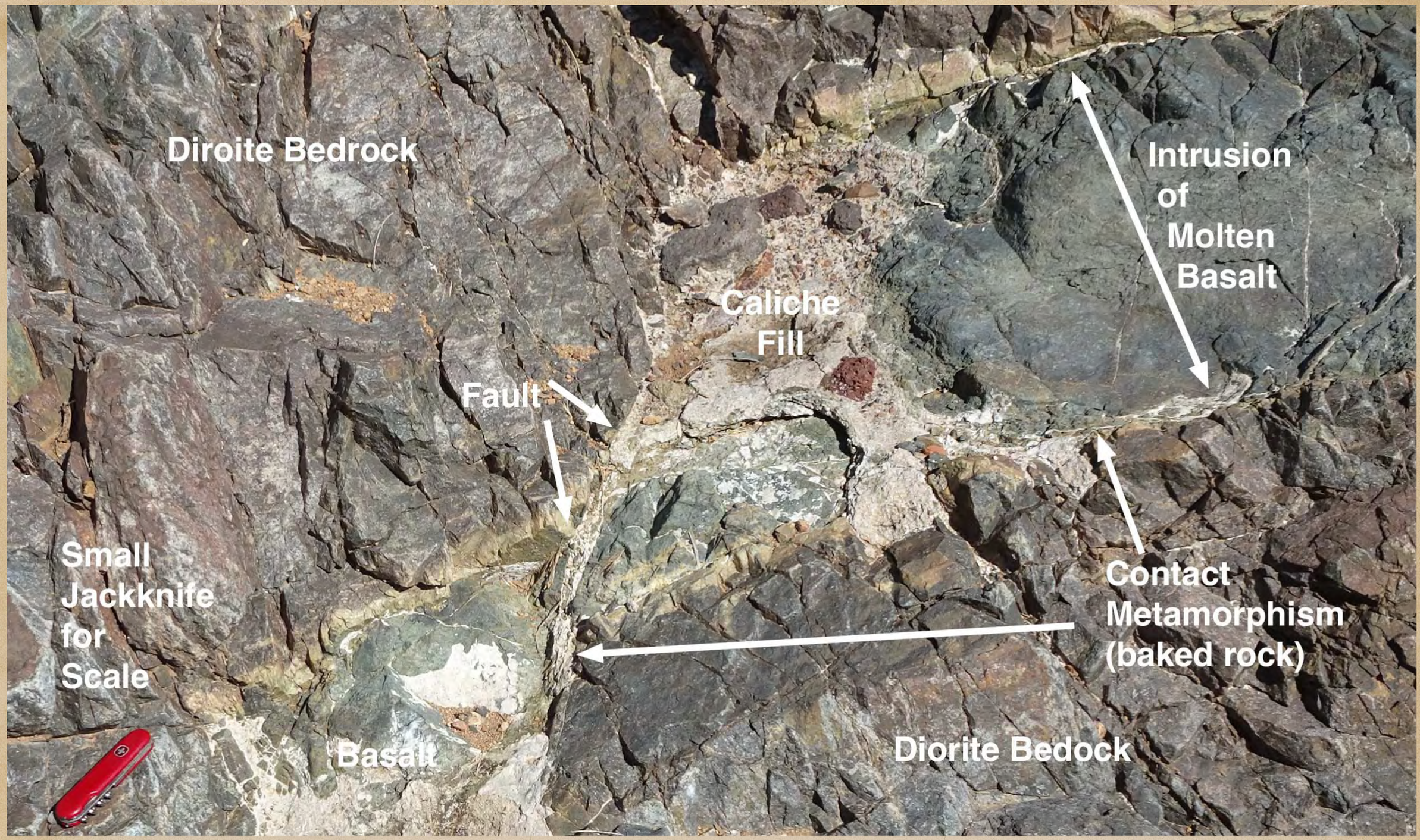
Compare this to the previous slide. The white lines on the rocks show how high the water is in early spring. Summer through autumn, except during floods, the water under the stream bed.

Big floods scour out the pool. Smaller floods leave the pool mostly filled with sediment, such as the sand and pebbles you see here. Future floods will wash away this sediment, digging out the pool.

The logs are about 10 feet higher than stream bed. There may have been huge flood that carried them here and left them “high and dry”. As in most of the year, the pool below is completely dry.

Cave Creek is usually dry in most of the area June-November. Even then, surface water can usually be found somewhere in The Jewel of the Creek. Bedrock near the surface forces underground water upward. South of The Jewel, Cave Creek continues to flow slowly under the surface toward Phoenix.

Floods carry a variety of rocks and minerals downstream. Red jasper is one of the most colorful. This rock probably came from bedrock 20 miles upstream. When it’s wet, jasper becomes bright red.



A short distance ahead is a small intrusion of basaltic magma. It is offset by a geologic fault. The molten rock created a baked zone (contact metamorphism) where the magma heated the surrounding, cooler rock. This intrusion aligns with a similar intrusion 200 yards ahead in Boca Grande Wash.

Saguaro cacti don’t usually grown in the moist riparian area on the bottom of The Jewel. This saguaro was an exception. It may have died because of old age, flood damage or rot disease.

The blue-green color of the boulder is caused by the metamorphic mineral chlorite. Veins of molten white quartz were injected into cracks while the rest of the rock was a solid. Nearby bedrock doesn't look like this, so it has clearly been washed downstream by floods.

The mouth of Boca Grande Wash contains a wide range of rock types carried down from higher up in its watershed. Some, such as the white balls of volcanic ash, are less common in Cave Creek. White ash rock does occur along Cave Creek at Chalk Canyon, five miles upstream. But ash balls from Chalk Canyon are worn away by the time they get down here. (It’s actually ash, not chalk.)

Agate

Calcedony

Within the sediments washed down Boca Grande, are banded agate and surgery calcedony. Both are forms of quartz that are composed of extremely small crystals. Water is sometimes called “The universal solvent.” These semi-precious stones form when water circulates through the volcanic ash. The water very slowly picks up quartz mineral and impurities as it flows through the hardened ash and deposits the quartz in openings in the volcanic ash.

Nearby a boulder of basalt rests on a platform of diorite rock. Diorite is different igneous rock type that contains more quartz than basalt, but less quartz than granite. The boulder may have been moved to this position by falling from above, or by a huge flood on Boca Grande Wash.

The basalt boulder is weathered round and has holes where water vapor has escaped. The diorite bedrock under the bolder is smooth and breaks into angular faces. Diorite weathers to a rusty color.

Up Boca Grande Wash is a mass of calcite and clay (caliche) deposited by circulating groundwater like you saw earlier. Caliche has cemented the boulders into a hard natural (usually dry) waterfall.

A dark intrusion of basaltic magma into diorite in Boca Grande is off-set by a small geological fault.
This intrusion lines up with the similar dark intrusion you saw earlier along Cave Creek.
These are probably two exposures of the same intrusion separated by 100 yards of overburden.

A short distance ahead, the Dragonfly Trail leaves the Boca Grand stream bed. The light colored “China Wall” rhyolite surface at the hiking sticks contains an unusual mineral feature.

Little cubes (and similar geometric shapes) resulted when yellow pyrite (“fools gold”) formed cubic crystals. Later, the pyrite (iron sulfide) weathered to the rusty iron oxide mineral, hematite.
But this hematite occurrence is unusual in that it has kept the shape of the original pyrite crystals.

Layering in this boulder shows that it probably started as a sedimentary rock. The rock became hardened by heat and pressure (metamorphism) deep underground. Weathering has produced two kinds of iron oxidation. Oxidation in a low-oxygen environment caused green iron mineralization. The exterior, exposed to the atmosphere, weathered to form a different form of iron oxide. (rust)

The bedrock above the ancient rhyolite and meta-basalt is Chalk Canyon tuff. (volcanic ash) 20 million years ago nearby volcanic vents were spewing basaltic lava and ash on top of the far older meta-basalt and rhyolite. Here, the top boundary of the older rock is hidden under rocks and sediment.

Fossils are rare in the Cave Creek area. These fossil roots were probably made in bodies of water that formed while the nearby volcanoes north of us were erupting layers of basaltic lava and ash. Basalt is a dark rock, like the small rocks you saw on top of the “amphitheater” outcrop. Unlike granite and rhyolite, basalt is dark in color because basalt contains very little quartz.

A few hundred yards up hill, at the top, is this Native American geometric petroglyph.

A specific meaning of such petroglyphs may have been lost with the collapse of the Hohocam culture a millennium (1000 years) ago.

The petroglyph is very easy to find because it’s at a sharp bend in the trail. In fact, the boulder almost blocks the trail.

Other Spur Cross petroglyphs are not accessible by public trails.

Back down to the main part of The Jewel of the Creek, the trail leads to a biological surprise. Arizona's only native palm trees are located in Palm Canyon, 150 miles west of here. That's near the Colorado River and the quirky Sonoran Desert town of Quartzsite. The seeds of this palm tree must have washed down in a flood from non-native trees planted upstream for landscaping.

The sign in front of a sandy tan rhyolite outcrop is where we cross back from Spur Cross Ranch Conservation Area and into the half of The Jewel owned by the Desert Foothills Land Trust.

A small mine adit (tunnel) was excavated where prospectors hoped to find productive gold ore. It's only about about 20 feet deep. Given its size, they probably didn't find much. After the accident above, you learned about earlier, this and other open mines were fenced off.

Powerful floods have toppled large trees. The tree above is still alive, but nearly horizontal, and growing new vertical “trunks.” Erosion caused by foot traffic has exposed the roots at the far end.

Erosion is an ongoing process in nature. Erosion can also be accelerated or even caused by humans.

This is an image of the same tree as the last slide. It was taken in 2022.

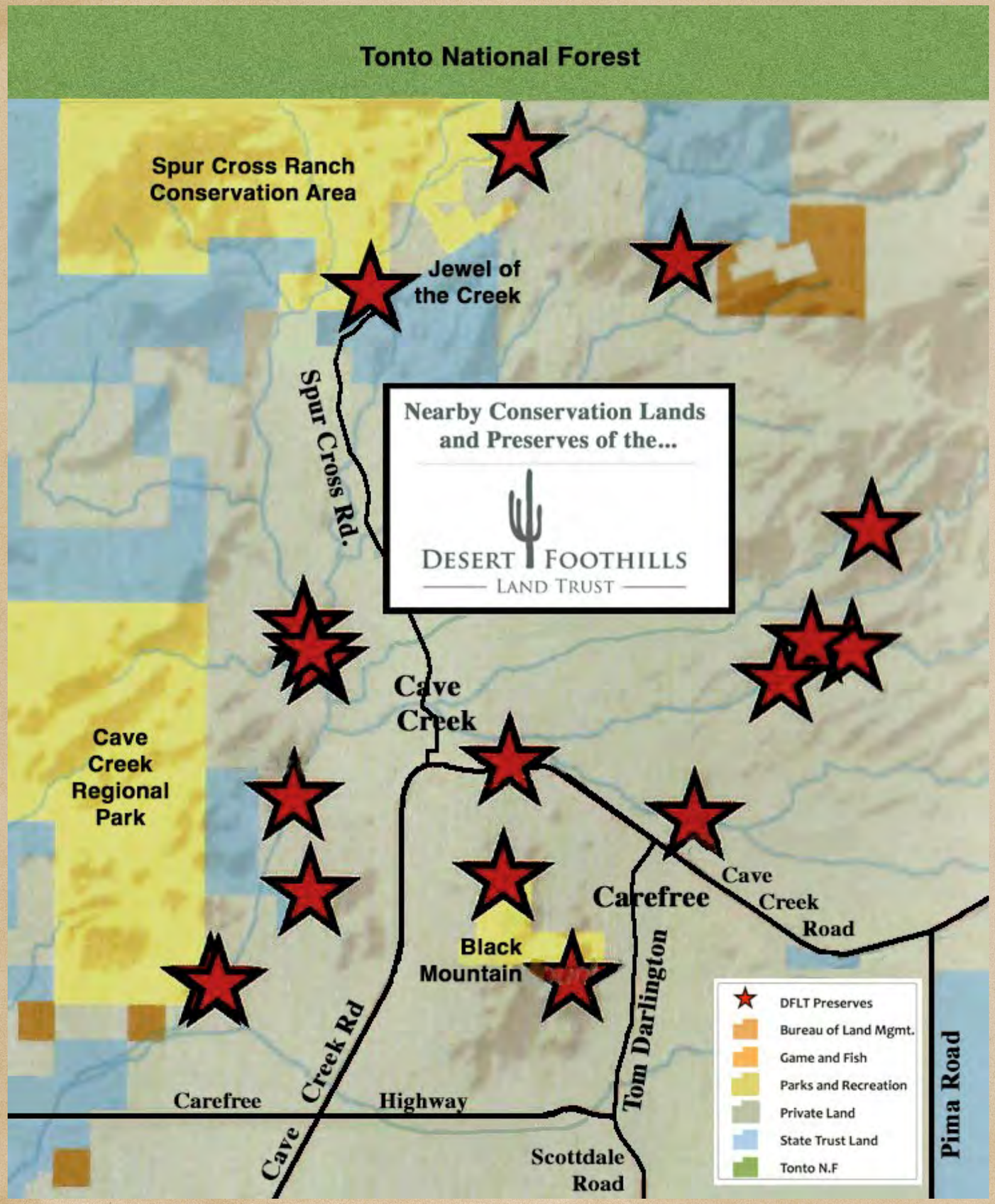
In the previous image, the horizontal root over the path is nearly covered by dirt. But foot traffic has pulverized the clay soil and whisked the dust away. Flip back and look at the same root in the previous image.

In about 10 years, normal foot traffic has worn down the trail 3-4 inches leaving the root well above the dirt path. Hikers have also eroded the trail in other parts of The Jewel..

Major floods wash massive amounts of branches and logs downstream. Flood debris completely blocked the creek-side trail in 2006. It must have taken workers many hours to clear out the tangle of branches. Sand and silt were deposited by slower currents at the end of the flood.

Primitive rocky steps were made to help hikers cross a large tree trunk. Step up carefully.

When streamflow is modest, especially during winter months, the Spur Cross ranger places plank bridges at stream crossings. Crossing here will take you back to the trail leading up to the trailhead.



The High Sonoran Desert is a very special place and there is a relatively large percentage of open space in the Carefree and Cave Creek area. Some of it is protected by town, county, state and federal governments with public access to all.

The Desert Foothills Land Trust (DFLT) is a nonprofit organization that preserves land by purchasing the land, or by encouraging, long-term conservation easements on privately owned properties. (See the red stars on this map.)

You can take part in this effort. Contributions to the DFLT will be gratefully accepted; dflt.org

Local Resources:

If you walk this tour, please pay the entry fee to the Spur Cross Ranch Conservation Area at the entry station by the big parking lot about a quarter mile north of The Jewel. Maps of all the Spur Conservation Area trails are available there.

There are free monthly off-trail geology walks up Cottonwood Wash. That route starts half mile north of the Jewel. Unlike this route, it does not follow trails open to the public. Guided hikes following this Jewel of the Creek geology tour are available on request. Information is available at the Maricopa County Parks and Recreation website.

Liscum is a ghost a town near the Jewel of the Creek entry station. https://apeekatthepeak.org/lost-towns-of-the-jewel/

Francis Carlson's book, "Cave Creek and Carefree, Arizona" is a comprehensive history of the area. The book includes gold discoveries and the changing ownership of the local mines. It may be purchased at the Cave Creek Museum.

The Cave Creek Museum has displays and other resources about the geology of the Cave Creek Mining District. They also have a large, noisy, working stamp mill (ore crusher) that is run monthly.

A free 50-page detailed and illustrated geology guide gives more technical information about this hiking route. It is available at no charge on the Desert Foothills Land Trust web site. The PDF document includes a much more extensive bibliography. Find it at: dflt.org - Events, Hikes and Programs (Menu) - Desert Encounters - Jewel of the Creek Geology Guide

The DFLT website also features a beautiful, professional and inspirational video, "Discover a Jewel."

Dozens of geoscience images with brief texts showing places around Cave Creek are published on the the Earth Science Picture of the Day, website. (Universities Space Research Association) Use the Archives link and search by "cave creek."

This guide made extensive use of a detailed geologic map and written report of the New River Mesa 7.5' Quadrangle, Maricopa County, Arizona, by geologists Charles A. Ferguson, Wyatt G. Gilbert and Robert S. Leighty. The whole document can be downloaded at no charge from the Arizona Geological Survey website. http://repository.azgs.az.gov/uri_gin/azgs/dlio/209

PowerPoint Edition of April, 2022