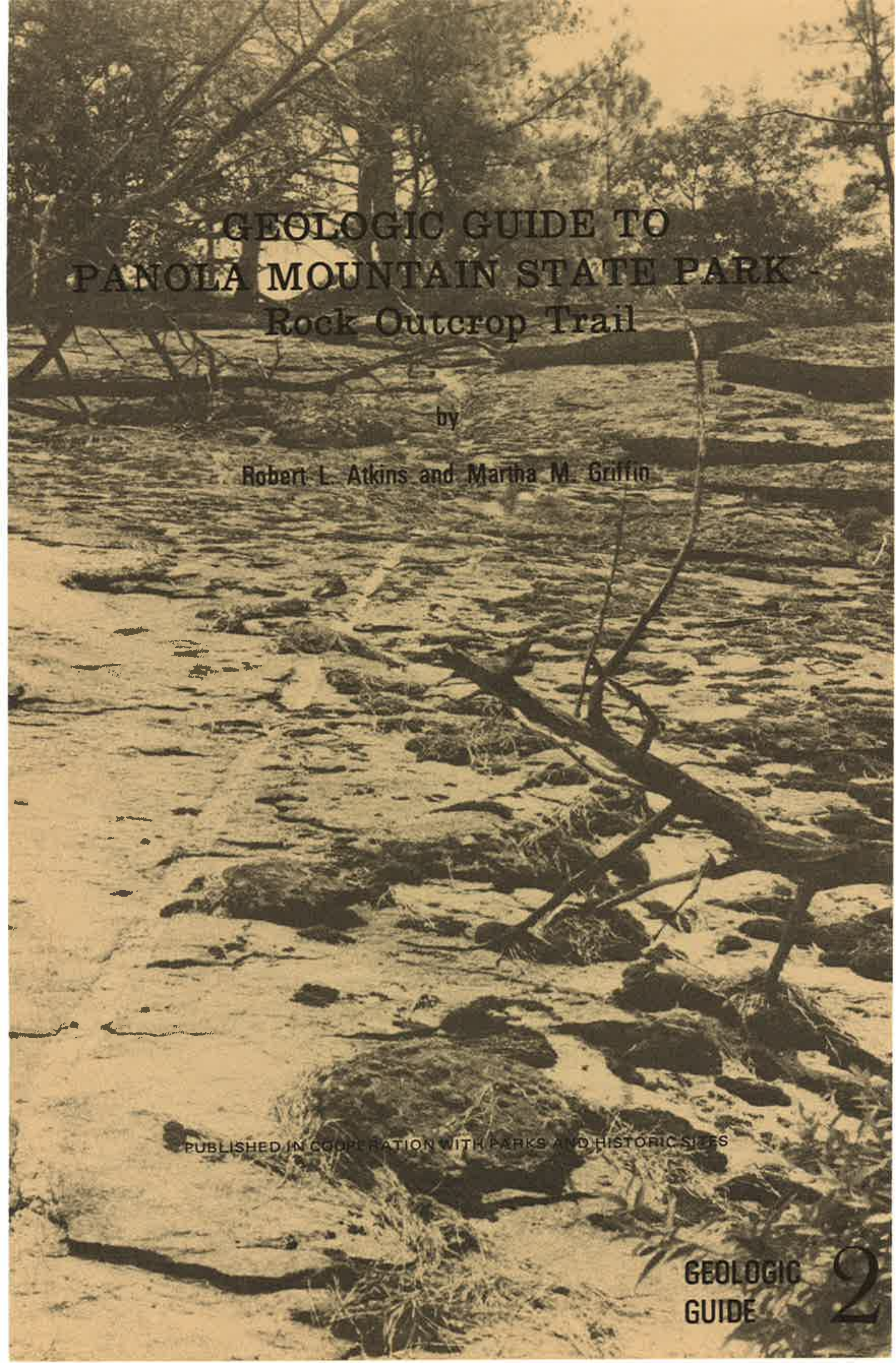


GEOLOGIC GUIDE TO PANOLA MOUNTAIN STATE PARK - Rock Outcrop Trail

by

Robert L. Atkins and Martha M. Griffin

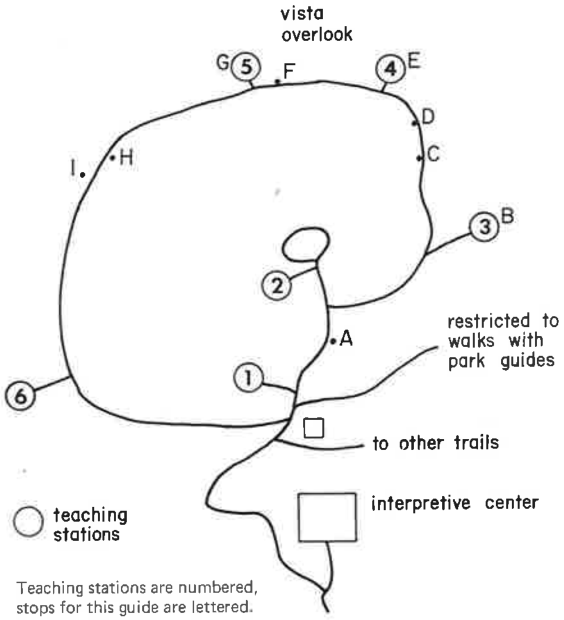
PUBLISHED IN COOPERATION WITH PARKS AND HISTORIC SITES

GEOLOGIC GUIDE 2

Rock Outcrop
Self-Guided Trail
(A Geologic Trail Guide)

By Robert L. Atkins and Martha Griffin
with illustrations by Kathleen Webster

Lettered stops in this guide refer to lettered 4x4 posts along the trail. Follow the trail map as you walk.



Please remain on the trail and remember to let plants and animals live in your eyes, not die in your hands.

STATE OF GEORGIA
DEPARTMENT OF NATURAL RESOURCES
Joe D. Tanner, Commissioner

THE GEOLOGIC AND WATER RESOURCES DIVISION
Sam M. Pickering, State Geologist and Division Director

ATLANTA
1977

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Italicized words appear in the glossary.

The cover is a picture of a granite pavement outcrop near Panola Mountain. This pavement outcrop illustrates exfoliation and a pegmatite crosscutting the Panola granite.

Panola Mountain (History)

Panola Mountain State Park is located in an ancient and largely leveled area of Georgia known as the Piedmont Province. This Province corresponds to an area of metamorphic and igneous rock which has been deformed by intense forces within the earth. An igneous rock, such as the Panola *granite,* is believed to have resulted from an injection of molten rock into existing rock during this period of great deformation.

Over millions of years, the Piedmont Province has been leveled to its roots by the forces of weathering and erosion. The erosional surface that remains today is dotted with hills which are remnants of various types of resistant rock and are referred to as *monadnocks.* In addition to Panola Mountain, other monadocks in the Atlanta area include Kennesaw Mountain, Arabia Mountain, Sweat Mountain, Pine Mountain, Sawnee Mountain and of course, Stone Mountain.

Panola Mountain State Park was established in order to protect the geologically and biologically complex, fragile, and unique environment that exists here. This guide is intended to aid the visitor in observing geologic processes and their interactions with other ecosystems.

You have now entered a pine stand which represents a stage in the natural succession of a typical southeastern forest. Because the pine so dominates this area, it is reasonable to assume that the land was formerly cleared, perhaps for farming or pastureland. When the area was no longer in crops, the pine claimed the field.
Follow the path to Stop A (See map).

Stop A — Forest Transition

Look back down the rise you have just climbed and compare the view with the forest that lies before you. See how many changes you can detect as you move into this new microenvironment. You are now in a more mature forest that is predominantly hardwood. You can see dogwood, oak, hickory and poplar trees and a few large pines. The forest is progressing toward an oak - hickory forest, a climax state in which there will not be any change unless there is a fire, etc.

Look among the trees and you will see another change: exposed rocks dot the forest floor. These granite *"float rocks"* resisted the weathering process that formed the soil around them and could indicate that they lie above granite. It is no wonder that this area was not cleared for agricultural use (figures 2 and 3).
Walk to fork in trail. Take right. Follow sign to Station 3. Take right and continue to Stop B.

Stop B — Weathering

The exposed granite which was formed hundreds of millions of years ago deep within the earth is now adjusting to a changed environment. This adjustment is known as weathering, and is brought about by physical and chemical means.

Physical weathering may be caused by the action of plants, animals, frost, wind, and heating by the sun. Can you detect evidences of physical weathering?

Chemical weathering may be caused by water and by plants and animals producing organic acids. The main agent of chemical weathering in the humid southeast is water. Given enough time, water dissolves minerals and erodes them away.

The dissolving power of water for certain rocks and minerals is greatly enhanced when CO_2, carbon dioxide gas, is dissolved in rainwater and ground water. Not only does CO_2 dissolve in water, but it reacts with it as well to form carbonic acid: H_20 (water) + CO_2 (carbon dioxide) $=H_2CO_3$ (carbonic acid). Carbonated water or

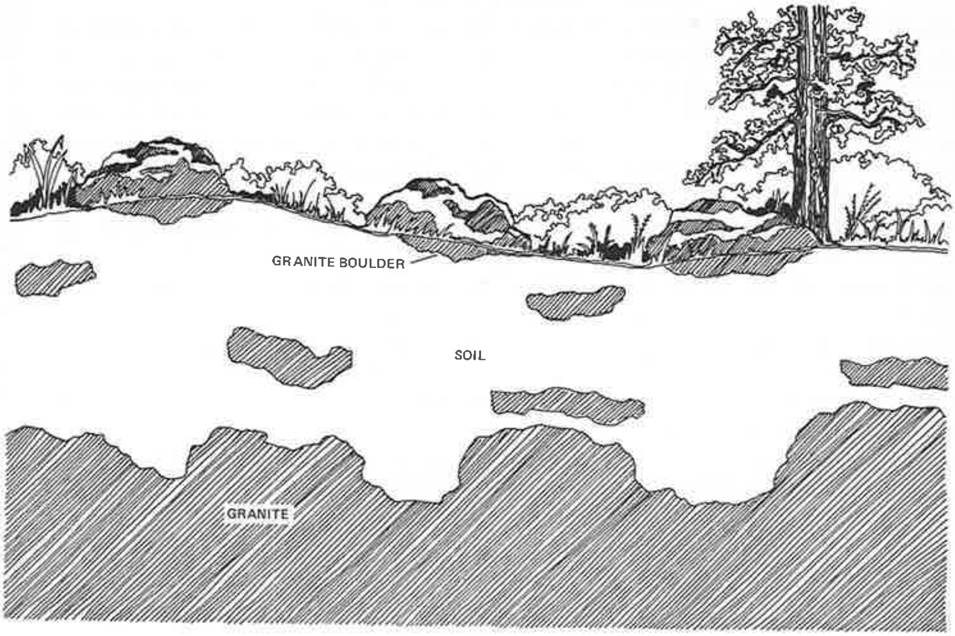

Figure 2 - Resistant granite boulders.

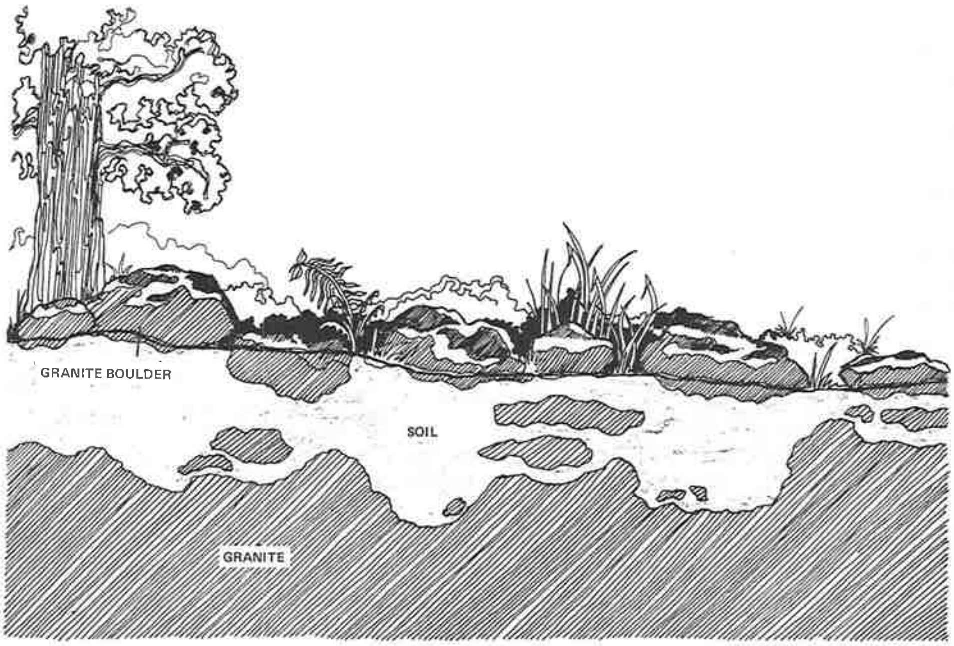

Figure 3 - Erosion of the soils exposes additional boulders.

carbonic acid is a weak acid, which breaks up and releases the H (hydrogen) ions. These H ions are aggressively reactive in many chemical and geological reactions. These reactions result in the breakdown of the rocks to soils.
What could have caused the large rock at Stop B to break apart so neatly? Does it appear that chemical and physical weathering processes work together in breaking down rock into soil?

Physical weathering aids chemical weathering by breaking rocks and exposing more surface area to water and air. A good example of physical weathering can be seen where trees have taken root in cracks in the rock. As the roots grow, they exert great pressure on the rock pushing it apart, thus exposing more surface area to chemical weathering. Proceed to Stop C.

Stop C

Soil Creep

If you face the marker and look up the hill, you will be struck by the angle between the very large trees and the saplings. The young trees that are leaning may have assumed this unusual position due to a phenomenon known as "soil creep." Soil creep is a barely perceptible down slope movement of soil — a very slow landslide which takes years to occur (figure 4).

Perhaps this leaning tree zone is an underground drainageway for rainwater, because it lies between large rock outcrops. The roadcut for the trail could also have caused a slow slide of the shallow soil. Any other ideas? Proceed to Stop D.

Stop D

(Physical) Mechanical Weathering

Here a young dogwood has taken root in a very large boulder. It is growing in a *joint*, a fracture along which little or no movement has taken place. Look up the hill beyond this boulder slightly to the right and note the gnarled, large tree is exerting tremendous pressure on the rock, forcing open the cracks in the granite. By increasing the exposed surface area, the weathering process is considerably accelerated.

What might account for the gnarled appearance of this oak? How might its age compare with an oak of equal height rooted in a thick soil? Walk to Station 4 overlook (Stop E).

Stop E

Exfoliation

Stretching through the forest before you is a flat and elongated granite outcrop which is often called *"pavement rock"*. There is little soil accumulation on pavements, since rainfall readily removes the weathered rock fragments. Look at the boulders and exposed rock and note the manner in which the surface of the rock is being removed in the form of thin slabs. Exfoliation is the process by which rock expands in response to removal of pressure. These horizontal fractures occur as a result of the spontaneous volume change which the rock undergoes (figure 5)

As erosion removes the *overburden*, (the overlying rock and soil) the granite expands and exfoliation takes place (figure 6).

The elliptical granite domes which result from exfoliation are a common feature of the Piedmont Province. Continue up hill to Stop F.

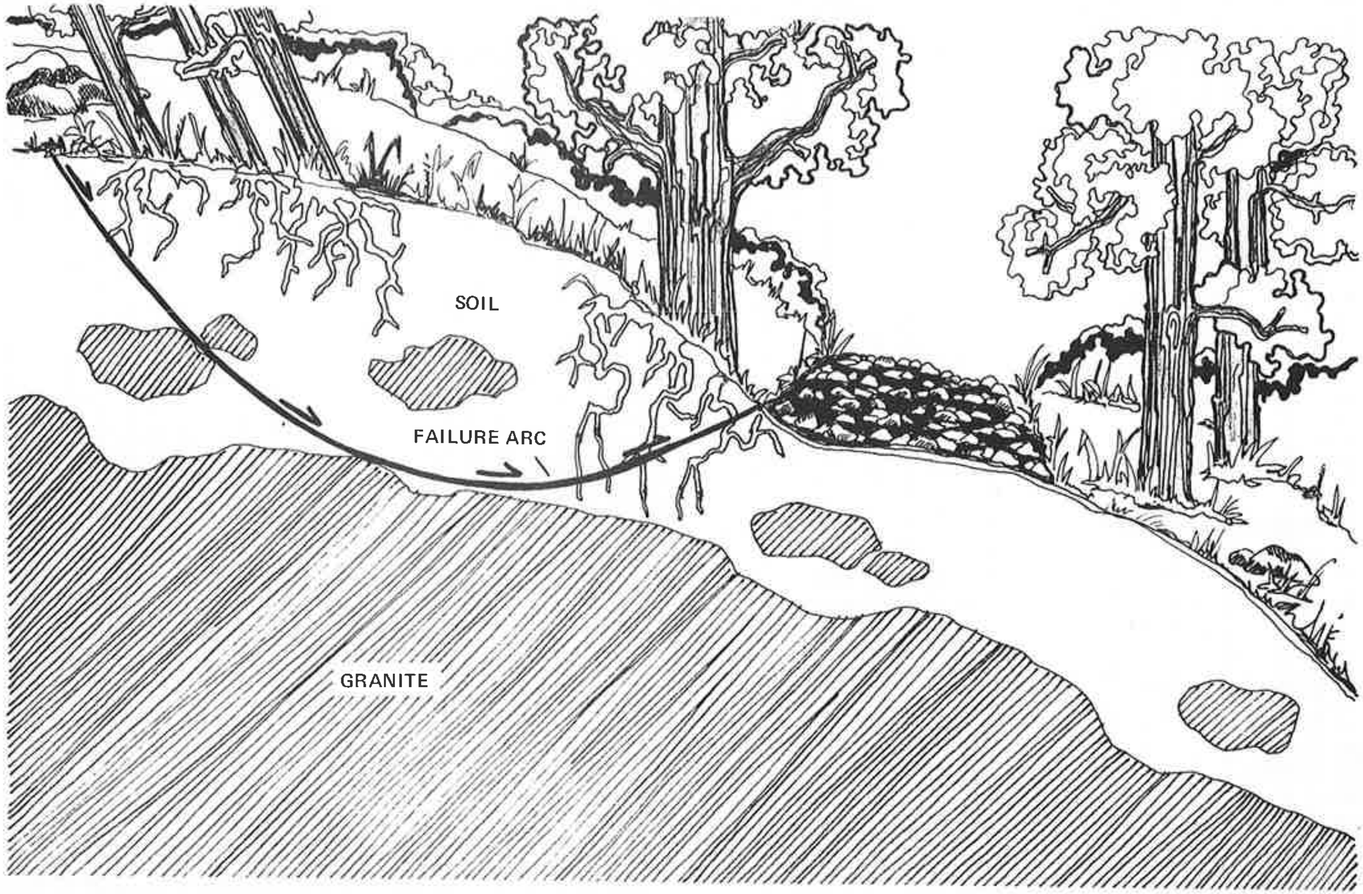

Figure 4 - Possible origin of soil creep.

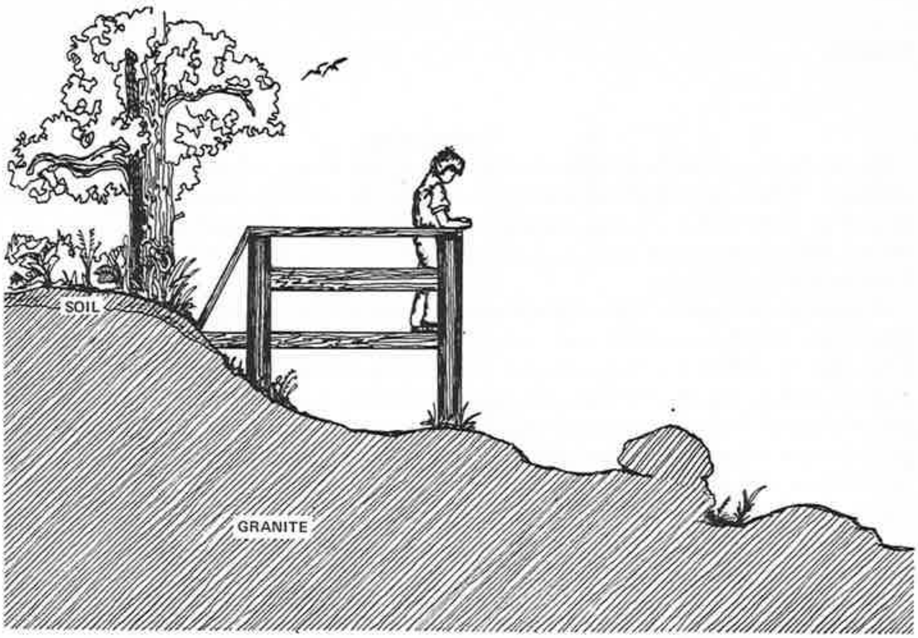

Figure 5 - Pavement rock outcrop.

Figure 6 - Photograph of exfoliation.

Stop F

Quarrying

In granite quarries rock breaks loose in great slabs, sometimes with explosive violence. When such a slab is cut into a block, the block expands measurably over a period of several days. Look closely at the large rock slab before you and you can detect drill holes which indicate a small amount of rock was removed, probably for local building purposes.

Although extensive quarrying operations exist at Stockbridge, Lithonia, and Stone Mountain, the Panola Mountain area has never been developed as a major quarry. This may be due to the lack of major industry or extensive building in the immediate area as well as the prohibitive cost of transporting this granite. In addition, the high percentage of inclusions (*xenoliths*), however interesting to the geologist, make the quarrying of monumental and architectural stone non-profitable. Proceed to Station 5 overlook (Stop G).

Stop G

Origin of Panola Granite

1. Panola granite is believed to have formed over 300 million years ago when the magma, or molten rock, was injected into the crust of the earth. As the *magma* was forced into the already existing country rock, sufficient energy was generated to force the rock apart (figure 7).

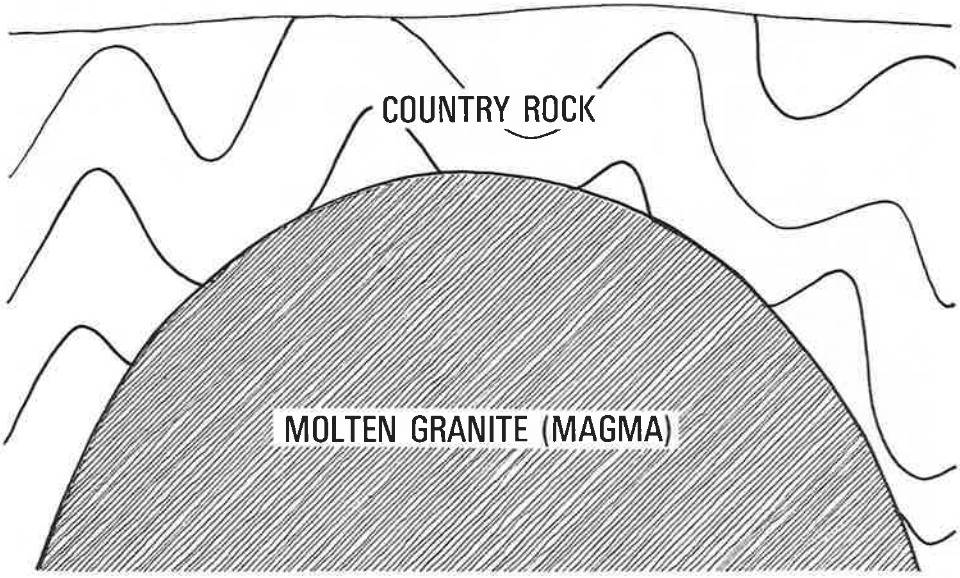

Figure 7 - A probable origin of the Panola Granite.

2. Heat from the *magma chamber* fractured the country rock, fragments of which broke off, melted, and became part of the magma. Other fragments were retained intact as *inclusions,* or xenoliths, at the periphery of the magma chamber. Several varieties of xenoliths may be found on Panola Mountain; these include rocks called *amphibolite, biotite gneiss* and *granite gneiss* (figures 8 and 9).

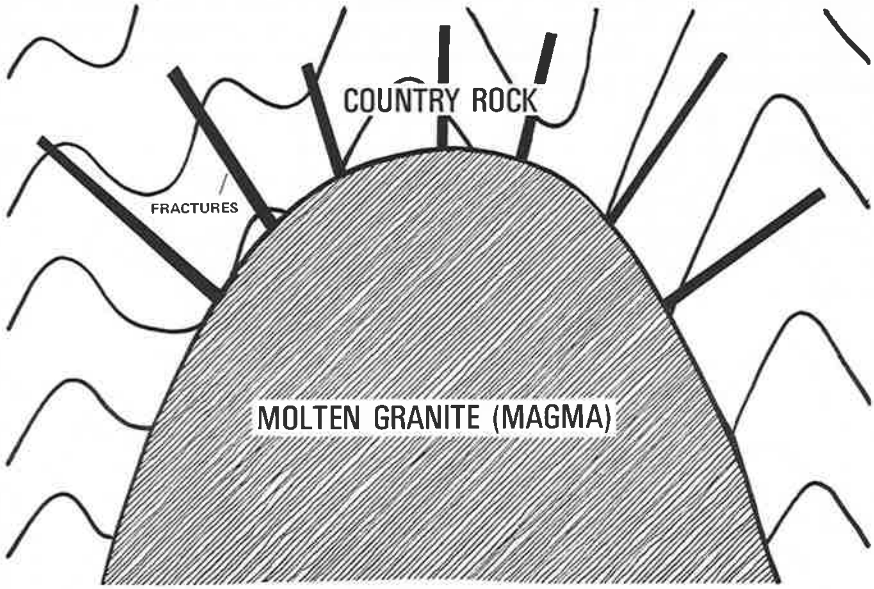

Figure 8 - Fracturing of the solidifying granite as it cooled.

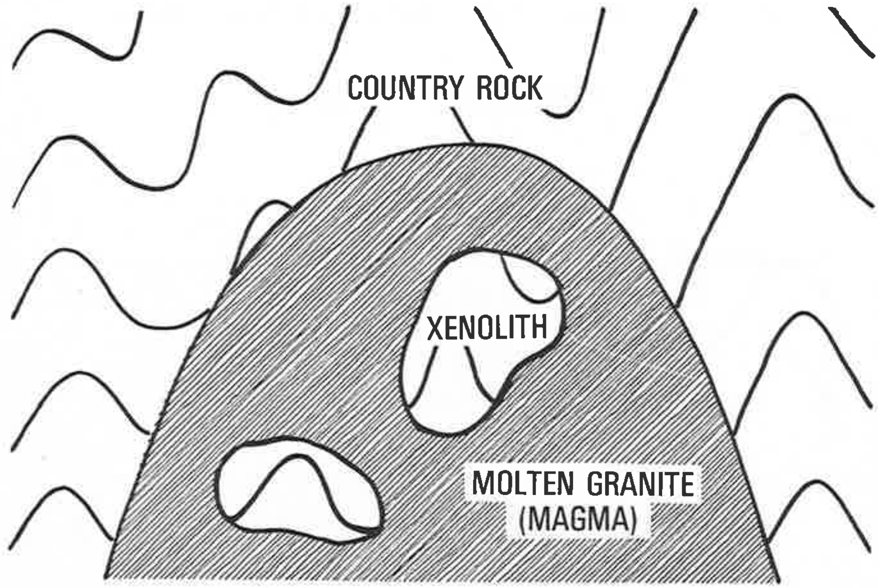

Figure 9 - Probable origin of the xenoliths.

3. During a cooling period that spanned millions of years, the rock contracted and cracked in response to tension, in much the same way as clay responds by cracking when it dries and hardens. These resulting fractures are known as joints, some of which were filled with minerals (*mineralized*) while others were not (figure 10).

4. Over millions of years, erosion has removed tens of thousands of feet of overlying rock, lowering the surface of the Piedmont Province to its present elevation and exposing Panola Mountain and other resistant rock outcrops to view. Eroded Piedmont sediments have formed the Coastal Plain and are presently being deposited offshore today (figure 11).

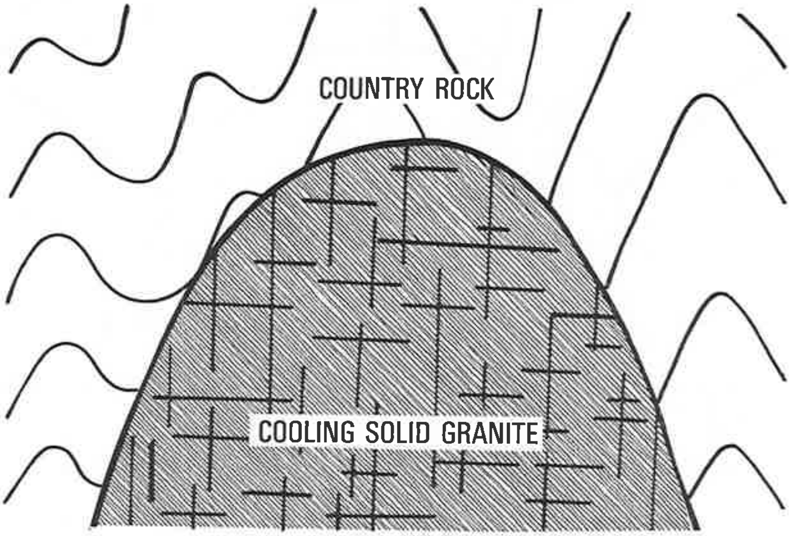

Figure 10 - Fracturing of the solidifying granite as it cooled.

PANOLA MOUNTAIN TODAY

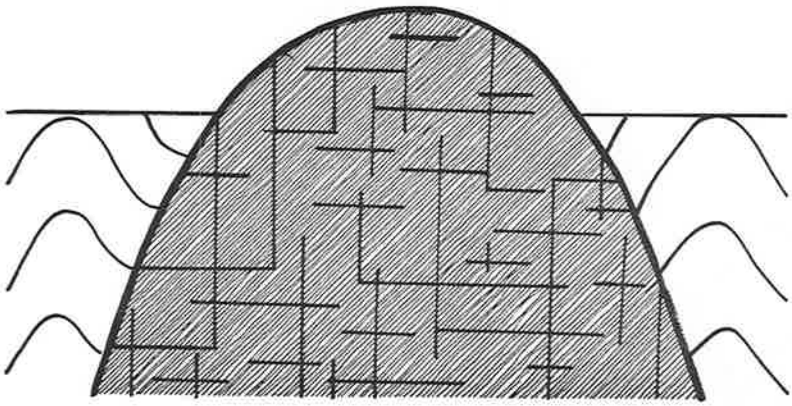

Figure 11 - Erosion of the overlying country rock exposing the Panola Granite to erosion. At this point in time, Panola Mountain originates.

Both Panola Mountain and Stone Mountain, visible on a clear day to the Northeast, stand as testimony to the intense forces deep in the earth that formed them; however it must be remembered that these granites are similar but not interconnected.

As you leave the overlook notice that the tree growth at this point is controlled by the joints or cracks in the rock. Only in the joint planes can a seedling find sufficient water, soil and nutrients to support life. Here, at lower elevations, the hardy pine represents the primary tree growth. The potential height for these trees is directly correlated to the depth attained by the root system in the joints. A tree that over-reaches itself will fall prey to the wind in this hostile environment. Continue to Stop H.

Stop H

Contact

The trail has now taken you to what appears to be a *contact* between the country rock and the Panola granite. Notice the appearance of the loose float rocks, which differ markedly from the granite boulders you observed earlier. This dark, dense rock is known as amphibolite. Many amphibolite xenoliths (county-rock inclusions) are to be found on the mountain and in many pavement rocks as well. A few feet ahead on your right is Stop I.

Stop I

Granite Outcrop

As you walk out over the granite outcrop, you can observe such features as joints (which represent planes of weakness), xenoliths, and rock slabs loosened by exfolia-tion. In places where physical weathering has recently removed rock, the minerals, *biotite, quartz* and *feldspar,* which are usually hidden by the mosses, are visible.

Note the unusual abundance of broken, fragmented rocks at this point. The probable explanation is that they are chips from the small quarrying operation that once existed here.

Do the drainageways appear to have developed in a haphazard fashion or is there an explanation for the patterns you observe? Close observation will reveal that the drainageways have etched themselves into the granite along the joints.

A well known feature of granite domes is the bowl-like depression known as a "weathering pit." In their formation it appears that the lichens or mosses act as the initial weathering agent. The humic or carbonic acids produced by the peaty material act upon the ferric acid brought up by capillary water and hasten the chemical break-down of the rock. These pits are generally found on the most vulnerable areas of the granite behind an exfoliated slab, in a joint, or adjoining a xenolith (figure 12).

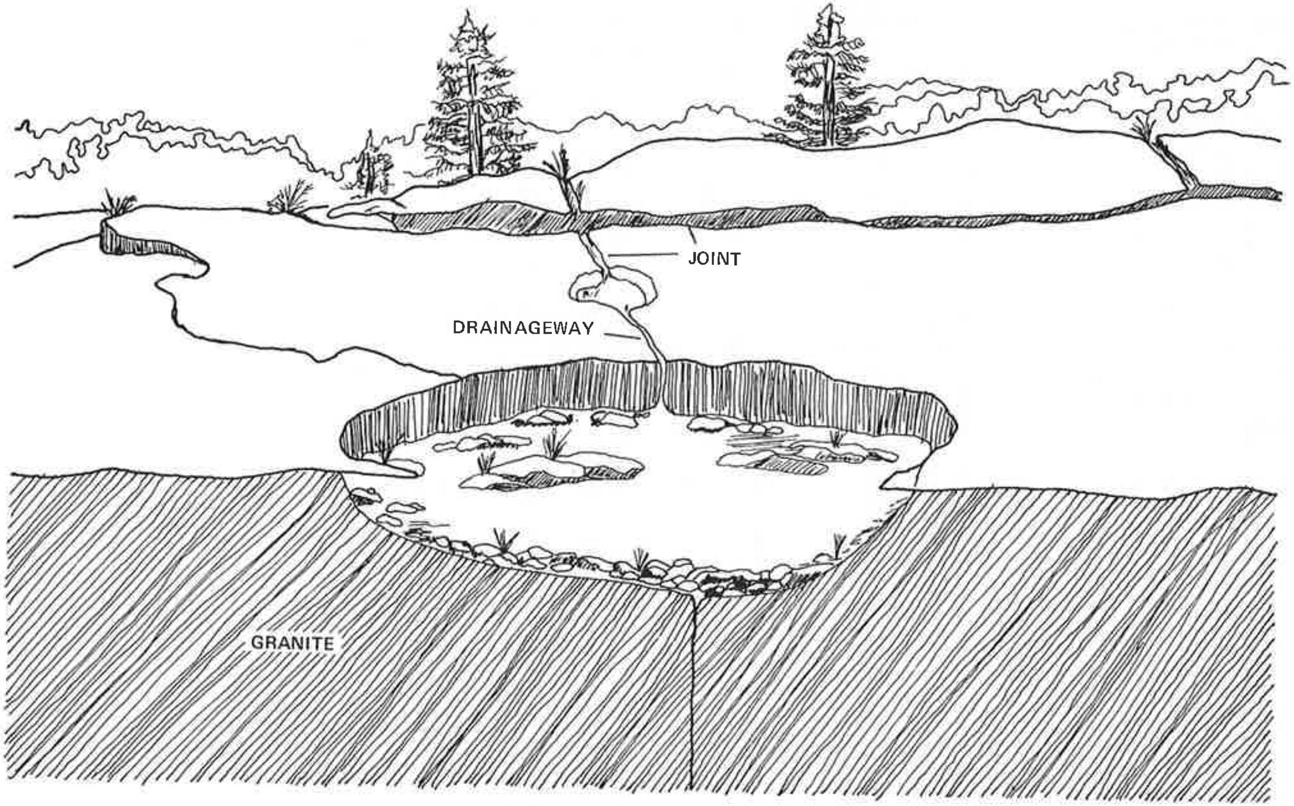

Figure 12 - Origin of weathering pits in the granite.

Summary

The landscape you have observed today reflects the existing state in a mighty conflict between internal and external forces. Over millions of years the restless earth constantly heaves up mountain chains, spews up magma, and rearranges topography. The forces of weathering and erosion, though less dramatic, are equally powerful as they work relentlessly toward establishing equilibrium.

Panola Mountain, more resistant than the surrounding country rock, has yet to succumb to the attack by lichens, mosses, trees, organic acids, or its most powerful foe, water. Ultimately, in the far reaches of geologic time, Panola will be reduced to soil. Until then, we are indeed priviledged to wonder at the beauty and marvel at the exquisite balance of forces that have created this complex and unique environment.

Acknowledgements

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Finally, the writers are indebted to all those who helped make this guide possible.

Glossary

Amphibolite — a metamorphic rock composed mainly of hornblende, a black to greenish black mineral.

Biotite — a black, platy mineral; a mica

Biotite gneiss — a term applied to banded rocks formed during high-grade regional metamorphism. The dark layers are composed of biotite mica and quartz and feldspar compose the lighter layers.

Contact — a boundary between two rock types.

Float rock — cobbles or boulders of loose rock in the soil horizon which have not been fully weathered.

Granite — a coarse-grained igneous rock consisting essentially of quartz, potassium feldspar and very commonly biotite and/or muscovite.

Granite gneiss — a term applied to banded rocks formed during high-grade regional metamorphism in which the parent rock may have been a granite.

Inclusion — fragment of pre-existing rock in a country rock.

Joint — a fracture in a rock along which there has been little or no movement.

Magma — a molten fluid formed within the earth's crust which may consolidate to form an igneous rock.

Magma chamber — a large reservoir in the earth's crust filled by molten rock.

Mineralize — introduction of additional minerals to a pre-existing rock.

Monadnock — an isolated hill which stands above an erosion surface.

Overburden — the soil or loose rock that overlies the bed rock.

Pavement rock — a flat rock outcrop.

Feldspar — a white, grey or pink, mineral that is commonly found in granite.

Quartz — a white to clear mineral, that can be colored by impurities, commonly found in granites and many metamorphic and sedimentary rocks.

Xenolith — an inclusion of a pre-existing rock in an igneous rock.

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