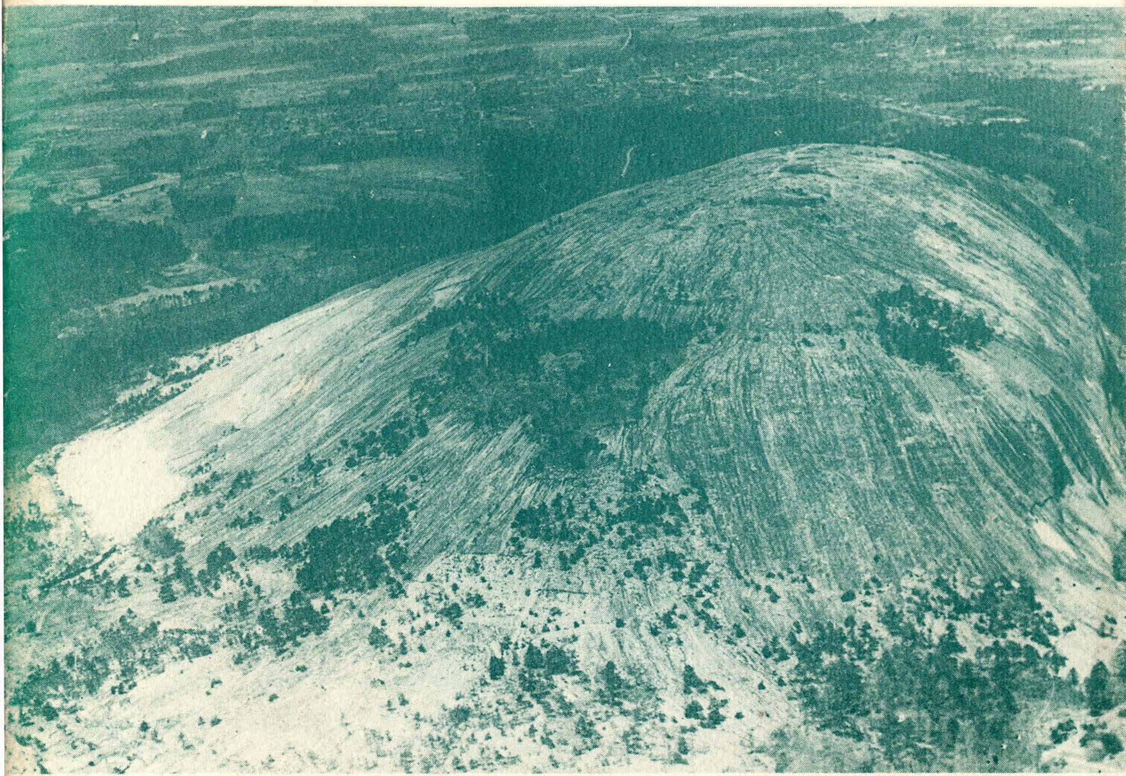
GEOLOGIC GUIDE TO STONE MOUNTAIN PARK

by

Robert L. Atkins and Lisa G. Joyce



Georgia Department of Natural Resources

Georgia Geologic Survey

GEOLOGIC GUIDE 4

Common Misconceptions About Stone Mountain

An average of four million people visit Stone Mountain Park each year. Very little geologic information is available to these visitors. With this lack of information, some misconceptions have developed concerning Stone Mountain and the granite named after the mountain. Several of these misconceptions are discussed below.

MYTH 1: Stone Mountain granite underlies half of Georgia, all of Georgia, three states, seven states, etc.

FACT: The Stone Mountain Granite is a relatively small unit. It extends northward to U.S. 78, southward to the park boundary, and its western contact lies within the park limits. It extends eastward towards Centerville (see Geologic Map of the Stone Mountain Area, p. 12-13).

MYTH 2: Stone Mountain is the largest exposed granite outcrop in the world.

FACT: Stone Mountain's size is quite inspiring. It probably is the largest granite dome east of the Mississippi River, as it rises approximately 750 feet (ft) above the surrounding topography; however, it is not the largest dome in the world. Many granite domes in the Sierras in the western United States are larger.

MYTH 3: Stone Mountain is 300 million years old.

FACT: The granite that forms Stone Mountain is approximately 300 million years old, but the mountain itself has only been exposed for approximately 15 million years.

MYTH 4: Stone Mountain used to be a volcano.

FACT: Although Stone Mountain Granite, like all other granites, is *igneous* in origin, it was formed quite differently from a volcano. A volcano is formed when magma and trapped gasses explode at the earth's surface. The molten rock that is spewed forth builds the volcano. In the case of the Stone Mountain Granite, magma collected approximately 16 kilometers (km) (10 miles (mi)) under the surface of the earth and cooled. Later, processes of uplift, erosion and exfoliation exposed the granite which forms Stone Mountain.

MYTH 5: The rounded depressions on the mountain were caused by lightning strikes.

FACT: The rounded holes, called weathering pits, are products of weathering, not lightning. They are formed when water collects in depressions in the granite. The trapped water mixes with organic acids from plants, and this solution slowly dissolves the granite to form these rounded depressions.

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Front cover: Photograph showing close-up view of the west face of Stone Mountain circa 1890 .

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The italicized words are defined in the glossary at the end of the booklet.

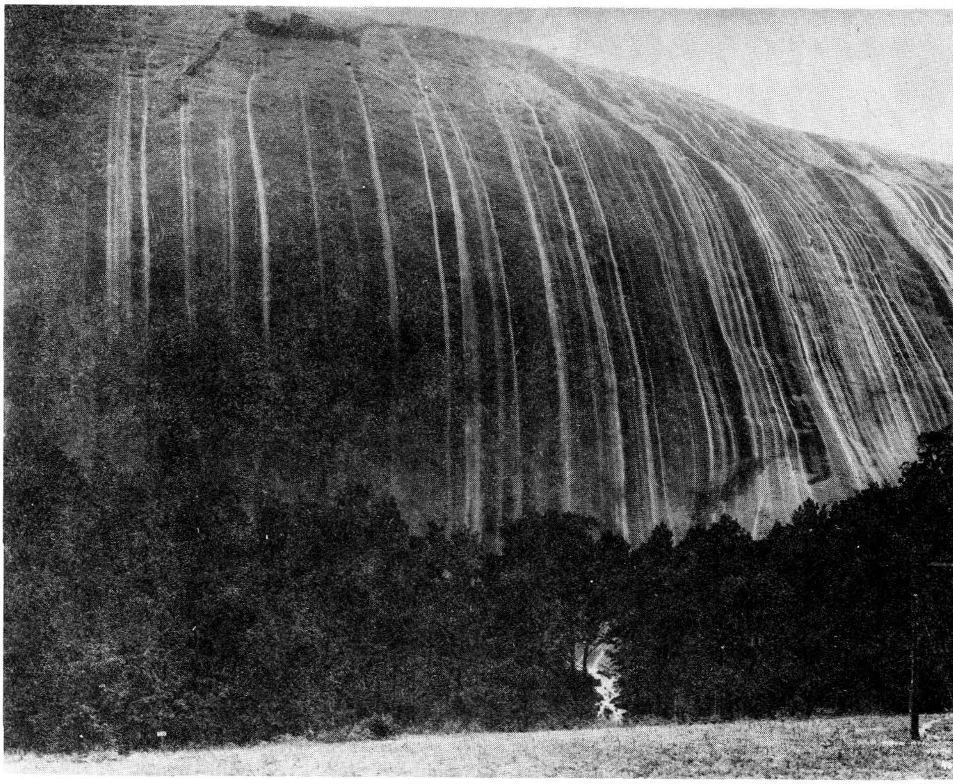


Figure 1. Close-up view of the north face of Stone Mountain circa 1890.

Introduction

Stone Mountain Park is located 16 mi east of Atlanta. The most obvious feature in the park is Stone Mountain, which rises approximately 750 ft above the surrounding countryside, covers 583 acres and has a physical volume of over seven and one-half billion cubic feet (Watson, 1902). Stone Mountain is elliptical in shape and trends in a northwest-southeast direction with its steepest side facing northward. The mountain occupies only a small portion of the area underlain by the granite (See Geologic Map of the Stone Mountain Area, p. 12). Stone Mountain may be compared to an iceberg in that only the tip of the granite body is above ground.

Approximately 300 million years ago (Whitney, 1976), the Stone Mountain granite was *intruded*, or pushed up while still molten, into the pre-existing rock at a depth of about 16 km (10 mi) below the surface. Weathering occurred, and slowly the layers of overlying rock above the granite were worn away, thus exposing the granite about 15 million years ago. The overlying rock, or *overburden*, exerted tremendous pressure on the granite. Once the pressure of the overburden was removed, the granite expanded outwards in all directions. This outward expansion is known as *exfoliation*, which causes the domal shape characteristic of Stone Mountain. As Stone Mountain Granite is more resistant to weathering than the surrounding rock, it is believed that the rock surrounding Stone Mountain has been levelled by weathering and erosion, while the mountain itself has been affected less and stands high above the countryside as an erosional remnant.

Until the mid-1800's, the major use of granite as a building stone was restricted to heavy, massive forms of architecture. Its use prior to the 1840's was due more to its accessibility than its popular desirability, but later the artistic value of the stone was recognized. Its properties such as hardness, structure, texture, strength, and ability to take a high polish contributed to its rise in popularity. The numerous colors and textures of various varieties of granite make it aesthetically valuable as well.

With the advent of the railroad, Stone Mountain became a source of high-quality stone, and quarrying began in 1847 on the mountain's east face. Rock was taken from the mountain and *pavement outcrops* (relatively flat, bare rock exposures) throughout the park area for use as building and monumental stone, curbing, and riprap. Prior to this, no commercial quarrying existed because the granite was too heavy for long hauls by wagon.

Between 1869 and 1882, the Stone Mountain Granite and Railway Co. made the first effort toward a systematic production of Stone Mountain Granite. In 1882, the Venable Bros. took over the production of the granite and through their efforts, Stone Mountain became one of the largest granite-producing areas in the nation (Watson, 1902).

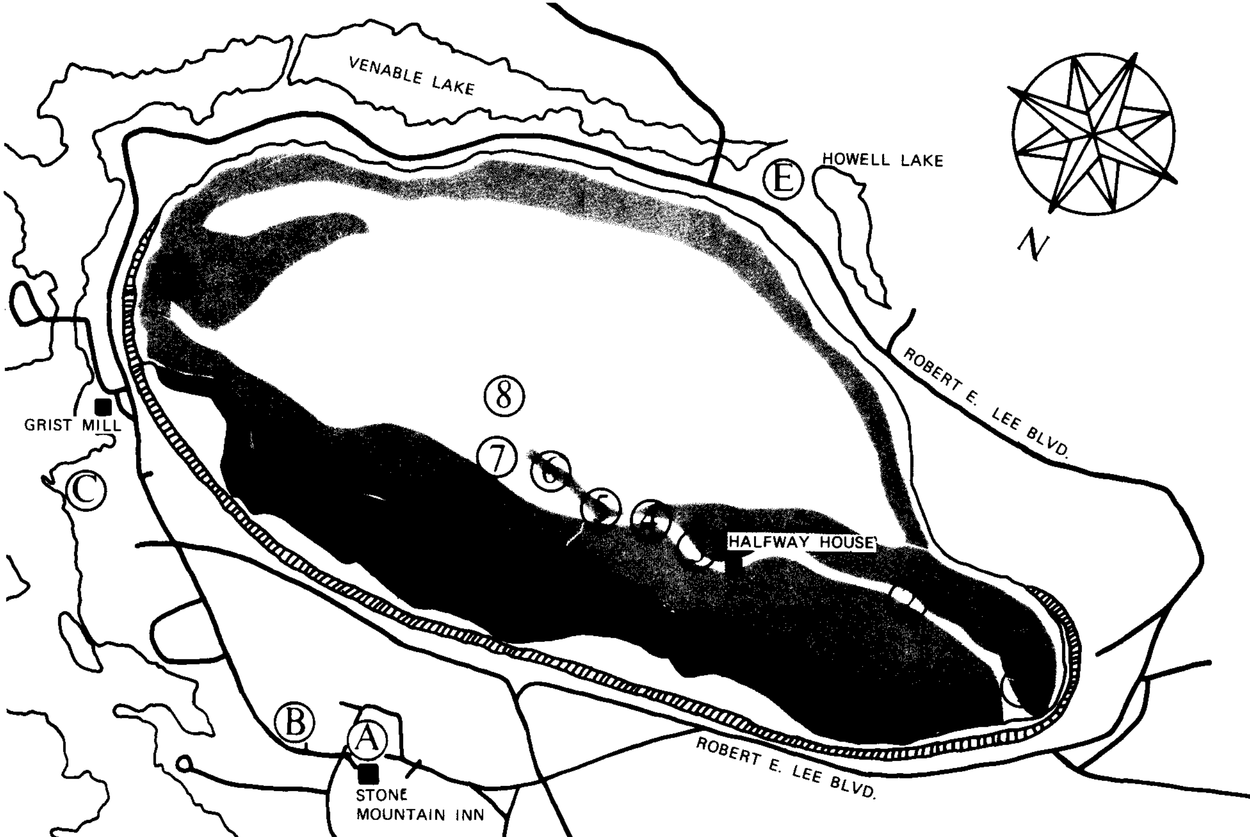


Figure 2. Location map for the Road Guide and Walk-up Trail Guide.

The Road Guide and the Walk-up Trail Guide

The purpose of the guide is to acquaint the reader with the geologic features of Stone Mountain. These features are discussed throughout the guide at each stop along the trail. The guide describes each feature, discusses its origin, and explains its significance as part of the total picture. One feature is described at each stop; however, several of the features are found at each of the stops. You may wish to see how many of these features you can identify by yourself.

This guide is divided into two sections. The first section is designed for the visitor who drives around the park. The second section is designed for visitors who take the walk-up trail to the top of the mountain. Quarrying and the minerals found in the park are discussed at the end of the Walk-up Trail Guide. Loose rocks and sharp edges may be encountered at each stop. Please use caution.

ROAD GUIDE

In this guide, the geologic features of Stone Mountain are described in five stops. These five stops are readily accessible from parking lots and involve short walking distances. A road log indicating directions and mileage to stops is given before the description to each stop.

The road guide begins in the parking lot for the skylift to the mountain top. Stop A is the pavement outcrop directly across the street from the Stone Mountain Inn. The road log mileage will vary depending on where you turn around and park your car. Nevertheless, your mileage should vary no more than .1 to .2 mi from mileage given in the guidebook.

Stop A

Weathering

The Stone Mountain Granite is subjected to constant change. Formed deep within the earth millions of years ago, it is continually adjusting to changes at the earth's surface. These changes, called *weathering*, attempt to restore the minerals to equilibrium with their surroundings. There are two main types of weathering: *physical weathering*, which breaks existing rock into smaller fragments; and *chemical weathering*, which acts on the minerals in the rock fragments and alters their chemical compositions.

Weathering Pits

At this stop, notice the irregularly rounded depressions which may or may not be filled with water. These depressions are called *weathering pits*. They are the result of chemical weathering of the granite by water combined with organic acids from plants. A more detailed discussion of weathering is included in the Appendix. Notice the occurrence of plants on the granite. How do you think the plants got there? The plant life on Stone Mountain may be described in a *plant succession*. First, the surface of the granite is weathered and lichens and mosses begin to grow. Water and organic acids from the early plant life further decompose the granite and a thin soil horizon forms which then may support grasses and wild flowers. Trees start to grow when sufficient soil has formed from the weathered granite. Most of the trees on the granite are stunted because there has not been a sufficient amount of soil collected to support the extensive root system of mature trees. Eventually, when much more weathering of the granite has occurred, not only mature pine trees but hardwoods as well will be able to flourish on Stone Mountain.

As you are examining the weathering effects at this stop, look closely to see if you can locate other geologic features on this outcrop.

Proceed to the other side of the parking lot. Stop B is the outcrop adjacent to the area on the map designated as a picnic area.

Stop B

As you walk over this outcrop, there are four major features to be observed: *joints*, *exfoliation*, *dikes*, and evidence of quarrying.

Joints

While walking on Stone Mountain and the granite pavement outcrops, you will notice fractures in the granite. These fractures are referred to as *joints*. They are fractures in the rock along which no movement has occurred. Parallel joints are called joint sets and two or more intersecting joint sets are called a *joint system*. Two distinct joint systems are found in the rock in and around Stone Mountain Park. The earlier of the two joint systems developed in the surrounding metamorphic rock as a result of stress during the folding. The second joint system was formed as the Stone Mountain granite cooled over a period of millions of years. The granite contracted and cracked in response to tension in much the same way as clay cracks as it dries and hardens. Some joints may be open, and many others are filled with a different rock type (*mineralized*). The fillings in the joints on Stone Mountain are *pegmatite* and *aplite*, and are referred to as pegmatite and aplite dikes.

Figure 3. Joints in the Stone Mountain Granite.

Exfoliation

Exfoliation is the process by which joints developed parallel to the topographic surface of the mountain. The Stone Mountain granite was emplaced approximately 16 km (10 mi) beneath the surface of the earth. With the removal of these 16 km (10 mi) of overlying rock by weathering processes, the granite was exposed. In order to adjust to the reduced pressure, the granite expanded. The curved slabs of granite lying loosely on the top of Stone Mountain are the result of this expansion, called exfoliation. This process is dynamic and ongoing and will continue as long as the granite is exposed.

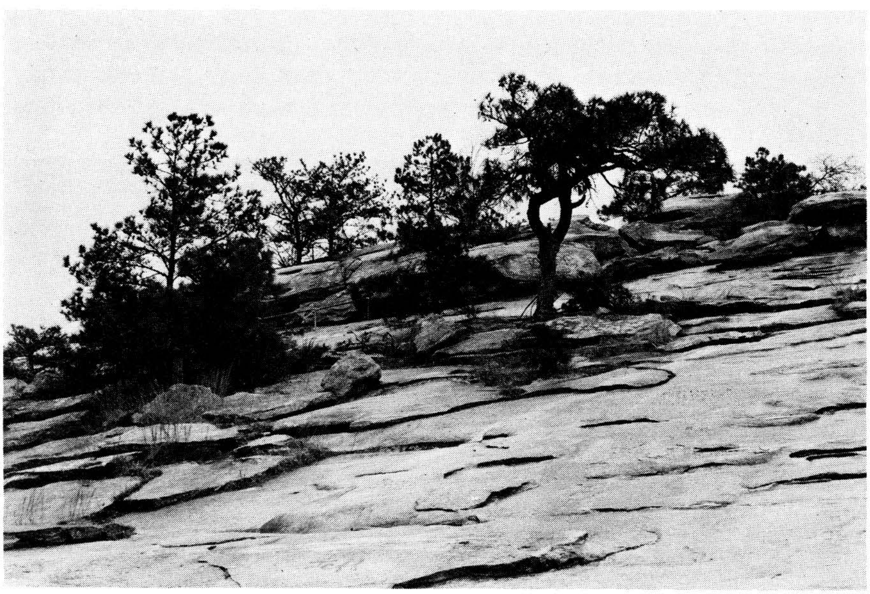


Figure 4. Exfoliation of the Stone Mountain Granite.

Dikes

As the magma cooled, the periphery of the granite cooled first, then contracted and cracked, forming fractures. New magma welled up and filled the cracks in the granite, forming a later rock. These rocked-filled fractures are called *dikes*. Their composition and texture may vary from that of the granite depending upon the conditions at the time of cooling. If the molten rock inside the fractures cooled quickly, *aplite* formed. If the cooling process was slow, *pegmatite* formed.

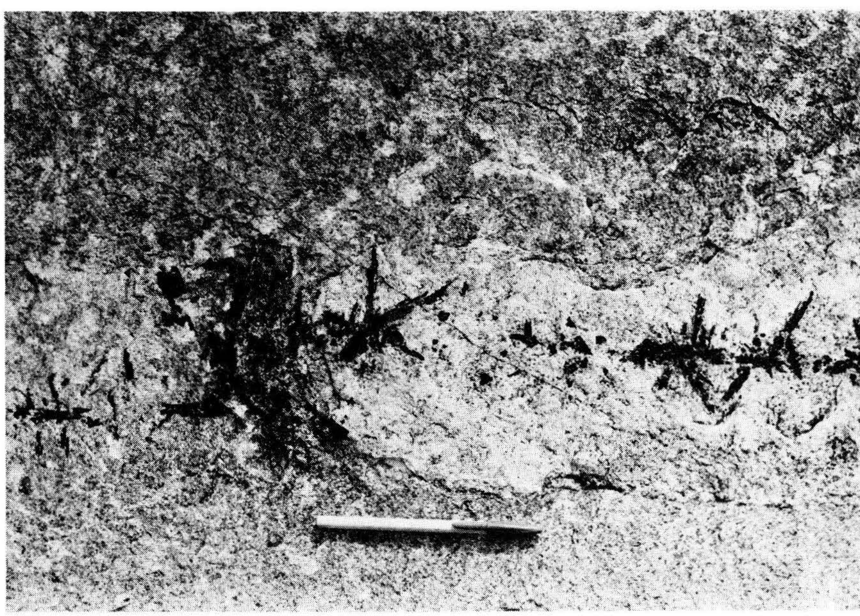


Figure 5. Tourmaline pegmatite in the Stone Mountain Granite.

Quarrying

As you walk over the outcrop, notice the fresh lighter colored areas of the outcrop and compare them to the weathered surfaces you saw at Stop A. These exposures are a result of quarrying. Quarrying is no longer active in the park, but it has left its mark on the granite for you to observe. (A more detailed discussion of quarrying is included in the Appendix.) Can you determine any evidence at this stop? Pay particular attention to the vertical walls.

Proceed to Stop C following the directions given in the road log.

Road Log

MILEAGE	REMARKS
0.0	Mileage begins at parking lot for skylift: Stop B.
0.1	Turn right onto Robert E. Lee Blvd. at the exit closest to Stop B.
0.3	Change to left lane preparing to turn left at first crossroad.
0.6	Intersection. Turn left by sign that says PICNIC PARKING—DEAD END
0.7	Stop C (end of road cut on left side of road).

Stop C

Diabase

After the intrusion of the Stone Mountain granite and related pegmatites and aplites, another intrusion took place in the Georgia *Piedmont*. This intrusion was one of a rock totally different from granite: *diabase*, a dark-colored, fine-grained rock. This intrusion took place approximately 180 million years ago. The diabase crops out at the end of the road in the left side of the hill. The diabase is a dark, fine-grained rock rich in iron and magnesium that crosscuts the light-gray granite. Notice how orange the dike area looks. This orange color is due to weathering of the diabase which releases the iron into the soil. From this information, can you tell if the Stone Mountain Granite has the same amounts of iron and magnesium as the diabase? What color would the Stone Mountain Granite be if it did?

Now look across the lake at the rocks on the opposite shore. What type of rock do you think is there by the color of the rock? Is it diabase or Stone Mountain Granite?

Figure 6. Diabase dike crosscutting the Stone Mountain Granite.

After this stop, turn around and return to the intersection to proceed to Stop D.

MILEAGE	REMARKS
0.85	Turn left at intersection
1.15	Pass Grist Mill Pavillion on left.
1.2	Curve in road—slow down. Prepare to turn right.
1.3	Turn into gravel lot on right at railroad crossing. This is Stop D.

Stop D

Quarry

The quarry is an excellent place to study structure and minerals because both are readily recognized in the fresh granite. Minerals such as biotite, tourmaline, quartz and feldspar may be seen almost anywhere in the quarry. Please refer to the mineral chart for descriptions. In this stop we will concentrate on some of the structure of the Stone Mountain Granite.

After parking in the gravel lot, walk across the railroad tracks and follow the gravel road to the edge of the granite. The road will bear to the left. Continue straight for approximately 50 ft. Turn 90° to your right and walk an additional 25 ft. At the base of a 1- to 2-foot drop near a rubble pile is a small xenolith.

Xenoliths

The Stone Mountain Granite is believed to have been formed approximately 300 million years ago at an approximate depth of 16 km (10 mi). When *magma* (molten rock) was forced into pre-existing rock, the magma forced the older rock apart. Heat from the magma chamber fractured the pre-existing rock, fragments of which broke off, melted, and became part of the *magma*. Other fragments remained intact as inclusions called *xenoliths*. The xenoliths found on Stone Mountain are biotite gneiss and amphibolite, characteristic of older metamorphic rocks that surround the Stone Mountain Granite.

Figure 7. Xenolith in the Stone Mountain Granite.

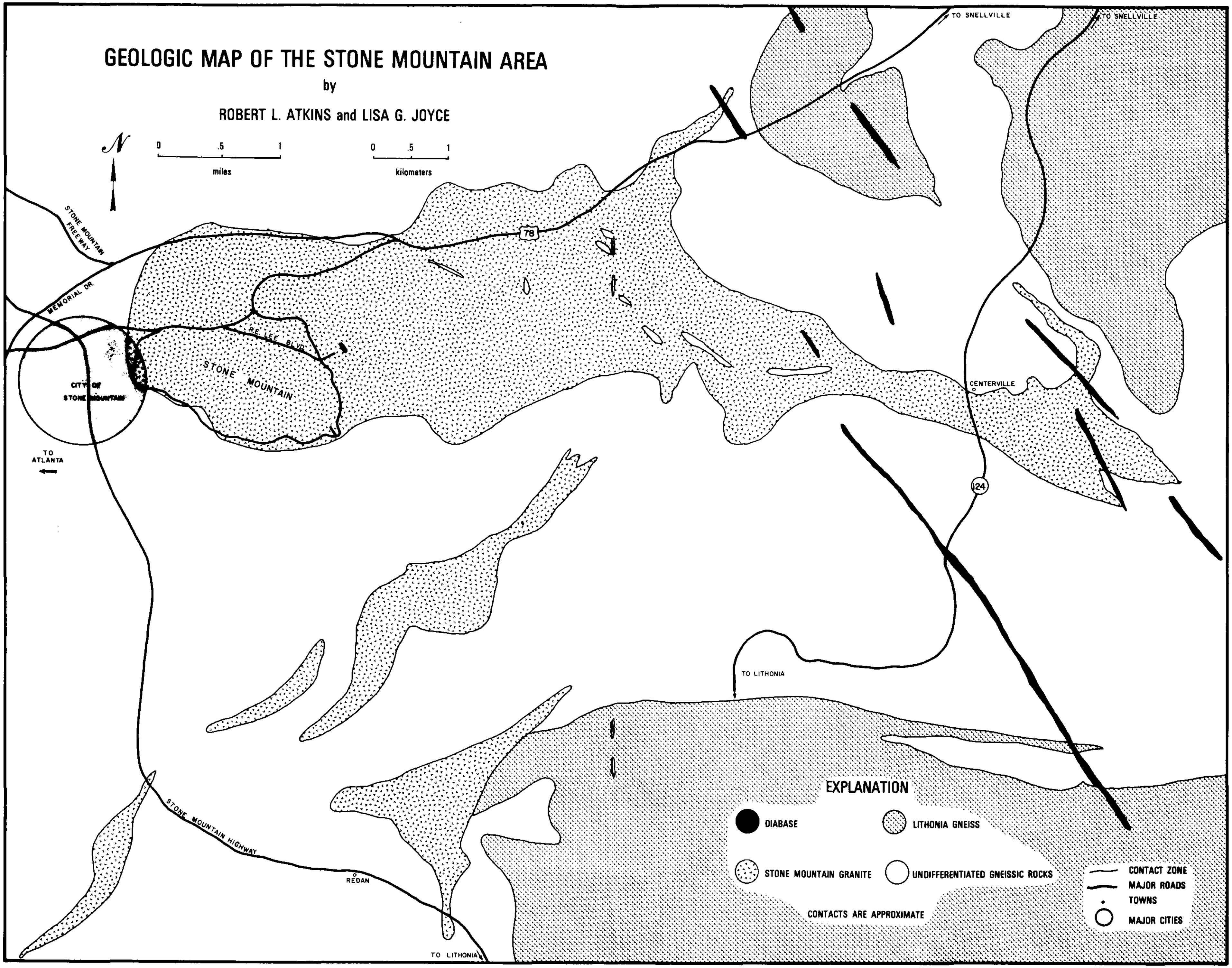
There is another large xenolith close to the large wall you can see above you. As you are walking up to the wall, see how many different minerals and structures you can recognize.

When you reach the wall, walk along the right side of it until you locate the second xenolith. How are these two xenoliths different from the Stone Mountain Granite? Notice the texture of the granite. It is massive and gray in color. The xenoliths are *banded biotite gneiss*, that is, the minerals are segregated into light- and dark-colored bands. This biotite gneiss existed before the Stone Mountain Granite was intruded and the banding is the result of a previous regional metamorphism.

GEOLOGIC MAP OF THE STONE MOUNTAIN AREA

by

ROBERT L. ATKINS and LISA G. JOYCE



Faults

Continuing along the wall approximately 70 ft away from the xenolith, you will cross two dikes. Follow the first dike down the slope for approximately 115 ft until you come to a small *fault* that offsets the dike approximately 3 inches (in.). A tourmaline pegmatite dike has intruded along the fault and the fault is at right angles (90°) to the dike.

Faults are fractures in the rock along which there has been movement. Faults are generated by either tensional forces (forces that pull the rocks apart) or compressional forces (forces that push the rocks together).

Figure 8. Pegmatite-filled fault. The fault offsets a late dike in the Stone Mountain Granite.

This is a good example of how geologists reconstruct the relative history of an area. Geologists know that the Stone Mountain Granite is the oldest rock unit at this stop, excluding the xenoliths, due to the *law of crosscutting relationships*. This geologic principle states that a rock, especially an igneous rock, is younger than any other rock across which it cuts. The first event to occur is numbered one (1) below.

In the case of the Stone Mountain Granite, there is evidence that the granite was intruded (1), cooled and cracked, and that dikes then intruded the cooled granite (2). Later, a small fault displaced the dike on which you are standing (3), and the fault was then intruded by the pegmatite dike (4). (Please refer to the photograph and sketch, fig. 8.)

Return to your car and turn right, continuing around Robert E. Lee Blvd. to Stop E.

MILEAGE	REMARKS
2.7	Road intersection; keep going.
2.8	Parking lot on right and recreational field on left. Park car. This is stop E.

Stop E

Country Rock

Park your car and walk into the field on the left side of the road. Walk toward the dam where you will notice that the rocks and soil change from white to red-orange.

In this area you will notice that the rock is weathered almost to soil. This "rotten rock" is called *saprolite*. Notice that the saprolite here is orange in color, and banded. At Stop D, which rock was banded? The saprolite used to be biotite gneiss before it was altered by the processes of weathering. You are now standing outside the Stone Mountain Granite *pluton*. Obviously the Stone Mountain Granite does not cover the area previously stated in the section on myths, because you are in sight of the mountain, yet outside of the granite body. Even so, there are many dikes of pegmatite and granite at this stop (See Geologic map of Stone Mountain area, p. 12-13).

END OF ROAD GUIDE

WALK-UP TRAIL GUIDE

The walk-up guide describes the geology along the trail. More than one geologic structure exists at each stop. You may want to try to identify by yourself other structures at each stop and between stops.

Stop 1

Quarrying

As you start up the walk-up trail, look closely at the low vertical wall of granite on your right just beyond the railroad tracks. There are chisel marks in the granite (See the section on quarrying in the Appendix for additional information). Granite tombstones dating as far back as 1845 may be found in old country churchyards; however, no records of early quarrying exist. In 1869, the first systematic quarrying of the Stone Mountain Granite was made by the Stone Mountain Granite and Railway Co. This company was succeeded by the Venable Bros. in 1882. During this time, the Stone Mountain Granite reached its peak production, turning out 25,000 paving blocks a day. The quarrying operation consisted of eight miles of railroad, steam engines, boilers, steam drills, etc., and was equal to any of the larger quarries in the East during this time. Stones from the quarry were used for the construction of post offices, courthouses, and street paving throughout the South and West. The Fulton County Courthouse and jail in Atlanta are, in part, constructed of Stone Mountain Granite. Government buildings in Tyler, Tex.; Macon, Savannah and Augusta, Ga.; Louisville, Ky., and other buildings in Philadelphia and the New York City area also were constructed using Stone Mountain Granite (Watson, 1902). Quarrying ceased on Stone Mountain in the early 1970's, but small-scale quarrying of the granite continues just east of the mountain.

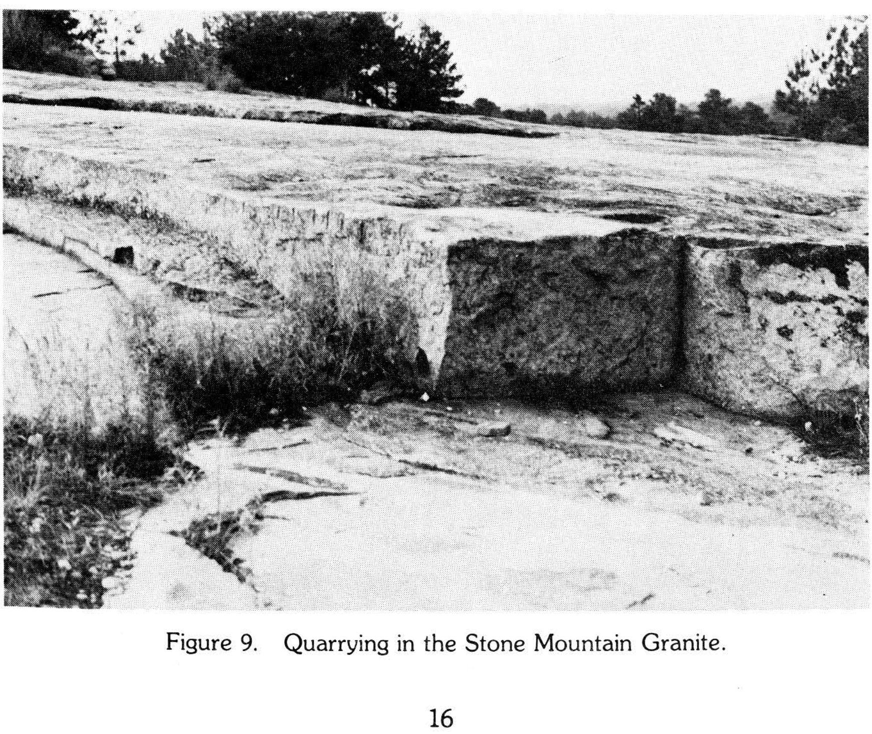


Figure 9. Quarrying in the Stone Mountain Granite.

Proceed up the trail taking care to notice the cracks in the granite. How do you think the cracks got there?

Stop 2

Joints

As you walk up the trail, one structural feature of Stone Mountain is very evident: long "cracks" in the granite. These are *joints*, fractures in the granite along which no major movement has occurred. There are two basic types of joints on Stone Mountain. Notice the joints that are more or less parallel with the surface of the mountain. These are *exfoliation joints* and were formed as the granite expanded. *Tensional joints* are the second type of joint found on Stone Mountain. These joints are the older of the two, having been formed as the intruded granite body cooled. They are not parallel to the mountain's surface. Some of these tensional joints have been widened by rainwater running along them and dissolving the granite. Can you locate these two types of joints?

Now follow the trail past the rest stop. Look around and think about how the loose slabs of rock and large boulders got there.

Figure 10. Vertical joints.

Stop 3

Exfoliation

As you walk along the railing between the large boulders, you can see evidence of *exfoliation*. After the overlying cover of rock and soil on the granite was removed by erosion, the granite began to expand upward and outward. This expansion caused tremendous strain within the granite, and as a result, it began to split into thin, curved slabs. The expansion that caused exfoliation also gave Stone Mountain its domal character. The exfoliation slabs are visible at the surface over the entire mountain and disappear at depth. Some of these loose slabs have been weathered extensively and reduced to the large slabs you see hanging precariously on the slopes of the mountain. Other slabs have slipped off the mountain and collected at the base.

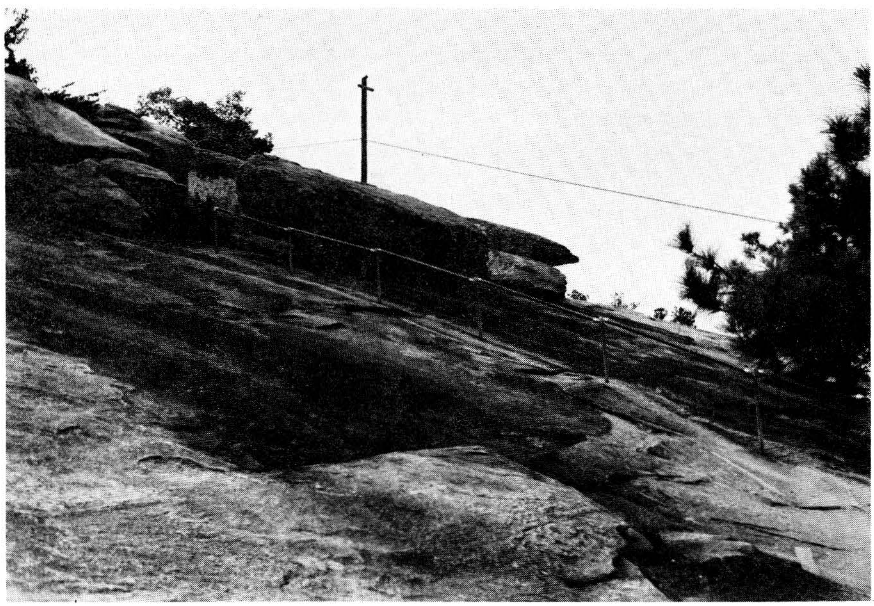


Figure 11. Exfoliation joints.

Continue up the trail to where the yellow trail markers separate. Take the trail on the right. Have you noticed bands of white rock crosscutting the granite?

Stop 4

Pegmatite

After the intrusion of the Stone Mountain granite, there were several more periods of intrusive activity. The Stone Mountain Granite cooled faster on the outside than on the inside, and the new *magma* found its way into fractures in the cooling granite. The mineralized fractures are called dikes and are classified according to the type of rock that has filled the fracture and the mineral grain size. A light-colored, fine-grained rock of similar composition to granite is called *aplite*. A rock compositionally similar to aplite, but coarse-grained, is called *pegmatite*. The most distinguishing characteristic of pegmatite is its large crystals of easily recognizable minerals: quartz, feldspar, mica, and tourmaline. Tourmaline is a dark-green to black elongate mineral with a triangular cross section. A typical crystal arrangement is a radiating pattern called a tourmaline rosette. Tourmaline is more resistant to weathering than the associated minerals of the pegmatite, and will stand above the weathered surface of the pegmatite.

Figure 12. Pegmatite.

Proceed to top of the mountain.

Stop 5

Weathering Pits

One of the most noticeable features is the hundreds of rounded holes and depressions in the granite. Depending on recent weather conditions, they may or may not be filled with water. These are weathering pits. Popular belief has it that they are scars on the granite from repeated lightning strikes. Actually, they are formed when water collects on the granite's irregular surface and combines with organic acid from plants to slowly dissolve these pits in the granite.

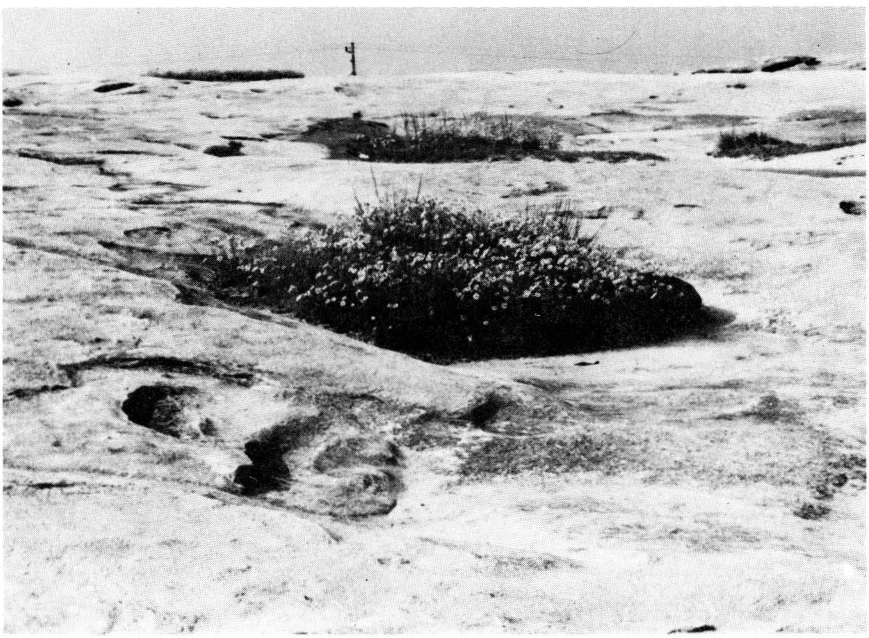


Figure 13. Weathering pit with plant community.

Stop 6

Relationship Of Flora To Geology

On Stone Mountain, as on other granite outcrops in the Piedmont, vegetation is typically restricted to weathering pits, joints, and behind exfoliated blocks. These are the areas where weathering gives lichens and mosses a roothold on the granite. They produce organic acids that combine with rainwater to further weather the granite. This action, given time, produces more soil which supports grasses. Eventually, enough soil is formed from the weathered granite to support pine trees and, finally, hardwoods to complete the line of plant succession.

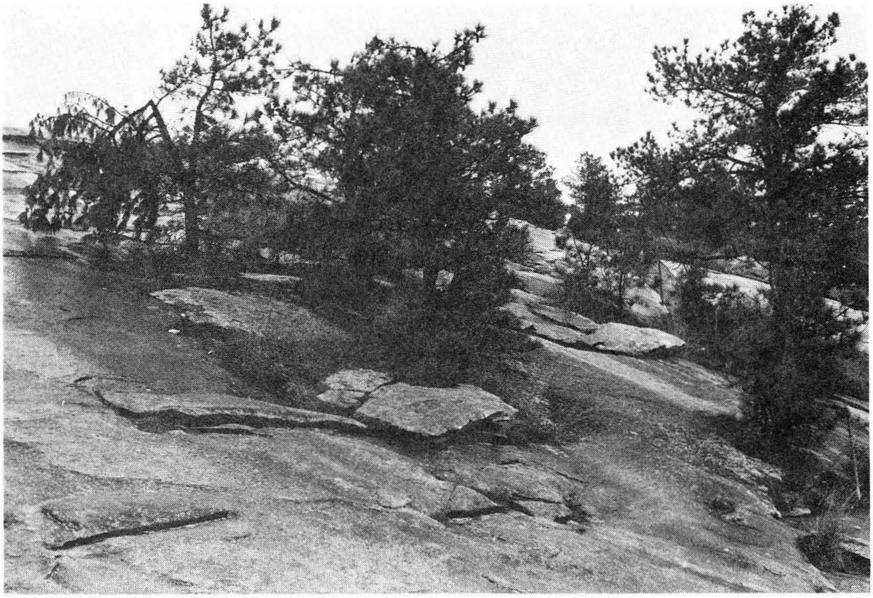


Figure 14. Relationship of flora to geology.

Stop 7

Extent of Rock Units

Anyone who spends time outdoors knows that rocks are not always exposed, but often are concealed by vegetation or have been weathered away. For this reason, the soils often must be relied upon to give us a clue to the type of rock that presently underlies an area. Once we know how different types of rock weather, we can determine the rock type in an area by observing soil color and texture. Close to the mountain and east of it you can see light-colored soils composed of sand-size particles of quartz and feldspar. This tells us that the predominant rock type in this area is granite because most of the minerals in granite are light colored and weather to sand-size particles of quartz and feldspar. Further away from the mountain, particularly north and west, the soil takes on a very orange-red clayey appearance. This tells us that these areas are underlain by amphibolite and biotite gneiss. The dark minerals in these rocks contain a high percentage of iron which, when oxidized with water, gives the weathered rock and soil a bright orange-red hue, similar to rust on an iron pipe.

Stop 8

Other Mountains

On a clear day, many other mountains in the Georgia Piedmont are visible from the top of Stone Mountain. Looking south, you can see Panola Mountain, Arabia Mountain, and Pine Mountain, often referred to as "Little Stone Mountain". Panola Mountain is composed of Panola Granite. Arabia and Pine Mountains are granite *gneiss*, a metamorphic rock of granitic composition.

To the northwest are Kennesaw and Sweat Mountains. Kennesaw Mountain is amphibolite, a foliated metamorphic rock composed of hornblende and feldspar; Sweat Mountain is quartzite, a metamorphosed sandstone.

Appendix

Minerals

Common minerals of this area are quartz, feldspar, hornblende, biotite, muscovite, garnet, and tourmaline. Tourmaline, biotite, muscovite, feldspar, and quartz are common minerals in the Stone Mountain Granite. Other less common minerals found within the area include uranophane (a type of opal), zircon, epidote, and pyrite (see table 1).

Physical and Chemical Weathering

Physical weathering is accomplished primarily by expansion of water due to freezing. Alternate freezing and thawing cycles force the rock apart with tremendous pressure. Other less important forces responsible for physical weathering include heat expansion, growing roots, worms, and other burrowing animals.

The main action of physical weathering is to aid *chemical weathering* by providing the large surface area necessary for chemical weathering to take place. The rate of chemical weathering depends on temperature, surface area, and the amount of water present. Water is the single most important chemical weathering agent. It commonly unites with organic acids from plants to form carbonic acid which weathers the rock and acts as a physical abrasive. Running water also carries other impurities which aid its efficiency as a weathering agent.

The combination of physical and chemical weathering has a very slow but devastating effect on Stone Mountain. On the trail, exposed granite has been reduced to sandy patches. In some places soil, which has been formed from sand and broken-down remains of lichens and mosses, supports the growth of grasses and small trees.

The large boulders sitting on top of Stone Mountain also are products of weathering. They are the remnants of exfoliation sheets whose edges have been weathered away. Weathering also loosens the shells from the mountain, causing them to slide off. The boulders at the base of the mountain are the result of this.

Other very noticeable features on Stone Mountain resulting from weathering are rounded holes and depressions in the granite. These rounded holes, referred to as weathering pits, are more pronounced on top of the mountain, but also can be found along the trail. They are formed when water runs along joints and/or collects in depressions in the granite. The trapped rainwater combines with organic acids from plants, and this carbonic acid slowly dissolves the granite, leaving the rounded pits. Many of these pits are presently filled with rainwater; thus it can be seen that weathering is an ongoing process.

Table 1. MINERAL IDENTIFICATION TABLE

MINERAL	COLOR	LUSTER	OTHER PROPERTIES	OCCURRENCE
Biotite	black to dark-green	glassy	common; occurs in flakes	schists, gneisses, granites, pegmatites
Epidote	yellow-green	glassy	granular	gneisses, schists
Feldspar	white to pink	glassy	breaks at right angles 90° to each other.	major rock-forming mineral in granite, pegmatite, gneisses
Garnet	dark-red	glassy	12-sided crystals	pegmatite, schists, gneisses
Hornblende	black	glassy	weathers red-orange	gneisses
Muscovite	clear to light-green	glassy	occurs in flakes	granite, pegmatite, gneisses, schists
Pyrite	pale-brass-yellow	metallic	brittle cubic crystals	found in all rock types
Quartz	smokey-clear	glassy	breaks like glass	granite, pegmatite, gneisses, schists
Tourmaline	black	glassy	elongated triangular	pegmatite, granite
Uranophane (Opal)	yellow	dull	not common	joint surfaces

Quarrying

The method of quarrying granite consists primarily of three stages. Steps one and three utilize the joints. Since the joints represent planes of weakness in the rock, the quarrymen learned that the rock broke easily along these fractures.

The quarrying method is outlined in the following photographs.

1) Raising the ledge - The ledge is raised by drilling to a desired depth, filling the bottom of the hole with blasting powder, and plugging the hole with clay.
(The clay forces the blast laterally instead of upward). The blast forces the rock open along one of the exfoliated joints and extends the joint to the surface.

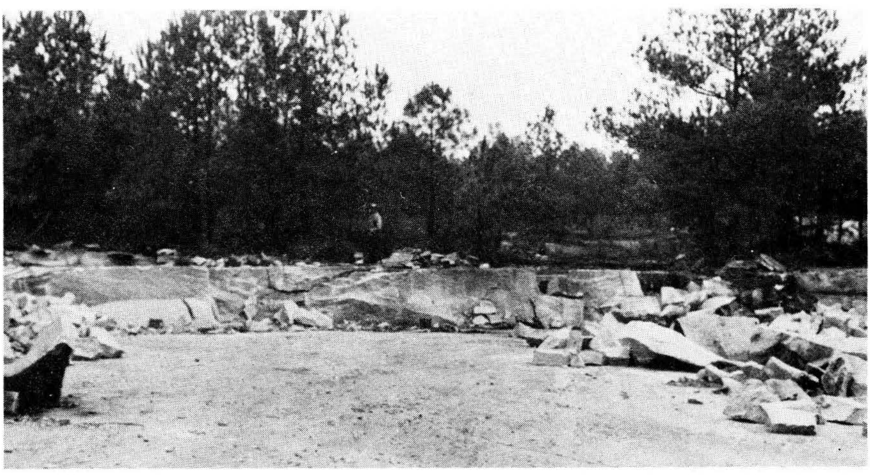


Figure 15. Quarrying—Raising the ledge

2) After the ledge has been raised, both ends are open. This allows the production of the stone to begin.

Figure 16. Quarrying—Opening the ends

3) Production stage - The final stage in quarrying is called the break. The width of the break depends upon the product.

In making the break, wedges or black powder can be used. However, black powder breaks the stone unevenly and the finished product is inferior. With wedges, the break is better controlled.

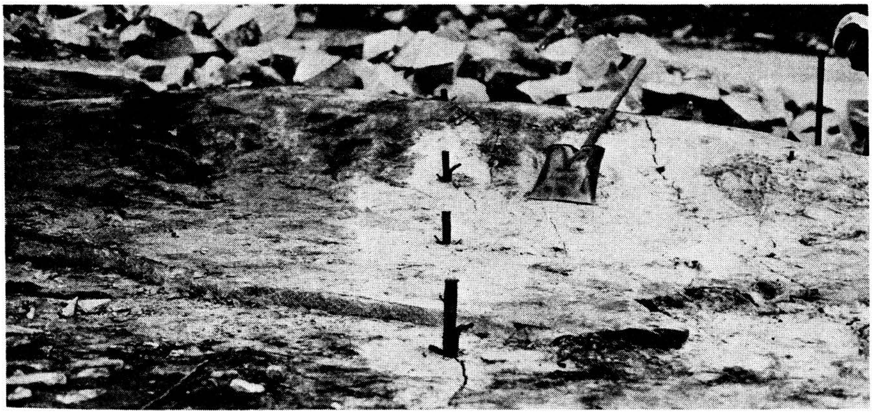


Figure 17. Quarrying—Opening of the break.

Concluding Statement

The landscape you have observed today reflects the mountain's existence in its stage of mighty conflict between internal and external forces. Over millions of years the restless earth constantly creates 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.

Stone Mountain, more resistant than surrounding 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, Stone Mountain will be reduced to soil. Until then we are indeed privileged to wonder at the beauty and marvel at the exquisite balance of forces that have created this complex environment.

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Glossary

Aplite - A fine-grained, light-colored, igneous rock that occurs as dikes in the granite.

Banded Gneiss - A regularly layered metamorphic or composite rock with alternating layers of different composition and/or texture. Thickness of individual layers is usually not more than a few inches.

Chemical Weathering - The process of weathering by which chemical reactions transform rocks and minerals into new chemical combinations that will remain indefinitely without further change under conditions prevailing at the earth's surface.

Coarse-grained - A textural term to describe minerals in igneous rocks that are visible to the naked eye.

Country Rock - The rock intruded by and surrounding an igneous intrusion.

Diabase - A dark-colored, fine-grained intrusive rock.

Dike - A tabular igneous intrusion that cuts across the planar structures of the surrounding rock.

Erosional Remnant - A topographic feature that stands higher than the surrounding topography.

Exfoliation - The process by which thin concentric sheets of rock are successively broken loose from the bare outer surface of a larger rock mass; caused by a combination of weathering and the release of continuing pressure of once deeply buried rock as it is brought to the surface by erosion.

Extrusive - An igneous rock which has flowed out at the earth's surface.

Fault - A surface or zone along which there has been displacement from a few centimeters to a few kilometers in scale.

Fine-grained - A textural term applied to igneous rocks whose minerals are too small to be seen with the naked eye but are visible with a hand lens.

Float - A general term for an isolated, displaced fragment of rock found on the surface.

Geologist - One who does or participates in any of the geological sciences.

Geology - The study of the planet earth. It is concerned with the origin of the planet, its materials and morphology, its history, and the processes that acted (and act) upon it to affect its historic and present forms.

Igneous Rock - A rock or mineral that has solidified from molten or partly molten material.

Intrusive - An igneous rock which was trapped in the earth's crust and did not reach surface.

Intrusion -- The process of emplacement of magma in pre-existing rock.

Joint - A surface of actual or potential fracture or parting in a rock without displacement. The surface usually is a plane.

Joint Set - A regional pattern of groups of parallel joints.

Joint System - Two or more joint sets that intersect. They may be of the same age or of different ages.

Law of crosscutting relationships - A stratigraphic principle whereby relative ages of rocks can be established: A rock (especially an igneous rock) is younger than any other rock across which it cuts.

Magma - Naturally occurring mobile liquid rock material generated within the earth.

Magma Chamber - A reservoir of magma in the earth's crust from which volcanic materials are derived; the magma has ascended into the crust from an unknown source below.

Metamorphic Rock - Any rock derived from pre-existing rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in the earth's crust.

Outcrop - That part of a geologic formation or structure that appears at the surface of the earth.

Pavement - A term to describe the flat exposures of rock.

Pegmatite - A very coarse-grained light-colored igneous rock that is composed of quartz and feldspar; common accessory minerals are tourmaline, garnet, and muscovite.

Physical Weathering - The process of weathering by which physical forces break down or reduce a rock to smaller and smaller pieces without altering the chemical composition.

Piedmont - The physiographic and geologic province of central Georgia composed primarily of Precambrian or Palezoic aged crystalline rock.

Pluton - An intrusive igneous body such as Stone Mountain.

Precambrian - An era in geologic time that began 4500 million years ago and ended approximately 600 million years ago.

Xenolith - An inclusion in an igneous rock to which it is not genetically related.

TIME (in millions of years)	ERA	PERIOD	FORMS OF LIFE	EVENTS IN GEORGIA
0	CENOZOIC	QUATERNARY	AGE OF MAN earliest man	
		TERTIARY	1st apes, grasses 1st monkeys AGE OF MAMMALS	Emergence of Stone Mountain
100	MESOZOIC	CRETACEOUS	extinction of dinosaurs 1st snakes 1st angiosperms (blooming plants)	Deposition of the Coastal Plain sediments, which is still occurring.
		JURASSIC	AGE OF REPTILES 1st birds, mammals	Intrusion of Diabase
200		TRIASSIC	1st dinosaurs	
	PALEOZOIC	PERMIAN	1st frogs, evergreens	
300		PENNSYLVANIAN	1st reptiles AGE OF AMPHIBIANS	Erosion of the Piedmont by streams, which is still occurring. Intrusion of Stone Mountain Granite
		MISSISSIPPIAN		
		DEVONIAN	1st scale trees, ferns, amphibians AGE OF FISHES	
400		SILURIAN	1st air breathing animals, land plants	Uplift, folding and faulting of the rocks and the formation of a mountain range in the Piedmont.
		ORDOVICIAN	1st fishes	
500		CAMBRIAN	1st hard-shelled invertebrates	Throughout the Paleozoic there was deposition of sediments which formed shales, sandstones, and greywackes.
600		PRECAMBRIAN	multi-cellular life forms one-celled life forms	Modified from 1:2,000,000 Geologic Map of Georgia

GEOLOGIC TIME CHART

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