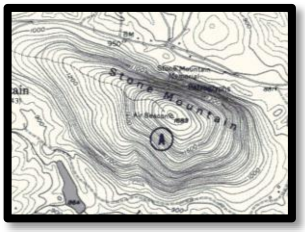
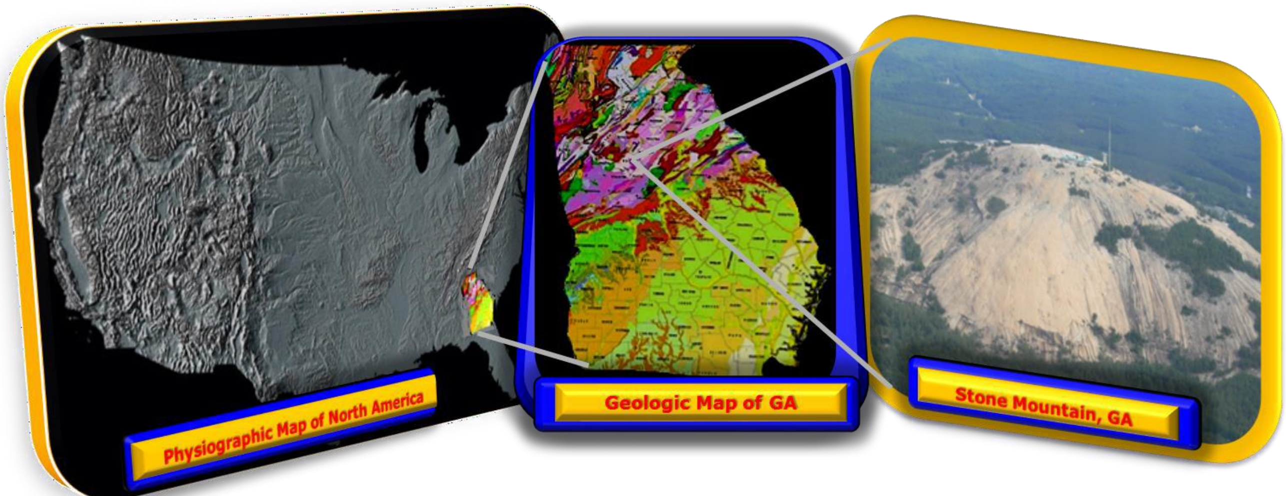
NATIONAL ASSOCIATION OF BLACK GEOLOGIST ANNUAL CONFERENCE FIELD TRIP



STONE MOUNTAIN GEORGIA

September 9th, 2024



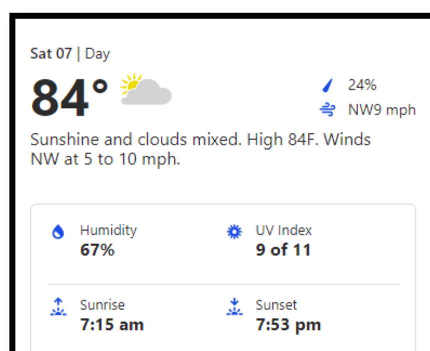
FIELD TRIP LEADER:

DR. ADITYA KAR

PROFESSOR OF GEOSCIENCE
DEPT. OF CHEMISTRY / GEOLOGY
& COOPERATIVE DEVELOPMENTAL ENERGY PROGRAM

FORT VALLEY STATE UNIVERSITY
FORT VALLEY, GA 31030.

Activity Level: Moderate, with short to medium walking over mostly flat with some inclines. Some slopes may be slippery. Watch where you step and also watch for broken glasses.



Equipment: You must wear solid flat shoes like sneakers – no flip flops, high heels, sandals, or other type shoes that are open either in the front or back.

Rule is what you carry to the field you must bring it back with you!

NABG ANNUAL CONFERENCE FIELD TRIP 2024: STONE MOUNTAIN, GA; Field Trip Leader: Dr. Aditya Kar, FVSU

ABSTRACT

Stone Mountain Park is located 16 mi east of Atlanta and the city of Stone Mountain is a suburb of Atlanta and is situated at the southern end of the Appalachian Mountains. The most obvious feature in the park is Stone Mountain, which rises approximately 750ft above the surrounding countryside, covers 583 acres and has a physical volume of over seven and one-half billion cubic feet. This famous granite monolith, an inselberg since it's the exfoliated remnant core of a considerably larger intrusion, primarily composed of quartz monzonite.

The dome of Stone Mountain was formed during the formation of the Blue Ridge Mountains around 300–350 million years ago (during the Carboniferous period), part of the Appalachian Mountains. The granite was dated at 291 m.y. It formed as a result of the upwelling of magma from within the Earth's crust. The magma intruded into the metamorphic rocks of the Piedmont region during the last stages of the Alleghenian Orogeny, which was the time when North America and North Africa collided. This magma solidified to form granite within the crust five to ten miles below the surface. At the base of Stone Mountain is surface evidence that the magma chamber underwent flow and entrained some of the country rock which are now evidenced by presence of xenoliths that are enclosed within the granite.

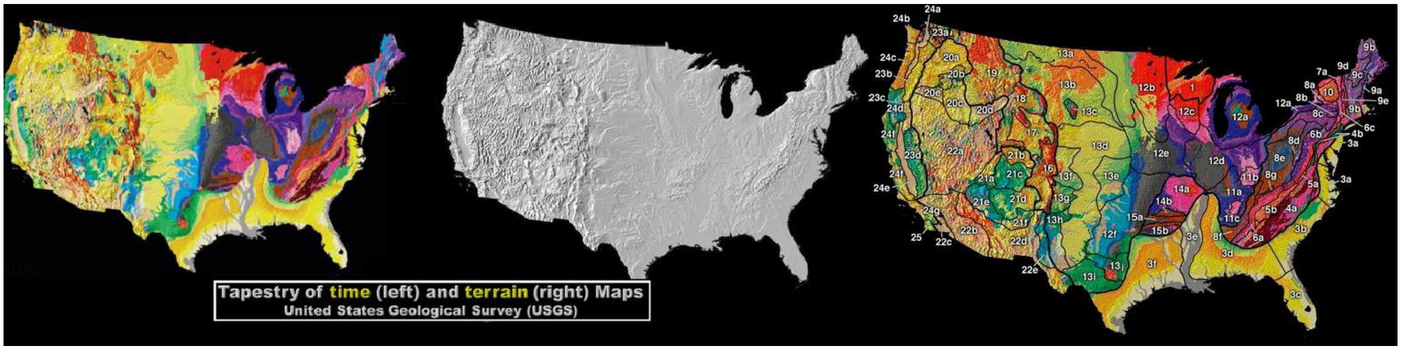
Stone Mountain pluton continues underground 9 miles (14 km) at its longest point into Gwinnett County. The minerals within the rock include quartz, plagioclase feldspar, microcline and muscovite, with smaller amounts of biotite and tourmaline. The tourmaline is mostly black in color, and the majority of it exists as optically continuous skeletal crystals, but much larger, euhedral pegmatitic tourmaline crystals can also be found in the mountain's numerous, cross-cutting felsic dikes. A mafic sill rests along the surface at the base of the mountain.

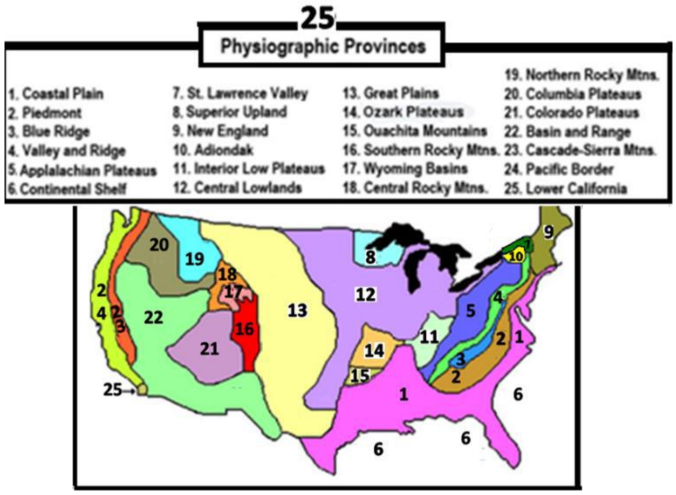
Over time, erosion removed the overburden and with the pressure released the granite expanded outwards in all directions. This outward expansion is known as exfoliation, which causes the domal shape characteristic of Stone Mountain. As Stone Mountain Granite is more resistant to weathering than the surrounding rock, the rock surrounding Stone Mountain has been leveled by weathering and erosion, while the mountain itself has been affected less and stands high above the countryside as an erosional remnant. Evidences of mechanical and chemical weathering are seen everywhere on the mountain These include exfoliation, jointing, solution pits, surface decomposition, and soil creation.

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 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, TX; 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. Quarrying ceased on Stone Mountain in the early 1970's, but small-scale quarrying of the granite continues just east of the mountain.

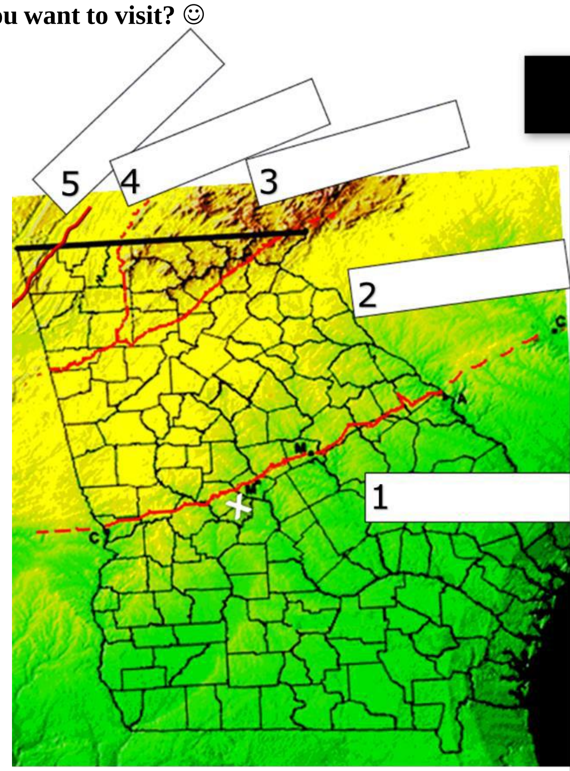
Figure: Young budding STEM specialists (rising 9th graders from all over the country with Dr. Aditya Kar at the summit (picture on left) and learning geology at the base of the hiking trail (picture on right) on one hot summer day in July at Stone Mountain, GA. In one such group was a 9th grader named Tramond Baisden, today he is the President of the National Association of Black Geoscientists.

Physiographic provinces of North America and Georgia





Identify which physiographic province you reside in:____________________________________
How many of these physiographic provinces have you visited?____________________________
How many do you want to visit? ☺ __________________________



Name the 5 physiographic provinces of Georgia

In which province is Atlanta and Stone Mountain?

In which province is Fort Valley (X)?

What is the name of the RED LINE that separates province 1 from province 2?

How old are the provinces 2-5?

How old is province 1?

Why did these provinces form?

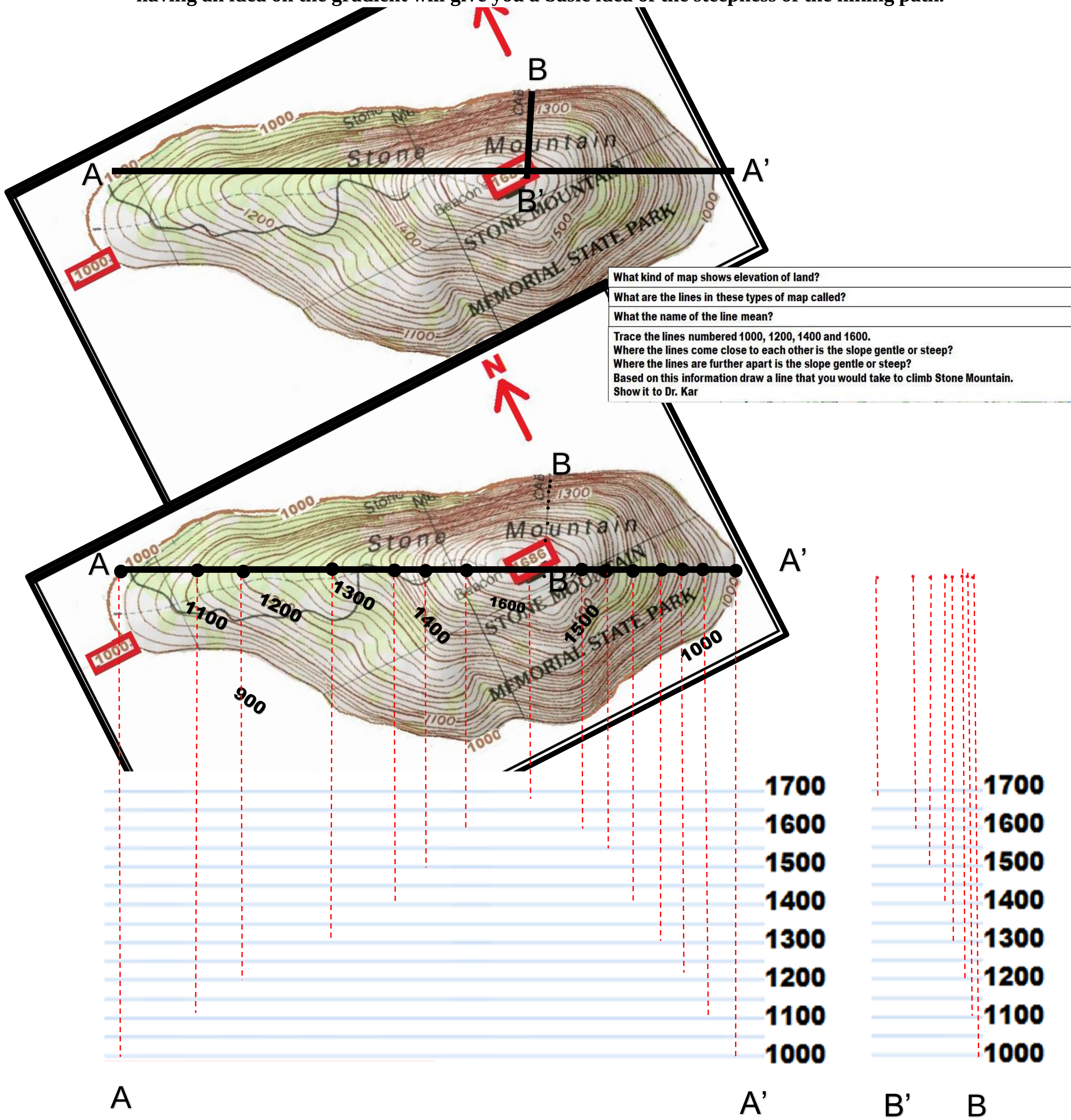
In which province will you find the following resources?

Gold:__________Coal:__________

TOPOGRAPHIC MAP

A quick exercise in mapping. Construct a topographic profile for the line marked A- A'.

The main reason is that later in the morning we are going to climb to the summit of the Stone Mountain so having an idea on the gradient will give you a basic idea of the steepness of the hiking path.

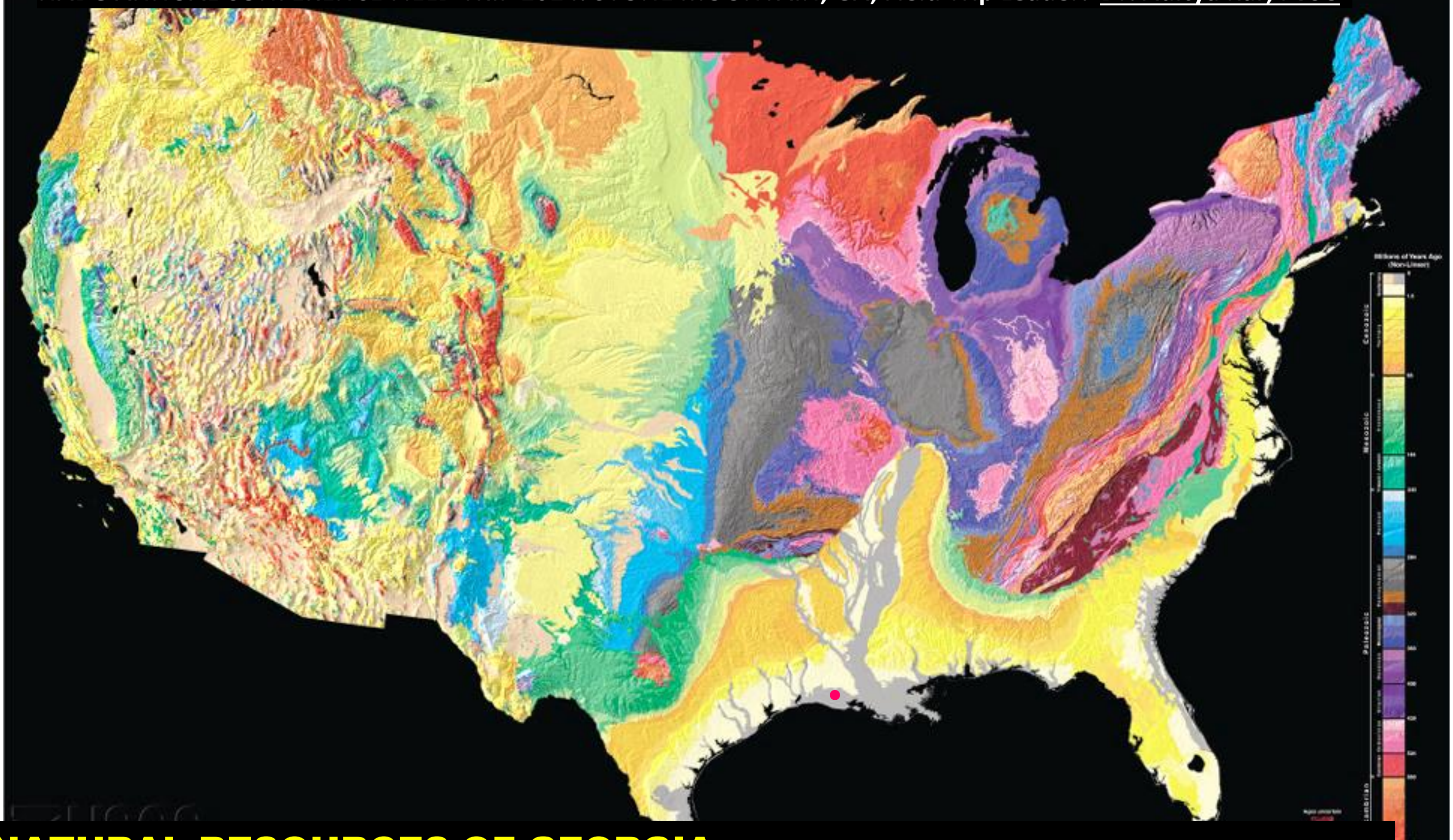


What kind of map shows elevation of land?

What are the lines in these types of map called?

What the name of the line mean?

Trace the lines numbered 1000, 1200, 1400 and 1600.
Where the lines come close to each other is the slope gentle or steep?
Where the lines are further apart is the slope gentle or steep?
Based on this information draw a line that you would take to climb Stone Mountain.
Show it to Dr. Kar



NATURAL RESOURCES OF GEORGIA

The Mineral Industry of Georgia

In 2009, Georgia's nonfuel raw mineral production - was valued at $1.4 billion, based upon annual U.S. Geological Survey data (USGS).

The State remained 14th in rank among the 50 States in total nonfuel raw mineral production value and accounted for 2.4% of the U.S. total.

Georgia continued to be the leading clay-producing State in the United States in 2009, accounting for 23% of the Nation's total clay (all kinds) production. Kaolin clay, by value, remained Georgia's leading nonfuel mineral commodity, followed by crushed stone. The combined value of these two leading mineral commodities accounted for 86% of the State's total nonfuel mineral production value.

In 2009, Georgia continued to lead the Nation in the quantities of kaolin and iron oxide pigments produced (descending order of value).

2nd of two barite-producing States,
3rd in crude mica,
4th in dimension stone,
5th in common clays, and
6th in crushed stone and decreased to sixth from fifth in feldspar.

The State rose to seventh from eighth in masonry cement

Additionally, Georgia was a significant producer of industrial sand and gravel, accounting for 3.2% of the total U.S. production of the commodity.

MINERALS:
Kaolin Feldspar Mica Bauxite Clay Shale Barite Ochre Umber Fuller's Earth Gold

ROCKS:
Granite Sand Limestone Coal Sand / Gravel Marble

What minerals are produced south of the Fall Line?

What minerals are produced north of the Fall Line?

The following part of the guide book has been excerpted from the following resource:

GEOLOGIC GUIDE TO STONE MOUNTAIN PARK
Robert L. Atkins and Lisa G. Joyce
GEORGIA DEPARTMENT OF NATURAL RESOURCES
Joe D. Tanner, Commissioner
ENVIRONMENTAL PROTECTION DIVISION
J. Leonard Ledbetter, Director
GEORGIA GEOLOGIC SURVEY
William H. McLemore, State Geologist
Atlanta
1980

STOPS 1 & 2: On the East side of Stone Mountain. Bus parks once and we walk to both stops.

REST ROOM: There is a largish REST ROOM for both Males and Females available in between the 2 stops across from the parking lot where the bus will be parked.

TIME: Between the 2 stops we spend at the most 1 hour 30 mins.

We board the bus and leave the quieter part of the park ride approximately 10 mins. to the busier west side of the park to the walking up trail.

STOP 3: We will do geology at the base of the walk up trail and then there would be 2 options.

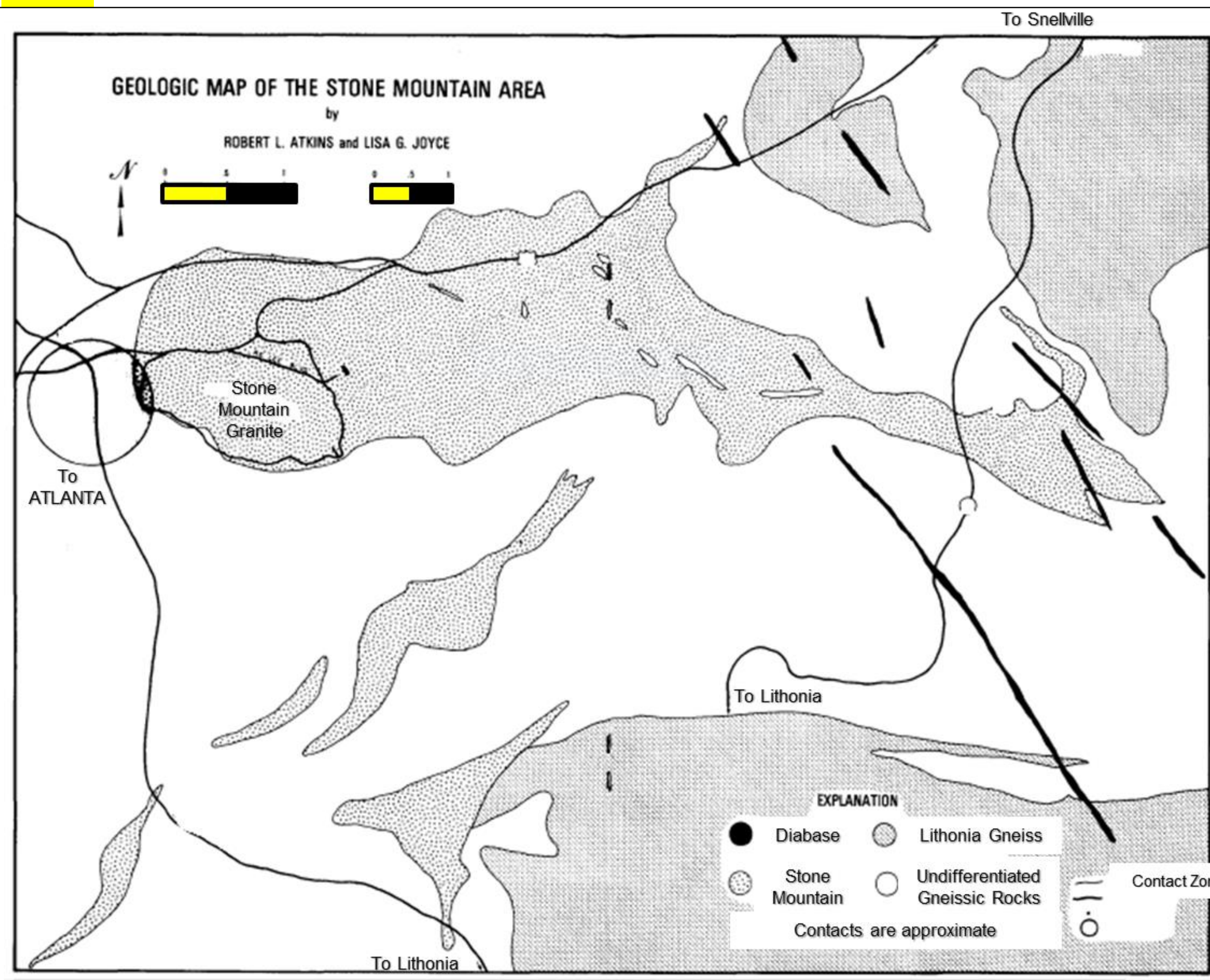
Option A: Doing similar but and not so similar geology as we climb Stone Mountain. Anyone can turn around and return to the base of the walk up path at any time.

Option B: After doing geology at the base stay at the base and there is Museum (free) with quite a bit of geology exhibit. Folks not climbing can explore that.

RESTROOM: There is a large restroom both for males and females at the base of the walk up trail and at the top of Stone Mountain. Water available at both places.

TIME: To climb, geology and back at the most 1 hour.

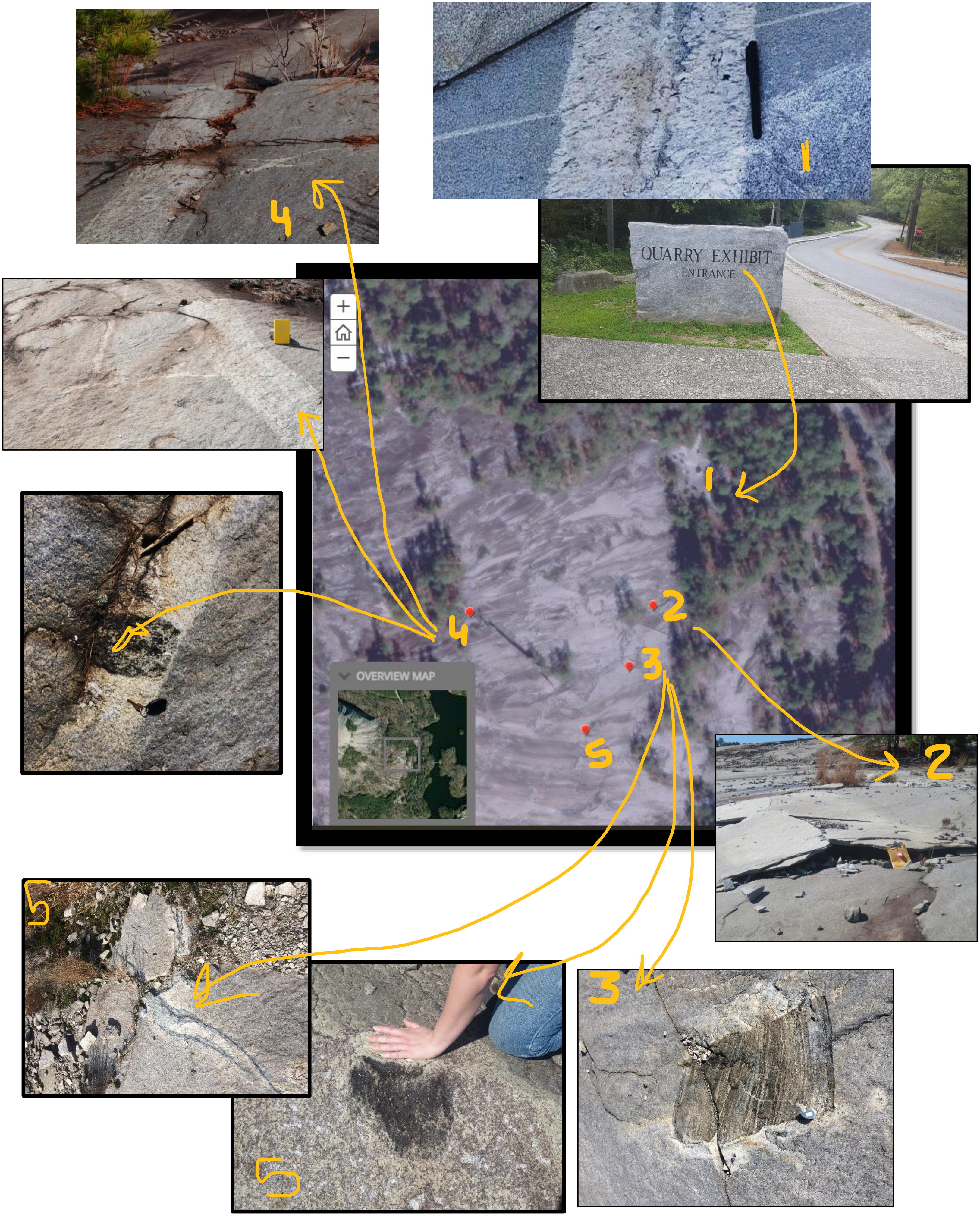
WATER: I recommend 2 bottles per person over the half day visit and climb.



TIME (in million 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.
		MISSISSIPPIAN		Intrusion of Stone Mountain Granite
		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

NABG ANNUAL CONFERENCE FIELD TRIP 2024: STONE MOUNTAIN, GA; Field Trip Leader: <u>Dr. Aditya Kar, FVSU</u>



Stop 1 Quarry Exhibit

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

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

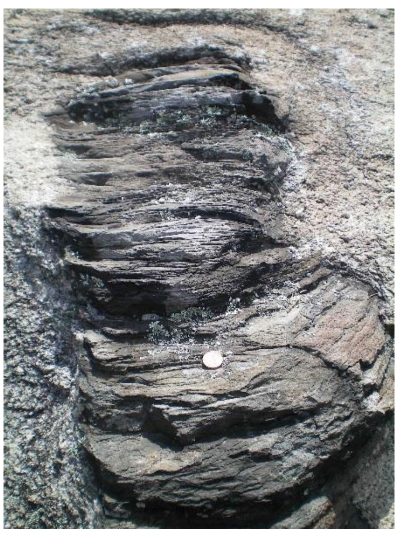


Figure Xenolith in the Stone Mountain Granite.

The Stone Mountain Granite is believed to have been formed approximately 300 million years ago approximately 10 miles deep when *magma* (molten rock) was forced into pre-existing rock, the magma forced the older rock apart. Heat from the magma chamber fractured the preexisting 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.

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.

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. 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.

IGENOUS ROCKS

Molten rock material, or magma, originates deep beneath the earth's crust and comprises the parent material from which all rocks form. When magma cools, it solidifies through process known as crystallization to form igneous rocks. This crystallization process can take place slowly and at great depth, or more rapidly when magma rises and flows out at the earth's surface as lava.

When magma cools slowly beneath the earth's surface, ions present in the liquid melt (magma) forms large, well-developed crystals. The rocks thus formed are said to have a coarse-grained (large crystals) texture and are called intrusive or plutonic igneous rocks. In contrast, magma which rises to reach the earth's surface produces volcanic eruptions and lava flows. The lava cools more rapidly at the earth's surface, not allowing the time needed for larger mineral grains to form. Igneous rocks which form in this environment are called extrusive or volcanic igneous rocks and exhibit a fine-grained texture (small crystals) composed of individual mineral grains too small to be seen with the unaided eye. The faster cooling leads to the fine-grained texture.

Answer the following questions:

1) What are igneous rocks?

2) How many broad types of igneous rocks are there are there (based on depth of formation and SiO_2 content)?

3) What is the difference between magma and lava?

4) How is crystallization of minerals related to cooling of magma/lava?

Questions related to the rock that forms the Stone Mountain.

5) Is this a volcanic igneous rock or plutonic igneous rock?
6) Why?

7) Why is the rock of Stone Mountain on Earth's surface?

8) Try to look closely and see if you can identify any minerals in this rock? If yes, name the minerals. Also, give an approximate value for hardness of the rock of Stone Mountain.

9) What is the SiO_2 content of this rock?

10) Look at your questions 5-9 and name the rock of Stone Mountain.

11) What is the age of Stone Mountain rock?

12) What are hardness scale values for the minerals that form the rock of Stone Mountain?
13) What would an approximate hardness of the Stone Mountain rock?

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.

Draw dikes and give a scale.

Figures showing dikes, aplites, tourmaline pods and clusters (left to right)

TOURMALINE: Boron Silicate: $(Na,Ca)(Mg,Li,Al,Fe^{2+})_3 Al_6 (BO_3)_3 Si_6O_{18} (OH)_4$

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

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. Notice the occurrence of plants on the granite. Possible Ecological Effects from Climate Change Research is generally lacking concerning the effects of climate change on Piedmont granite outcrop species. Such effects could plausibly include changes to hydrologic regimes, temperature changes, and interactive effects with known biotic factors such as invasive species. Ibáñez and others (2006) predicted that the Piedmont will experience increased aridity from climate change, possibly resulting in a dramatic restructuring of forest communities in the region. If this were to occur, the different community types sustained by various microhabitats within granite outcrops would likely be affected in different way

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.

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.

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. Pegmatite.

Figure Weathering pit

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.

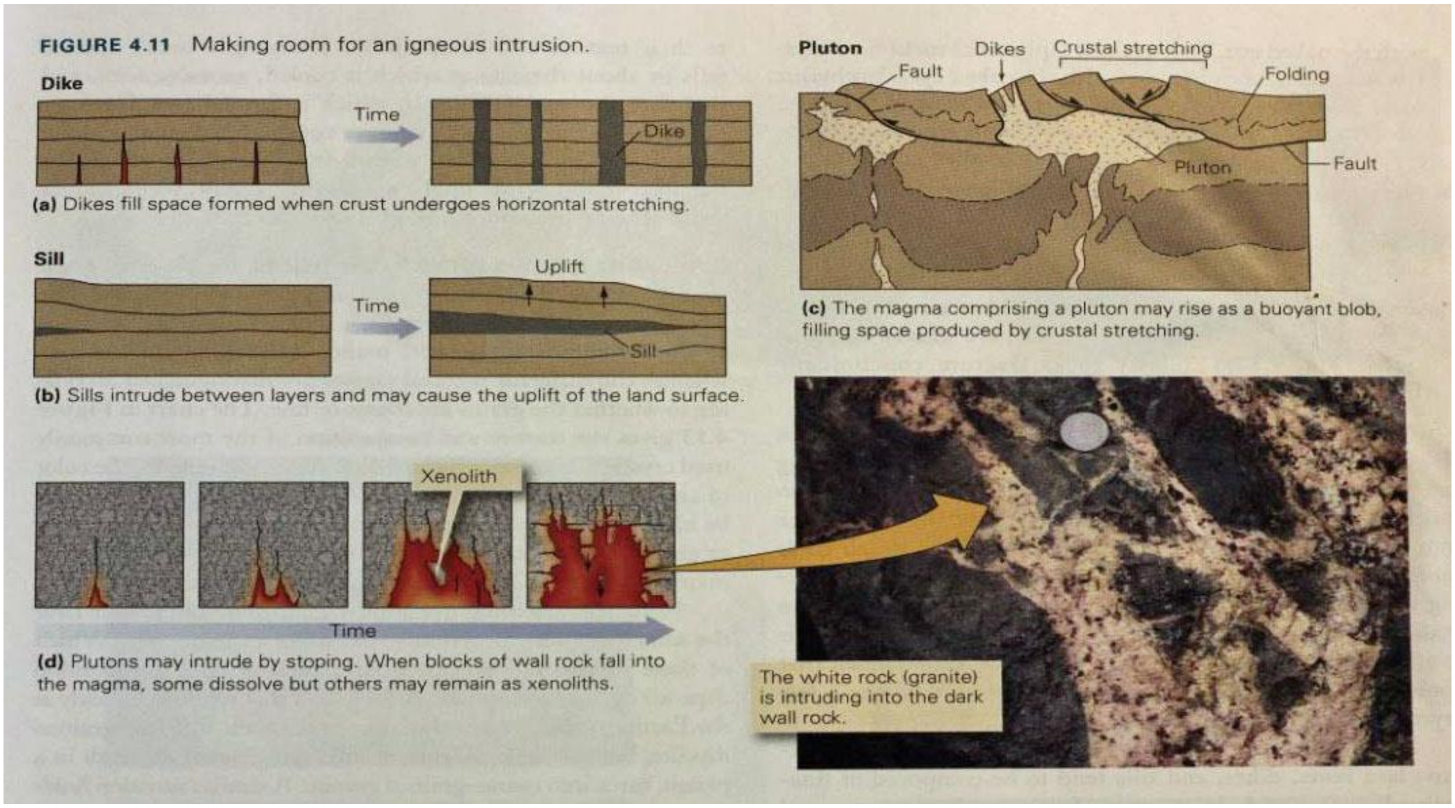


FIGURE 4.11 Making room for an igneous intrusion.

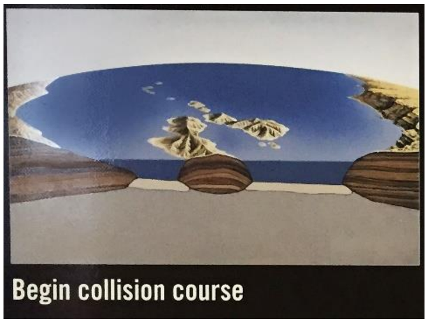
(a) Dikes fill space formed when crust undergoes horizontal stretching.

(b) Sills intrude between layers and may cause the uplift of the land surface.

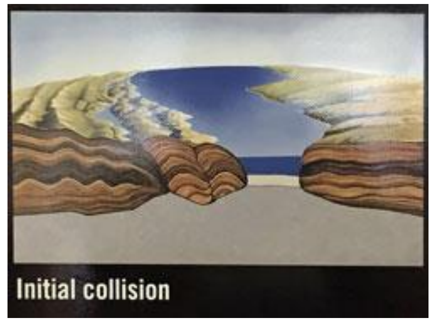
(c) The magma comprising a pluton may rise as a buoyant blob, filling space produced by crustal stretching.

(d) Plutons may intrude by stoping. When blocks of wall rock fall into the magma, some dissolve but others may remain as xenoliths.

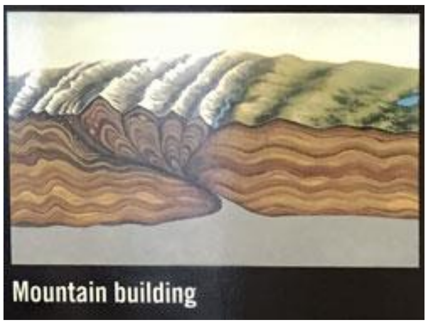
Geologic museum at the foot of the walk trail to the top depicts through the following cartoons building up of the Pangea and subsequent breakup



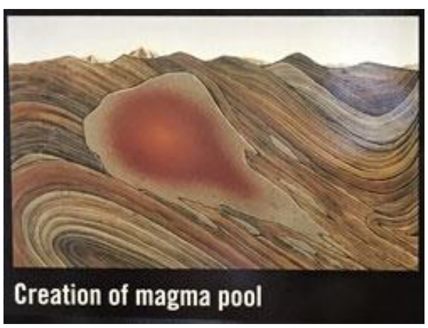
The energy and force from the Earth's interior slowly put the pre-continents of Africa and North America on a collision course.



As they continue to come together, ocean islands smashed into the North American continent.



The continents converged and eventually collided about 300 million years ago. The steady but unimaginable force of the two colliding masses buckled and fractured the Earth, creating the Appalachian Mountain chain to the west.

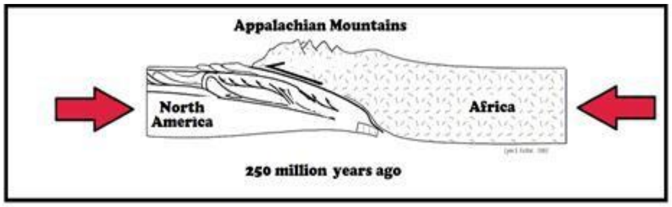


The extreme pressure and heat unleashed from the collision created melted rock or pooling magma below the Earth's surface. Among the hundreds of magma pools along the Appalachians, one magma pool had the distinction of becoming the future Stone Mountain.

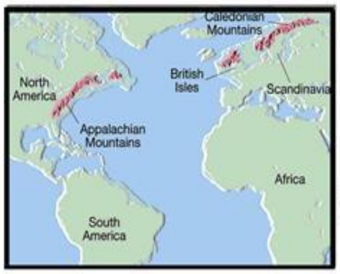
After a few million years of cooling, Stone Mountain solidified eight to ten miles below the Earth's surface.

Stone Mountain granite is more resistant to erosion than the surrounding countryside. For 285 million years, the eight to ten miles of land above the mountains wore away, leaving Stone Mountain standing almost 800 ft [250 m] high.

Basic Plate Tectonics



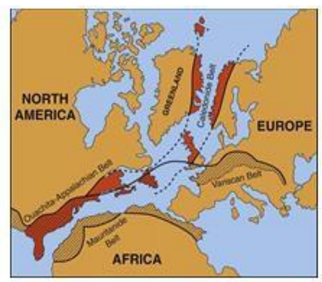
A. ______________

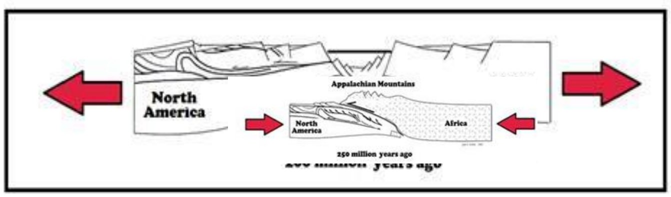


E. ______________

B. ______________

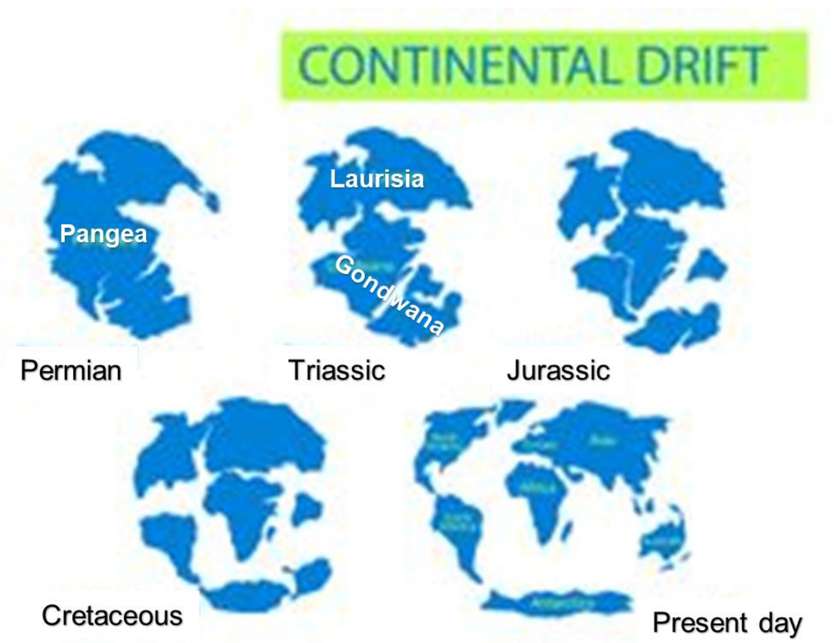
D. ______________





C. ______________

Provide an approximate age for the 5 diagrams above **(hint: two of the five are provided!).**



SOME INTERESTING FACTS ABOUT STONE MOUNTAIN

What is the weight of the stone that occupies the center piece of exhibit at the Quarry?

How far and wide has Stone Mountain granite traveled? How many states?

Any international destination?

What has the Stone Mountain granite been most used for (to construct what type of government buildings)?

Quarry Labor:
How has the quarrymen changed over time at Stone Mountain? Who were the earliest?
By the end of the 20th- century they were?

What were their wages?
True or false: In the 1920s, the quarrymen's wages were at an ALL TIME HIGH $1 / hour for unionized stonecutters, non-union and all other quarry workers made less.

The Danger
Silica dust from cutting the stone! But 7 quarrymen died of what other related accident?

Quarrying.
What was the last year of quarrying in Stone Mountain?