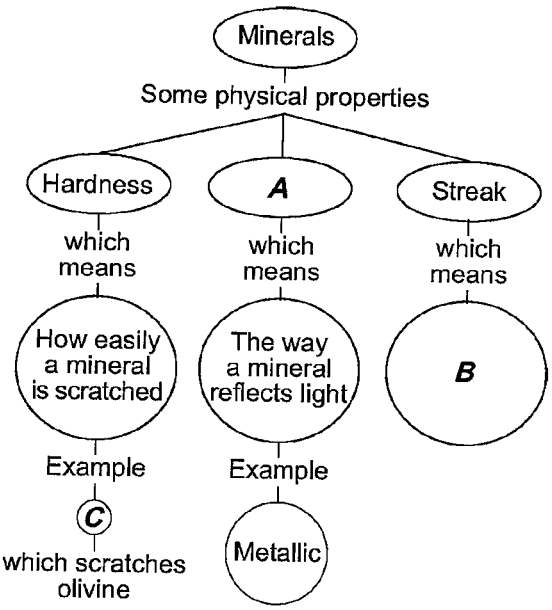
Name: _____

Questions 1 through 3 refer to the following:

The chart below shows some physical properties of minerals and the definitions of these properties. The letters *A*, *B*, and *C* indicate parts of the chart that have been left blank. Letter *C* represents the name of a mineral.



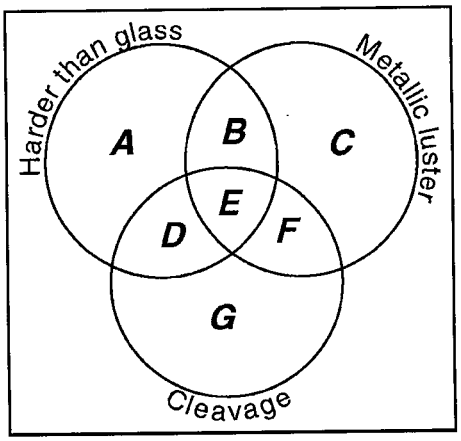
1) Which physical property of a mineral is represented by letter *A* in the given chart?

2) State the definition represented by letter *B* in the given chart.

3) Identify *one* mineral that could be represented by letter *C* in the given chart.

Questions 4 and 5 refer to the following:

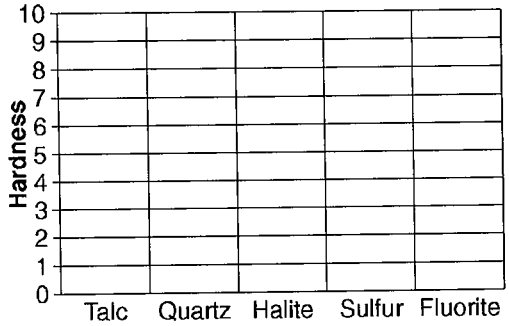
The diagram below depicts a mineral classification scheme that shows the properties of certain minerals. Letters *A* through *G* represent mineral property zones. Zone *E* represents the presence of all three properties. For example, a mineral that is harder than glass, has a metallic luster, but does not have cleavage, would be placed in zone *B*. Assume that glass has a hardness of 5.5.



4) In which zone of the Venn diagram shown would the mineral potassium feldspar be placed?

5) State the name of *one* mineral listed on the *Properties of Common Minerals Table* that could *not* be placed in any of the zones shown in the given Venn diagram.

Questions 6 and 7 refer to the following:



6) On the grid provided, construct a bar graph to represent the hardness of the minerals listed.

7) Which mineral shown on the grid would be the *best* abrasive? [*State one reason for your choice.*]

Questions 8 through 10 refer to the following:

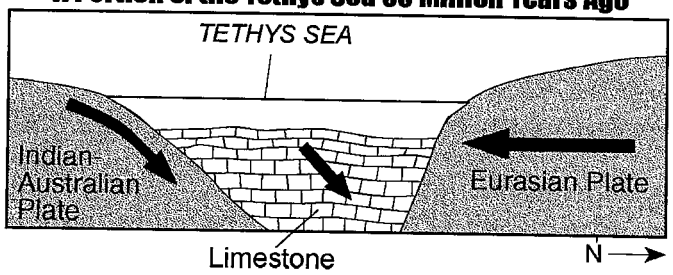
The passage and cross section below explain how some precious gemstones form. The cross section shows a portion of the ancient Tethys Sea, once located between the Indian-Australian Plate and the Eurasian Plate.

PRECIOUS GEMSTONES:

Some precious gemstones are a form of the mineral corundum, which has a hardness of 9. Corundum is a rare mineral made up of closely packed aluminum and oxygen atoms, and its formula is Al_2O_3. If small amounts of chromium replace some of the aluminum atoms in corundum, a bright-red gemstone called a ruby is produced. If traces of titanium and iron replace some aluminum atoms, deep-blue sapphires can be produced.

Most of the world's ruby deposits are found in metamorphic rock that is located along the southern slope of the Himalayas, where plate tectonics played a part in ruby formation. Around 50 million years ago, the Tethys Sea was located between what is now India and Eurasia. Much of the Tethys Sea bottom was composed of limestone that contained the elements needed to make these precious gemstones. The Tethys Sea closed up as the Indian-Australian Plate pushed under the Eurasian Plate, creating the Himalayan Mountains. The limestone rock lining the seafloor underwent metamorphism as it was pushed deep into Earth by the Indian-Australian Plate. For the next 40 to 45 million years, as the Himalayas rose, rubies, sapphires, and other gemstones continued to form.

A Portion of the Tethys Sea 50 Million Years Ago



8) According to the reading passage, which element replaces some of the aluminum atoms, causing the bright-red color of a ruby?

9) State one physical property of rubies, other than a bright-red color, that makes them useful as gemstones in jewelry.

10) Based on the given information, identify the metamorphic rock in which the rubies and sapphires that formed along the Himalayas are usually found.

Questions 11 through 14 refer to the following:

ASBESTOS:
Asbestos is a general name given to the fibrous varieties of six naturally occurring minerals used in commercial products. Most asbestos minerals are no longer mined due to the discovery during the 1970s that long-term exposure to high concentrations of their long, stiff fibers leads to health problems. Workers who produce or handle asbestos products are most at risk, since inhaling high concentrations of airborne fibers allows the asbestos particles to become trapped in the workers' lungs. Chrysotile is a variety of asbestos that is still mined because it has short, soft, flexible fibers that do not pose the same health threat.

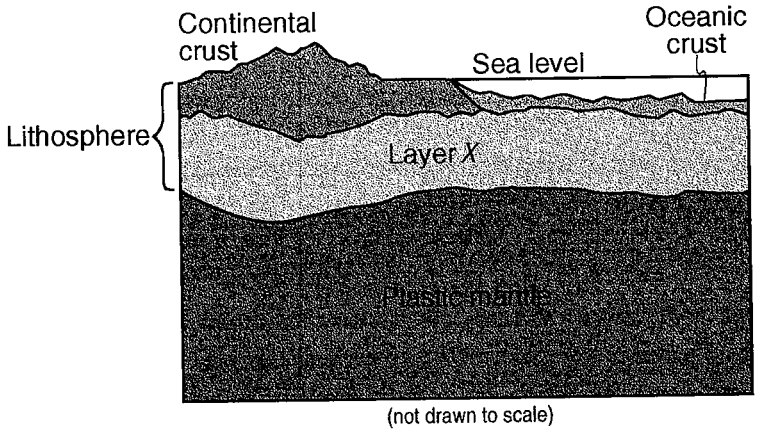
11) Based on the reading passage, state *one* reason for the decline in global asbestos use after 1980.

12) Chrysotile is found with other minerals in New York State mines located near 44° 30′ N, 74° W. In which New York State landscape region are these mines located?

13) What determines the physical properties of minerals, such as the long, stiff fibers of some varieties of asbestos?

14) The chemical formula for chrysotile is $Mg_3Si_2O_5(OH)_4$. State the name of the mineral found on the *Earth Science Reference Tables* that is *most* similar in chemical composition.

15) The cross section below shows a portion of Earth's interior. Layer *X* is part of Earth's interior.



(not drawn to scale)

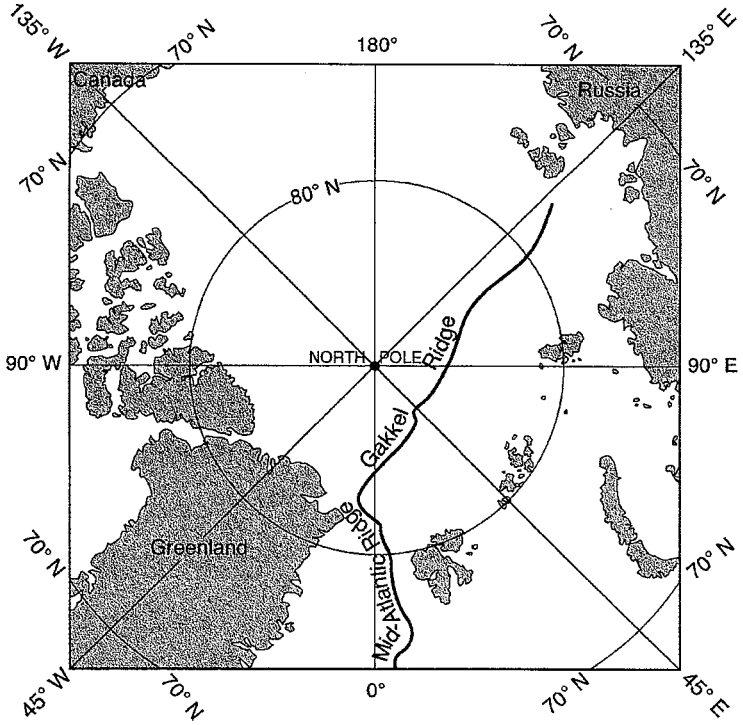
The minerals biotite and amphibole may be found in igneous bedrock of both the oceanic crust and the continental crust. Identify *two* other minerals commonly found in the basaltic oceanic crust.

16) The passage below describes the Gakkel Ridge found at the bottom of the Arctic Ocean. The map below shows the location of the Gakkel Ridge.

THE GAKKEL RIDGE:

In the summer of 2001, scientists aboard the U.S. Coast Guard icebreaker *Healy* visited one of the least explored places on Earth. The scientists studied the 1,800-kilometer-long Gakkel Ridge at the bottom of the Arctic Ocean near the North Pole. The Gakkel Ridge is a section of the Arctic Mid-Ocean Ridge and extends from the northern end of Greenland across the Arctic Ocean floor toward Russia. At a depth of about 5 kilometers below the ocean surface, the Gakkel Ridge is one of the deepest mid-ocean ridges in the world. The ridge is believed to extend down to Earth's mantle, and the new seafloor being formed at the ridge is most likely composed of huge slabs of mantle rock. Bedrock samples taken from the seafloor at the ridge were determined to be the igneous rock peridotite.

The Gakkel Ridge is also the slowest moving mid-ocean ridge. Some ridge systems, like the East Pacific Ridge, are rifting at a rate of about 20 centimeters per year. The Gakkel Ridge is rifting at an average rate of less than 1 centimeter per year. This slow rate of movement means that there is less volcanic activity along the Gakkel Ridge than along other ridge systems. However, heat from the underground magma slowly seeps up through cracks in the rocks of the ridge at structures scientists call hydrothermal (hot water) vents. During the 2001 cruise, a major hydrothermal vent was discovered at 87° N latitude 45° E longitude.



State the *two* minerals that were most likely found in the igneous bedrock samples collected at the Gakkel Ridge shown on the map.

17) **A NEW OREGON VOLCANO?**

The Three Sisters are 10,000-foot volcanic mountain peaks in Oregon. Volcanic eruptions began building the Three Sisters from andesitic lava and cinders 700,000 years ago. The last major eruption occurred 2,000 years ago.

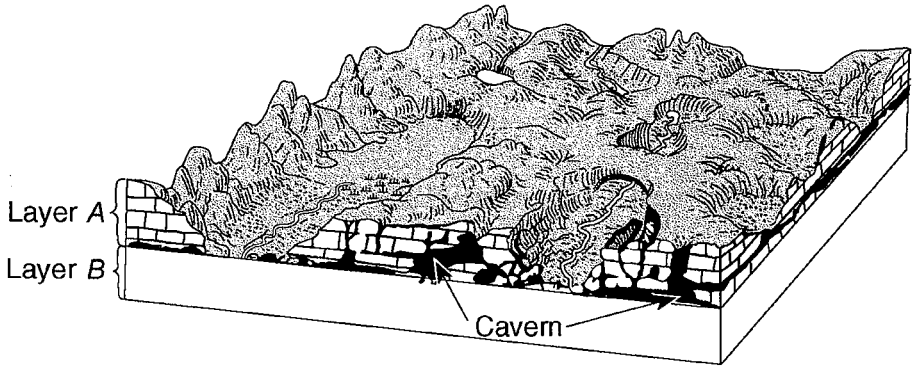
West of the Three Sisters peaks, geologists have recently discovered that Earth's surface is bulging upward in a bull's-eye pattern 10 miles wide. There is a 4-inch rise at its center, which geologists believe could be the beginning of another volcano. The uplift was found by comparing satellite images. This uplift in Oregon may allow the tracking of a volcanic eruption from its beginning, long before the smoke and explosions begin.

This uplift is most likely caused by an upflow of molten rock from more than four miles below the surface. Rock melts within Earth's interior and then moves upward in cracks in Earth's crust, where it forms large underground pools called magma chambers. Magma upwelling often produces signs that help scientists predict eruptions and protect humans. When the pressure of rising magma becomes forceful enough to crack bedrock, swarms of small earthquakes occur. Rising magma releases carbon dioxide and other gases that can be detected at the surface.

Identify *one* of the minerals found in the andesite rock of the Three Sisters volcanoes mentioned in the reading passage.

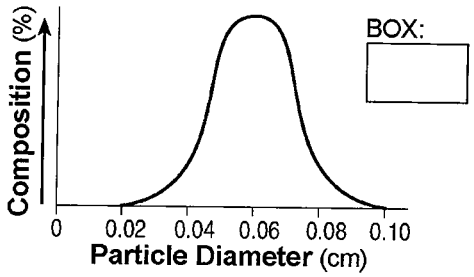
Questions 18 and 19 refer to the following:

The block diagram below shows the landscape features of an area of Earth's crust. Two sedimentary rock layers, *A* and *B*, are labeled in the diagram. The rock symbol for layer *B* has been omitted.



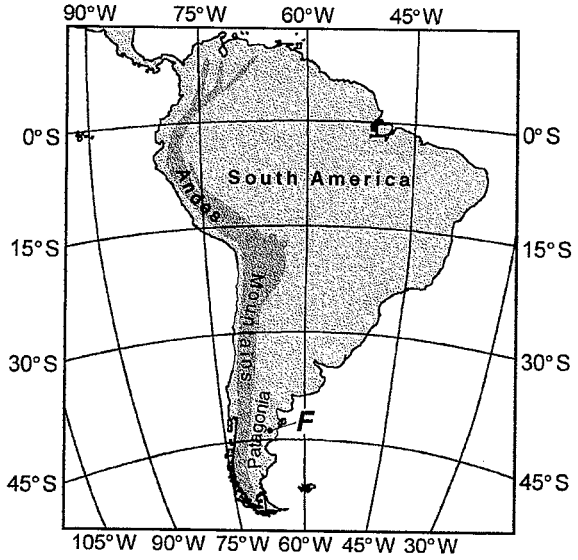
18) Identify the *most* abundant mineral in rock layer *A* in the block diagram shown.

19) The graph below shows the particle sizes that compose the clastic sedimentary rock in layer *B* in the block diagram shown.



In the box above, draw the map symbol from the *Earth Science Reference Tables* that represents rock layer *B*.

20) Point *F* on the map below shows the location where an unusual mammal fossil was found.



FOSSIL JAW OF MAMMAL FOUND IN SOUTH AMERICA:

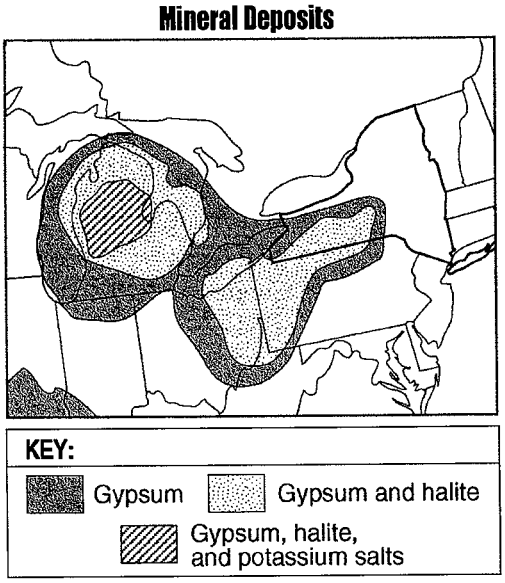
Paleontologists working in Patagonia have found the tiny fossil jaw that may be the first evidence of early mammals in South America.

The fossil, which measures less than a quarter-inch long, is believed to be from the middle or late Jurassic Period. Researchers said it suggests that mammals developed independently in the Southern Hemisphere.

The fossil, named *Asfaltomylos patagonicus*, was discovered in a shale formation in Patagonia. Dinosaurs were the dominant land animal at that time. Mammals were tiny, and hunted insects in the dense tropical vegetation. The now-arid region also has yielded some remarkable dinosaur fossils from the same period in a vast ancient boneyard covering hundreds of square miles.

State the name of the dominant sediment particle that was compacted to form the shale in which the described fossil was found.

21) The map below shows the approximate area in a portion of North America where some sedimentary rock layers composed of gypsum, halite, and potassium salt minerals are found in Earth's crust.



Identify the sedimentary rock composed of halite in the given map and explain how this rock is usually formed.

Questions 22 through 24 refer to the following:

GRAYWACKE:

Graywacke is a type of sandstone composed of a great variety of minerals. Unlike a "clean" sandstone where both the sand-sized grains and cement are composed mostly of quartz, graywacke is a "dirty" sandstone which can be composed of potassium feldspar, plagioclase feldspar, calcite, hornblende, and augite, as well as quartz.

Graywacke can be used for paving highways. The hard, massive bedrock is first drilled and then blasted into large chunks. Stone crushers grind these chunks into pebble-sized pieces. Truckloads of the graywacke pebbles are then hauled to plants where asphalt for paving is made.

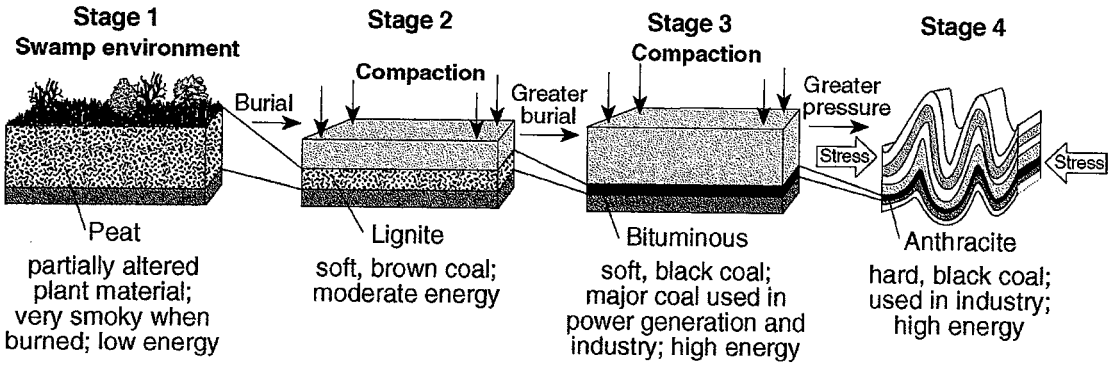
22) Based on the reading passage, state *one* difference in the mineral composition of a "clean" sandstone and a "dirty" sandstone.

23) Based on the reading passage, identify *one* rock-forming process that must have occurred after the sediments were deposited to form graywacke.

24) Based on the reading passage, state *one* negative environmental impact a graywacke quarry could have on the area where it is located.

Questions 25 and 26 refer to the following:

The sequence of diagrams below shows four stages in coal formation.



25) Which type of rock is forming above the coal material during stages 2 and 3 in the given diagram?

26) State the form of coal represented in the diagram which normally has the *highest* density. [*Explain why.*]

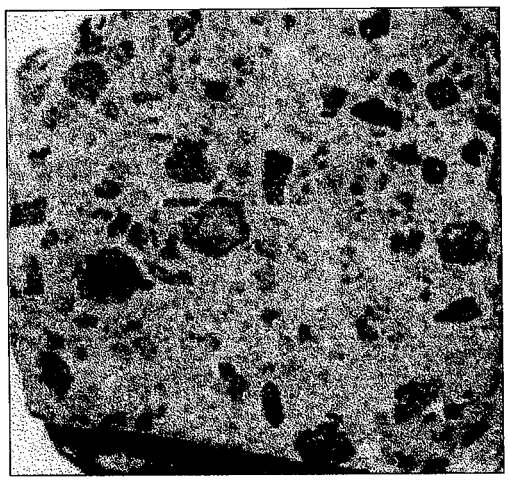
27) Complete the table below with descriptions of the observable characteristics used to identify granite.

Characteristic of Granite	Description
Texture	
Color	
Density	

Questions 28 and 29 refer to the following:

The passage below describes the properties of porphyritic rocks. The photograph shows a sample of andesite rock that has a porphyritic texture.

PORPHYRITIC ROCKS:
Igneous rocks that have two distinctly different crystal sizes have a porphyritic texture. They contain large, coarse-grained crystals called phenocrysts, which are visible to the naked eye. These crystals are surrounded by fine-grained crystals called groundmass.



28) Identify the evidence shown by the given photograph that indicates that *two* different cooling events occurred during the formation of this rock.

29) The andesite sample in the given photograph has a small percentage of quartz. List *three* other minerals that are found in this sample.

Questions 30 and 31 refer to the following:

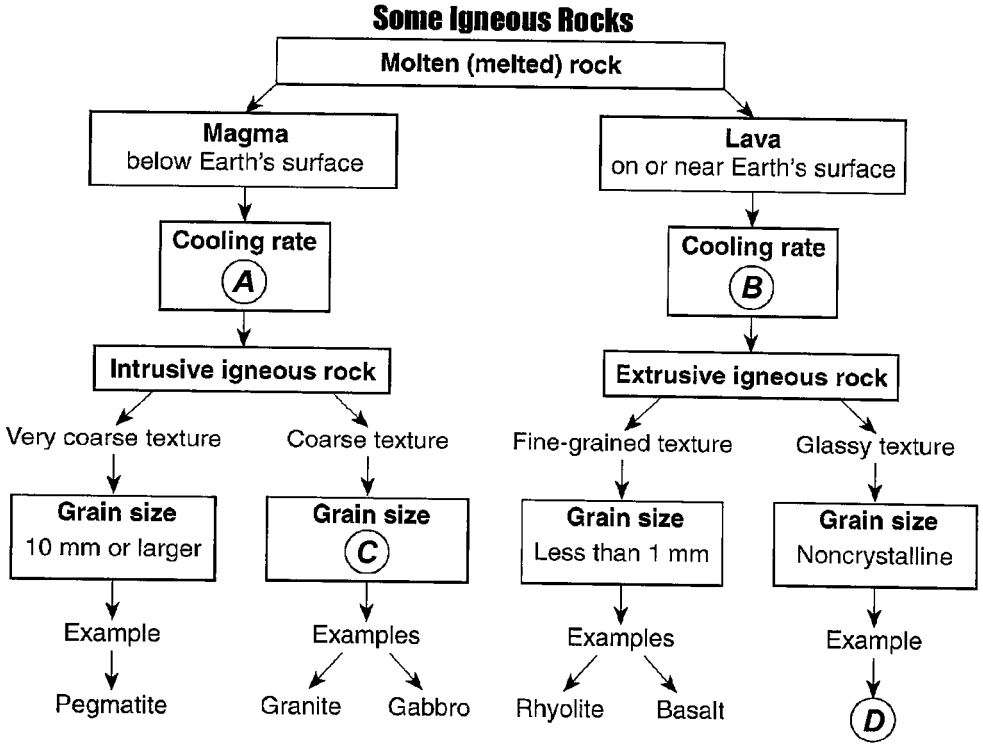
EARTH'S EARLY ATMOSPHERE:
Early in Earth's history, the molten outer layers of Earth released gases to form an early atmosphere. Cooling and solidification of that molten surface formed the early lithosphere approximately 4.4 billion years ago. Around 3.3 billion years ago, photosynthetic organisms appeared on Earth and removed large amounts of carbon dioxide from the atmosphere, which allowed Earth to cool even faster. In addition, they introduced oxygen into Earth's atmosphere, as a by-product of photosynthesis. Much of the first oxygen that was produced reacted with natural Earth elements, such as iron, in the lithosphere and produced new varieties of rocks and minerals. Eventually, photosynthetic organisms produced enough oxygen so that it began to accumulate in Earth's atmosphere. About 450 million years ago, there was enough oxygen in the atmosphere to allow for the development of an ozone layer 30 to 50 kilometers above Earth's surface. This layer was thick enough to protect organisms developing on land from the ultraviolet radiation from the Sun.

30) Based on the reading passage, state *one* reason why the first rocks on Earth were most likely igneous in origin.

31) Based on the reading passage, identify *one* mineral with a red-brown streak that formed when oxygen in Earth's early atmosphere combined with iron.

Questions 32 through 34 refer to the following:

The flowchart below shows the formation of some igneous rocks. The circled letters *A*, *B*, *C*, and *D* indicate parts of the flowchart that have not been labeled.



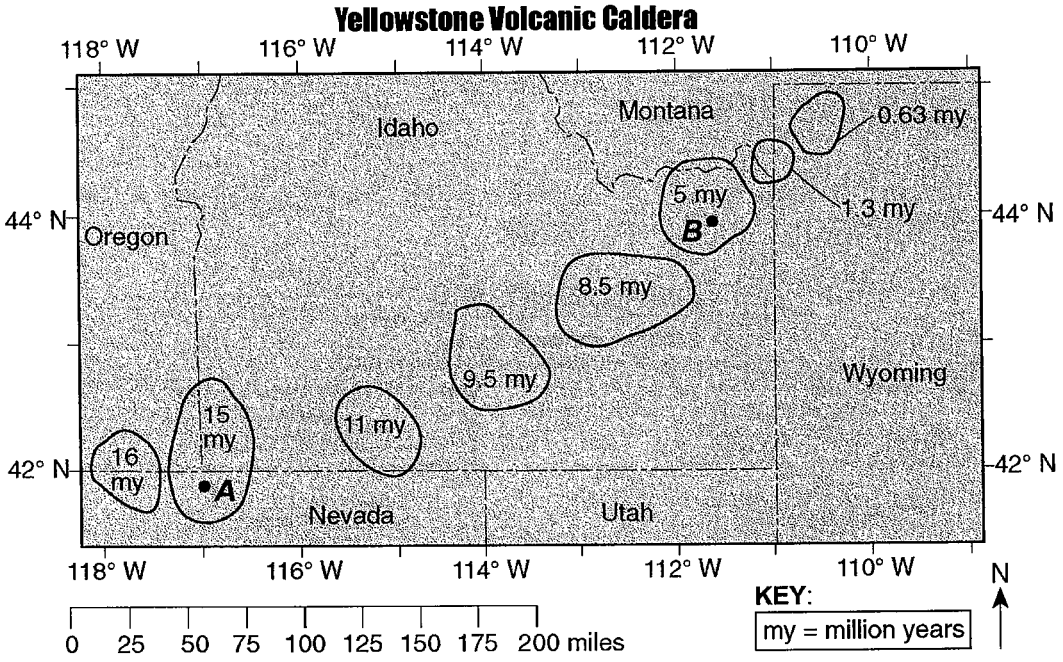
32) Based on the flowchart, contrast the rate of cooling at Ⓐ that forms intrusive igneous rock with the rate of cooling at Ⓑ that forms extrusive igneous rock.

33) Give the numerical grain-size range that should be placed in the flowchart at Ⓒ. [*Units must be included in your answer.*]

34) State *one* igneous rock that could be placed in the flowchart at Ⓓ.

Questions 35 and 36 refer to the following:

The map below shows the outlines and ages of several calderas created as a result of volcanic activity over the last 16 million years as the North American Plate moved over the Yellowstone Hot Spot. *A* and *B* represent locations within the calderas.



THE YELLOWSTONE HOT SPOT:

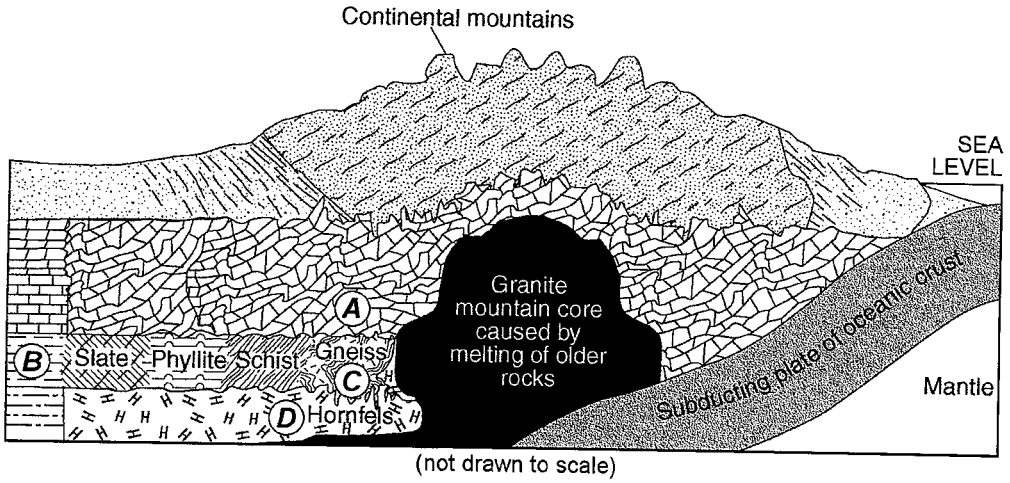
The Yellowstone Hot Spot has interacted with the North American Plate, causing widespread outpourings of basalt that buried about 200,000 square miles under layers of lava flows that are a half mile or more thick. Some of the basaltic magma produced by the hot spot accumulates near the base of the plate, where it melts the crust above. The melted crust, in turn, rises closer to the surface to form large reservoirs of potentially explosive rhyolite magma. Catastrophic eruptions have partly emptied some of these reservoirs, causing their roofs to collapse. The resulting craters, some of which are more than 30 miles across, are known as volcanic calderas.

35) Describe the texture and color of the basalt produced by the Yellowstone Hot Spot described.

36) Identify *two* minerals found in the igneous rock that is produced from the explosive rhyolite magma.

Questions 37 through 40 refer to the following:

The cross section below shows the bedrock structure of a portion of the lithosphere. Letters *A* through *D* represent locations in the lithosphere.



(not drawn to scale)

37) Identify *one* of the most abundant minerals in the metamorphic rock at location *A* in the given cross section.

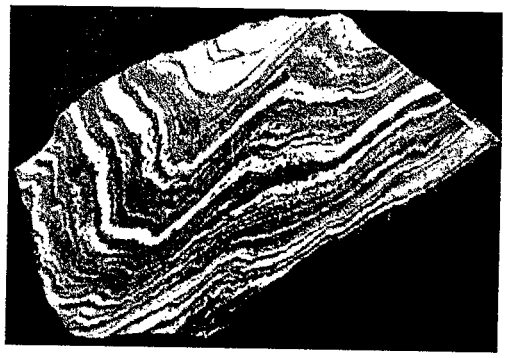
38) Explain why the type of rock changes between locations *B* and *C* in the given cross section.

39) Identify the grain size of the metamorphic rock at location *D* in the given cross section.

40) Explain why the oceanic crust subducts beneath the continental crust when the two plates collide.

Questions 41 through 43 refer to the following:

The photograph below shows a sample of gneiss.



41) What observable characteristic could be used to identify the rock sample shown as gneiss?

42) Identify *two* minerals found in gneiss that contain iron and magnesium.

43) A dark-red mineral with a glassy luster was also observed in the gneiss sample shown. Identify the mineral and state *one* possible use for this mineral.

Questions 44 through 46 refer to the following:

The data table below shows some characteristics of four rock samples, numbered 1 through 4. Some information has been left blank.

Data Table

Rock Sample Number	Composition	Grain Size	Texture	Rock Name
1	mostly clay minerals		clastic	shale
2	all mica	microscopic, fine	foliated with mineral alignment	
3	mica, quartz, feldspar, amphibole, garnet, pyroxene	medium to coarse	foliated with banding	gneiss
4	potassium feldspar, quartz, biotite, plagioclase feldspar, amphibole	5 mm		granite

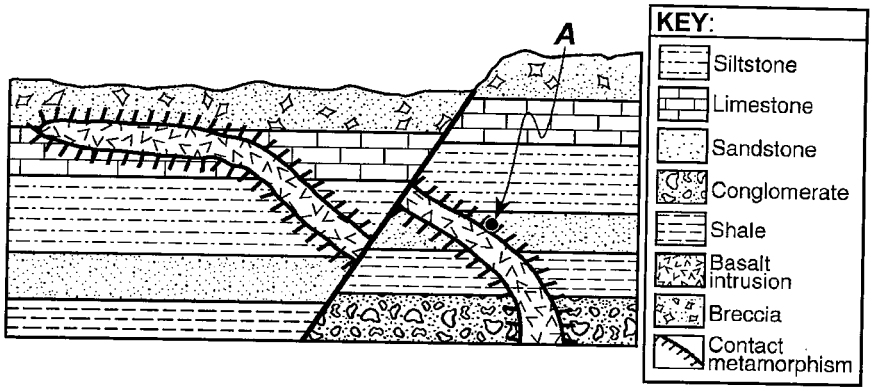
44) State a possible grain size, in centimeters, for most of the particles found in sample 1 described in the given table.

45) Write the rock name of sample 2 described in the given table.

46) Write a term or phrase that correctly describes the texture of sample 4 in the given table.

Questions 47 and 48 refer to the following:

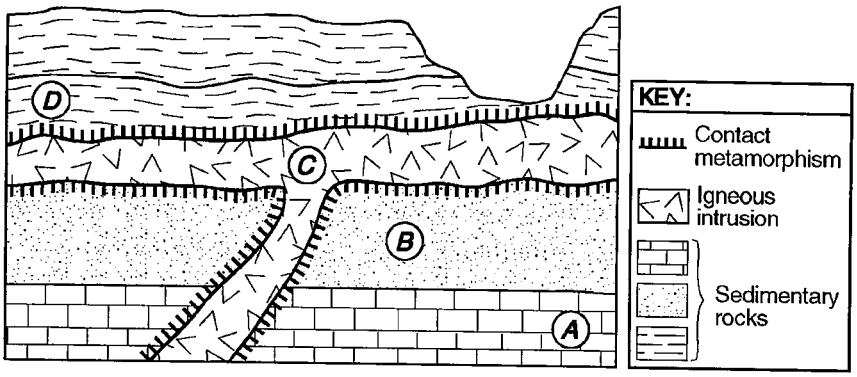
In the geologic cross section below, the rock layers have not been overturned. Point *A* is located in the zone of contact metamorphism.



47) Which metamorphic rock most likely formed at point *A* in the cross section shown?

48) What is the *largest* silt particle that could be found in the siltstone layer in the cross section shown?

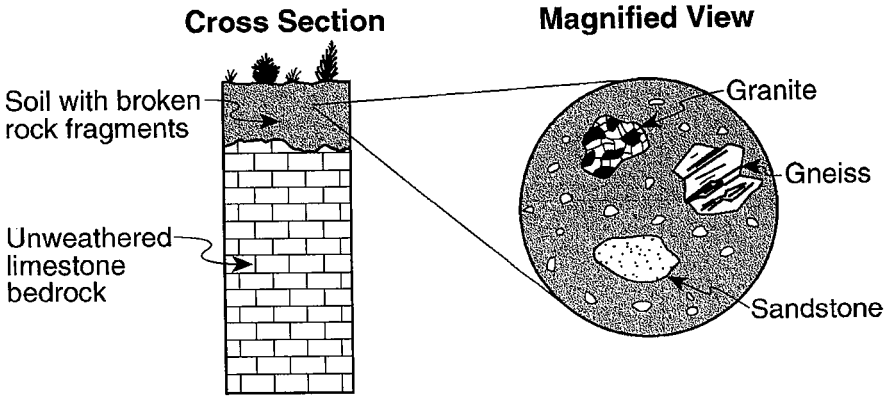
49) A cross section showing a portion of Earth's crust is provided below. Letters *A*, *B*, *C*, and *D* represent rock units that have not been overturned.



Identify by name the most abundant mineral in rock unit *A* in the cross section shown.

Questions 50 and 51 refer to the following:

The cross section below shows an area near Watertown, New York. The top layer of soil contains broken rock fragments. A representative sample of this layer has been magnified.

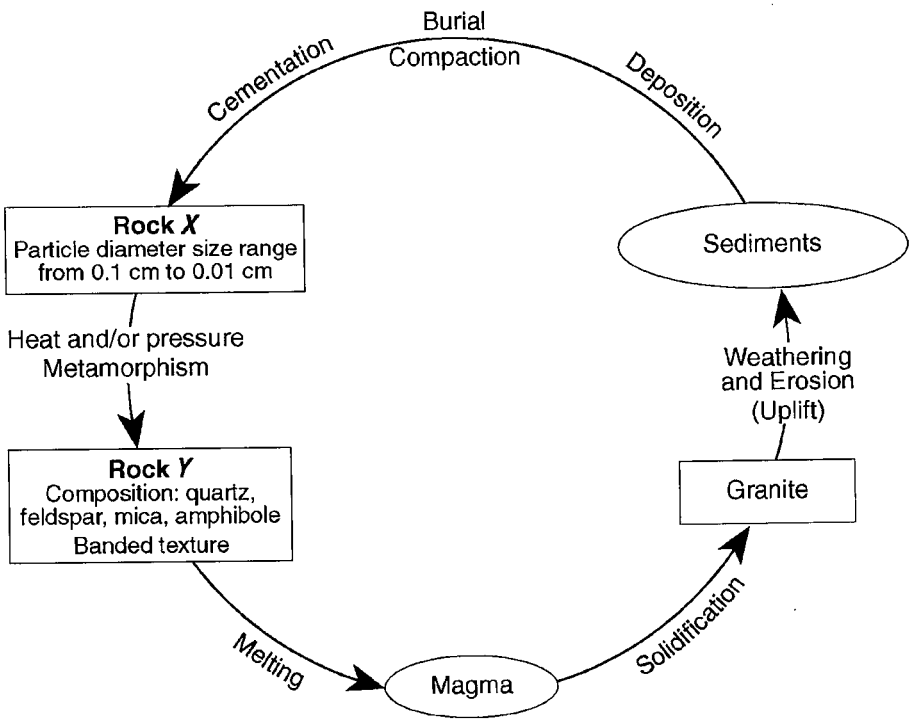


50) Identify *one* mineral that could be found in all three rock fragments shown in the magnified view.

51) State *one* observable characteristic, other than mineral composition, that could help identify the gneiss fragment shown in the diagram.

Questions 52 and 53 refer to the following:

The diagram below represents a part of the rock cycle. The igneous rock, granite, and the characteristics of sedimentary rock *X* and metamorphic rock *Y* are shown.



52) Identify sedimentary rock *X* in the given diagram.

53) Identify metamorphic rock *Y* in the given diagram.

54) Rocks and minerals are natural resources that are mined all over the world. State *one* negative impact that should be considered before mining these natural resources.