



Boy Scout Geology Merit Badge / Parent Guide

Welcome to Treasures of the Earth Gem & Jewelry Shows!!! If you are just surfing in, you might like to start at the [beginning](#) and have a look around.

THERE ARE thirteen requirements for the Geology badge, shown below in brown type. If you want to work on this badge, talk with your counselor, and we have provided the background information you will need to complete the steps listed.

GEOLOGY

1.Explain what geology means.

"Geo" means earth, and "logy" means science and study of. Geology is the science that studies the earth and the rocks it is made of, and the changes and processes the earth has had and is now experiencing.

Read [A Geologist Talks to Webelos](#) on the previous page

Earth Materials

2. Make a collection of at least 10 different earth materials or geological specimens from your locality or an area of special interest to you. Label, to the best of your ability, classify, and explain the origin and use of the materials collected.

See the [collection information](#) for Wolf and Bear Cub Scouts, and [Managing your collection](#) for information on labeling and displaying your collection.



Alternatives: In place of requirement 2, you may present a collection of 10 different rocks, with specimens of sedimentary, igneous, and metamorphic rocks properly marked, cataloged, and displayed. Or you may present a collection of 10 different minerals (or ores) properly marked, cataloged, and displayed. Also identify each of the 10 minerals, and give their sources and possible uses.

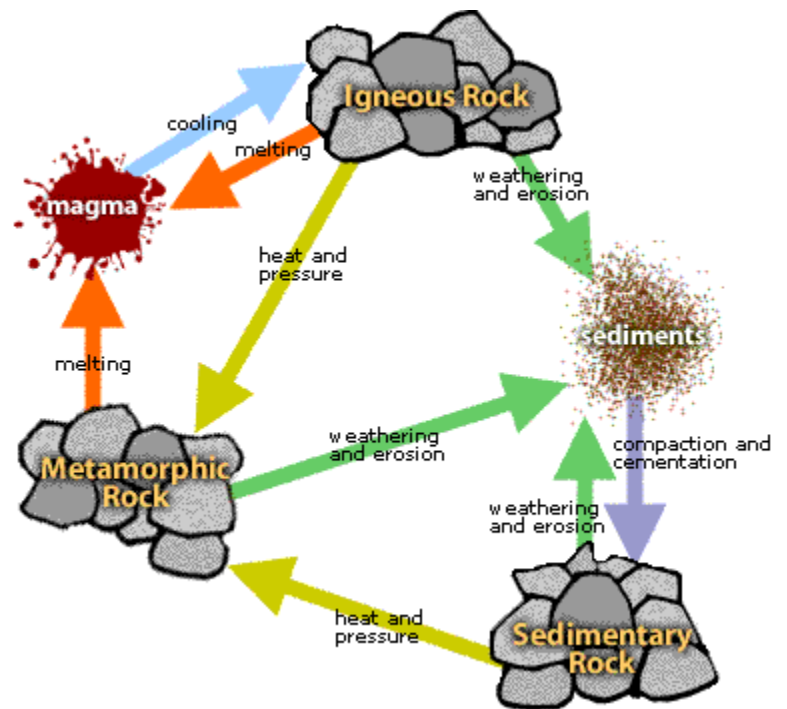
3. Define rock. Discuss and define three classes of rocks. List the characteristics of each class, how they are formed, and how they are named.

A **rock** is usually composed of 2 or more minerals in some physical combination, although some rocks are composed of only one mineral. Examples of rocks are limestone, sandstone, granite, or shale.

Igneous Rocks

Igneous rocks are **crystalline solids** which form directly from the cooling of magma. This is an exothermic process (it loses heat) and involves a **phase change** from the liquid to the solid state. The earth is made of igneous rock - at least at the surface where our planet is exposed to the coldness of space. Igneous rocks are given names based upon two things: composition (what they are made of) and texture (how big the crystals are).

- Click [here](#) for more on igneous rock composition and texture.
- Click [here](#) for more on elements and minerals common in igneous rocks.
- Click [here](#) for more on magma and igneous rocks.
- Click [here](#) for more on plate tectonics and the formation of magma.
- Click [here](#) for a chart summarizing the main divisions of igneous rocks.
- Click [here](#) for more on basalt and granite.



Sedimentary Rocks

In most places on the surface, the igneous rocks which make up the majority of the **crust** are covered by a thin veneer of loose sediment, and the rock which is made as **layers of this debris get compacted and cemented together**. Sedimentary rocks are called secondary, because they are often the result of the accumulation of small pieces broken off of pre-existing rocks. There are three main types of sedimentary rocks:

Clastic: your basic sedimentary rock. Clastic sedimentary rocks are accumulations of clasts: little pieces of broken up rock which have piled up and been "lithified" by compaction and cementation.

Chemical: many of these form when standing water evaporates, leaving dissolved minerals behind. These are very common in arid lands, where seasonal "playa lakes" occur in closed depressions. Thick deposits of salt and gypsum can form due to repeated flooding and evaporation over **long periods of time**.

Organic: any accumulation of sedimentary debris caused by organic processes. Many animals use calcium for shells, bones, and teeth. These bits of calcium can pile up on the seafloor and accumulate into a thick enough layer to form an "organic" sedimentary rock.

- Click [here](#) for more on sedimentary processes and rocks (RCC).
- Click [here](#) for more on sedimentary rocks (GPHS).

Metamorphic Rocks

The metamorphics get their name from "meta" (change) and "morph" (form). **Any rock can become a metamorphic rock.** All that is required is for the rock to be moved into an environment in which the minerals which make up the rock become unstable and out of equilibrium with the new environmental conditions. In most cases, this involves burial which leads to a rise in temperature and pressure. The metamorphic changes in the minerals always move in a direction designed to restore equilibrium. Common metamorphic rocks include slate, schist, gneiss, and marble.

- Click [here](#) for more on metamorphic processes and rocks (RCC).
- Click [here](#) for more on metamorphic rocks (GPHS).

□ **4. Define mineral.** Tell how to identify minerals. Tell how rocks and minerals differ. List five of the most common rock-forming minerals. Tell how they are identified. Tell how hardness, specific gravity, color, streak, cleavage, luster, and crystal form are useful in identifying minerals.

A **mineral** is a natural substance which has its own distinctive structure and may have its composition expressed with a chemical formula. Some examples are quartz, calcite, and galena. Quartz has the chemical composition SiO_2 .

About 100 minerals are relatively common. There have been over 4000 minerals identified by mineralogists, but only about the hundred or so are easily collectable. Some collectors want to obtain a piece of every known species, but this is impossible because some are so rare.

Properties of minerals

You can tell the differences between minerals by looking for certain properties. Because each mineral is unique both chemically and structurally, each has its own set of physical, optical, and structural properties which aid in its identification.

Chemistry refers to the basic building blocks that the mineral is made of. Optical properties are the way a mineral looks and what light does when it shines on it. Physical properties such as hardness and streak can be tested easily. Most geologists only do the most basic physical property tests for an identification, so we will briefly discuss some physical properties.

Physical properties

Let's consider the physical properties that are easy to test. They may be divided into 2 groups: those concerned with the effects of light on the mineral, and other tests.

Light-dependent properties: The easiest tests to do are about how light interacts with the mineral. These are color, luster and diaphany. You can do all of these light tests using only your eye.

Color is the most obvious property of the mineral, but it is also the least usable because a given mineral, like quartz, may have a variety of colors (colorless, purple, blue, pink, black, violet, green, tan, et cetera).

Luster is easy to tell by looking at the mineral. Does the mineral reflect light like a piece of metal? If so, then it has metallic luster. If not, then it has non-metallic luster. Non-metallic luster is further subdivided into how brilliant the mineral reflects the light: vitreous (like glass), adamantine (brilliant, bright like metal), pearly, greasy, oily, dull, et cetera.

Diaphany means how translucent the mineral is. Can you see through it like a clear crystal, or not? Or maybe just a little. The answers for diaphany may be opaque, translucent, or transparent. This property is usually noted for a thin chip of the mineral because if the mineral is strongly colored, it may mask this property.

Other Properties of Minerals

Specific gravity is the measure of each mineral's own unique density and how it compares to the density of water. The mineral's density is what makes the mineral heavy or light. Some minerals are very dense, like the native metals copper, silver, or gold, and some are even lighter than water and will float! Volcanic pumice will float on water. You have to have a specially designed balance to measure specific gravity.

Quartz is always a good mineral to compare another sample to, since it has a specific gravity of 2.54. Minerals with a specific gravity higher than around 3.2 are considered to have relatively high specific gravity. They either contain heavy atoms, like those of the middle of the Chemist's Periodic Table (titanium, manganese, iron, cobalt, nickel, copper, zinc, lead) or have a very dense packing arrangement of the atoms (like with carbon in diamond).

Streak is an easy field test to do. Interestingly, the powder of a particular mineral may or may not be the same color as the mineral! Using an unglazed piece of porcelain, like the back of a common bathroom tile, you can do a streak test. The color of the powdered mineral (the streak) may surprise you. Try it for a piece of pyrite (fool's gold).

Hardness measures how hard the mineral is relative to other minerals. It is called the scratch or hardness test. Most minerals will not scratch a quartz crystal. Many years ago, a man named Moh took a lot of minerals and tried to scratch them with each other. From his experiment, he came up with chart of the relative hardness of his minerals, one to another. This chart is called Moh's hardness scale. Talc is the softest, diamond is the hardest.

Moh's hardness scale, an easy way to remember it:

The girl could flirt and flirt quickly though Connie didn't.

Talc Gypsum Calcite Fluorite Apatite Feldspar Quartz Topaz Corundum Diamond

A chemical test allows us to determine if the mineral reacts with dilute acid. We use a drop of 10% hydrochloric acid to check for **effervescence**, or fizzing, and note if there is a reaction.

There are many other minor physical properties to note, such as **magnetism**, **solubility**, **taste**, **odor**, ease of melting (**fusibility**), and so forth. Get a basic book that discusses these properties so you can learn to do these tests yourself. Then you will not have to have an "expert" identify most of the common minerals you will find. Some books are available which present the physical properties information arranged in tables so you can use what you learn to identify the mineral yourself. One of the best of these books is an old textbook which you might pick up at a used book dealer: Mineralogy by Kraus, Hunt, and Ramsdell, 1936, McGraw-Hill Book Co. The tables are from pages 453-621, inclusive.

Location gives a really good clue as to what a mineral could be, because some minerals are well known to come from certain areas. Now that you know a little about identifying minerals, get your FIELD NOTE BOOK and MAP, and you are set to go do some collecting!

See the [Basics of Rock and Mineral Collecting](#)

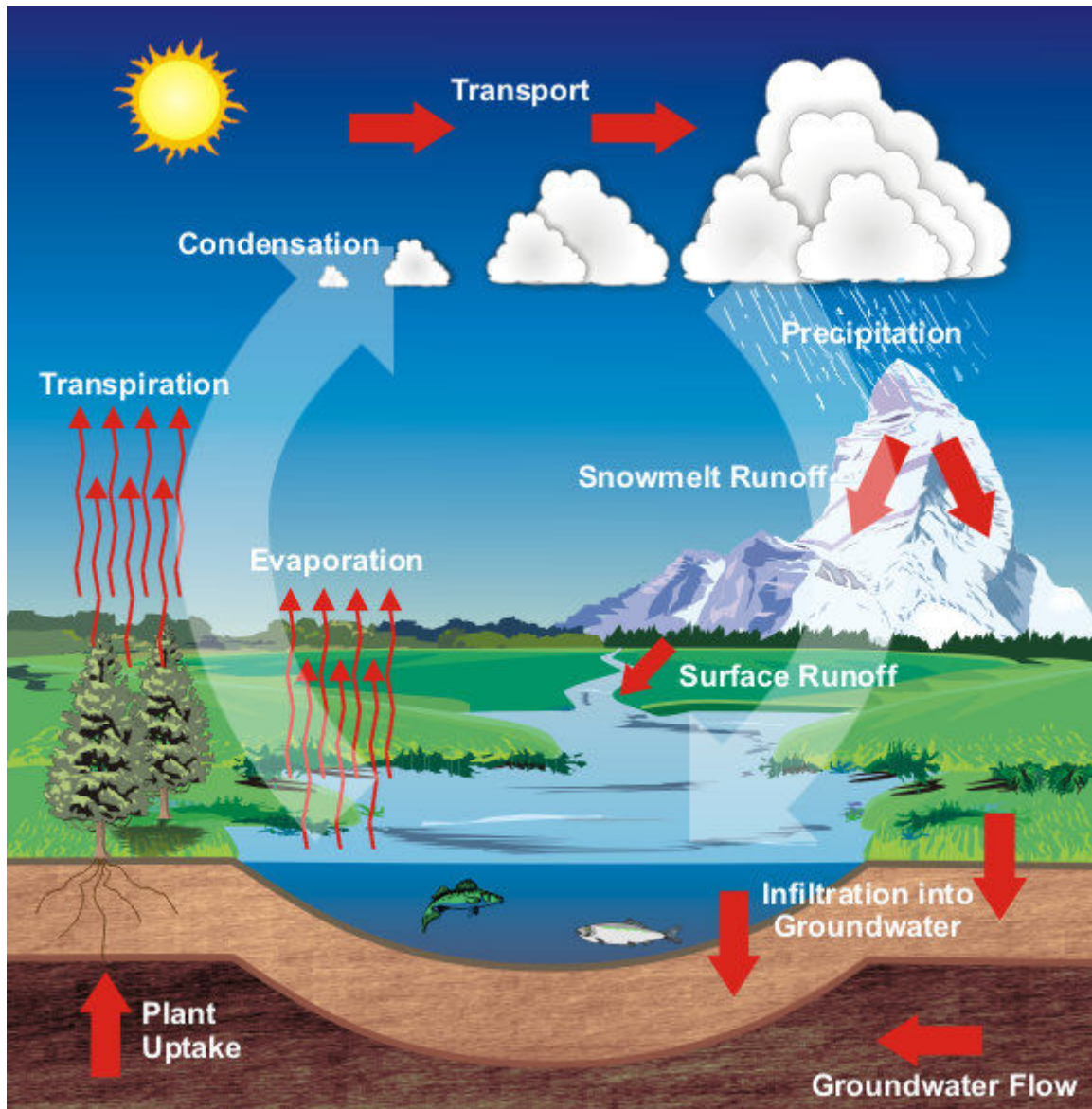
Earth Processes

5. Secure a topographic map of your locality or an area of special interest to you.

Explain the origin of the landscape, including any unusual features. Account for any influences of the landscape on the location of towns, parks, highways, railroads, airports, industries, or similar structures.

Maps are an essential part of a geologist's working tools. Topographic maps are very detailed and use lines to show contours, or the mountains and valleys, of an area. The USGS (United States Geological Survey) has very detailed maps. You can order them over the internet at <http://mapping.usgs.gov/mac/findmaps.html> and you can also find the local agency that sells topo maps in your area. Hikers, campers, fishermen... anybody who is outdoors off the beaten path will find topo maps useful.

6. Draw a diagram of the hydrologic cycle and discuss it and its effects with your counselor.



7. Do ONE of the following:

- Tell about the occurrence of volcanos on land and in the ocean. Describe the difference between intrusive igneous rocks and extrusive igneous rocks.
- Describe the major steps in the geologic history of a mountain range. Describe the anticline, syncline, fault, strike, dip and an unconformity. Discuss the relationship between mountain building and erosion in forming the present landscape.
- Describe the major features of an ocean floor between the shorelines on either side.

See [How the Ouachita Mountains Formed](#) and [Faults and earthquakes](#)

- 8. Make a chart showing the geological eras and periods and show in what geologic time the rocks in your region were formed.

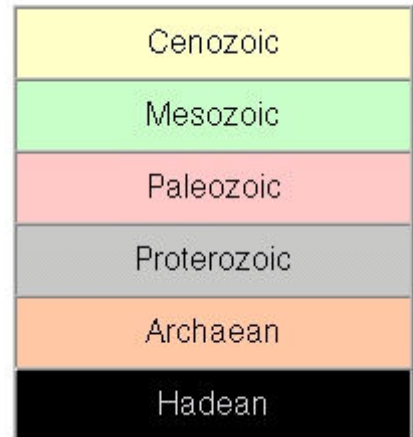
See the [Geologic Time Scale](#)

Geological Time Scale

Few discussions in geology can occur without reference to geologic time. Geologic time is often discussed in two forms:



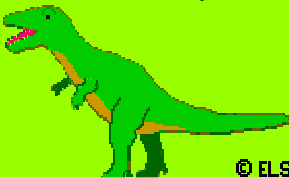


Relative time ("chronostratic") -- subdivisions of the Earth's geology in a specific order based upon relative age relationships (most commonly, vertical/stratigraphic position). These subdivisions are given names, most of which can be recognized globally, usually on the basis of fossils.





Absolute time ("chronometric") -- numerical ages in "millions of years" or some other measurement. These are most commonly obtained via radiometric dating methods performed on appropriate rock types.



Think of relative time as physical subdivisions of the rock found in the Earth's stratigraphy, and absolute time as the measurements taken upon those to determine the actual time which has expired. Absolute time measurements can be used to **calibrate** the relative time scale, producing an integrated geologic or "geochronologic" time scale.

The first geologic time scale was proposed in 1913 by the British geologist Arthur Holmes (1890 - 1965). This was soon after the discovery of radioactivity, and using it, Holmes estimated that the Earth was about 4 billion years old - this was much greater than previously believed.

EON	ERA	PERIOD	EPOCH	PIVOTAL EVENTS		
Phanerozoic Eon	Cenozoic Era	Quaternary Period "The Age of Man" 1.8 mya to today	Holocene 11,000 ya to today	Human civilization		
			Pleistocene The Last Ice Age 1.8-.011 mya	The first humans (Homo sapiens) evolve. Mammoths , mastodons, saber-toothed cats , giant ground sloths, and other Pleistocene megafauna . A mass extinction of large mammals and many birds happened about 10,000 years ago, probably caused by the end of the last ice age .		
			Pliocene 5-1.8 mya	 First hominids (australopithecines). Modern forms of whales. Megalodon swam the seas		
			Miocene 24-5 mya	 More mammals, including the horses, dogs and bears. Modern birds. South American monkeys, apes in southern Europe, Ramapithecus.		
		Tertiary Period 65 to 1.8 mya	Neogene 24-1.8 mya	Oligocene 38-24 mya	Starts with a minor extinction (36 mya). Many new mammals (pigs, deer , cats , rhinos, tapirs appear). Grasses common.	
				Eocene 54-38 mya	Mammals abound. Rodents appear. Primitive whales appear .	
				Paleocene 65-54 mya	First large mammals and primitive primates, plesiadapiforms.	
			Paleogene 65-24 mya	Cretaceous Period 146 to 65 mya	Upper 98-65 mya	High tectonic and volcanic activity. Primitive marsupials develop. Continents have a modern-day look. Minor extinction 82 mya. Ended with large extinction (the K-T extinction) of dinosaurs, pterosaurs , ammonites , about 50 percent of marine invertebrate species, etc., probably caused by asteroid impact or volcanism.
					Lower 146-98 mya	 The heyday of the dinosaurs. The first crocodilians, and feathered dinosaurs appear. The earliest-known butterflies appear (about 130 million years ago) as well as the earliest-known snakes, ants, and bees. Minor extinctions at 144 and 120 mya.
					Jurassic Period 208 to 146 mya	 Many dinosaurs, including the giant Sauropods . The first birds appear (Archaeopteryx). The first flowering plants evolve. Many ferns, cycads, ginkgos, rushes, conifers, ammonites , and pterosaurs . Minor extinctions at 190 and 160 mya.
Mesozoic Era	"The Age of Reptiles" 248 to 65 mya	Triassic Period 248 to 208 mya	 The first dinosaurs , mammals, and crocodyloformes appear. Mollusks are the dominant invertebrate. Many reptiles, for example, turtles, ichthyosaurs . True fishes appear. Triassic period ends with a minor extinction 213 mya (35% of all animal			
"Visible Life"	Organisms with skeletons or hard shells.	540 mya through today.				
"Visible Life"						

Organisms with skeletons or hard shells. 540 mya through today.			families die out, including labyrinthodont amphibians, conodonts, and all marine reptiles except ichthyosaurs). This allowed the dinosaurs to expand into many niches.
	Paleozoic Era 540 to 248 mya	<p><u>Permian Period</u> "The Age of Amphibians" 280 to 248 mya</p> 	"The Age of Amphibians" - Amphibians and reptiles dominant. Gymnosperms dominant plant life. The continents merge into a single super-continent, Pangaea. Phytoplankton and plants oxygenate the Earth's atmosphere to close to modern levels. The first stoneflies, true bugs, beetles, and caddisflies. The Permian ended with largest mass extinction. Trilobites go extinct, as do 50% of all animal families, 95% of all marine species, and many trees, perhaps caused by glaciation or volcanism.
Phanerozoic Eon		Carboniferous Wide-spread <u>coal swamps</u> , foraminiferans, corals, bryozoans, brachiopods, blastoids, seed ferns, lycopsids, and other plants. Amphibians become more common. 360 to 280 mya	<p><u>Pennsylvanian Period</u> 325 to 280 mya</p>
	<p><u>Mississippian Period</u> 360 to 325 mya</p>		 <p>First winged insects.</p>
"Visible Life"		<p><u>Devonian Period</u> "The Age of Fishes" 408 to 360 mya</p> 	Fish and land plants become abundant and diverse. First tetrapods appear toward the end of the period. First amphibians appear. First sharks, bony fish, and ammonoids. Many <u>coral reefs</u> , brachiopods, crinoids. New insects, like springtails, appeared. Mass extinction (345 mya) wiped out 30% of all animal families) probably due to glaciation or meteorite impact.
Organisms with skeletons or hard shells. 540 mya through today.	Paleozoic Era 540 to 248 mya	<p><u>Silurian Period</u> 438 to 408 mya</p>	The first jawed fishes and <u>uniramians</u> (like insects, centipedes and millipedes) appeared during the Silurian (over 400 million years ago). First vascular plants (plants with water-conducting tissue as compared with non-vascular plants like mosses) appear on land (Cooksonia is the first known). High seas worldwide. Brachiopods, <u>crinoids</u> , <u>corals</u> .
Phanerozoic Eon		<p><u>Ordovician Period</u> 505 to 438 mya</p>	Primitive plants appear on land. First corals. Primitive fishes, seaweed and fungi. Graptolites, bryozoans, gastropods, bivalves, and echinoids. High sea levels at first, global cooling and glaciation, and much volcanism. North America under shallow seas. Ends in huge extinction, due to glaciation.
		<p><u>Cambrian Period</u> "The Age of Trilobites" 540 to 500 mya</p> 	"Age of Trilobites" -The <u>Cambrian Explosion</u> of life occurs; all existent phyla develop. Many marine invertebrates (marine animals with mineralized shells: shell-fish, <u>echinoderms</u> , <u>trilobites</u> , brachiopods, <u>mollusks</u> , primitive graptolites). First vertebrates. Earliest primitive fish. Mild climate. The supercontinent Rodinia began to break

<p>"Visible Life"</p> <p>Organisms with skeletons or hard shells.</p> <p>540 mya through today.</p>			<p>into smaller continents (no correspondence to modern-day land masses). Mass extinction of trilobites and nautiloids at end of Cambrian (50% of all animal families went extinct), probably due to glaciation.</p>
<p>Proterozoic Eon</p> <p>2.5 billion years ago to 540 mya</p>	-	<p>Vendian/Ediacaran Period</p> <p>600 to 540 Million Years Ago</p>	<p>Vendian biota (Ediacaran fauna) multi-celled animals appear, including sponges. A mass extinction occurred. The continents had merged into a single supercontinent called Rodinia.</p>
		-	<p>First multicellular life: colonial algae and soft-bodied invertebrates appear. Oxygen build-up in the Mid-Proterozoic.</p>
<p>Archeozoic Eon (Archean)</p> <p>3.9 to 2.5 billion years ago</p>			<p>"Ancient Life" - The first life forms evolve - one celled organisms. Blue-green algae, archaeans, and bacteria appear in the sea. This begins to free oxygen into the atmosphere.</p>
<p>Hadean Eon</p> <p>4.6 to 3.9 billion years ago</p>			<p>"Rockless Eon" - The solidifying of the Earth's continental and oceanic crusts.</p>

9. Do ONE of the following:

- a. Tell what fossils are and how they aid in understanding the story of the earth's history.
- b. Make a collection of 10 different fossils and identify them to the best of your ability.
- c. Discuss with your counselor the theory of continental drift.

Read [The Stories Fossils Tell](#) and [Our Changing Earth](#)

Geology and People

- 10. Discuss two environmental problems related to geology.** Tell how land-use planning relates to geology. Tell why faulting, landslides, waste disposal, pollution, water supply, and subsidence are important in land-use planning. Give an example of poor use of land in your area or an environmental hazard in your area related to geologic features or processes.

Read [How Geology affects the Environment](#)

11. Do ONE of the following:

a. Describe five energy sources, how they occur, and how they are used today. Describe the source of the products supplied by your local utilities. Tell which of these products are related to geologic processes.

b. Visit a mine, oil or gas field, gravel pit, stone quarry, or similar area of special interest to you. Make a collection of geologic specimens found at the site visited. Tell about the geology of the place.

Read [Geology and sources of energy](#)

Careers in Geology

12. Do ONE of the following:

a. Read a pamphlet about careers in geology. Tell what you learned.

See [Careers in Geology](#)

b. Visit with a geologist, other than your counselor. Tell what he or she does. Find out how he or she prepared for the job.

If you would like to visit some geologists by email, here are people who have agreed to help by telling you what they do:

[Doug Hanson](#) a former Boy Scout who works for the Arkansas Geological Commission. Put his name in the subject box when you contact him.

[Gary Patterson](#) Center for Earthquake Research and Information, Memphis TN

[Bekki White](#) A petroleum geologist who has worked in the oil fields of southern Arkansas

[Mark Witherspoon](#) an Eagle Scout who has his own geological consulting firm, and partner

[Dan McCullough](#), Little Rock, AR

[Gary Robinson](#) a geophysicist and scoutmaster with Troop 113 in Aurora, Colorado

[Christian Maloney Cicimurri](#), educator and paleontologist, Curator of Education, Bob Campbell Geology Museum

13. Discuss with your counselor what you have learned about careers in geology and how to prepare for them.

Partially Prepared by Darcy Howard, Troop 198 -- If you are looking for more merit badges to work on via the internet, visit the [Merit Badge Research Center](#) at www.meritbadge.com