



# Houston Gem and Mineral Society's Home Scavenger Hunt for Economic Minerals and Rocks

## Subset 3 of Minerals 15–20

The Houston Gem and Mineral Society assembles Economic Mineral and Rock sets for distribution free to teachers and homeschool groups (information on the set and how to request it are at <https://hgms.org/education/mineral-and-fossil-sets/>). This set consists of samples of minerals and some rocks that are important economically in our society. The set is a helpful teaching aid, but you do not have to have one to complete this scavenger hunt, which is specifically designed with activities that can be easily done at home or in the classroom with common school supplies and other ordinary objects. The activities are labeled for the grades they align to in the Texas Essential Knowledge and Skills for Science (TEKS).

**All activities in this scavenger hunt should be conducted with adult supervision.**

Minerals are defined as naturally occurring, inorganic solids with a definite chemical composition and an ordered internal structure. Minerals are the ingredients that make up rocks, and economic minerals and rocks are used to make things—whatever doesn't come from plants was made from economic minerals and rocks. This scavenger hunt will help you learn how economic minerals and rocks are used in our everyday life in our communities.

Minerals are dug from the Earth's crust within an ore deposit. Most of an ore consists of rock of no economic value, called "gangue." An ore is not mined from the Earth unless either the quantity or quality or both of its mineral content are sufficiently high to make a profit from extracting it, either by shaft or open-pit mining.

An economic mineral can be a metal or nonmetallic. Most ore minerals belong to three groups of nonsilicate minerals:

1. Native elements (examples: gold, silver, copper, sulfur, and graphite)
2. Sulfides (examples: galena, pyrite, chalcopyrite, and stibnite)
3. Oxides (examples: hematite, magnetite, rutile, cuprite, and corundum)

The native elements are each a single element, such as gold, which has the chemical symbol Au. The sulfides and oxides are represented by a chemical formula, such as galena, which is lead sulfide (PbS), and rutile, which is titanium dioxide (TiO<sub>2</sub>). Nonsilicate minerals are much less abundant in the Earth's crust than its major component of silicate (SiO<sub>4</sub><sup>2-</sup>) minerals.

## Contents

### Minerals in Subset 1

1. Galena (lead sulfide or PbS)
2. Copper (Cu)
3. Sphalerite (zinc sulfide or ZnS)
4. Chalcopyrite (copper iron sulfide or CuFeS<sub>2</sub>)
5. Halite (sodium chloride or NaCl)
6. Gypsum (calcium sulfate dihydrate or CaSO<sub>4</sub>•2H<sub>2</sub>O)
7. Sulfur (S)

### Minerals in Subset 2

8. Hematite (iron oxide or Fe<sub>2</sub>O<sub>3</sub>)
9. Garnet (X<sub>3</sub>Y<sub>2</sub>(SiO<sub>4</sub>)<sub>3</sub> in which X can be Ca, Mg, Fe<sup>2+</sup>, or Mn<sup>2+</sup> and Y can be Al, Fe<sup>3+</sup>, Mn<sup>3+</sup>, V<sup>3+</sup>, or Cr<sup>3+</sup>)
10. Magnetite (ferrous ferric iron oxide or Fe<sub>3</sub>O<sub>4</sub>)
11. Fluorite (calcium fluoride or CaF<sub>2</sub>)
12. Pyrite (iron sulfide or FeS<sub>2</sub>)
13. Barite (barium sulfate or BaSO<sub>4</sub>)
14. Limestone (calcium carbonate or CaCO<sub>3</sub>)

### Minerals in Subset 3

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17. Potassium Feldspar (potassium aluminum silicate or KAlSi<sub>3</sub>O<sub>8</sub>)..... 7
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## 15. Granite



Granite is an igneous rock that consists primarily of quartz, potassium feldspar, and muscovite mica in varying percentages. Small amounts of dark-colored silicate minerals can be mixed in. Quartz has a hardness of 7 and feldspar has a hardness of 6 on the Mohs hardness scale, which makes

granite a hard rock, ideal for high-use and weather-exposed surfaces. The Mount Rushmore National Memorial is carved in a granite mountain. Igneous rocks form from magma (molten rock) cooling and hardening beneath the surface of the Earth. They can be exposed later as a result of tectonic activity, such as mountain building and continental drift. Where accessible deposits of granite are found in sufficient quantity and quality, it are quarried as dimension stone, which is rock cut and finished to specific size and shape for many uses: monuments for cemeteries and public places, building facing (including the Texas Capitol building), and, most recently, countertops and tabletops in homes, restaurants, and other buildings. Rough blocks of granite are used as riprap to protect coastlines by preventing erosion, such as forming the jetties at Galveston Island of the Texas coast. Crushed granite gravel is often used on trails, such as in the Houston area.

### Activities:

**K-3:** The Texas State Capitol building is constructed with Texas pink granite that is mined in central Texas. The pink or red color comes from the large amounts of potassium feldspar among the other minerals in the granite. Draw a picture of pink granite by drawing nine rectangles at different angles and different sizes. Each rectangle should touch edges of the other rectangles around it. Color two-thirds (2 of every 3) of the rectangles in a pinkish tan color, and color the remaining 1/3 of them in a light gray color. Then, take a black crayon or marker and put a bunch of black dots mixed in with the other two colors. You have drawn a Texas pink granite! The pinkish tan is the feldspar, gray is quartz, and black dots are biotite and other mafic minerals, which are rich in magnesium and iron.

**4-5:** Two common building stones are granite and limestone. Granite is a mixture of minerals. The two most common are feldspar and quartz. Quartz is the most common mineral on the surface of the earth and is harder than steel with a rating of 7 on the Mohs hardness scale of 1–10, with 1 being talc and diamond being 10. Limestone (calcite) has a hardness of 3 on the hardness scale. Could calcite scratch quartz? Yes No. Could quartz scratch calcite? Yes No.

### 15. Granite continued

**6+**: Although granite is a hard rock, over many thousands of years, granite exposed at or near to the Earth's surface can decompose due to a process called weathering. Feldspar alters into tiny pieces of clay and quartz decomposes into pieces of quartz that are much larger than the clay, eventually reducing to the size of beach sand.

Fill a glass jar about  $\frac{3}{4}$  full, add some sand and some muddy or clayey dirt. Shake it up and watch as the particles settle to the bottom of the jar. Which settles faster in water: the sand or the fine pieces of clay in the mud? \_\_\_\_\_

(In answering the following questions related to the jar experiment, you can conduct research online.)

If a river carrying clay and sand empties into the ocean, which settles faster next to the beach?

\_\_\_\_\_

How does the energy introduced by wave action on the beach influence settling:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Is the sand or clay carried farther out into the ocean before it settles? \_\_\_\_\_.

## 16. Basalt and Diabase (plagioclase feldspars or $(Na,Ca)(Si,Al)_4O_8$ and hornblende series minerals or $(Ca,Na)_{2-3}(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH,F)_2$ )



Basalt and diabase are dark-colored rocks consisting of plagioclase feldspars and hornblende series

minerals in various percentages. They contain the same minerals but differ in crystal size. Basalt is an extrusive igneous rock with microscopic crystals that did not have much time to form when the source lava was extruded in an eruption and cooled relatively quickly. Diabase has a similar mineral composition to basalt but richer in silica and with visible crystals because they could grow during relatively slower cooling within intrusions such as filled fractures or dikes extending away from the magma body but not exposed to the Earth's surface.

### Igneous Rocks: Crystallization Environment and Composition

	Intrusive	Extrusive	Composition
Ultramafic rocks	Peridotite	None	Silica poor
Mafic rocks	Gabbro	Basalt	↕
Intermediate rocks	Diorite/Diabase	Andesite	
Felsic rocks	Granite	Rhyolite	Silica rich

Basalt flows are common in many areas around the world. One of the largest of these hardened lava flows is the Deccan Traps in India. Where basalt flows can be readily accessed, they are quarried for the superior hard, tough gravel they make when crushed to various sizes. This gravel is used in constructing asphalt, concrete, and gravel roads. Large pieces are used as riprap along some coastlines to protect from erosion. Where diabase is exposed at the surface it can be quarried for the same uses as basalt. A famous diabase exposure is the Palisades Cliffs along parts of the Hudson River in New York and New Jersey. The diabase has the appearance of columns, and the name "Palisades" means a fence of stakes, derived from the Latin word *palus* meaning stake.

### Activities:

**K-3:** Draw a picture of a volcano with red lava being erupted from the top and flowing down one side of the volcano. The crater at the top and any flows down the volcano are where you find basalt after the lava cools to form rock.

## 16. Basalt and diabase continued

**K-3:** Basalt is called an extrusive igneous rock because it was extruded or came out to the Earth's surface and cooled quickly. The crystals that form are very small because they didn't have much time to grow before hardening to rock. You may not even be able to see them without magnification. Rocks that form below the surface of the Earth cool slowly and form larger crystals. Compare different individual grain sizes by putting a little salt in one bowl, dried rice in another bowl, and dried beans (or something of similar size) in another. Compare them side by side.

Circle which one has the finest (smallest) grain size: Salt Rice Beans

Circle which one has the coarsest (largest) grain size: Salt Rice Beans

**4-6:** Read the preceding activity comparing grain size for salt, rice, and beans. Research the density (total mass divided by total volume in units of  $\text{g/cm}^3$ ) of these three substances. Write the order from least to most dense: Least dense = \_\_\_\_\_ < \_\_\_\_\_ < \_\_\_\_\_ = Most dense

Does this differ from the individual grain size order of salt < rice < bean? Circle your answer: Yes No

**5-7:** Mt. Everest is the tallest mountain in the world above sea level at 8,848 m. The Empire State Building in New York is 443 m. The height above the ocean floor of the Mauna Kea volcano in Hawaii, which is made from basaltic lava flows, is 10,210 m high. The tallest mountain in our solar system is Olympus Mons on Mars, which is also a volcano made from basaltic lava flows. It has a height of 21,229 m. Draw an illustration, to scale, comparing these four things. Label the scale you used.

**7+:** Basalt is the most common volcanic rock on the surface of the Earth and makes up most of the ocean floor. Most of the basalt on the ocean floor erupts from cracks and is rapidly cooled by the cold ocean water surrounding the lava to form pillow basalts. They are called pillow basalts because the large basalt rock bubbles look like pillows up to 1 m across. Research the thermal conductivity of water and of air and explain why water cools erupted lava to basalt more rapidly than air:

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## 17. Potassium Feldspar (potassium aluminum silicate or $\text{KAlSi}_3\text{O}_8$ )



Potassium feldspar (also called K-feldspar) is a primary constituent of light-colored igneous rocks, such as granite and rhyolite. Feldspars are the most common minerals in the Earth's crust, forming more than half of it (quartz is the most common mineral on the surface of the continents). The three principle varieties of K-feldspar are microcline, orthoclase, and sanidine, which form at low, medium, and high

temperatures, respectively. They have the same chemical composition but different crystal structures. K-feldspar is common in many rocks used as building stones. In some massive deposits of the igneous intrusive rock pegmatite, the amount of K-feldspar may be large enough to be commercially exploitable. Potassium feldspar is used for aggregate in concrete and asphalt, and in the manufacture of glass and ceramics, primarily porcelain, such as for sinks, bathtubs, and toilets. It is also used in the manufacture of fiberglass.

### Activities:

**K-5:** When feldspar decomposes, it forms clay. There are a lot of other minerals that also decompose to form clay. Clay particles are very small and hold water in the soil better than sand because the smaller clay particles have more surface area and fit tightly together. Having the right amount of clay is important to growing crops, and too much clay would not drain well. You can demonstrate this by filling two self-sealing sandwich or snack bags with water. Take scissors and cut a tiny piece of a bottom corner off one bag and a larger piece off the other bag. Circle which bag empties out faster:



Small opening in the bag



Large opening in the bag

So, could water flow faster through a rock with large openings between the grains (sand) or small openings (clay)? Circle your answer (on the next page):

17. Potassium feldspar continued



Water flows faster through clay grains



Water flows faster through sand grains

**4-5:** The mineral halite (salt) has a chemical formula of NaCl. Salt is used to season and preserve food, but too much salt can cause a person’s blood pressure to increase and cause health problems. Potassium is also a vital nutrient for our diet, and potassium chloride (KCl) is used by some people as a substitute for NaCl for table salt. Most people know that bananas are high in potassium, but there are many foods that are better sources of potassium. Research how much potassium is in a serving of banana and find four other foods that are higher in potassium to complete this table. Circle which of these would be your favorite for consuming potassium in your diet:

Food	Potassium (mg)
Banana	

**6-8:** Some potassium feldspar occurs in rocks called pegmatites, which can contain extremely large crystals up to several inches or even feet across, along with many gemstones such as tourmaline and beryl. One of the feldspar gemstones is moonstone. Research why moonstones have the property of adularescence and explain here: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**8+:** The name potassium feldspar reflects this mineral’s large content of potassium. Find potassium on the periodic table of the elements. What is its atomic number? \_\_\_\_\_. What element sits above it on the periodic table? \_\_\_\_\_. What group is potassium in and what does that tell you about its properties? \_\_\_\_\_

\_\_\_\_\_

## 18. Quartz (silicon dioxide, SiO<sub>2</sub>)

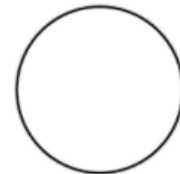
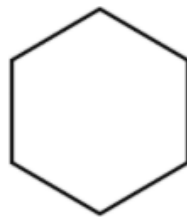


Quartz is the most common mineral on land and the Earth's surface. It is so common because it consists of silicon and oxygen, the most important chemical elements in the Earth's crust. It is a constituent of most light-colored igneous rocks, many metamorphic rocks such as gneiss, and sedimentary rocks such as sandstone. Beach sand is

usually made up mostly of small, rounded pieces of quartz. Quartz is one of the most important economic minerals as a major component of cement and glass in the form of sand. Quartz is used commercially as an abrasive because it is the most common mineral that has a hardness of 7 or more on the Mohs hardness scale for minerals, which means it is harder than glass or steel. Quartz crystals are a piezoelectric material, so if an alternating voltage is applied to them, it causes the crystals to create mechanical vibrations or electronic oscillations at a constant frequency. This signal is extremely stable across a wide range of temperatures and environmental conditions. Thus, billions of quartz crystals are used as components in watches, video games, computers, cell phones, and other electronic equipment.

### Activities:

**K-2:** Quartz crystals are often used as gemstones because they are very hard, so they resist scratching, and they come in a variety of colors depending on the impurities they contain. The crystals form as hexagonal prisms. The most popular is amethyst, which is the purple variety of quartz. Circle which shape is a hexagon (six-sided polygon) and color it purple, like one face of an amethyst crystal.



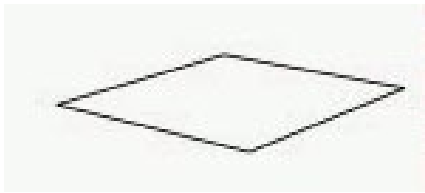
**3-5:** Because quartz sand is very hard, it makes good sandpaper. It is harder than most minerals and is harder than steel. Examine some sandpaper at your house, a hardware store, or an online retailer. Is the sandpaper labeled "flint" on the paper side or on the package? Yes No. If so, this means that it is made from quartz.

(continued next page)

### 18. Quartz continued

If it is not labeled “flint,” is there another label on the back or on the package? Circle the one that you find: Garnet          Silicon carbide          Ceramic          Aluminum oxide (the synthetic form of the mineral corundum, which is 9 on the Mohs hardness scale of 1–10. Some forms of corundum are the gemstones of ruby and sapphire.)

**K-5:** When many minerals break, they crack along very smooth, straight sides called cleavage planes that are determined by the crystalline structure. Quartz does not have any perfect cleavage faces, so when it breaks, the fracture surfaces look like broken glass, forming a concave (bowl-shaped) conchoidal fracture. Take an ice cube outside, put it in a clear plastic bag, and hit it softly with a hammer until it breaks. Does ice break along smooth, even faces or does it break along curved surfaces? Circle what you find:



Smooth cleavage face



Conchoidal fracture

**6-8:** Quartz gemstones come in many colors depending on what impurities are in the quartz molecular structure. Iron is the source of purple in amethyst and yellow in citrine, and titanium or manganese produce the pink in rose quartz. Agates are very fine-grained quartz crystals with impurities such as iron and manganese that give the individual bands in the rock the wide range of colors. When quartz crystals are being cut and polished to make finished gemstones, the person doing the grinding always drips water on the crystal to capture dust, because the quartz dust, also known as silica, can cause damage to a person’s lungs. Because quartz is such a common commercially used mineral, there are many construction and industrial activities that produce these very small particles of respirable crystalline silica. Research activities that could expose workers to silica dust and list some of them:

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**8+:** A geode is a hollow subspherical stone nodule. Quartz crystals are a common lining of the internal cavity of geodes. Research how geodes form in areas of volcanic activity or by sedimentary processes and explain how the quartz crystals got inside of a hollow rock: \_\_\_\_\_

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## 19. Bauxite



Formed by weathering, bauxite is a group of aluminum oxides and is the main ore that we get aluminum from. Aluminum is the most abundant metal element in the Earth's crust and the third most abundant element in the crust, trailing only oxygen and silicon. Because aluminum reacts with water and air to form various oxides and hydroxides, aluminum metal is never found in its pure form in nature.

Bauxite is formed when aluminum-bearing rocks (typically those with a high content of the mineral feldspar) lose their silica by the weathering process of leaching. Using aluminum instead of steel for some parts of cars and trucks makes them lighter, which saves fuel and reduces polluting emissions.

### Activities:

**K-1:** Aluminum is very malleable, which means that it can bend without breaking. Take a piece of aluminum foil and try bending it. Did it crack and break when you tried to bend it? Circle your answer:  
Yes No

**K-4:** Collect an aluminum drink can and a steel food can that are about the same size. Empty both cans. Which can is heavier? [circle one]



Aluminum pop-top can



Steel can

Aluminum has a lower density than steel, so it is lighter. However, steel is stronger than aluminum. You can easily dent or flatten an aluminum can compared with a steel one.

**3-5:** Aluminum metal is very soft and can be easily scratched with a steel nail. However, when aluminum is processed by calcining in high heat to reduce and oxidize it to  $Al_2O_3$ , it makes a synthetic form of the second hardest mineral, corundum, which is also known as the gemstones ruby and sapphire. Examine some sandpaper at your house, a hardware store, or an online retailer. Is the sandpaper labeled "aluminum oxide": Yes No

### 19. Bauxite continued

What is the advantage of using sandpaper that is made from minerals that are rated 9 on Mohs compared with sandpaper made with quartz, which is 7 on hardness scale of 1–10, with 10 representing the hardest mineral, diamond? \_\_\_\_\_

\_\_\_\_\_.

**6-8:** Aluminum is one of the lightest metals. Which would weight more, a cubic centimeter of aluminum, which has an atomic number of 13 on the periodic table of the elements, or a cubic centimeter of iron with an atomic number of 26? \_\_\_\_\_.

**8+:** Research the density of aluminum and steel. Modern commercial aircraft are about 80% aluminum by weight. Approximately how much weight was saved by using aluminum instead of steel for an average-size airplane that weighs 41,000 kg: \_\_\_\_\_

\_\_\_\_\_.

**8+:** Some metals are permanently magnetic (ferromagnetic), which means they are attracted to a magnet. Check if an aluminum drink can is magnetic by applying a refrigerator magnet to it and circle your answer:

Magnetic      Nonmagnetic

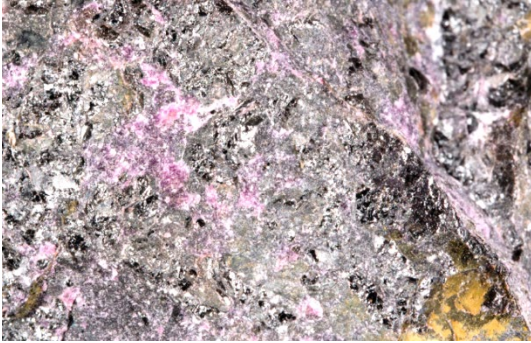
Find aluminum on the periodic table of the elements. What is its atomic number? \_\_\_\_\_.

What group is aluminum in and what does that tell you about its properties, including whether ferromagnetism is a property of the group: \_\_\_\_\_

\_\_\_\_\_.

\_\_\_\_\_.

## 20. Chromite ( $\text{FeCr}_2\text{O}_4$ )



Chromite is the only mineral containing chromium that is common enough to be mined. Chromium is an important economic mineral that is in common use around the world, such as an additive in making steel to give it resistance to corrosion. Stainless steel contains at least 10.5% chromium. It is also used as a plating on steel to prevent rust and gives it a very shiny, mirror-like finish. Most of the world's production of chromium is from South Africa, Turkey, and Kazakhstan. The USA must import almost all its chromium because it has no

chromite concentrations large enough to mine.

### Activities:

**K-1:** Look around your home or school for items that you think are made with stainless steel. If they are not coated or painted, they probably have a shiny silver color that looks like aluminum foil. Kitchen appliances such as refrigerators, ovens, dishwashers, and toasters or toaster ovens are likely made out of stainless steel that has chromium in it so they won't rust easily. Check whether you correctly identified steel items by applying a refrigerator magnet to them—most stainless steel is magnetic (unless it has a high content of the metal nickel) and will attract the magnet, even if the steel is coated or painted. Draw some of the things you found that are made from steel:

**K-3:** Chrome-coated steel and stainless steel containing chromium are much heavier than aluminum or plastic. Apply a refrigerator magnet to your flatware (knives, forks, and spoons) to see if they are magnetic, which indicates they are made with stainless steel. Find a plastic fork or spoon and hold it in one hand. Hold a similar-size stainless steel fork or spoon in your other hand. Circle which is heavier of the same-size utensils:

20. Chromite continued



Plastic utensil



Stainless steel utensil

**4-5:** Chromium is very hard at 8.5 on the Mohs hardness scale from 1 to 10. Steel is about 6.5. What advantage would be provided by coating drill bits with chrome? \_\_\_\_\_  
\_\_\_\_\_.

**6+:** For many years, the impact-absorbing bumpers on cars were chrome-plated steel for both function and style. Starting in the 1970s, automobile manufacturers began replacing chrome bumpers with plastic covers over steel or aluminum bumper bars to reduce vehicle weight and thus improve fuel economy. If the two chrome steel bumpers on a car weigh 68 kg each and are replaced with aluminum-construction bumpers that weigh 9 kg each, how much weight is saved: \_\_\_\_\_.

The average car weighs 1,800 kg. What percentage of the weight was saved by replacing the bumpers: \_\_\_\_\_.

The US EPA says that for every 45 kg a vehicle's weight is reduced, the fuel economy is increased by about 1.5%. How much was the fuel economy improved by replacing the bumpers: \_\_\_\_\_.