Basic Mineral, Rock and Fossil Set with TEKS Discussions

Houston Gem & Mineral Society
with the assistance of the Texas Earth Science Teachers Association (TESTA)

LIST OF SPECIMENS IN THIS SET

Note: not every mineral is present in every box. We run out and have to substitute other minerals. Check the name and not the number.

***Web** – I provide suggested words for the search engine Google to show a variety of specimens. Web sites change so often that it is impossible to provide the user with a working set of direct links.*

♦ ♦ ♦ Hardness Minerals ♦ ♦ ♦

The minerals are used to discuss physical properties of minerals.
Specimens 1 to 9 are listed in order of the Mohs hardness scale.

1. **TALC**, hardness of 1 -

Hydrated Magnesium Silicate. This mineral is usually found in metamorphosed oceanic crust. It is so soft that your fingernail will scratch it. Ground talc is often used as "baby powder." [Put *talc rough* into Google to see talc used for carving.] Our specimens are from Montana, USA.

2. **GYPSUM**, hardness of 2 -

Hydrated Calcium Sulfate: A very common mineral that precipitates **as seawater evaporates. The** most common use is for making sheet rock wallboard. [Put *naica gypsum* into Google to see the huge gypsum crystals from Mexico.] These specimens come from Chihuahua, Mexico or from Texas.

3. **CALCITE**, hardness of 3 -

Calcium Carbonate: A very common mineral that typically is precipitated by organisms like clams, which use it to make their skeletons. When large amounts of these biological products accumulate and get cemented together, the rock is called limestone. Calcite may be dissolved and re-precipitated by hot ground water as large and beautiful crystals. [Put *calcite collectors* into Google to see the varieties.] These are cleavage fragments.

4. **FLUORITE**, hardness of 4 -

Calcium Fluoride: Typically found in beautiful crystals in hydrothermal deposits (200 degrees C and 2000 PSI) along with metallic ore minerals. Ancient peoples discovered that fluorite ("flowing stone") would make many ore minerals melt more easily. This mineral shows 4 **directions of cleavage.** [Put *fluorite crystals* into Google to see the range of colors.] This specimen may be from Chihuahua, Mexico, China, or New Hampshire.

5. **APATITE**, hardness of 5 -

Calcium Phosphate with some fluorine: Apatite comes from both organic and inorganic sources. Many living creatures (like sharks) make their skeletons and teeth out of hydrated calcium phosphate. Their accumulated remains are mined for fertilizer. Inorganic apatite is found in igneous rocks. [Put *apatite crystals* into Google to see the range of colors.] These crystals are from Mexico or Morocco.

6. **MICROCLINE**, hardness of 6 -

Potassium Aluminum Silicate: Microcline is one of a family of minerals called feldspars. They are found in igneous rocks and weather to clay minerals. Note that there are two directions of cleavage at nearly right angles (micro-cline = little angle) to each other. [Put *feldspar moonstones* into Google to see optical effects.] Specimens can be from Texas, Colorado, or other states where pegmatite minerals are found.

7. **QUARTZ**, hardness 7 -

Silicon dioxide: Quartz is the most common mineral on the continents of the earth. Sand is primarily quartz that has eroded from somewhere else, like granites, and has been concentrated by rivers. When minerals cement the sand together, the rock is called sandstone. Quartz can be recognized by its hardness (it will scratch glass) and its lack of cleavage. Broken quartz looks just like broken glass, and it is just as sharp. It grows in hexagonal crystals with striations on the sides. Many common forms of quartz (agate, chalcedony, flint, chert, jasper) are made of tiny crystals, the result of rapid crystallization. [Web: Put "quartz varieties" into Google.] These crystals are from Arkansas, USA.

8. **TOPAZ**, hardness 8 –

Aluminum fluohydroxysilicate: When nicely colored (blue, yellow, pink) and transparent, topaz is a gemstone. Topaz is found in pegmatite veins associated with granites. A pegmatite is the last material to crystallize as a large igneous body cools. Pegmatites frequently contain rare and beautiful minerals like topaz. Our specimens are rounded, water-worn pebbles collected from a stream in Brazil, so they do often not show crystal faces. Topaz has a single direction of weakness, called a cleavage plane, which shows up if a pebble is broken. [Web: Put "brazil topaz crystals" into Google.]

9. **CORUNDUM**, hardness 9 –

Aluminum oxide: Corundum is found in silica-deficient, high-temperature metamorphic rocks or in aluminum-rich igneous rocks. If silica is present, corundum will not form because aluminum silicates are much more stable. The diagnostic test for corundum is its hardness. You will find it harder than anything in this box, harder than any mineral but diamond. Minor impurities can color corundum red (ruby) or blue (sapphire). [Web: Put "mineral corundum" into Google and see the range of colors for corundum.] These corundum crystals are from India.

♦ ♦ ♦ Minerals ♦ ♦ ♦

10. **GARNET** (grossular) - Mexico

Calcium aluminum silicate: This garnet is light-colored because it is does not contain iron or manganese. Note the shape of this crystal – it has 12 sides and is called a rhombic dodecahedron because each of the faces is a rhomb. [Web: Put "Rhombic Dodecahedron" into Google and see some great pictures of this crystal shape] Recognizing this crystal shape is key for identifying garnets. Garnets come in a wide range of colors. [Put *garnet colors* into Google.] This mineral will scratch glass. If your piece of garnet is missing, look at the garnet crystals in #22, garnet schist. This rock contains shiny mica and grains of garnet (usually red to black).

11. **CALCITE** – location unknown

Calcium carbonate: This specimen is for breaking. Look at the shape of the cleavage fragment and see that it has 3 directions of cleavage (planes of fracture), none of which is perpendicular. Gently tap this cleavage fragment with a hammer until it breaks. Note that all the fragments have the same shape as the original. The fracture planes and the angles are diagnostic for this mineral. [Put *crystal cleavage* into Google to see sites that discuss this important feature.] Save the fragments to show again.

12. **PYRITE**, known as "fool's gold," from the silver mines of Peru.

Iron sulfide: diagnostic properties are its brassy gold color, its brittleness, and when present, its cubic crystals. Once a minor iron ore, most pyrite is mined today for its trace content of precious metals like gold. [Put *pyrite specimens* into Google.] Pyrite can grow in cubes or pyritohedrons (12-sided crystal where the faces are pentagons). [Put *pyritohedron* into Google to see a description of the crystal shape.]

Pyrite is a striking example of metallic luster. It is shiny and opaque because it reflects light. Use the enclosed streak plate (unglazed tile) to see the distinctive streak color.

13. **BARITE** - cleavage fragment from Hatch, NM or Potosi, MO.

Barium sulfate: Barite is a white mineral. Try a "heft" test and note that barite (density of 4.3) has a much greater specific gravity than quartz (density of 2.9) or calcite. Barite is commonly used in drilling mud to make it much heavier than water. A "barium milkshake" is a suspension of barite and clay that is given to patients to make their intestinal track visible on x-rays. [Put *barite uses* into Google to see industrial uses.]

14. **HEMATITE** – massive hematite from Arizona or Michigan

Iron oxide: This specimen may have a striking "specular" (like a mirror) luster. This mineral is quite important as an ore of iron. Iron is produced in "blast furnaces" where carbon from coke (from coal) is mixed with hematite and burned in a blast of air. The partial combustion of the carbon produces carbon monoxide (CO), which captures oxygen from the iron oxide to produce metallic iron. Finely-divided hematite is red in color. Your specimen may be like that. Though some of these specimens are black, they will produce **a red streak** on the unglazed ceramic plate. [Put *hematite mineral* into Google to see mineral varieties.]

15. **QUARTZ** – milky quartz – warning SHARP Edges

Silicon dioxide: These are broken pieces of quartz and show no crystal faces. These also show no cleavage because quartz does not break along flat planes – instead, it breaks like glass ("conchoidal" or shell-shaped, fracture). The color looks milky because the quartz contains tiny bubbles of the water from which it crystallized. Put *quartz fluid inclusions* into Google and click on images to see photomicrographs of the bubbles. Pieces can be from Arkansas or Colorado.

16. **AZURITE AND MALACHITE** – Arizona or Morocco

Hydrous copper carbonate: These copper ore minerals are very similar in composition but are very different in color. Azurite is the blue mineral and it is an inexpensive paint pigment. It has a problem because it gradually alters to the green mineral, malachite, in a humid environment like Houston. Copper is easily corroded to green and blue minerals. Try this experiment. Take a copper penny minted before 1982 (these are all copper rather than the more recent copper plated zinc ones) and wrap it in a paper towel which is moistened with sodium chloride (common salt) solution (about a teaspoon/cup). Seal it wet in a jar and leave it a week and you will see green copper chloride corrosion. [Put *malachite azurite bisbee Arizona* into Google to see bigger specimens.]

28. **MUSCOVITE** – various sources – pegmatites in Colorado, New Hampshire or Brazil

Potassium aluminum silicate: This mineral has perfect cleavage in one direction. The atoms are so aligned that there is a plane of weakness in the structure. Try splitting the book of muscovite into thinner sheets. It is an excellent electrical and thermal insulator and resists high temperatures. You may have seen it as the glitter in artificial snow. Put *muscovite specimens* into Google to see pictures. Muscovite is a member of the **Mica** group, which contains many other minerals with similar properties.

♦ ♦ ♦ Rocks ♦ ♦ ♦

These are used in a discussion of the rock cycle.

51. **CLAY** – Houston, TX

This is Houston gumbo clay collected about 5 feet below the surface from a building site. A gardener would call it gumbo, and a homebuilder would not like it because it is clay that swells when wet. Try the experiment of putting 1 drop of water on a lump the size of a pea, and you will see the clay ball swell to a larger size when it gets wet. This swelling causes foundations to break and streets to crack. Mix up some in water, and you will see that it takes hours for the mud to settle out of the water, indicating that the grain size is very fine. [Put *soil profile* into Google.]

17. **SHALE** – Texas or Pennsylvania

Shale is a sedimentary rock that is made up of very small clay and silt particles. [Put *shale photomicrograph* into Google and see the fine structure in shale.] Black shale also contains abundant organic matter, which can be a source for hydrocarbons if buried deeply and heated to the right temperature.

18. **SLATE** – Maine

Heat and pressure will convert (metamorphose) shale into slate. The metamorphism creates mica flakes perpendicular to the pressure applied to the rock. The slate splits easily along the mica. A common use for slate is flooring or roofing for houses. [See *slate uses* to find other uses.]

22**. GARNET SCHIST** – North Carolina, Colorado or New Hampshire

More heat and pressure will convert (metamorphose) slate into garnet schist. The mica grows in size to be quite visible, and some of the iron minerals now turn into garnet. Look closely and see that the garnet has the same dodecahedral shape as #10. [Put *metamorphic rock garnet schist* into Google.]

19. **LIMESTONE** – Texas

Limestone is a sedimentary rock that is primarily composed of calcium carbonate. Frequently the calcium carbonate is the skeletons of microscopic animals. This rock will fizz in 5% hydrochloric acid. [Put *limestone photomicrograph* into Google and see the fine structure of limestone.] Limestone is often quarried for gravel, building stone, and thinner "flags" for walkways and building facings. Many Texas state government buildings are faced with a fossiliferous white limestone quarried near Austin, Texas

20. **MARBLE** – Georgia

Heat and pressure will convert (metamorphose) limestone into marble. Marble is commonly used for flooring and the external panels for buildings. [Put *metamorphic rocks marble* into Google for more info.]

50. **SAND** – unknown location

This is pure quartz sand which would be suitable for glass manufacture. Most sand, like what you find in Galveston, has too many non-quartz grains in it for glass making. [Put *sedimentary rock sand* into Google.] Sand is used in the manufacture of cement and as a binder for concrete in buildings and roadways.

26. **SANDSTONE** – Arkansas and Texas

Sandstone is a sedimentary rock that is made up of visible grains of mostly quartz sand, other minerals, and small rock fragments with a small amount of quartz cement. [Put *sandstone photomicrograph* into Google and see the fine structure of sandstone.]

21. **QUARTZITE** – Texas

Heat and pressure will convert (metamorphose) sandstone into quartzite by strongly cementing the grains together. The bond is so strong that a fracture will break across the sand grains rather than around them. The purple samples come from the Brazos River. I have broken each pebble. Quartzite has almost no commercial use. [Put *quartzite rock* into Google to see examples.]

27. **BASALT** – Lahitas, Texas

Basalt is a common extrusive igneous rock that is rich in magnesium, calcium, and iron. Most of the oceanic crust is basalt. This rock cooled from a lava flow at the surface of the earth. [Put *igneous rock basalt* into Google.]

29. **RHYOLITE** – Davis Mountains, Texas

Rhyolite is a common extrusive igneous rock that is low in iron, calcium, and magnesium. Look closely with a microscope (10x) and you will see the tiny, glassy, blocky crystals, which are a high-temperature, early crystallizing sanidine, a potassium feldspar. These crystals formed at some depth before the lava spilled out on the surface. There are also bubbles which formed as the lava reached the surface and the dissolved gasses came out. Still later, some of these bubbles and cracks were filled by low-temperature minerals (clay, calcite, zeolites, quartz, and agate) as water moved through the cooling lava. [Web: Put *rhyolite rock* into Google]

30. **CONGLOMERATE** – Brownwood, TX

Conglomerate is sedimentary rock with a large proportion of grains larger than 2 mm that have been cemented together. This rock is cemented with hematite. This rock is just like sandstone but with coarsely sized grains. Note that the rock contains both big and little grains. That means that the rock is poorly sorted. These typically are found in a debris flow. Note also that the big grains are chert, a sedimentary rock that is commonly produced by weathering limestone. [Put *rock conglomerate* into Google.]

An excellent discussion of sedimentary rocks is found at

http://www.homepage.montana.edu/~esci111/RockCycle-1/sedimentary.htm
(*Editor's note: Link does not work.)*

25. **SCORIA** – New Mexico

When basalt lava with a lot of gas included reaches the surface of the earth, the dissolved gas bubbles out as the rock cools, leading to this characteristic porous texture. Iron minerals in the lava can oxidize and color the surface red. [Put *igneous rock scoria* into Google.]

24. **PUMICE** – California

When lava is very viscous and full of gas, it will cool into what is essentially foam. This rock floats! Try it. You should store the pumice dry to keep it from gradually adsorbing water and sinking. [Put *igneous rock pumice* into Google.] Pumice is used as an abrasive for cleaning porcelain and in personal care products for callus removal.

23. **GRANITE** – Texas, New Hampshire, Colorado

The pink crystals are microcline feldspar. The gray areas are quartz. The black spots are biotite mica, magnetite and pyroxenes. The continents are floating on a granite basement in a sea of basalt. The central part of the Texas Hill Country, where this granite is found, is an exposed PreCambrian landscape uncovered by the uplift of the Rocky Mountains in New Mexico. They are the oldest rocks in Texas.

♦ ♦ ♦ Fossils ♦ ♦ ♦

We are including a limited number of fossils so we can introduce some animal adaptation concepts.

47. **COAL** – Illinois

Coal is a rock made from the compressed cellulose of plants. For coal to be formed, the plants must have been present in great abundance, and they must have been buried in an oxygen-free environment, such as a bog, swamp, or lake. This is bituminous coal which has been subjected to greater temperatures and pressures during burial than the lignite coals of Texas, which still look a lot like peat moss.

55. **PETRIFIED WOOD** – Bryan, Texas

Silica: Wood petrifies when the wood cells are filled with silica (quartz or opal). The original cell walls are still present and protected from biological attack by the filling. If you were to put the petrified wood in hydrofluoric acid (Dangerous and slow), you would dissolve the silica and have a piece of wood left. This is a hardwood; you can see that it is made up of large cells. [Put *petrified wood structure* into Google.]

100. **OAK** – modern

This is not a fossil. Compare with #55.

57**. SHARK TEETH** – Peace River, Florida.

Calcium phosphate: A modern sand shark lives for about 15 years, and during that time he discards 40,000 teeth. Each tooth is replaced in about 3 weeks. Florida mines about 1 billion pounds of phosphate rock for fertilizer each year, and most of that was derived from animal bone. There is a beach at Tampa, Florida that is brown in color because the grains are bone. Sharks have sharp teeth to capture slippery fish or to cut out pieces from their prey. They do not chew. [Put *fossil shark teeth* into Google.]

58. **RAY TEETH** – Peace River, Florida

Calcium phosphate: The grinding surface of the ray tooth is the smooth one. One of the surprising things that rays eat are oysters IN the shell. They crush up the whole thing. Rays are not aggressive toward humans. [Put *fossil ray teeth* into Google.]

DISCUSSIONS YOU CAN DO WITH THIS SET OF SPECIMENS:

♦ ♦ ♦ Hardness. ♦ ♦ ♦

Hardness – Specimens 1 to 9 are listed in order of the Mohs hardness scale. Try an experiment. Scratch one mineral with another, and then do it in reverse order. You will find that the lower numbers are softer than the higher numbers. Go ahead. Scratch some minerals. That is what they are here for. You can also use some common materials for hardness testing: A fingernail is hardness of 2½, a copper penny (before 1982) is 3, a steel knife is 5, glass is about 5½, and a steel file 6½. It is much easier to scratch something with a sharp edge. Rub your finger over the scratch line. If you made a scratch on a softer mineral, then you will see a scratch or indentation, but if you tried to scratch a harder mineral, you will likely see a line of the softer mineral smeared on the harder one. Check to see which scratched which.

Safety tips:

- If you are scratching glass, put the glass plate on the table, don't hold it in your hand. Use thick pieces of glass (like a Ward's scratch plate or a pickle bottle), not thin things like glass slides or common window glass.
- When doing a hardness test with a nail, be careful not to stick yourself or anyone else.
- Don't put any mineral in your mouth.
- Always wash your hands after handling minerals.

♦ ♦ ♦ Mineral Properties. ♦ ♦ ♦

Minerals are natural, inorganic, solid crystalline compounds—they have fixed chemical compositions and regular crystalline structures. Rocks are mixtures of minerals and may contain substances (like coal) that are not minerals.

Crystal Shape – Crystal shape is one of the diagnostic features of minerals. Note that corundum (#9) is hexagonal in shape, as is apatite (#5). Quartz (#6) is different. It is ditrigonal. That means that its shape is two three-sided prisms. Look at the crystal and note that the prism is not made up of 6 equal-sized faces, but two sets of 3 equal-sized faces.

Can you prove that the crystals in the garnet schist (#22) have the same shape as #10?

Cleavage – Demonstrate that cleavage for calcite (#11) is size independent.

Density – Pick up the barite (#13) in one hand and another specimen of about the same size in the other. Juggle them up and down and you will notice that the barite is considerably heavier. If you have the equipment, measure the specific gravity of each by weighing the specimen, getting the volume by lowering it on a string into a volumetric cylinder and determining the density in grams/cm3. Another way to measure specific gravity is to weigh the specimen in the air and then in water. The difference is the volume. The specific gravity, then, is the weight in air divided by the weight loss in water.

Hardness – Your fingernail is harder than talc (#1) and gypsum (#2). Rank the hardness specimens with common material such as a copper penny (minted before 1982), a nail and glass. Determine the difference between quartz (#7) scratching feldspar (#6) and the reverse.

Can hardness support my contention that #15 is quartz even though it looks nothing like #7?

Chemical Reactions – Try the copper corrosion experiment as mention above with salt and sodium bicarbonate. Check for color differences. Try again with a lemon.

Prove that limestone fizzes with 5% hydrochloric acid. It will not work with vinegar. Obtain an oyster shell and try again.

Streak (white porcelain plate #101) – Streak is also diagnostic for many minerals. Try it for azurite, hematite, and pyrite. Some streaks are vastly different colors than the bulk mineral.

♦ ♦ ♦ Outline of a Rock Cycle Talk. ♦ ♦ ♦

♦ ♦ ♦ Embellish to taste. ♦ ♦ ♦

The rock cycle explains how igneous, metamorphic, and sedimentary rocks are related to each other. Plate tectonic movement is responsible for recycling rock materials and is the driving force behind the rock cycle.

Start: Suppose you start off by digging a hole in the school lawn. You will find dirt, sand, and maybe a shell. You might also find a fossil elephant. There were fossil elephants walking around the area of the school as recently as 10,000 years ago. A pair of elephant tusks (mammoth) were found in Katy 10 years ago, and such fossils are routinely found in the Brazos River. One of the reasons that mammoths are no longer here is that early man ate many of them! I bet we could feed the whole school on an elephant barbeque.

Dig to 10,000 feet, 2 miles: It getting hotter and the pressures are much higher. Dirt has turned into shale; sand has turned into sandstone; shells and organic lime have turned into limestone. This is just the beginning.

Dig to 100,000 feet, 20 miles: Higher pressure and temperature: shale to slate and then schist; sand to quartzite; limestone to marble.

Dig to 200,000 feet, 40 miles: The rocks are beginning to melt. In the subduction zones under the Pacific coast, things are melting at as little as 20 miles down to a composition similar to granite. If this lava got back to the surface in a volcano, we could expect to see scoria and pumice.

Uplift: Bring the granite to the surface and weather it like at Enchanted Rock, TX. It will produce sand and dirt. Things like quartz last longer than feldspars, which are brittle and break up into little pieces, then degrade to make clay minerals. The quartz in granite eventually becomes sand, and the feldspar to clay cycle leads to shales. The cycle starts all over.

♦ ♦ ♦ Fossils. ♦ ♦ ♦

A fossil is any trace of previous life – original or mineralized bones, preserved tracks, carbonized leaf remains, holes left behind when shells dissolve away. These are all fossils.

Petrify – The petrified wood has been mineralized with quartz. Can you support that claim?

Structure – Look at the cells in the petrified wood (#55) and compare to #100 a piece of modern oak. In both samples, you should see big and little cells. This is the diagnostic feature for a hardwood.

Animal adaptations – Play paleontologist and consider how different kinds of teeth might affect how an animal lives and its survivability. Sharks have pointy cutting teeth. Cats have pointy teeth. Can cats take a bite out of a mouse or are they really good at capturing mice? Can sharks chew? Can cats chew?

Rays have crushing teeth and can eat an oyster in the shell. Speculate on what would happen to human teeth if a person tried to eat an oyster in the shell.

Add experiment requiring collection of data, graphing.