

# Rocks and Minerals

2009

## Society of Mining, Metallurgy & Exploration

### List of Rocks & Minerals in Teacher Kit for NSTA

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### ACKNOWLEDGEMENTS

This collection of Arizona rocks and minerals comes to you through the efforts of many people. The individual rock and mineral specimens were donated to the NSTA conference by:

- Arizona Mining and Mineral Museum [www.mines.az.gov](http://www.mines.az.gov) (fluorite, gypsum)
- Arizona Rock Products Association (granite, sandstone, halite, limestone, basalt, marble)
- ASARCO, Mission Mine (chalcopyrite)
- BHP Billiton, Pinto Valley Mine (schist)
- Clear Creek Crystal Mine, Arkansas (quartz)
- Freeport McMoRan Copper & Gold Inc., Sierrita Mine (molybdenite)
- Friends of the Arizona Mining and Mineral Museum [www.fammm.org](http://www.fammm.org) (breaking, sorting rock)
- Hickman Farms (egg cartons)
- Society of Mining, Metallurgy & Exploration [www.smenet.org](http://www.smenet.org) (CDs, CD labels, CD cases)

### ARIZONA MINING INDUSTRY

Arizona ranks first in non-fuel mineral production in the U.S. and produces more than 65% of the Nation's domestic copper. The value of mineral output from Arizona in 2008 was near \$7.8 billion. The Arizona mining industry directly employs tens of thousands of Arizonans. In addition to copper, Arizona also produces gemstones, molybdenum, silver, gold, industrial minerals, and coal.

## MINERAL IDENTIFICATION TABLES

Luster Cleavage	Hardness	Color Streak St=	Diagnostic Features	Formula	Name
<b>Metallic Good Cleavage</b>					
Metallic good cleavage	1-1.5	Lead gray to blue gray St=Gray-black	Heavy (Sp.Gr. = 4.6-4.7)	MoS <sub>2</sub>	<b>Molybdenite</b>
<b>Metallic No Cleavage</b>					
Metallic No cleavage	3.5-4	Brassy yellow color St=greenish black	Brassy color, greenish streak Bronze or iridescent tarnish	CuFeS <sub>2</sub>	<b>Chalcopyrite</b>
<b>Non-metallic Good Cleavage</b>					
Non-metallic good cleavage	2	Clear to white St=white	Good layered cleavage Selenite=clear layers; Alabaster = white grainy, massive; Satin Spar = fibrous	CaSO <sub>4</sub> .2H <sub>2</sub> O	<b>Gypsum</b>
Non-metallic good cleavage	2.5	Colorless to white color St=white	Salty taste Cubic cleavage colorless to white	NaCl	<b>Halite</b>
Non-metallic good cleavage	4	Any color from purple, white yellow, green, etc.	Good octahedral cleavage (4) Cubic crystals common	CaF <sub>2</sub>	<b>Fluorite</b>
<b>Non-metallic No Cleavage</b>					
Non-metallic no cleavage	7	Colorless or white, also gray or any color  Purple or violet (+ferric iron) Rose red or pink (+titanium) Smoky yellow to brown and black (+radiation) Light yellow quartz Milky white (+fluid inclusions) Opalescent or chatoyant quartz (due to fibrous inclusions)	Glassy luster to greasy Conchoidal fracture Prismatic crystals	SiO <sub>2</sub>	<b>Quartz</b>  Amethyst  Rose quartz  Smoky quartz Citrine Milky quartz Cat's Eye quartz

## IGNEOUS ROCKS

Texture √	Color >	light colored; pink, white, gray, green, lavender	dark gray to black
<b>Coarse</b> = Can see crystals = crystals are larger than a pencil point >	intrusive plutonic >	<b>Granite</b> Gray or pink. Can see quartz - gray, glassy grains. Can see feldspar = pink, buff, or white.	
<b>Fine</b> = cannot identify minerals in matrix; = dull, finer grains than a pencil point >	extrusive volcanic >		<b>Basalt</b> Usually black or rust red. May have some or lots of gas bubble holes (called vesicular), some holes may be filled.

## SEDIMENTARY ROCKS

### Clastic Sedimentary Rocks

Particles	Size	Minerals	Characteristics	Grain Size	Rock Name
Sand	2- 1/16 mm	Quartz, feldspar	Granular	Predominantly quartz sand; Looks sandy May shed sand grains); Feels rough	<b>Sandstone</b>

### Non-Clastic Sedimentary Rocks

Mineral composition	Chemical formula	Characteristics	Rock Name
Calcite	CaCO <sub>3</sub>	Fizzes (bubbles) in HCl or acetic acid	<b>Limestone</b>

## METAMORPHIC ROCKS

### Foliated (banded) Metamorphic Rocks

Characteristics	Minerals Contained	Rock Name
Thin, irregular layers of mica & platy minerals, Commonly pale gray green, Medium-grained, grains visible, Uneven surfaces, Crystals of garnet or other minerals in mass of mica flakes	Mica (muscovite, biotite), Chlorite, Talc, Hornblende, Quartz, Garnet, or Feldspar	<b>Schist</b>

### Non-foliated Metamorphic Rocks

Characteristics	Parent Rock	Rock Name
Fizzes in dilute acid, Medium to coarse grained, sugary to crystalline, White to pink or other colors, Composed of calcite (CaCO <sub>3</sub> ), Will not scratch glass	Limestone	<b>Marble</b>

## 2. CHALCOPYRITE

$\text{CuFeS}_2$  (Copper Iron Sulfide)



**Chalcopyrite**

Cleavage:	Poor
Fracture:	Uneven
Hardness:	3.5 - 4
Sp. Gr.:	4.1-4.3
Color:	*Brass yellow
Streak:	*Greenish black
Luster:	Metallic; opaque
Crystals:	Mostly compact, masses of very small crystals
Name:	The name is from the Greek <i>chalkos</i> , "copper".

**Uses of Chalcopyrite:** It is the primary copper sulfide ore that is mined in Arizona for the production of copper.

**Uses of Copper:** Copper is second only to iron as a metal essential to modern civilization. The greatest use of copper is for electrical purposes, mostly as wire. Copper is also common as plumbing pipes, pots/pans, and decorative containers. Coins (pennies, dimes, quarters) use significant amounts of copper. Copper is also used as roof cover (often tarnishing green). Copper is easily stretched, molded, and shaped; is resistant to corrosion; and conducts heat and electricity efficiently.

Copper is also extensively used in alloys, such as brass (copper and zinc), bronze (copper and tin with some zinc), and German silver (copper, zinc, and nickel).

Copper is used in building construction, power generation and transmission, electronic product manufacturing, and the production of industrial machinery and transportation vehicles. Copper wiring and plumbing are integral to the appliances, heating and cooling systems, and telecommunications links used every day in homes and businesses. Copper is an essential component in the motors, wiring, radiators, connectors, brakes, and bearings used in cars and trucks.

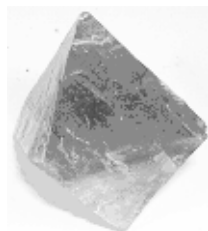
The percentage of copper used in the United States by industry is: Building Wire (16%), Plumbing & Heating (14%), Automotive (11%), Electric Utilities (9%), Air Conditioning & Commercial Refrigeration (8%), Telecommunications (7%), Factory Equipment (6%), Electronics (6%), Appliances & Extension Cords (3%), and Other (20%).

Copper sheets are used in cooking utensils and in roofs. Copper tubes are used to make pipes for plumbing and carrying natural gas. Copper wire is used to carry electric current. Extruded copper, that is, copper that has been squeezed through a hole, forms rods, hinges, tubes, and door handles.

The use of copper is increasing. In the 1970s, a 1,500 square-foot house used about 280 pounds of copper. Today, a 2,200 square-foot house uses about 450 pounds of copper. A car in the 1970s used about 35 pounds of copper. Now, the average car contains 1.5 kilometers (0.9 mile) of copper wire, and 45 to 100 pounds of copper will go into one automobile. A Boeing 727 airplane uses 9,000 pounds of copper.

### 3 FLUORITE

CaF<sub>2</sub> (Calcium Fluoride)



Cleavage:	*perfect in four directions forming octahedrons.
Fracture:	subconchoidal to splintery
Hardness:	*4
Sp. Gr.:	3.2
Color:	clear, purple, blue, green, yellow, pink and brown colors due to impurities
Streak:	white
Luster:	non-metallic -- vitreous; transparent to translucent.
Crystals:	isometric; cubic & octahedral common
Other:	fluoresces easily under ultraviolet light
Name:	The name is from the Latin <i>fluere</i> , "to flow", because fluorite melts easily and is used as a flux in the smelting of metallic ores.

#### Fluorite

Fluorite is found as secondary deposits in sedimentary and metamorphic rocks and in veins by itself or with barite or metallic minerals.

**Uses of Fluorite:** There are three principal types of industrial use for fluorite, corresponding to different grades of purity.

Metallurgical grade fluorite, the lowest of the three grades, has traditionally been used as a flux to lower the melting point of raw materials in steel production to aid the removal of impurities. It is also used in the processing of aluminum ore (bauxite).

Ceramic (intermediate) grade fluorite is used in the manufacture of opalescent glass, enamels and cooking utensils. Fluorite is used in the pottery, optical, and plastics industries, in the manufacture of opalescent glass, and in enameling cooking utensils.

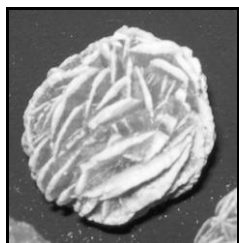
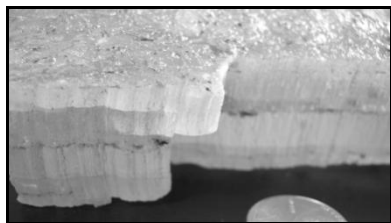
The highest grade, acid grade fluorite, is used to make hydrofluoric acid by decomposing the fluorite with sulfuric acid. Hydrofluoric acid is the primary feedstock for the manufacture of virtually all organic and inorganic fluorine-containing compounds, including fluoropolymers and perfluorocarbons, and is also used to etch glass. Fluorite is also used as a source of fluorine for fluorinated water. Fluorite is used to make the chemicals added to toothpaste and drinking water to help prevent the formation of cavities in teeth.

Fluorite also has ornamental and lapidary uses. It is not commonly used as a gemstone because of its low hardness and good cleavage. It is sometimes used for ornamental carvings.

Fluorite is used in special optical uses instead of glass in some high performance telescopes and camera lens elements. Exposure tools for the semiconductor industry make use of fluorite optical elements for ultraviolet light. Fluorite has a very low dispersion, so lenses made from it exhibit less chromatic aberration than those made of ordinary glass. In telescopes it allows crisp images of astronomical objects even at high power.

## 6. GYPSUM

$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  (Calcium Sulfate Hydrate)



Gypsum

<b>Cleavage:</b>	*Perfect parallel to the long axis and distinct in two others
<b>Fracture:</b>	Splintery
<b>Hardness:</b>	*1.5-2
<b>Sp. Gr.:</b>	2.3-2.4
<b>Color:</b>	White, colorless, gray, and brown
<b>Streak:</b>	White
<b>Luster:</b>	Non-metallic -- vitreous to dull; transparent to translucent
<b>Crystal:</b>	Monoclinic; bladed to tabular, often twinned
<b>Other:</b>	*Thin cleavage fragments are flexible, i.e. they will bend without breaking, but will not return to their unbent condition.
<b>Name:</b>	The name gypsum is from the Arabic <i>jibs</i> , "plaster" and then to the Greek <i>gypsos</i> , for gypsum of plaster or "chalk".

The variety of gypsum called *selenite* grows as large, clear, bladed crystals; the variety *satin spar* grows as white fibrous masses; and the variety *alabaster* occurs as white sugary masses.

**Uses of Gypsum:** Gypsum is used chiefly for the manufacture of wall board for interior walls and ceilings (also called sheet rock). It is estimated that the average American home contains nearly eight tons of gypsum.

In the manufacture of plaster of Paris, the gypsum is ground and then heated until about 75 % of the water has been driven off, producing the substance  $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ . This material when mixed with water, slowly absorbs the water, crystallizes, and thus hardens or "sets." Plaster of Paris is used extensively for gypsum lath, wallboard, and for molds and casts of all kinds.

Gypsum is used in agriculture to neutralize alkali soils and to break up hardpan and caliche. It serves as a soil conditioner. Uncalcined gypsum is used as a retarder in Portland cement. Satin spar and alabaster are cut and polished for various ornamental purposes, but are restricted in their uses because of their softness.

Gypsum can be added to paint as a filler. The variety of gypsum called alabaster is a soft solid form of gypsum that can be easily cut and polished into carvings and sculptures.

## 5. HALITE (salt)

NaCl (Sodium Chloride)



**Halite**

Cleavage:	*Perfect in three directions at 90 degrees, forming cubes
Hardness:	*2 to 2.5
Sp. Gr.:	2.17
Color:	Colorless or tints of gray, yellow, red, blue, green, purple
Luster:	Non-metallic -- vitreous; transparent to translucent
Crystals:	Isometric; usually the simple cube
Streak:	White
Other:	*Salty taste
Name:	The name halite is from the Greek <i>hals</i> , "salt".

Halite occurs in widespread evaporite deposits of chemical sedimentary rocks and is commonly associated with gypsum, thenardite, borax, and other salts.

**Uses of Halite:** In the United States, over 40% of salt is used in the chemical industry (mainly for the production of chlorine and caustic soda), and another 40% is used as a de-icer on roads in winter. The remaining is consumed in several industries, including manufacture of rubber and other goods, agriculture, and food processing. Table salt accounts for only about 1% of U.S. salt and is also used in the preservation of butter, cheese, fish, and meat.

Halite is used in the chemical industry and is a source of chlorine for the manufacture of hydrochloric acid and sodium for many sodium compounds. Salt is used to prepare sodium hydroxide, soda ash, caustic soda, hydrochloric acid, chlorine, metallic sodium, used in ceramic glazes, metallurgy, curing of hides, mineral waters, soap manufacture, home water softeners, highway de-icing, photography, herbicide, fire extinguishing, nuclear reactors, mouthwash, medicine (heat exhaustion), in scientific equipment for optical parts.

Halite is often used both residentially and municipally for managing ice. Because brine (a solution of water and salt) has a lower freezing point than ordinary water, putting salt on ice will cause it to melt. It is common for homeowners in cold climates to spread 'rock salt' on their walkways and sometimes driveways after a snow storm to melt the ice. It is not necessary to use so much salt that the ice is completely melted; rather, a small amount of salt will weaken the ice so that it can be easily removed by other means. Also, many cities will spread a mixture of sand and salt on roads during and after a snowstorm to improve traction.

Halite is a food supplement for humans and animals (table salt). It is also used food seasoning and food preservation. In addition, it is used in pellet form in water softeners (This . Salt is used extensively in the natural state in tanning hides, in fertilizers, in stock feeds, in salting icy highways, and as a weed killer.

## 4. MOLYBDENITE

$\text{MoS}_2$  (Molybdenum sulfide)



<b>Cleavage:</b>	Perfect basal cleavage. Laminae flexible, but not elastic. Sectile. Layers are curved due to the softness of the molybdenite.
<b>Hardness:</b>	1-1.5
<b>Sp. Gr.:</b>	4.7
<b>Color:</b>	Blue black
<b>Streak:</b>	Black to greenish black
<b>Luster:</b>	Metallic greasy feel; opaque
<b>Crystal:</b>	Hexagonal, platy crystals, scaly
<b>Other:</b>	Greasy, slippery feel. Writes on paper
<b>Name:</b>	The name molybdenite is from the Greek word meaning <i>lead</i> .

### Molybdenite

**Uses of Molybdenite:** Molybdenite is the chief ore of molybdenum. General uses for molybdenum are in machinery (35%), for electrical applications (15%), in transportation (15%), in chemicals (10%), in the oil and gas industry (10%), and assorted others (15%).

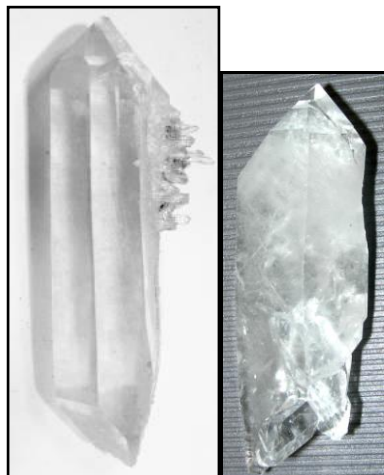
Most molybdenum (nickname = moly) is alloyed with iron to make steel, making it stronger and more highly resistant to heat. The alloys are used to make such things as rifle barrels and filaments for light bulbs. Stainless steels include the strength and corrosion-resistant requirements for water distribution systems, food handling equipment, chemical processing equipment, home, hospital, and laboratory requirements. Alloy steels include the stronger and tougher steels needed to make automotive parts, construction equipment, gas transmission pipes. Tool steels use molybdenum make bearings, dies, machining components; cast irons use moly for steel mill rolls, auto parts, and crusher parts; super alloys use moly in furnace parts, gas turbine parts, chemical processing equipment.

Molybdenum is also used in the chemicals and lubricant industries. Molybdenum has uses as catalysts, paint pigments, corrosion inhibitors, smoke and flame retardants, dry lubricant (molybdenum disulfide) on space vehicles, as it is resistant to high loads and temperatures. As a pure metal, molybdenum is used because of its high melting temperatures (4,730 F.) as filament supports in light bulbs, metal-working dies and furnace parts. Molybdenum cathodes are used in special electrical applications. It can also be used as a catalyst in some chemical applications.

Molybdenum has recent application as electrodes for electrically heated glass furnaces and foreheaths. The metal is also used in nuclear energy applications and for missile and aircraft parts. Molybdenum is valuable as a catalyst in the refining of petroleum. Molybdenum is used in applications as a filament material in electronic and electrical applications. Molybdenum is an essential trace element in plant nutrition. Some lands are barren for lack of this element in the soil. Molybdenum sulfide is useful as a lubricant, especially at high temperatures where oils would decompose. Almost all ultra-high strength steels with minimum yield points up to 300,000 psi (lb/in.2) contain molybdenum in amounts from 0.25 to 8%.

# 1. QUARTZ

SiO<sub>2</sub> (Silicon Oxide)



Cleavage:	None
Fracture:	*Conchoidal
Hardness:	*7
Sp. Gr.:	2.6
Color:	Colorless, purple ( <i>amethyst</i> ), pink to deep red ( <i>rose</i> ), yellow ( <i>citrine</i> ), brown to black ( <i>smoky</i> ), white ( <i>milky</i> )
Streak:	White
Luster:	Non-metallic -- vitreous; transparent to translucent
Crystals:	Hexagonal; six sided, often with one or more faces striated crosswise
Name:	The name quartz is from the German <i>Quarz</i> , of uncertain origin.

Quartz is an important rock forming mineral that develops and persists in many different environments. It is one of the common minerals in granite and rhyolite and in metamorphic rocks. Much of the world's sand and consequently sandstone (a sedimentary rock) is quartz, the result of the physical breakdown of rocks containing quartz and quartz's resistance to physical and chemical attack. It is also associated with many ore bodies, particularly gold and pegmatites containing many rare earth elements (lithium, beryllium, etc.).

**Uses of quartz and microcrystalline varieties of quartz:** Quartz is widely used as gemstones or ornamental material, as amethyst, rose quartz, cairngorm, tiger eye, aventurine, carnelian, agate, and onyx. As sand, quartz is used in mortar, in concrete, as a flux, as an abrasive, and in the manufacture of glass and silica brick. In powdered form it is used in porcelain, paints, sandpaper, scouring soaps, and as a wood filler. In the form of quartzite and sandstone, it is used as a building stone and for paving purposes.

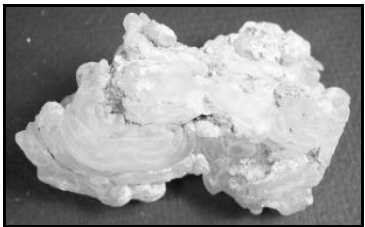
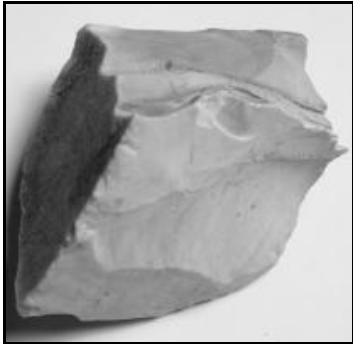
Quartz has many uses in scientific equipment. Because of its transparency in both the infrared and ultraviolet portions of the spectrum, quartz is made into lenses and prisms for optical instruments. The optical activity of quartz (the ability to rotate the plane of polarization of light) is used in making an instrument to produce monochromatic light of differing wavelengths.

Because of its piezoelectric property, quartz has specialized uses. It is cut into small oriented plates and used as radio oscillators to permit both transmission and reception on a fixed frequency. The tiny quartz plate used in digital quartz watches serves the same function. This property also renders it useful in the measurement of instantaneous high pressures such as result from firing a gun or atomic explosion.

Quartz sand is the base mineral for the glass and fiberglass industries and is also used in concrete. Quartz crystals, both natural and synthetic are used for electronic radio frequency

control and in quartz watches; also in optical instruments. Finely ground quartz is used as filler in porcelain, paints and wood filler. Quartz is also used as an abrasive in sandblasting and sandpaper. Colored varieties are considered semi-precious gemstones. Amethyst is the birthstone for February.

Except for form, the finely crystalline varieties of quartz have the same mineral properties as the larger-crystallized varieties. The very finely crystalline (massive or cryptocrystalline) varieties of quartz are very common in Arizona and occur in the following subvarieties:

<p><b>Chalcedony</b></p>   <p><b>Chert</b></p>	<p>Non-metallic -- waxy luster, vitreous to dull; translucent to opaque . The name chalcedony is derived from <i>Chalcedon</i>, an ancient Greek city of Asia Minor.</p> <p><b>Varieties of chalcedony include:</b></p> <p><b>Agate:</b> vari-colored, banded or patterned; translucent.</p> <p><b>Jasper:</b> vari-colored, generally red (or green), sometimes banded or patterned; opaque.</p> <p><b>Carnelian:</b> red; translucent</p> <p><b>Bloodstone:</b> green with red spots; opaque</p> <p><b>Flint:</b> vari-colored, generally solid dull colors; opaque</p> <p><b>Chert:</b> a general term for cryptocrystalline quartz, of any color</p> <p><b>Chrysoprase:</b> apple green; translucent</p> <p><b>Tiger's Eye:</b> quartz after asbestos (pseudomorph); fibrous character retained; yellow or brown</p>
<p><b>Opal</b> (not a form of quartz, but with a similar composition)</p>	<p><b>Opal</b> is a hydrous silica with no crystal structure, but instead it is composed of closely packed silica spheres.</p> <p>Hardness = 5.5, Sp. Gr. = 2.0-2.25;</p> <p>Luster is non-metallic -- vitreous; transparent to translucent; clear, white, milky/bluish, yellow, black are common colors; sometimes displays "fire" or a play of colors due to refractive properties of the aggregate of spheres. It is the birthstone of October. The name possibly derives from the Sanskrit <i>upala</i>, "precious stone".</p>

## IGNEOUS ROCKS

### 8. BASALT (rock)



Basalt is a dark, fine grained rock that is often vesicular (having gas pockets). The gas pockets may be filled with secondary minerals, such as quartz, zeolite minerals, calcite, opal, etc. and then it is called amygdaloidal basalt.

Basalt with large masses of olivine (sometimes called peridot) or gas pockets filled with zeolite minerals are found in Arizona. The peridot is thought to have originated in the Earth's mantle; the zeolites are secondary minerals filling vesicles (gas bubble holes).

Basalt is an extrusive igneous rock occurring as thin to massive lava flows. The flows sometimes accumulate to thicknesses of thousands of feet and cover thousands of square miles. The volcanoes that produce basaltic lavas are relatively quiet, like the Hawaiian Islands volcanoes.

The name is of uncertain origin, but may have originated with Pliny who used the Ethiopian word *basal* for iron-bearing rocks.

**Uses of basalt:** Basalt is used for a wide variety of purposes. It is most commonly crushed for use as an aggregate in construction projects. Crushed basalt is used for road base (road bed material), concrete aggregate, asphalt pavement aggregate, railroad ballast, filter stone in drain fields, ground cover in landscaping, and many other purposes.

Basalt is also cut into dimension stone and sometimes polished for use as floor tiles, building veneer, monuments and other stone objects. Other uses of basalt are in the production of high quality textile fibers, floor tiles, acid-resistant equipment for heavy industrial use, rock-wool, basalt plastic pipers, basalt plastic reinforcement bars, basalt fiber roofing felt (ruberoid), basalt laminate used as a protective coating, heat-insulating basalt fiber materials, glass wool (fiber glass). Basalt is used where its weight is important, such as in levees to hold back flood waters.

Basalt is used in manufacturing and is made into fine, superfine, and ultra-fine fibers. Comprised of single-ingredient raw material melt, basalt fibers are better than other fibers in terms of thermal stability, heat and sound insulation properties, vibration resistance and durability. Basalt products have no toxic re-action with air or water and are non-combustible and explosion proof.

Basalt replaces almost all applications of asbestos and has three times its heat insulation properties. Basalt-based composites can replace steel and all known reinforced plastics. The life of basalt fiber pipes, designed for a variety of applications, could be at least 50 years without maintenance or electrical or technical protection. Basalt fibers, together with carbon or ceramic fibers, as well as various metals, are applied in new hybrid composite materials.

Basalt is the best reinforcement for concrete due to its tensile strength and natural resistance to deterioration. Basalt is used as reinforcement for composites and for polyester/epoxy resins and plastics as used in automotive body panels, boat hulls and protruded products. It is used for friction-resistant materials, such as brake pads and linings, and in high-temperature insulation applications. Basalt is also used for passive fire protection materials and for filler for gypsum and sheetrock board requiring increased 'burn-thru' capability to meet building regulations. It is also used for filler in high-performance automotive mufflers.

## 7. GRANITE (rock)



Granite is a coarse to medium grained igneous rock that forms from the cooling of magma deep within the Earth. It is made up mainly of varying amounts of the minerals: quartz, orthoclase, muscovite, biotite and hornblende.

The color of granite can be light or dark brown or reddish depending on the amount of light colored minerals (quartz or orthoclase feldspar) or dark colored minerals (biotite, hornblende or plagioclase feldspar) or stain of iron oxides.

The name is from the Latin *granum*, for “grains”.

**Uses of granite:** Because of its resistance to breaking and weathering and its ability to take a high polish, granite is used in construction, as an ornamental stone, monuments, floor tiles, cutting boards and countertops. Granite may also be crushed for construction aggregate and desert landscaping.

Granite is one of the most popular building materials. Granite dimension stone is used in buildings, bridges, paving, monuments and many other exterior projects. Indoors, polished granite slabs and tiles are used in countertops, tile floors, stair treads and many other design elements. Granite tiles are often used as flooring and wall panels to produce an elegant, high-luster space.

In large construction projects, granite can be used as a structural element and as decorative facing or veneer. Granite is often used as a street curbing. Curbs made from granite are more durable than those made of concrete and are more decorative.

Granite is the stone most often used as a grave marker in the United States and many other countries. It is a durable, attractive material, especially when polished. Granite is also the rock type most often associated with "permanence".

With increasing amounts of acid rain in parts of the world, granite has begun to supplant marble as a monument material, since it is much more durable. In building and for countertops, the term "granite" is often applied to all igneous rocks with large crystals, and not specifically to those with a granitic composition.

## SEDIMENTARY ROCKS

### 9. LIMESTONE (rock)

$\text{CaCO}_3$  (Calcium Carbonate)



**Fossiliferous Limestone**



**Limestone**

Limestone is a chemical sedimentary rock composed primarily of calcite. Generally it is dense, fine grained, non-clastic and usually white to dark gray with a hardness of 3-4.

Its most distinguishing feature is the fizzing in weak hydrochloric or acetic acid (vinegar).

Coquina is limestone made entirely of sea shells.

Fossiliferous limestone contains shells of sea animals.

Crystalline limestone

**Uses of Limestone and Marble:** The greatest consumption of limestone is in the manufacture of lime and Portland cement. It is composed of about 75% calcium carbonate (calcite) with the remainder silica and alumina, with small amounts of magnesium carbonate and iron oxide. When water is mixed with cement, hydrous calcium silicates and calcium aluminates are formed, creating hard concrete.

Limestone is an important raw material for the chemical industry, and finely crushed limestone is used as a soil conditioner, for whitening, and whitewash. Great quantities are quarried each year as a flux for smelting various metallic ores, and as an aggregate in concrete and as road metal. A fine-grained limestone is used in lithography.



Calcite in several forms is used in the building industry. Limestone and marble as dimension stone are used both for construction purposes and decorative exterior facings. Polished slabs of travertine and Mexican onyx are commonly used as ornamental stone for interiors.

Calcite (limestone and marble) is also used to collect sulfur dioxide from the smokestack gases that result from burning coal for energy or smelting sulfide ore minerals.

It is finely ground and used for a filler in many products such as paint, kitchen counter and bathroom vanity tops, chalk for lining athletic fields and plastics; also as a dusting on chewing gum, to keep the gum from sticking to the wrapper. Being relatively soft (hardness 3), it makes a mild abrasive additive to toothpaste. Limestone is used extensively as a building stone and is often carved into monuments.

The main use of calcite (and limestone and marble, which are made of calcite) is in cement and lime mortars. Calcite is also used as a filler in paper, paint, and plastics. A minor use for its optical properties is in scientific instruments. Calcite is used in agriculture and horticulture as a soil amendment to treat acidic soils and provide calcium to livestock. It is also the main ingredient in antacid tablets.

## 10. SANDSTONE (rock)



	<p>Sandstone is a sedimentary rock made up of fine grained particles (.05-2 mm) of pre-existing rocks. The sand grains (often quartz) were transported mechanically by wind, water or ice to the place of deposition. There, they were cemented together by silica, carbonates, clay, iron oxide, or other minerals.</p>
	<p>Sandstone is identified by its sandy texture, which feels gritty - like coarse sandpaper.</p>

**Uses of Sandstone:** Sandstone is a source of sand for construction aggregate. When quarried and separated into plates or sheets along bedding planes, it is used as flagstone (Arizona is the flagstone capital of the United States). Cut into blocks, it is used as a building stone. It is crushed for use in concrete and asphalt and to fill in dikes and jetties. Rough and weathered sandstone is used as fireplaces, walls, and walkways. It is used as decorative stones, as bookends, clocks, paperweights, coaster, and other decorator items.

Sandstone is a silica source for glass, plate glass, fine table glassware, and common glassware. Sandstone is used in chemical industries as flooring and lining, due to its acid and alkali resistant properties. It is also used in load-bearing masonry.


## METAMORPHIC ROCKS

### 11. MARBLE (rock) $\text{CaCO}_3$ (Calcium Carbonate)

	<p>Marble is a metamorphic rock formed from limestone or dolomite. The colors can vary from pure white to gray, green, yellow, brown, black, red or any combination thereof, depending on the 'impurities' in the parent limestone.</p>
	<p>Bands or streaks result from plastic flow during extreme deformation due to high pressure and temperature. It is still calcite (as is limestone) and therefore will effervesce vigorously in weak hydrochloric or acetic acid. (See calcite; limestone; travertine)</p>

**Uses of Marble:** Marble is an important industrial rock. It can be cut into slabs, polished and used for finished exteriors and interiors of buildings, floors and counter tops (although it is quite soft and dulls easily from abrasion or acid exposure). It is also used for carved statuary. Coarsely crushed marble is used as landscaping, paving and roofing rock; finely crushed it makes poultry grit; and very finely ground marble is used as fillers and extenders for paints, plastics, paper and adhesives. See also limestone for additional uses of marble.

### 12. SCHIST (rock)







	<p>Schist is medium to coarse grained, crystalline, with prominent parallel mineral orientation, especially of mica. Typically, schist is predominately muscovite mica which lends a silvery white to gray sparkly appearance. Accessory minerals (such as garnets, staurolite, tourmaline) commonly grow in the schist.</p>
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**Uses of Schist:** Schist is added to clay mixtures as a strengthening material in vitreous clay pipe (red sewer pipe), clay roof tiles, and drywall joint compounds.

Schist is sometimes used as an ornamental building stone because it takes a fine polish and can be quite beautiful. Schist and gneiss show an alignment of their crystals because the high pressure in which they were formed tends to cause crystals to grow in the same alignment. Schist contains more mica than gneiss does, and since mica is a flaky mineral, schist is harder to work with. Schist is more difficult to polish than gneiss, and tends to stand up less well to weathering if placed, say, on the outside of a building. Schist is also a source of the semi-precious gemstone called garnet.

## Mineral and Rock Samples: (GEM booth at NSTA, Phoenix AZ, 2009)

Be sure to label the samples with the numbers, it will make doing the activities easier. Paint a white spot on the sample and then write on the spot with an indelible marker.

1. Quartz	2. Chalcopyrite	3. Fluorite	4. Molybdenite	5. Halite	6. Gypsum
					
7. Granite	8. Basalt	9. Limestone	10. Sandstone	11. Marble	12. Schist
