EARTH CRUST

Average depth of the earth crust thickness is 8-10 km. There are two different rocks which have different chemical and biological content.

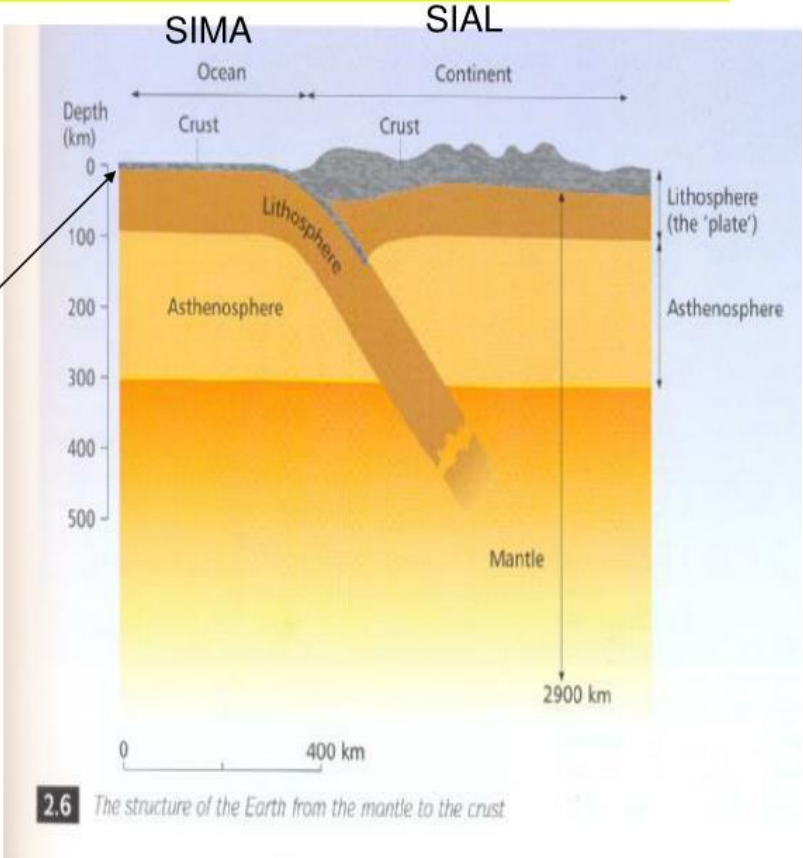
-Sial; average density: 2.7 gr/cm^3 (granite, sandstone and limestone)

-Sima; 2,8-3 gr/cm^3 (bazalt type rocks)

The sial layer in the ocean floor is almost absent. Sima reaches 8-10 km thickness.

1. CRUST : SIAL & SIMA

- Silica (Si) + magnesium (Mg) = **SIMA**
- Silica (Si) + aluminium (Al) = **SIAL**
- Sima at its deepest is temp of 1200 C
- Crust separated from mantle by the **MOHO** (MOHOROVICIC) **DISCONTINUITY**
- The crust and rigid top layer of mantle are collectively known a the **LITHOSPHERE (the PLATE)**



2.6 The structure of the Earth from the mantle to the crust

MATERIALS WHICH GENERATES THE CRUST

• Eight of the 106 elements found on the Earth's surface are very common.

• The 8 most common elements in the crust form 98.59% by weight of the ground shell.

Oxygen	Silisium	Aluminum	Iron	Calcium	Sodium	Potassium	Magnesium
%46.6	%27.72	%8.13	%5	%3.63	%2.83	%2.59	%2.09

• The remaining 98 elements constitute 1.4% by weight of the earth's crust.

MINERALS

More than 2000 minerals on Earth generates rocks, rocks constitute the crust.

-It is found naturally

-Has chemical composition (element or compound form).

-It can be expressed by a specific crystal system.

-It is mostly solid, liquid (mercury and water)

-Generally inorganic, at least organic compounds.

• **By definition a mineral is:**

• Naturally occurring

• An inorganic solid

• Ordered internal molecular structure

• Definite chemical composition

• Rock

• A solid aggregate of minerals

The Importance of Minerals

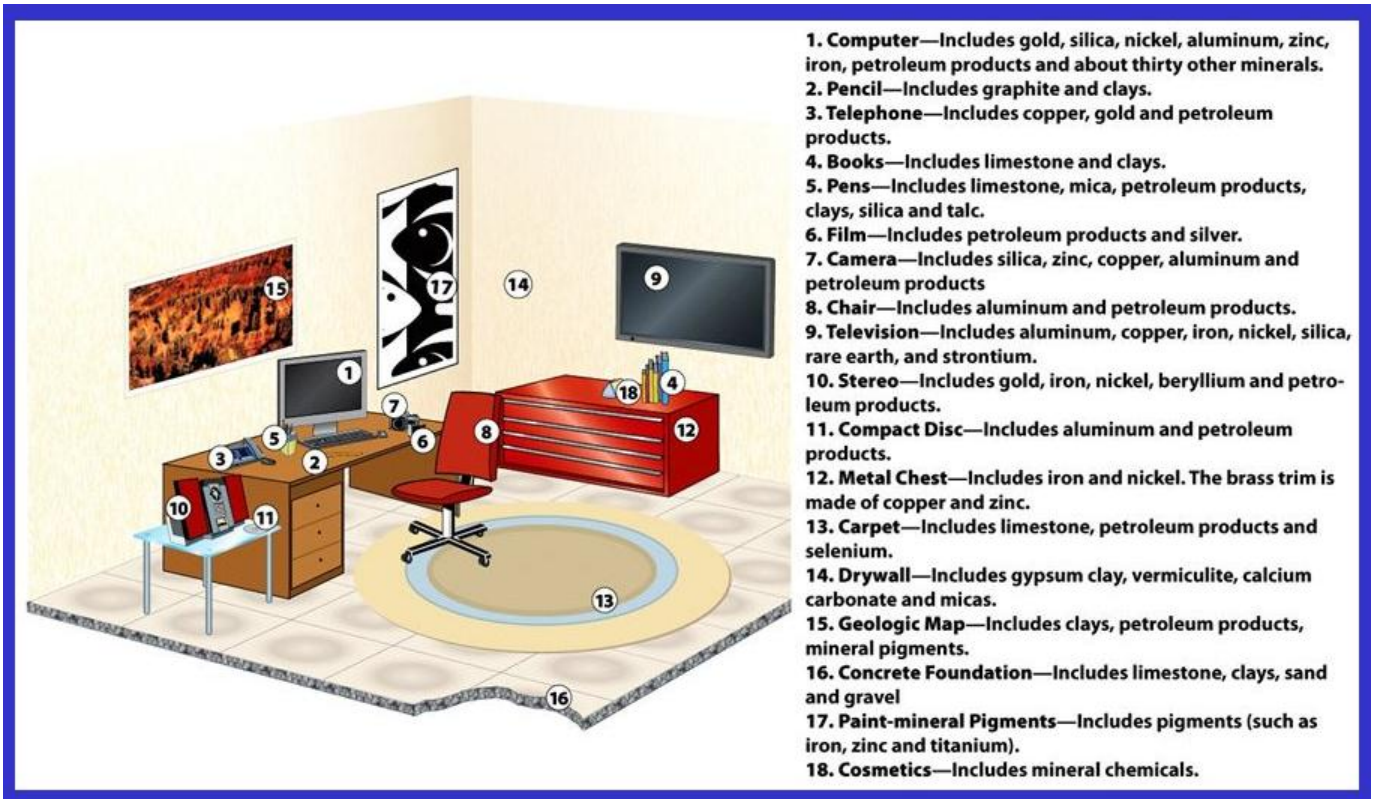
• Minerals and mines are part of the legacy that remains to us from the geological past. These are the basic building blocks of the solid part of the earth and are very important for construction geology;

• The minerals and rocks are the main sources for the production of automobiles, computers and many other things we use,

• Minerals and rocks play an important role in many earth processes such as landslides, coastal erosion and volcanic activity,

• Studies on minerals and rocks provide important information on earth history,

• Knowing process properties of the minerals and rocks provides to how the mechanisms in the earth and to understand how we can best manage our earth resources



CRYSTAL SHAPES OF MINERALS

Mineral Shape	Picture	Example	
Cubic		halite	
Monoclinic		gypsum	
Triclinic		feldspar	
Tetragonal		Zircon	
Hexagonal		quartz	
Orthorhombic		sulfur	

PHYSICAL PROPERTIES OF MINERALS

The main physical properties of minerals; Tenacity, Hardness, Cleavage, Fracture, Streak, Luster and Density

Tenacity

• The property of tenacity describes the behavior of a mineral under deformation. It describes the physical reaction of a mineral to externally applied stresses such as crushing, cutting, bending, and striking forces. Adjectives used to characterize various types of mineral tenacity include 'brittle,' 'flexible,' 'elastic,' 'malleable,' 'ductile,' and 'sectile'
Mica (turns back to its original state when twisted), Chlorite (remains twisted) When the hammer hit some minerals can become extended or plate.

Gold Silver Copper

• Brittle - Breaks or powders easily.

• Malleable - can be hammered into thin sheets.

• Sectile - can be cut into thin shavings with a knife.

• Ductile - bends easily and does not return to its original shape.

• Flexible - bends somewhat and does not return to its original shape.

• Elastic - bends but does return to its original shape.

Most mineral species are brittle, and will crumble or fracture under pressure or upon the application of a blow. Such materials break or powder easily.

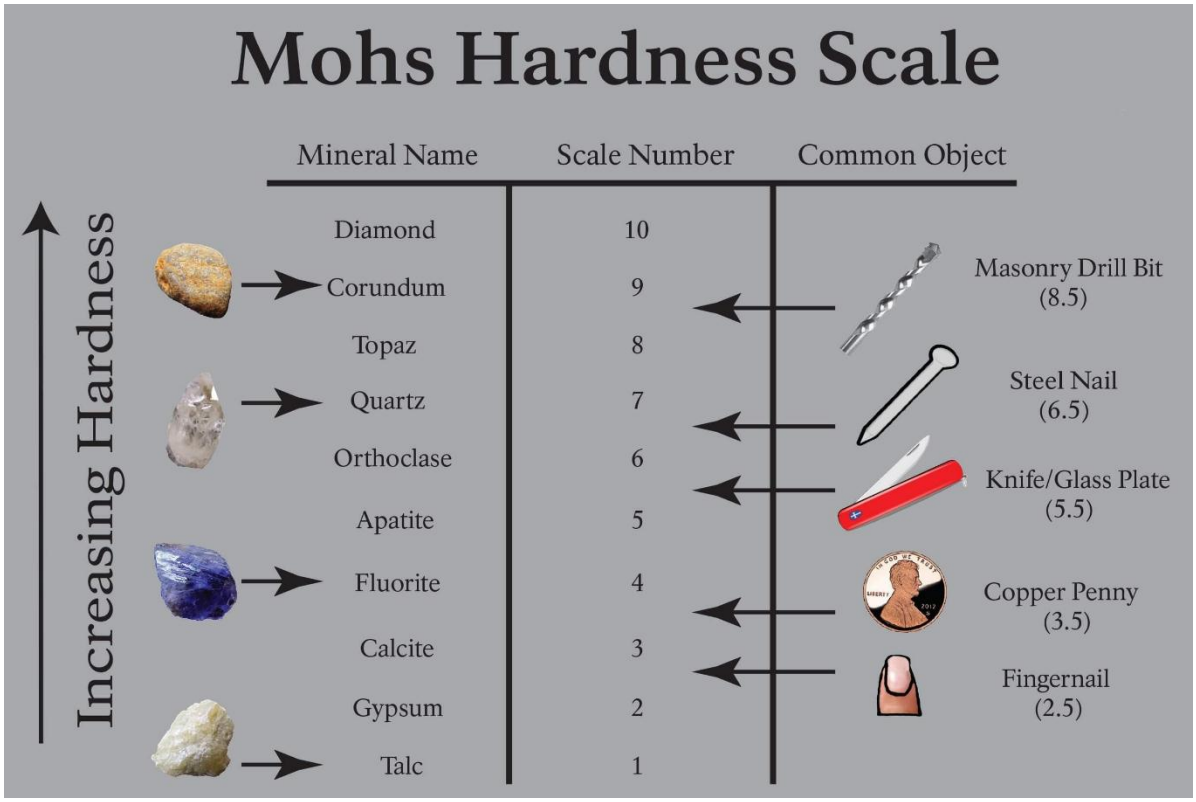
Antimony quartz

Hardness

Hardness has traditionally been defined as the level of difficulty with which a smooth surface of a mineral specimen may be scratched. The hardness of a mineral species is dependent upon the strength of the bonds which compose its crystal structure.

Hardness is a property characteristic to each mineral species and can be very useful in identification.

Hardness minerals are resistance to scratching. It is the result of the cohesion between these molecules. It is determined with the aid Mohs hardness scale formed by mineral hardness.



RATING	DESCRIPTION	MINERAL EXAMPLE
1: VERY SOFT	EASILY CRUMBLES. CAN BE SCRATCHED WITH A FINGERNAIL (2.2)	TALC
2: SOFT	CAN BE SCRATCHED WITH A FINGERNAIL (2.2)	GYPUSM 
3: SOFT	CAN BE SCRATCHED WITH A COPPER PENNY (3.5)	CALCITE 
4: SEMI-HARD	CAN BE SCRATCHED WITH A NAIL (5.2)	FLUORITE 
5: HARD	CAN BE SCRATCHED WITH A NAIL (5.2)	APATITE 
6: HARD	MINERAL WITH HARDNESS OF 6 OR MORE CAN SCRATCH GLASS	FELDSPAR 
7: VERY HARD	CAN BE SCRATCHED WITH A COCRETE NAIL (7.5)	QUARTZ 
8: VERY HARD		TOPAZ 
9: EXTREMELY HARD	USED IN INDUSTRIAL TOOLS FOR CUTTING AND GRINDING	CORUNDUM 
10: THE HARDEST	DIAMOND IS USED TO CUT ALL MINERALS	DIAMOND 

Cleavage

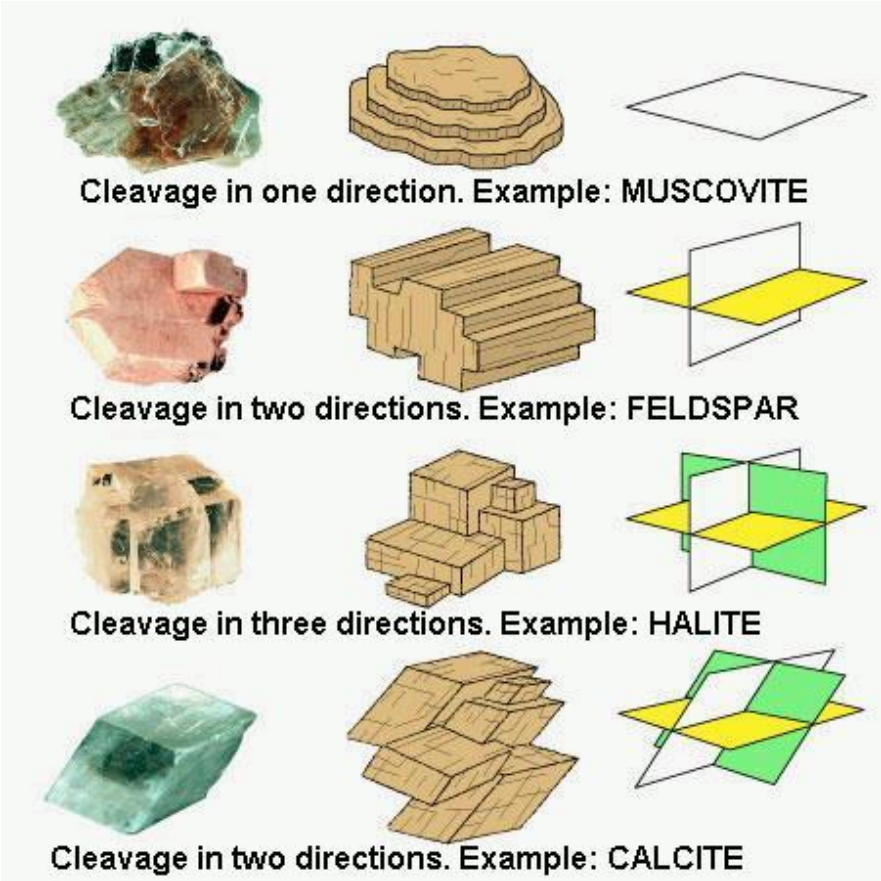
• A cleavage plane is a plane of structural weakness along which a mineral is likely to split smoothly.

• Cleavage thus refers to the splitting of a crystal between two parallel atomic planes.

• Despite the fact that every mineral belongs to a specified crystal system, not every mineral exhibit cleavage.

• Cleavage planes, if they exist, are always parallel to a potential crystal face. However, such planes are not necessarily parallel to the faces which the crystal actually displays. Fluorite, for example, has octahedral cleavage yet forms cubic crystals.

• Nonetheless, the property of cleavage, if it is present, can offer important information about the symmetry and inner structure of a crystal.



Fracture

If the mineral contains no planes of weakness, it will break along random directions called fracture. Several different kinds of fracture patterns are observed.

• Conchoidal fracture - breaks along smooth curved surfaces.

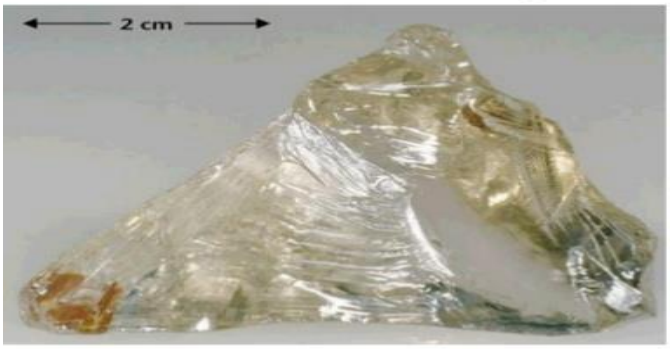
• Fibrous and splintery - similar to the way wood breaks.

• Hackly - jagged fractures with sharp edges.

• Uneven or Irregular - rough irregular surfaces

Fracture

Fracture is the way a mineral breaks when it doesn't break along cleavage planes.



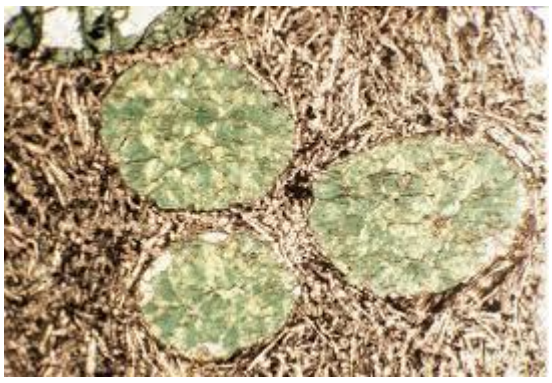
Quartz has conchoidal fracture.

Asbestos has splintery or fibrous fracture.

Colour

• Color is sometimes an extremely diagnostic property of a mineral, for example olivine and epidote are almost always green in color.

• But, for some minerals it is not at all diagnostic because minerals can take on a variety of colors. These minerals are said to be allochromatic. For example quartz can be clear, white, black, pink, blue, or purple.



Streak

Streak is the color produced by a fine powder of the mineral when scratched on a streak plate. Often it is different than the color of the mineral in nonpowdered form Hematite: red; Limonite: brown; Magnetite: dark gray; Chromite: brown;

Magnetite: dark gray;

Chromite: brown

Luster

Luster refers to the general appearance of a mineral surface to reflected light. Two general types of luster are designated as follows:

• Metallic - looks shiny like a metal. Usually opaque and gives black or dark colored streak.

• Non-metallic - Non metallic lusters are referred to as

vitreous - looks glassy - examples: clear quartz, tourmaline

resinous - looks resinous - examples: sphalerite, sulfur.

pearly - iridescent pearl-like - example: apophyllite.

greasy - appears to be covered with a thin layer of oil - example: nepheline.

silky - looks fibrous. - examples - some gypsum, serpentine, malachite.

adamantine - brilliant luster like diamond.

Structure

Kidney, chordal, chordal radial, concussion, lump and concentric.

•Kidney : **Chalcedon**, hematite

•Chordal: **Asbestos**, gypsum, calcite,

•Radial: **Antimony**,

•Chordal radial: **Pyrite**, barite

•Concussion: **Calcite**, agate, pyrite, agate,

•Lump: **Flintstone**

•Concentric: **Agat,** Calcedon

Specific Gravity

• Density refers to the mass per unit volume.

• Specific Gravity is the relative density, (weight of substance divided by the weight of an equal volume of water).

• In cgs units density is grams per cm^3 , and since water has a density of 1 g/cm^3, specific gravity would have the same numerical value has density, but no units (units would cancel).

• Specific gravity is often a very diagnostic property for those minerals that have high specific gravities.

• In general, if a mineral has higher atomic number cations it has a higher specific gravity.

Mineral	Composition	Atomic # of Cation	Specific Gravity
Aragonite	$CaCO_3$	40.08	2.94
Strontianite	$SrCO_3$	87.82	3.78
Witherite	$BaCO_3$	137.34	4.31
Cerussite	$PbCO_3$	207.19	6.58

Specific gravity can usually be qualitatively measured by the heft of a mineral, in other words those with high specific gravities usually feel heavier.

Most common silicate minerals have a specific gravity between about 2.5 and 3.0. These would feel light compared to minerals with high specific gravities

Mineral	Composition	Specific Gravity
Graphite	C	2.23
Quartz	SiO_2	2.65
Feldspars	$(K,Na)AlSi_3O_8$	2.6 - 2.75
Fluorite	CaF_2	3.18
Topaz	$Al_2SiO_4(F,OH)_2$	3.53
Corundum	Al_2O_3	4.02
Barite	$BaSO_4$	4.45
Pyrite	FeS_2	5.02
Galena	PbS	7.5
Cinnabar	HgS	8.1
Copper	Cu	8.9
Silver	Ag	10.5

Radioactivity

The radioactivity in the minerals comes from the uranium (U) and thorium (Th) found in them. Some elements such as potassium (K) and rubidium (Rb) also have a small amount of radioactivity.

It is aimed to determine the geological age by making use of the radioactivity feature in minerals.

Major Mineral Groups

Minerals are grouped by their chemical composition. Silicates, oxides, sulfates, sulfides, carbonates, native elements, and halides are all major mineral groups.

1. Silicates , 2. Oxides , 3. Sulfates, 4. Sulfides, 5. Carbonates, 6. Native Elements

7. Halides

1-Silicates

• Silicate minerals contain silicon (Si) and oxygen (O), the two most abundant elements in the earth's crust.

• Over 90% of the common rock-forming minerals are silicates.

• Common silicate minerals include: olivine, pyroxene, amphibole, biotite mica, muscovite mica, plagioclase feldspar, orthoclase feldspar, and quartz.

Olivine :

• The composition of olivine is $(Mg,Fe)_2SiO_4$

• Olivine is identified by its glassy luster, conchoidal fracture, and olive-green color.

• Its hardness is 6.5.

• Its specific gravity is 3.2.

2-Oxides

• Oxide minerals are made up of oxygen and one or more metals.

• Common oxide minerals include: hematite and limonite

Hematite :

• Hematite, an iron oxide, has a composition of Fe_2O_3.

• Hematite is identified by its non-metallic or metallic luster and its red to red-brown streak.

• Hematite is identified by its non-metallic or metallic luster and its red to red-brown streak.

• Its hardness is 1.5 to 5.5.

• Its specific gravity is 4.9 to 5.3.

• Hematite is used in pigments and as an iron ore.

Hematite, shown here, is an iron oxide. It is a common iron ore.

3-Sulfates

• Sulfate minerals contain sulfur and oxygen (SO_4) combined with other elements.

• Common sulfate minerals include: gypsum and barite.

Gypsum :

• Gypsum has a composition of $CaSO_4 \cdot nH_2O$.

• Gypsum is identified by its non-metallic luster; colorless to white color; and very low hardness.

• Gypsum is soft. Its hardness is 2.

• Its specific gravity is 2.3.

• Gypsum is used in wallboard (drywall) and plaster of paris

Gypsum, shown here, is a sulfate mineral. This variety of gypsum, characterized by long, shiny needles, is called satinspar.

4- *Sulfides*

• Sulfide minerals contain sulfur and a metal.

• Common sulfide minerals include: galena and pyrite

Galena :

• Galena has a composition of PbS.

• Galena is identified by its metallic, silvery gray luster; gray to dark gray streak; high specific gravity; and three perfect cleavages at 90 degrees.

• Its hardness is 2.5.

• Its specific gravity is 7.4 to 7.6.

• Galena is a lead ore. It is used in television glass, auto batteries, solder, ammunition, and paint.

Galena is a common lead ore. Notice how the samples are almost cubes. Galena is in the cubic crystal system. The right photograph shows a galena sample and its streak. Galena's high specific gravity makes it feel especially heavy. Its specific gravity helps geologists to identify it.

5-Carbonates

• Carbonate minerals contain carbonate (CO_3), a combination of carbon and oxygen, combined with other elements.

• Common carbonate minerals include: calcite and dolomite.

Calcite :

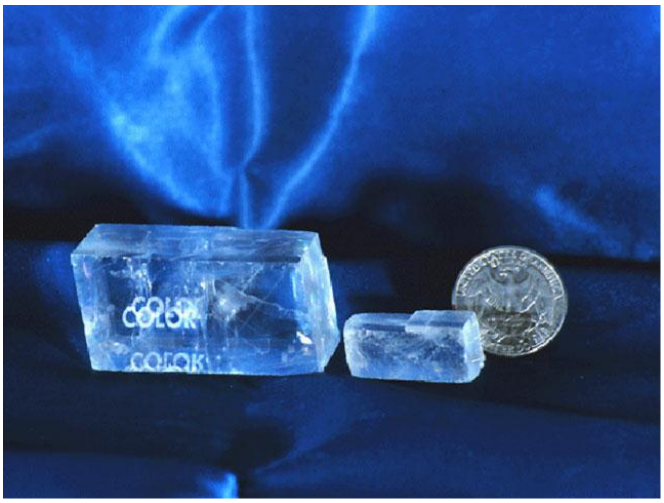
• Calcite has a composition of $CaCO_3$.

• Calcite is identified by its glassy to earthy luster; color variety; and its perfect cleavage in three directions (not at 90 degrees). Calcite fizzes in hydrochloric acid.

• Its hardness is 3.

• Its specific gravity is 2.7.

• Calcite forms the rocks limestone and marble. It is used in fertilizer, cement, paper, building stone, and many other industries.



Calcite has excellent cleavage in three directions at 75 degrees, and commonly forms the rhombohedral shapes seen here. Another property of calcite is double refraction, meaning light traveling through the mineral forms double images

6- Native Elements

• Native elements are minerals that form as individual elements. Gold and copper are examples of metallic native elements.

• Diamonds are a type of non-metallic native element.

Gold :

Gold is a valuable native element. Its composition is Au. It is identified by its gold color, gold streak, and very high specific gravity (19.3). It is used as a monetary standard, in jewelry, and in scientific and medical instruments.

7-Halides

• Halides include such elements as chlorine and fluorine. Common halide minerals include halite and fluorite.

Halite :

Halite, the mineral name for common salt, is a halide mineral. Its composition is NaCl. It is identified by its cubic form, salty taste, and colorless appearance. Its hardness is 2.5. Its specific gravity is 2.1 to 2.6. Halite is used for nutrition, snow removal, water softeners, and many other products.