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PHYSICAL PROPERTY OF MINERALS

Rocks are aggregate of minerals i.e. rocks may consist of aggregate of only one type of mineral (these type of rocks exist very few in nature), or may be an aggregate of two or more different types of minerals. Thus minerals are the main building blocks of rocks.

A mineral is defined as– “a naturally occurring inorganic substance; having an ordered internal structure, and has a fixed chemical composition.”

“Naturally occurring” means that people did not make it. “Inorganic" means that the substance is not made by an organism. “Definite chemical composition" means that all occurrences of that mineral have a chemical composition that varies within a specific limited range. “Ordered internal structure” means that the atoms in a mineral are arranged in a systematic and repeating pattern.

That they are naturally occurring and inorganic separates minerals from most manufactured substances as well as materials formed only in biological processes. Most minerals form by inorganic processes but some, identical in all respects to inorganically formed minerals, are produced by organic processes (for example, the calcium carbonate in the shells of clams or snails). A few naturally occurring substances called *mineraloids* have characteristic chemical compositions but are amorphous. Opal is an example. Their internal structure and chemical composition gives minerals characteristic physical and chemical properties that provide clues to identify the minerals.

Physical Propertiey of minerals

Colour, luster, streak, hardness, cleavage, fracture, and crystal form, *tenacity* are the most useful physical properties for identifying most minerals.

1.Colour

Colour is one of the most obvious properties of a mineral but it is often of limited diagnostic value, especially in minerals that are not opaque. While many metallic and earthy minerals have distinctive colors (or example olivine and epidote are almost always green in colour), transluscent or transparent minerals can vary widely in color. These minerals are said to be *allochromatic.* For example quartz can be clear, white, black, pink, blue, or purple.

2. Streak

Streak is the color produced by the fine powder of a mineral when scratched on an unpolished piece of white porcelain plate called streak plate. Often the colour of powder of a mineral is different than the color of the mineral in non-powdered form.

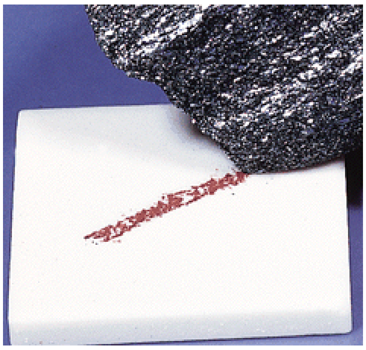


Figure- The streak of this dark gray mineral (hematite), obtained by rubbing it on the white streak plate is reddish brown.

3. Lusture

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

I. ***Metallic*** - looks shiny like a metal. Usually opaque and gives black or dark coloured streak e.g. galena.

II. ***Non-metallic*** - Non metallic lusture are referred to as-

a. ***Vitreous*** - looks glassy - examples: clear quartz, tourmaline.
b. ***Resinous*** - looks resinous - examples: sphalerite.
c. ***Pearly*** - iridescent pearl-like - example: apophyllite.

d. ***Greasy*** - appears to be covered with a thin layer of oil - example: nepheline.
e. ***Silky*** - looks fibrous. - examples - some gypsum, serpentine, malachite.
f. ***Adamantine*** - brilliant luster like diamond.

4. Crystal habit/Form

A crystal is a solid, homogeneous, orderly array of atoms and may be nearly any size. The arrangement of atoms within a mineral determines the external shape of its crystals. The faces that develop on a crystal depend on the space available for the crystals to grow. If crystals grow into one another or in a restricted environment, it is possible that no well-formed crystal faces will be developed. However, crystals sometimes develop certain forms more commonly than others, although the symmetry may not be readily apparent from these common forms. The term used to describe general shape of a crystal is ***habit/form.***

a) ***Cubic*** - cube shape, e.g. pyrite.

b) ***Octahedral*** - shaped like octahedrons, e.g. fluorite.

c) ***Tabular*** - rectangular shape, e.g. feldspar.

d) ***Acicular* -** long, slender crystals, e.g. millerite.

e) ***Prismatic* -** abundance of prism faces, e.g. tourmaline.

f) ***Bladed* -** like a wedge or knife blade, e.g. kyanite.

5. Hardness

Hardness is the resistance of a mineral to scratching or abrasion by other materials. Hardness is determined by scratching the surface of the sample with another mineral or material of known hardness.

Hardness is determined on the basis of Moh's relative scale of hardness exhibited by some common minerals. The Mohs Hardness Scale (Table 1), consists of ten minerals ranked in ascending order of hardness (along with harness of some common substances) with diamond, the hardest known substance, assigned the number 10.

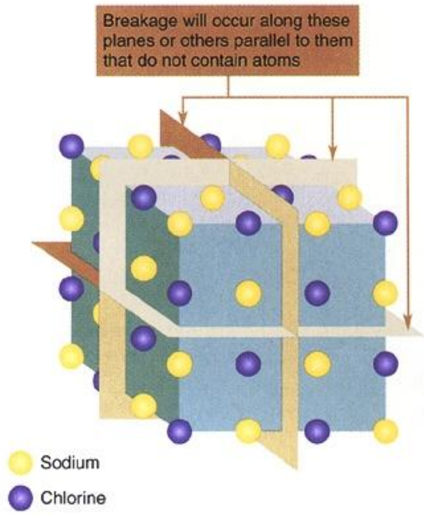
Mineral	Hardness
Talc	1
Gypsum	2
Calcite	3
Fluorite	4
Apatite	5
Orthoclase	6
Quartz	7
Topaz	8
Corundum	9
Diamond	10

← Piece of plastic, 1
← Fingernail, 2.5
← Copper coin, 4.5
← Glass plate, 5.5
← Steel file, 6.5

Table 1- Moh's Hardness Scale.

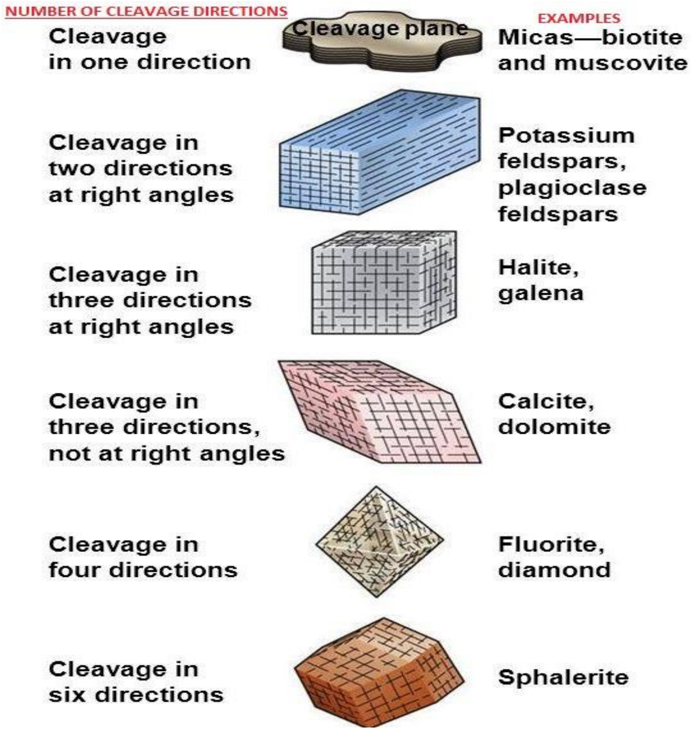
6. Cleavage and Fracture

The way in which a mineral breaks is determined by the arrangement of its atoms and the strength of the chemical bonds holding them together. Because these properties are unique to the mineral, careful observation of broken surfaces may aid in mineral identification. A mineral that exhibits cleavage consistently breaks, or cleaves, along parallel flat surfaces called cleavage planes.



(The illustration above shows that atoms of sodium (yellow) and chlorine (blue) in the mineral halite are parallel to three planes that intersect at 90°. Halite breaks, or cleaves, most easily between the three planes of atoms, so it has three directions of cleavage that intersect at 90°. The photograph illustrates the three directions of cleavage in halite.)

Minerals have characteristic numbers of cleavages (Figure below). This number is determined by counting the number of cleavage surfaces that are not parallel to each other.



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.

7. Tenacity

Tenacity is the resistance of a mineral to breaking, crushing, or bending. Tenacity can be described by the following terms.

a) ***Brittle*** - Breaks or powders easily.
b) ***Malleable*** - can be hammered into thin sheets.
c) ***Sectile*** - can be cut into thin shavings with a knife.
d) ***Ductile*** - bends easily and does not return to its original shape.
e) ***Flexible*** - bends somewhat and does not return to its original shape.
f) ***Elastic*** - bends but does return to its original shape.

8. Specific Gravity

Specific Gravity is the relative density, (weight of substance divided by the weight of an equal volume of water). In c.g.s 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.

Most silicate, or rock-forming, minerals have specific gravities of 2.6 to 3.4; the ore minerals are usually heavier, with specific gravities of 5 to 8 (Table 2). If you compare similar samples of two different minerals, the one with the higher specific gravity will feel the heaviest; it has a greater heft. For most minerals, specific gravity is not a particularly noteworthy feature, but for some, high specific gravity is distinctive (examples are manganite, pyrite and galena).

Mineral	G
Halite	2.1–2.6
Gypsum	2.3–2.4
Serpentine	2.3–2.6
Orthoclase	2.5–2.6
Chalcedony	2.6–2.64
Quartz	2.65
Plagioclase	2.6–2.8
Chlorite and illite	2.6–3.0
Calcite	2.7
Muscovite	2.7–3.0
Biotite	2.8–3.1
Dolomite	2.8–3.1
Anhydrite	2.9–3.0
Pyroxene	3.2–3.6
Olivine	3.2–3.6
Barite	4.3–4.6
Magnetite	4.4–5.2
Pyrite	4.9–5.2
Galena	7.4–7.6

Table 2- Specific Gravity (G) of some common minerals.

9. Magnetism

Magnetic minerals result from properties that are specific to a number of elements. Minerals that do not have these elements, and thus have no magnetism are called *diamagnetic*. Examples of diamagnetic minerals are quartz, plagioclase, calcite, and apatite. Elements like Ti, Cr, V, Mn, Fe, Co, Ni, and Cu can sometimes result in magnetism. Minerals that contain these elements may be weakly magnetic and can be separated from each other by their various degrees of magnetic susceptibility. These are called *paramagnetic* minerals. Paramagnetic minerals only show magnetic properties when subjected to an external magnetic field. When the magnetic field is removed, the minerals have no magnetism.

10. Piezoelectricity Minerals

The name originates from the Greek word *piezos* meaning "pressure" and expresses the observation that electricity is generated on applying pressure to a piezoelectric material/minerals. A good example of piezoelectric mineral is quartz.

11. Pyroelectric Minerals

Pyroelectricity can be described as the ability of certain materials to generate a temporary voltage when they are heated or cooled. Although artificial pyroelectric materials have been engineered, the effect was first discovered in minerals such as tourmaline and quartz.