

**First year of Geomatics Department  
Engineering Geology 2020  
Lecture 4**

**MINERALS  
(IRON ORE– GYPSUM)**



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# IRON

**Iron** is one of the most abundant elements on Earth, but it does not occur in nature in useful metallic form. "**Iron ore**" is the term applied to a natural iron-bearing mineral or rock in which the content of iron is sufficient to be commercially usable. **Metallic iron**, from which steel is derived, must be extracted from iron ore.



**Steel** is a combination of iron with a small amount of **carbon**. When heated in the presence of a reductant, iron ore will yield metallic iron. Iron ore almost always consists of iron oxides, the primary forms of which are **magnetite** and **hematite**.



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# BACKGROUND

Iron (Fe) is a metallic element and composes about 5% of the Earth's crust. When pure it is a dark, silvery-gray metal. It is a very reactive element and oxidizes (rusts) very easily. The reds, oranges and yellows seen in some soils and on rocks are probably iron oxides. The inner core of the Earth is believed to be a solid iron-nickel alloy. Iron-nickel meteorites are believed to represent the earliest material formed at the beginning of the universe.

The principle ores of iron are Hematite  $\text{Fe}_2\text{O}_3$ , (70% iron) and Magnetite  $\text{Fe}_3\text{O}_4$ , (72 % iron).



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# THE PROPERTIES OF IRON

Iron is about 8 times heavier than water (its relative density is 7.87). When iron is exposed to the air it starts to turn back into iron oxide and the red powder that forms on the surface of iron is what we call rust. You may have seen rust on old cars or old iron sheds or roofs. To make iron stronger and less likely to rust it can be combined with carbon and other elements to make steel.

The mineral magnetite is very magnetic, and if you dangle a piece on a length of string it will orient itself north-south. Iron and some alloys of iron are also magnetic.

Chemical Symbol:	Fe
<u>Mineral:</u>	iron oxides: eg hematite and magnetite
<u>Relative density:</u>	7.87
<u>Malleability:</u>	High
<u>Ductility:</u>	High
Melting point:	1535°C
<u>Atomic Mass:</u>	55.85





# HOW DOES IRON ORE FORM

The **iron** ore deposits began forming when the first organisms capable of photosynthesis began releasing oxygen into the waters. This oxygen immediately combined with the abundant dissolved iron to produce hematite or magnetite. These minerals deposited on the sea floor in great abundance, forming what are now known as the "banded iron formations."

**Banded iron formations (BIFs)** are sedimentary rocks containing more than 15% iron composed predominantly of thinly bedded iron minerals and silica (as quartz). Banded iron formations may contain iron in carbonates (siderite or ankerite) or silicates (minnesotaite, greenalite, or grunerite), but in those mined as iron ores, oxides (magnetite or hematite) are the principal iron mineral



# USES

Almost all of the iron ore that is mined is used for making **steel**. Raw iron by itself is not as strong and hard as needed for construction and other purposes. So, the raw iron is alloyed with a variety of elements (*such as tungsten, manganese, nickel, vanadium, chromium*) to strengthen and harden it, making useful steel for construction, automobiles, and other forms of transportation such as trucks, trains and train tracks.



**Powdered iron**: used in metallurgy products; magnets; high-frequency cores; auto parts; catalyst.

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# USES

**Radioactive iron (iron 59):** in medicine; tracer element in biochemical and metallurgical research.

**Iron blue:** in paints, printing inks; plastics; cosmetics (eye shadow); artist colors; laundry blue; paper dyeing; fertilizer ingredient; baked enamel finishes for autos and appliances; industrial finishes.

**Black iron oxide:** as pigment; in polishing compounds; metallurgy; medicine; magnetic inks; in ferrites for electronics industry

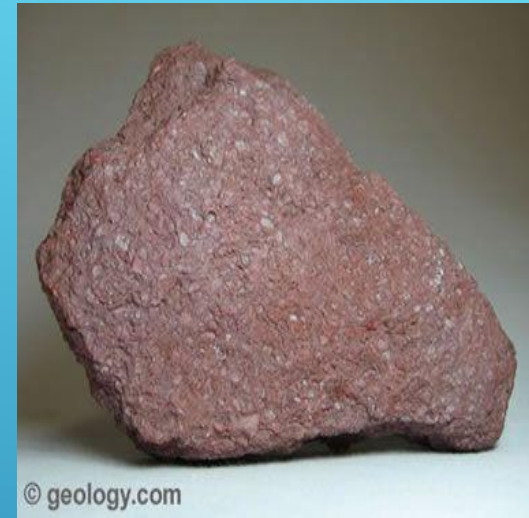


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# HEMATITE

Hematite is one of the most abundant minerals on Earth's surface and in the shallow crust. It is an iron oxide with a chemical composition of  $\text{Fe}_2\text{O}_3$ . It is a common rock-forming mineral found in sedimentary, metamorphic, and igneous rocks at locations throughout the world.



Hematite has an extremely variable appearance. Its luster can range from earthy to submetallic to metallic. Its color ranges include red to brown and black to gray to silver. It occurs in many forms that include micaceous, massive, crystalline, botryoidal, fibrous, oolitic, and others.



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# PHYSICAL PROPERTIES OF HEMATITE

<b>Chemical Classification</b>	Oxide
<b>Color</b>	Black to steel-gray to silver; red to reddish brown to black
<b>Streak</b>	Red to reddish brown
<b>Luster</b>	Metallic, submetallic, earthy
<b>Diaphaneity</b>	Opaque
<b>Cleavage</b>	None
<b>Mohs Hardness</b>	5 to 6.5
<b>Specific Gravity</b>	5.0 to 5.3
<b>Diagnostic Properties</b>	Red streak, specific gravity
<b>Chemical Composition</b>	$\text{Fe}_2\text{O}_3$
<b>Crystal System</b>	Trigonal
<b>Uses</b>	The most important ore of iron. Pigment, heavy media separation, radiation shielding, ballast, polishing compounds, a minor gemstone

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# GEOLOGIC OCCURRENCE

Hematite is found as a primary mineral and as an alteration product in igneous, metamorphic, and sedimentary rocks. It can crystallize during the differentiation of a magma or precipitate from hydrothermal fluids moving through a rock mass. It can also form during contact metamorphism when hot magmas react with adjacent rocks.



The most important hematite deposits formed in sedimentary environments.

Many of the sedimentary iron deposits contain both hematite and magnetite as well as other iron minerals. These are often in intimate association, and the ore is mined, crushed, and processed to recover both minerals.

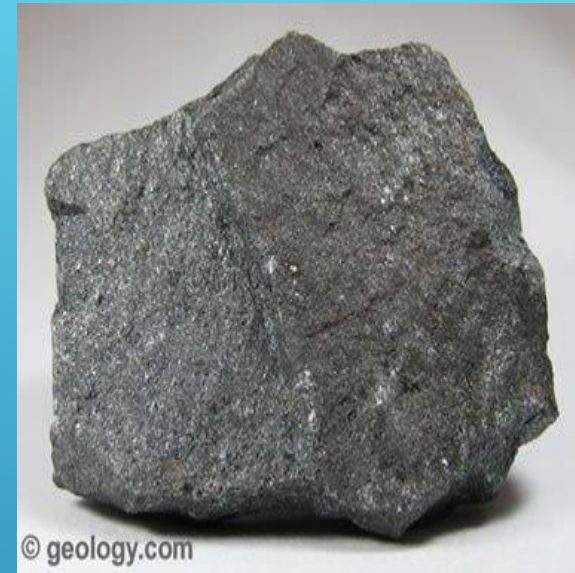


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# MAGNETITE

Magnetite is a very common iron oxide ( $\text{Fe}_3\text{O}_4$ ) mineral that is found in igneous, metamorphic, and sedimentary rocks. It is the most commonly mined ore of iron. It is also the mineral with the highest iron content (72.4%).

It is one of just a few minerals that are attracted to a common magnet. It is a black, opaque, submetallic to metallic mineral with a Mohs hardness between 5 and 6.5. It is often found in the form of isometric crystals. It is the most strongly magnetic mineral found in nature.



# PHYSICAL PROPERTIES OF MAGNETITE

Chemical Classification	Oxide
Color	Black to silvery gray
Streak	Black
Luster	Metallic to submetallic
Diaphaneity	Opaque
Cleavage	None
Mohs Hardness	5 to 6.5
Specific Gravity	5.2
Diagnostic Properties	Strongly magnetic, color, streak, octahedral crystal habit.
Chemical Composition	$\text{Fe}_3\text{O}_4$
Crystal System	Isometric
Uses	The most important ore of iron. Heavy media separation. Studies of Earth's magnetic field.

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# GYPSUM

**Gypsum** is a mineral found in crystal as well as masses called gypsum rock. It is a very soft mineral and it can form very pretty, and sometimes extremely large colored crystals. Massive gypsum rock forms within layers of **sedimentary** rock, typically found in thick beds or layers. It forms in lagoons where ocean waters high in **calcium** and **sulfate** content can slowly evaporate and be regularly replenished with new sources of water. The result is the accumulation of large beds of **sedimentary gypsum**. Gypsum is commonly associated with rock salt and sulfur deposits.



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# PHYSICAL PROPERTIES OF GYPSUM

<b>Chemical Classification</b>	Sulfate
<b>Color</b>	Clear, colorless, white, gray, yellow, red, brown
<b>Streak</b>	White
<b>Luster</b>	Vitreous, silky, sugary
<b>Diaphaneity</b>	Transparent to translucent
<b>Cleavage</b>	Perfect
<b>Mohs Hardness</b>	2
<b>Specific Gravity</b>	2.3
<b>Diagnostic Properties</b>	Cleavage, specific gravity, low hardness
<b>Chemical Composition</b>	Hydrous calcium sulfate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
<b>Crystal System</b>	Monoclinic
<b>Uses</b>	Used to manufacture dry wall, plaster, joint compound. An agricultural soil treatment.

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# USES OF GYPSUM

**Gypsum board** is primarily used as a finish for walls and ceilings, and is known in construction as drywall, wallboard, sheetrock or plasterboard.

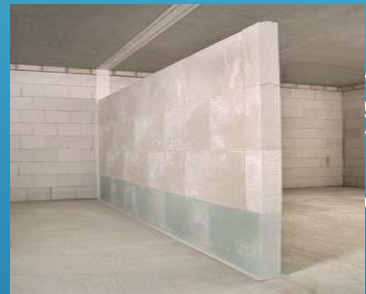


**Gypsum blocks** are used like concrete blocks in building construction.



**Gypsum mortar** is an ancient mortar used in building construction.

**Plaster ingredients** are used in surgical splints, casting molds and modeling.



**Fertilizer and soil conditioner:**

**As alabaster,** a material for sculpture, it was used especially in the ancient world before steel was developed, when its relative softness made it much easier to carve.



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# GEOLOGIC OCCURRENCE

Gypsum is a common mineral, with thick and extensive evaporate beds in association with sedimentary rocks. Deposits are known to occur in strata from as far back as the Archaean eon.

Gypsum is deposited from lake and sea water, as well as in hot springs, from volcanic vapors, and sulfate solutions in veins. Hydrothermal anhydrite in veins is commonly hydrated to gypsum by groundwater in near-surface exposures. It is often associated with the minerals halite and sulfur. Gypsum is the most common sulfate mineral. Pure gypsum is white, but other substances found as impurities may give a wide range of colors to local deposits.

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# GEOLOGIC OCCURRENCE

Gypsum is also formed as a by-product of sulfide oxidation, amongst others by pyrite oxidation, when the sulfuric acid generated reacts with calcium carbonate. Its presence indicates oxidizing conditions. Under reducing conditions, the sulfates it contains can be reduced back to sulfide by sulfate-reducing bacteria. Electric power stations burning coal with flue gas desulfurization produce large quantities of gypsum as a byproduct from the scrubbers.



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# THANKS

Please visit the following links:

[https://ar.wikipedia.org/wiki/%D8%A7%D9%84%D8%AA%D8%B9%D8%AF%D9%8A%D9%86\\_%D9%81%D9%8A\\_%D9%85%D8%B5%D8%B1](https://ar.wikipedia.org/wiki/%D8%A7%D9%84%D8%AA%D8%B9%D8%AF%D9%8A%D9%86_%D9%81%D9%8A_%D9%85%D8%B5%D8%B1)

<https://www.youtube.com/watch?v=1Pio9UEFCUE>

<https://www.youtube.com/watch?v=i6BIyQJZdTg>

[https://www.youtube.com/watch?v=gj\\_MhEyMEcw](https://www.youtube.com/watch?v=gj_MhEyMEcw)

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