GEOLOGY L0.8

QENA STUDENT CLUB

ORES

What are Ores?

A naturally occurring mineral containing a valuable constituent (such as metal) for which it is mined and worked

Gold–Copper ore

- **Note: All ores are minerals but not all minerals are ores**
- **Compare between ORE and MINERAL**

MINERAL	VS	ORE
The natural materials in which the metals or their compounds are found in earth are called **minerals.** 		Those minerals from which metals can be extracted profitably, conveniently and quickly are called **ores.** 
All minerals are not ores.		All ores are minerals.
Clay and Bauxite are minerals of Aluminium		Bauxite is ore of Aluminium but not clay as Al can be extracted economically , easily from Bauxite but not clay

Properties of ores:

- Made of different minerals
- Differ in distribution throughout the world
- Can be found in rocks on land or in seas
- Ores are usually found in igneous rocks
- Ores are non-renewable
- Ores are denser than common rocks
- Ores are metals
- Ores of iron and aluminum are the two most-used metals.

Places to find ores:

- Old continental rocks : in continents that are older

- Orogenic belts : they happen due to collision of plates and deposition of ores in the rocks

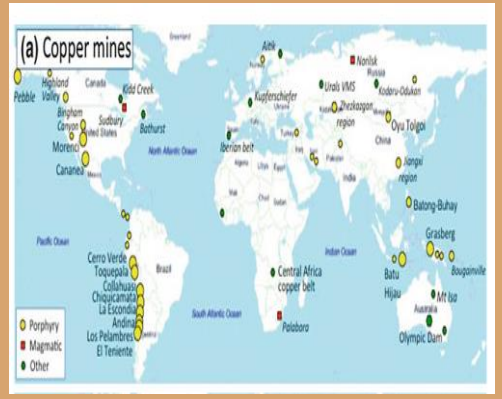
- Hydrothermal activity : deposition of minerals that are not solidified with igneous rocks move up the surface and solidifies , they are called hydrothermal deposits.

List of some metals and their common ores with their chemical composition:

Metal	Ore	Composition	Metal	Ore	Composition
Aluminum	Bauxite	$Al_2O_3.nH_2O$	Zinc	Zinc blende or Sphalerite	ZnS
	Diaspore	$Al_2O_3.H_2O$		Calamine	$ZnCO_3$
	Kaolinite	$Al_2Si_2O_5(OH)_4$		Zincite	ZnO
Iron	Haematite	Fe_2O_3	Lead	Galena	PbS
	Magnetite	Fe_3O_4		Anglesite	$PbSO_4$
	Siderite	$FeCO_3$		Cerrusite	$PbCO_3$
	Iron pyrite	FeS_2	Tin	Cassiterite (Tin stone)	SnO_2
	Limonite	$Fe_2O_3.3H_2O$	Silver	Silver glance (Argentite)	Ag_2S
Copper	Copper pyrite	$CuFeS_2$		Pyrargyrite (Ruby silver)	Ag_3SbS_3
	Copper glance	Cu_2S		Chlorargyrite (Horn Silver)	AgCl
	Cuprite	Cu_2O		Stefinite	Ag_2SbS_4
	Malachite	$CuCO_3.Cu(OH)_2$		Prousitite	Ag_2AsS_3
	Azurite	$2CuCO_3.Cu(OH)_2$			

Factors responsible for finding ores:

- Surface mapping (from geologic maps)
- Observation
- Sampling and Analysis
- Geosciences
- Geostatistical models



(copper geologic map)

Scientists use geosciences (geophysics and geochemistry)

a. Geochemistry : study the chemistry of rocks and minerals to identify if they have ores but they cannot determine how deep they are
b. Geophysics: study the properties of rocks by using tools

Note:

There is no exploration technique that can give a complete picture of what is below the surface. The geologist must be able to assess the data collected. It is important to look at all the clues to find minerals. Millions of dollars are spent on exploration. However, only a very small number of explored areas become profitable mines.

Ways to find ores:

- **Seismic waves reflection:** when these waves hit the ores are bounce back, they depth can be recorded on geophone
- **Gravimeter:** they measure the difference in gravity of rocks and the denser rocks would have more ores
- **Electric current:** When passing electric current through rocks the two conductors that can conduct the current are either water or ores
- **Magnetometer:** they are used to detect the change in earth magnetic field caused by the existence of iron ore in rocks

Extraction of ores:

1. MINIG

Mining site

- **SURFACE MINING**

Surface mining is a cost-effective method for extracting minerals near Earth's surface, including coal, iron, and bauxite, and is particularly suitable for extracting minerals near the earth's surface.

- **UNDERGROUND MINING (SUBSURFACE MINING)**

Underground mining is ideal for extracting minerals deep under the earth's surface, such as gold, lead, and silver. The depth and economic value of the deposit determine the mining method, with the Mponeng Gold Mine in South Africa being the deepest.

- **PLACER MINING**

Placer mining is a process of separating valuable metals from sediments through sifting, often found in natural sediment accumulation environments like riverbeds, sands, and sands.

- **IN-SITU MINING**

In-situ mining involves extracting minerals from earth without extracting rocks and ore, primarily uranium, by injecting a solution that dissolves the mineral and pumps it back to the surface.

2.Hand-picking: The ore is broken into little pieces, and the sand and mud that adheres to it are washed away by a stream of water.

3.Hydraulic washing: This procedure is also known as levigation or gravity separation. It is based on the specific gravities of the ore and gangue particles being different.

4.Electromagnetic separation: Magnetic ore is separated from impurities by placing powdered ore on a leather belt over magnetic rollers, attracting ore particles and removing impurities, enabling extraction of chromite, rutile, and wolframite.

5. The froth floatation process is a widely used method for sulphide ores, involving a large tank filled with ore, water, pine oil, metal sulphide, and ethyl xanthate or potassium ethyl xanthate. It removes oil-soaked ore particles, stabilizes the mixture with cresol and anisole, and uses ethyl xanthate as collectors.

6.Liquation: This technique is appropriate for ore with readily fusible mineral particles and a high melting gangue.

7.Chemical separation (leaching): The process involves using a chemical reagent to dissolve powdered ore, separating bauxite from Fe2O3, SiO2, and TiO2, with Al2O3 being soluble and the rest insoluble.

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$
$$NaAlO_2 + 2H_2O \rightarrow Al(OH)_3 + NaOH$$
$$2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$$
$$Ag_2S + 4NaCN \rightarrow 2Na[Ag(CN)_2] + Na_2S$$

Side effects of mining

- Mining is unsafe for human and the environment
- It causes soil erosion
- Pollutes soil, water and air
- Affect biodiversity
- Affect human health

Important terminology (geo words)

- Ore: A type of rock that contains minerals with important elements including metals that can be extracted from the rock at a profit.
- Gangue: commercially worthless material that surrounds, or is closely mixed with, a wanted mineral in an ore deposit.
- Ore deposits: Ore accumulation. Parts of the crust, where ores are concentrated
- Mining: Extraction of ores, or other valuable minerals from the ore deposits

Summary of Digging deeper in EARTH COMM

Almost all of Earth's mineral resources are on the continents. The water of the oceans contains huge amounts of chemical elements, for he most part, the concentrations are extremely small. For most of these chemical elements, the cost of extraction makes it impractical to use them as mineral resources.

Gold is a good example. Its concentration in ocean water is only 0.011 µg (millionths of a gram) per liter. That adds up to more than 10 billion total kilograms of gold in the oceans. It is far greater than the known reserves of gold in continental ore deposits. The technology used to extract gold from seawater is difficult and expensive. It is not at all economical.

Great areas of the deep ocean floor are covered with dark-colored, rounded masses.

Many of these areas are found in the Pacific Ocean. The masses are called iron– manganese nodules.

They range in size from golf balls to large fists. They consist of very fine-grained minerals of iron and manganese, with many other chemical elements in smaller concentrations. Techniques for mining them from the ocean floor have been developed.

There are two problems : The sediment stirred up and suspended in the water during mining would have a harmful effect on the deep ocean environment. Also, the open oceans do not belong to any one country. They belong to humankind.

Earth's continents are geologically old. The oldest continental bedrock is 4 billion years old. This is only half a billion years younger than Earth itself.

Also, large areas of Earth have bedrock that is older than a billion years. However, the geologic processes that form the bedrock record work on short geologic time scales. This means that there has been plenty of time for the geologic record of the continents to become very varied. It shows a jumble of irregularly shaped areas. The areas are colored in with a variety of colors and patterns. These are rocks of different types and different ages. You can see that a large part of the United States has complex geology.

They have not been subjected to ore-forming processes. In contrast, most areas of the western United States and some areas of the eastern United States show a complex pattern of rock types. These areas are called orogenic belts.
The word “orogenic” means “mountain-building.” These are areas where collisions between Earth’s lithospheric plates have resulted in a great uplift of the land surface. Mountains have been formed. In many places, these mountains have been worn down from their original heights. In some of those areas, igneous activity has led to deposition of various ores.

One of the most important processes that forms ore is called hydrothermal activity.
Magmas contain many valuable chemical elements. These elements are in very small amounts. They become concentrated in water-rich “juices.” These juices are left over after most of the magma has crystallized to form ordinary igneous rocks. These elements tend not to be included in the main minerals that crystallize from the magma. These juices work their way upward toward the surface. As they move upward, they cool. This causes a great variety of unusual minerals to crystallize. Many deposits are valuable ores. One example of this is a hydrothermal deposit. Much of the copper, zinc, tin, lead, mercury, gold, silver, platinum, and so on, come from hydrothermal ore deposits.

Ores of iron and aluminum are the two most-used metals. Almost all iron ore comes from special sedimentary rocks. These rocks are very rich in iron minerals. These minerals were deposited in the oceans far back in geologic time.
In the United States, these rocks are mined for iron ore. The mining takes place in northern Minnesota and northern Michigan. Aluminum ore consists of aluminum oxides. These are formed when rocks that contain aluminum are weathered at Earth’s surface in warm and humid climates. Aluminum ore is also called bauxite. Some bauxite is mined in the United States. However, most comes from other countries.

Some countries are richer in mineral deposits than others. Countries that have large areas of very old continental rocks are especially rich in mineral resources. Canada, Russia, Congo, South Africa, Brazil, and Australia are some examples. The United States has lots of energy reserves. (These include coal, oil, and natural gas.) However, it is not as rich in most mineral deposits as other large countries. The United States has abundant iron, copper, and tin deposits. Yet almost all of the aluminum must be imported. This is also the case for ores of several special metals that are important in making steel. These include nickel, cobalt, and chromium.

The United States government stockpiles important metals. This is done in case supplies from other countries become reduced or cut off in the future.

Looking for mineral resources relies on many factors. Observation, data, and analysis is crucial. A good understanding of the geosciences is important. Experience is also valuable. However, there is still quite a lot of uncertainty. Minerals may not be in the places prospectors expect them to be. Also, even if a mineral deposit is found, problems can arise. There is no guarantee that it is concentrated. It may not be profitable to extract a mineral deposit if it is not highly concentrated. Exploration is very expensive. Drilling is the most expensive way to explore. However, it is the only sure way to confirm the type and amount of minerals present.

In mineral exploration, drill holes are often at least 300 m deep. They may cost $150 per meter.
In oil exploration, a single drill hole may cost millions of dollars. Geologists try to avoid spending money on “dry holes.” They use other ways to find out more about what is below the surface. This helps them to eliminate areas with low exploration potential.

Geologists map the surface by examining rock types in the field. They know that all mineral deposits are associated with specific kinds of rocks. Therefore, they can look for those specific rocks as “guides to ore.” They do this before any other kind of work. Then they look for folds, faults, and fractures in the rocks. They also look for any unusual colors and rock formations that do not seem consistent with the surroundings. They also may take rock samples to analyze in the laboratory. Then they record all the information on a map. Geologic maps help geologists infer what lies below the surface.

An instrument called a magnetometer is used to detect changes in Earth’s magnetic field. Rocks that contain a lot of iron-bearing minerals affect the local magnetic field. Geologists can also measure how well rocks conduct electricity. Geologists put electrical current in the ground for exploration. Most of the current flows through water in the pore spaces of rock. If a rock conducts electricity very well, it is likely to contain one of two things. It may just contain a lot of water. It also may contain a lot of metallic minerals. The

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TEST YOUR SELF

1. **Why do we not actively extract valuable elements, such as gold, from ocean water?**

a. Ocean water do not contain much amounts of gold.
b. Gold is located at too great a depth to bring to the surface.
c. The extraction of gold from ocean water is not profitable.
d. We do not have the technology to remove gold from ocean water.

Answer: c

2. **How do magnetometers work?**

a. By detecting local changes in Earth's magnetic field.
b. By pointing in the direction of magnetic minerals.
c. By measuring how well rocks conduct electricity.
d. By calculating the quantity of a magnetic mineral deposits.

Answer: a

3. Which of the following best describes the distribution of mineral ores?

a. Ores are found everywhere, but the technology to extract those ores are limited.
b. Ores come from sedimentary rocks which are the most widely distributed rocks on a continent.
c. Ores are only found in the oldest continental bedrock
d. Ores are only a very tiny fraction of the rocks of continent.

Answer: d

4. Ores are ..... Rocks of the Africa continent.

a. Evenly distributed throughout the
b. Usually near Earth's surface in the
c. Most often found in sedimentary
d. A very small fraction of the

Answer: d

5. Which are the most two abundant metals in the earth's crust?

a. Lead and mercury
b. Iron and aluminum
c. Gold and silver
d. Copper and zinc

Answer: b

6. How do geologic maps aid in mineral exploration?

a. They help geologists infer what lies beneath the surface.
b. They show the depth of mineral deposits.
c. They show geologists where to drill for minerals.
d. They show the amount of minerals in each kind of rock.

Answer: a

7. what are the environmental implications associated with surface mining?

a. Surface mining disturbs the land surface and can therefore destroy an ecosystem.
b. Surface mining disturbs the land surface and can therefore change patterns of surface water runoff.
c. Drainage from surface mining can pollute surface water and ground water.
d. All the above.

Answer: d

8. What risks to human are associated with mining?

a. Mining involves working with heavy equipment.
b. underground mines can collapse.
c. long term exposure to many minerals causes health problems for miners and processors.
d. all the above.

Answer: d

9. When is strip mining used?

a. when the final desired products are large blocks of rock.
b. When mineral resources lie deep beneath the surface.
c. when an ore body has irregular geometry.
d. when the deposit is thin and widespread sheet like layers near the surface.

Answer: d

10. Which of the following factors will not be considered when determining whether surface or underground mining should be used to remove mineral resources from the ground?

a. Size of the ore.
b. depth of the ore.
c. grade (quality)of the ore.
d. the process by which the ore was formed.

Answer: d

11. Which factor is LEAST likely to affect whether a mineral deposit is considered to be an ore deposit?

a. How dense the ore is
b. The market value of the element
c. The concentration of the element in the ore
d. How readily the element can be extracted from the ore

Answer: d

12. What determines whether a metal is considered to be abundant or scarce?

a. Whether it is organic or inorganic
b. Whether it is renewable or nonrenewable
c. How many different forms it occurs in on Earth
d. How much it must be concentrated to be economically profitable

Answer: d

13. Which is NOT a property of metals

a. Brittleness
b. Malleability
c. Good thermal conductivity
d. Good electrical conductivity

Answer: a

14. Which is a NOT an example of an industrial material or mineral deposit

a. Coal
b. Quartz
c. Iron ore
d. Diamond

Answer: a

15. Which ore is not correctly paired with a metal commonly extracted from it?

A- bauxite – aluminum
B- galena - zinc
C- hematite - iron
D- malachite – copper

Answer : B

16. Gold may be separated from other sediments by panning because it has a high

A- specific gravity
B- conductivity
C- reflectivity
D- ductility

Answer : A

17. Which determines whether a metallic element becomes concentrated in the liquid fraction
during magmatic segregation

a. Its density

b. Its conductivity

c. Its susceptibility to magnetic fields

d. Its compatibility in early

Answer: a

18. Which is a NOT an example of an industrial material or mineral deposit

a. Coal

b. Quartz

c. Iron ore

d. Diamond

Answer: a

20. Which of the following is NOT TRUE about the process of hydrothermal alteration?

a. It is common around igneous intrusions.

b. During this process chemical reactions occur between a hot fluid and preexisting country rock

c. It rarely changes the composition of the preexisting country rock.

d. Many types of metallic ore deposits are formed by this process.

Answer : c

21. Khetri mines are famous for:

a. Coal

b. Gold

c. Copper

d. Iron

Answer: c

22. This mineral is the same as ordinary rust and is the principal ore of iron:

a. Sphalerite
b. Quartz
c. Hematite
d. Bauxite

Answer : C

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Answer: d

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Answer: d

25. One who studies minerals as part of earth's crust for a better understanding of landforms is called:

a. Scientists

b. Geographers

c. Geologists

d. Ecologists

Answer: c

26. What process causes organic remains to turn into fossil fuel?

A. Pressure caused by overlying rocks and sediments

B. The constant layering from microscopic sea life

C. Millions of years of physical and chemical change

d. The movement of fluids through layers of permeable rocks

Answer: c

27. Minerals are deposited and accumulated in the stratas of which of the following rocks?

a. Sedimentary rocks

b. Metamorphic rocks

c. Igneous rocks

d. None of the above

Answer: a

28. Which material is commonly extracted from quarries?

a. coal

b. peat

c. marble

d. potash

Answer: c

29. Which of the following is a nonferrous mineral?

a. Manganese

b. Petroleum

c. Aluminum

d. Iron

Answer: c

30. Metals like gold, silver and platinum are known as which of the following?

a. Ferrous minerals

b. Non-ferrous minerals

c. Non-metallic minerals

d. Precious minerals

Answer: d

31. Which one of the following is largely derived from ocean water?

a. Bauxite

b. Magnesium

c. Gold

d. Mica

Answer: b

32. Which of the following regions of India contain most of the reserves of coal, metallic minerals, mica and many other non-metallic minerals?

a. The Himalayas

b. Alluvial plains of North India

c. Rock system of peninsula in Rajasthan

d. Peninsular plateau region

Answer: d

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b. The constant layering from microscopic sea life

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d. The movement of fluids through layers of permeable rocks

Answer: c

34. A mineral deposit called a lode is formed by:

a. Metal fragments deposited in stream beds

b. Layers accumulating in cooling magma

c. Hot mineral solutions in the cracks of rocks

d. Precipitation of mineral from seawater

Answer: c

THANKS

Made By:

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