

## Semester 6:

**Unit: UEF 3.1.1**

**Course: Mineral and Energy Resources**

**Coeff: 2 / Credits: 4**

**Course: 1.5 hours Practical works: 1.5 hours**

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### Content of the COURSE:

#### Chapter 1:

**Definitions:** ore deposits, mining geology, metallogeny; ore, texture, parageneses; metallotects; veins, clusters, concordant and peneconcordant layers; syngenetic and epigenetic mineralization.

**Chapter 2 :** Basic concepts of ore deposits and the deposits of useful substances and industrial minerals.

**Chapter 3 :** Classification of ore deposits.

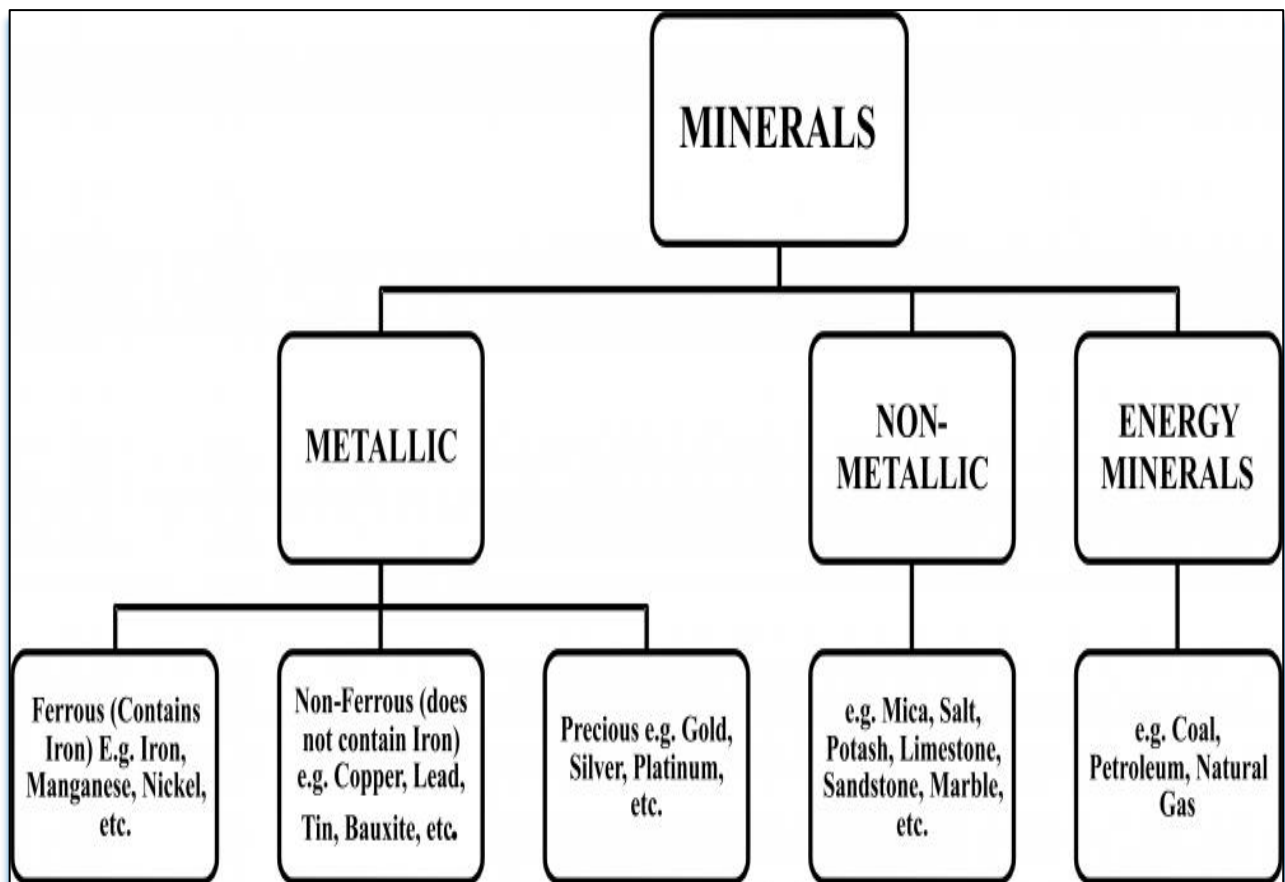
**Chapter 4 :** The main types of mineralizing fluids that form deposits (conformed waters, magmatic and metamorphic fluids).

### Practical works

- 1 - Review of major petrographic groups: igneous, metamorphic, and sedimentary rocks, macro and micro.
- 2 - Textures and structures of mineralizations, paragenesis;
- 3 - Hydrothermal alterations.

## Introduction

Mineral and energy resources encompass all terrestrial materials of natural origin in solid (mineral resources) or liquid or gaseous (energy) states, whether exploited or not. These resources are non-renewable, and their rational exploitation and controlled use remain a significant challenge. Faced with technological developments and immense population growth, the search for and discovery of new mineral and energy resource deposits has become an absolute necessity. In public usage, the classification of these resources is based primarily on their use:



## **CHAPTER I: Definitions and concepts**

### **I.1. Definitions**

#### **I.1.1. Ore deposit geology (French: Gîtologie):**

Is the science that studies the formation of mineral deposits, Descriptive study of the deposits (geological environment, mineralogy, geometry of the mineralization).

#### **I.1.2. Mining geology:**

A branch of applied Earth Sciences concerned with the study and evaluation of ore deposits and the most cost-effective methods of mining and extraction.

#### **I.1.3 Metallogeny:**

The science **that studies the formation mechanisms of ore deposits**, which can be of magmatic, hydrothermal, sedimentary, or metamorphic origin. It has three main objectives:

- To describe mineral deposits (ore deposit)
- To understand the formation mechanisms of deposits
- To provide prospecting guides for explorers

#### **I.1.4. Metalotect:**

This refers to a geological feature (a fault, a fold, etc.) that influenced the formation of the deposit. A metalotect is a geological feature, related to tectonics, magmatism, metamorphism, lithology, geochemistry, etc., that appears to favor the formation of a mineral deposit or concentration. (An important guide for prospecting.)

#### **I.1.5. An occurrence (French: Un indice):**

is an indication of the presence of mineralization without any indication of economic value; the term "occurrence" is used in English.

#### **I.6. Clarke:**

It represents the average concentration of an element in the Earth's crust (oceanic and continental).

#### **I.1.7. Ore (French: minerai):**

An **ore** is a rock containing a specific concentration of metal. It therefore consists of a valuable component, which is the metal (iron, zinc, copper, gold, platinum, etc.), called the "mineralization," and a non-metallic component called the:

'**Host Rock**' or "**gangue**." In other words, **ore** is the raw material of a given metal. The name of the **ore** is derived from the name of the metal, e.g., copper ore, zinc ore, etc. If the ore is composed of several metals, they are listed together, starting with the most abundant, e.g., Cu-Zn ore, Au-Pt ore.

**I.1.8. Texture / structure** In petrography, the **texture** (a term used on a small scale) of a rock or ore characterizes the spatial arrangement of the crystals relative to each other at the scale of the sample, thin section, polished section, or even at a finer scale. The synonym for **texture** on a large scale is **structure**.

- There are 10 **texture types** (massive, mottled, banded, veined, spheroidal, reniform, crushed, lacunar, skeletal, and friable).
- The **structure** can be divided into **13 groups** (equigranular, heterogranular, lamellar, fibrous, zonal, crystalline, oriented, intimately associated, rimmed, substitutional, crushed, collomorphic, spherulitic, and clastic).

### **I.1.9. Syngenetic mineralization:**

Mineralization that formed at the same time as the host rock.

### **I.1.10. Epigenetic mineralization:**

Mineralization that formed after the host rock.

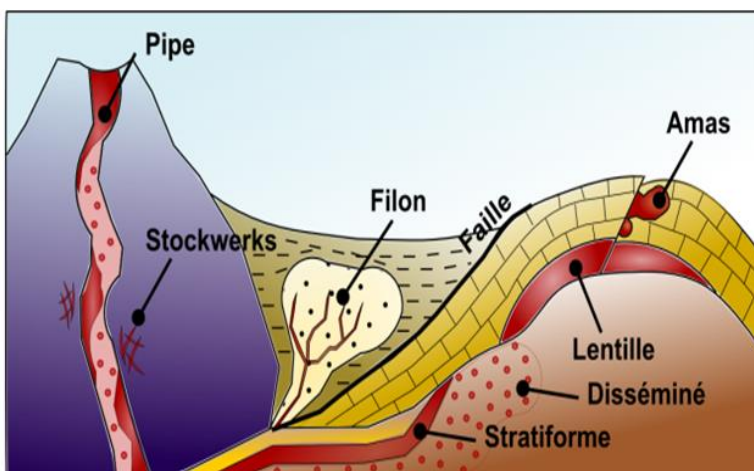
### **I.1.11. Parageneses:**

Refers to the association of minerals that formed under similar conditions, resulting from the same geological and geochemical process. The study of the sequential order of formation of these minerals, called the paragenetic sequence, allows us to trace the geological history of a deposit, interpret pressure and temperature conditions, and understand the evolution of deposits over time.

## **I.2 morphologies of mineral concentrations**

The morphological types of mineral concentration are as follows:

- **Massive mineralization**, or **mineralization disseminated** within the host rock,
- **Conformal (French: concordante)** mineralization with its surrounding rock (stratiform deposit, for example),
- **Disconformal mineralization (French: discordante):**
  - Lenses, clusters (**French: lentilles, amas**)
  - Veins, lodes (**lodes=Fr: filons**) (Veins are smaller while lodes are larger, more extensive)
  - Stockwerks (German word, en anglais stockwork; walls, roof, slope)
  - Pipes and chimneys (A type of volcanic explosion chimney).



It is based on the geological formation of the deposit:

- **Regular deposits:** lenses, veins, lodes
- **Irregular deposits:** stockworks, disseminated

## I.2. Morphology of Conformal Ore Bodies

### I.2.1 Conformal Ore Bodies in Sedimentary Rocks

These deposits are called stratiform. These **conformal** deposits are found in various types of sedimentary rocks.

#### ➤ Limestones

Base metal sulfide deposits are often found in limestones. Increased permeability due to dolomitization or fracturing, combined with greater reactivity and solubility, makes them potential horizons for mineralization. Sometimes mineralization can occur as syngenetic stratiform deposits.

#### ➤ Clay Rocks

Shales, argillites, marls, and schists are important rocks for concordant deposits (copper in shales).

#### ➤ Arenaceous Rocks

Feldspathic sandstones and alluvial gravels are good host rocks for concordant ore deposits. Recent and fossil placers of gold, uranium, and thorium are important in such rocks.

### I.2.2 Igneous Rocks

The massive deposits or sulfide masses that fill vesicles are often exhalative, associated with volcanic extrusions, while platinum, chromite, magnetite, nickel, and titanium deposits occur as concordant mineralized bodies in plutonic rocks.

### I.2.3 Metamorphic Rocks

Most concordant deposits in metamorphic rocks are of sedimentary origin. They represent the metamorphic equivalents of deposits that originate either as sedimentary or igneous deposits.

## I.3 Morphology of Discordant Mineral Bodies

Discordant mineralized bodies can be subdivided into those with an approximately regular shape and those with highly irregular outlines.

### I.3.1 Regularly Shaped Ore Bodies

Ore bodies with a regular shape are of two types: tabular and tubular (*tabulaire et tubulaire*).

#### I.3.1.1 Tabular Deposits

These are extensive in two dimensions but limited in the third. **Veins** and **lodes** belong to this category. Veins result primarily from the filling of open spaces, while dike formation is due to the extensive replacement of pre-existing rocks along often straight faults and fractures. Since such a genetic distinction is often ambiguous, all tabular deposits are generally referred to as veins. Veins are often inclined, and in this case, one can speak of a wall and a roof. They frequently pinch and bulge as they follow the stratigraphic sequence. An initial fracture in the rock changes position as it passes through lithologies with different physical properties.

### I.3.1.2 Tubular Deposits

These are relatively short in two dimensions, but extensive in the third. When **vertical** or **subvertical**, they are called **pipes** or **chimneys**. When horizontal or subhorizontal, they are called mantos. The infilling can be of various types and origins (mineralized breccias). Mantos and pipes can be branched, and the branches can be interconnected. Mantos and pipes often form an association where pipes frequently feed the mantos.

### I.3.2 Irregularly shaped mineralized bodies

They are of two (02) types - **disseminated deposits** and **irregular replacement deposits**.

#### I.3.2.1 Dispersed Deposits

In these deposits, ore minerals are **dispersed** throughout the host rock, for example, diamonds in kimberlite. In other deposits, the **dissemination** may be primarily along intersecting veinlets, forming an intercalated network called a stockwork. This type of mineralization is generally found outward in the subeconomic mineralization and at the boundary of the mineralized zone. They are therefore irregular in shape and can cut across geological boundaries. The general shapes are cylindrical or cap-like.

**Stockworks** commonly occur in acidic to intermediate intrusions of plutonic igneous rocks, but they can cut through even the host rocks. Most of the world's copper and molybdenum, and some tin, silver, mercury, and uranium, originate from these deposits.

#### I.3.2.2 Irregular Replacement Deposits

Many ore deposits are formed by the replacement of pre-existing rocks, particularly carbonate rocks. This replacement often occurs at the contact with an igneous intrusion (metamorphic contacts or pyrometasmatic deposits). These deposits are extremely **irregular**. The ore body may be ejected along an available planar structure (bedding, joint, fault, etc.). These deposits are characterized by the development of calc-silicate minerals such as diopside, wollastonite, andradite-type garnet, and actinolite. They are also called skarn deposits.