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

Texture, by definition, describes the arrangement of the constituent minerals of an ore, certainly taking into account parameters such as grain size, shape, and abundance.

In metallography, the concept of texture is very important since it represents the result of the ore's formation conditions; texture thus provides information on the mechanisms by which the deposit was formed.

Although texture studies are generally conducted on a small scale, we show here that they can be studied at two different scales:

at the sample scale, which is referred to as megatexture or megascopic texture, determined with the naked eye or a magnifying glass, and at the scale of the polished section under a microscope, which is referred to as microscopic texture or microtexture.

1. Macroscopic Texture of Ores

This type of texture encompasses approximately 12 different types, which are:

1.1. Massive Texture

An ore in which the samples are fairly homogeneous and generally composed of a small number of minerals. This type of texture is characteristic of ore deposits usually formed at high temperatures. Examples: Cr, Fe, Ni-Cu, Skarn, VMS.

1.1.Dispersed texture (or disseminated deposit)

Dispersed texture (or **disseminated deposit**) characterizes metallic minerals distributed as "flies," small grains, or isolated crystals within the host rock. Often associated with copper-bearing porphyries, this texture indicates hydrothermal or magmatic precipitation where sulfides (pyrite, chalcopyrite) fill the interstices or replace pre-existing minerals.

Main characteristics:

Distribution: The minerals are dispersed irregularly, sometimes in clusters with diffuse outlines.

Shape: Millimeter-sized grains or "flies" (small aggregates).

Association: Often found in altered (silicified, chloritized) or magmatic rocks, unlike massive veins.

Transition: Can evolve into stockwork textures as the concentration increases.

These deposits are common for copper, nickel, and gold sulfides, and often require the processing of large volumes of rock due to the low local concentration.

1.2.The layered or laminated texture

The layered or laminated texture of mineralization is characterized by an arrangement of alternating layers (beds or laminae) of metallic minerals (**sulfides**) and gangue (**chert, tuff**). Often associated with volcanogenic sulfide deposits, it results from **sedimentary** or **exhalative deposition** , sometimes subsequently deformed.

Key Characteristics:

- **Alternation:** Succession of sulfide beds (pyrite, chalcopyrite, sphalerite) and silicate or carbonate beds.
- **Origin:** Typical of sedimentary exhalative (SEDEX) or volcanogenic (SMV) mineralizations, deposited at the bottom of the water.
- **Deformation:** Lamination can be emphasized by deformation or recrystallization, showing thin, parallel, and continuous layers.
- **Thickness:** The laminae are generally very thin, and may be folded or boudinaged.

Example: (Banded Iron Formation) iron deposits.

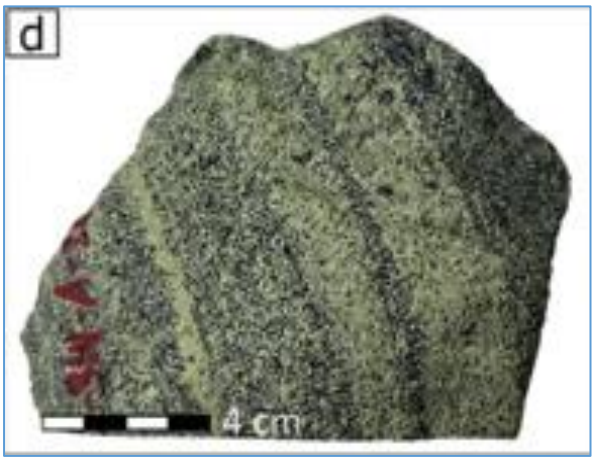
BIF (Banded Iron Formation)

1.3.The banded texture

The banded texture of mineralization is a vein structure characterized by alternating bands of minerals of different compositions (often **1 mm** to **1 cm**), deposited successively. Common in hydrothermal deposits (barite, fluorite, sulfides), it exhibits a symmetrical or asymmetrical appearance, indicating an open and progressive infilling.

Ores in which minerals accumulate in superimposed bands, from mm to cm thick.

- **Formation:** Resulting from the sequential precipitation of minerals from hydrothermal fluids in fractures or cavities.
- **Appearance:** Alternating bands of different colors or compositions (e.g., Quartz-Barite, Sulfides-Calcite), often symmetrical with respect to the vein center (comb-like structure).
- **Context:** Often found in fluorite (F-Pb-Zn), barite, or epithermal veins.
- **Variants:** Can be associated with breccia or massive textures within the same deposit. This texture indicates repeated opening of the fracture and physicochemical changes in the fluid over time



(d) **Banded chromite** with varying percentages of dissemination.

NOTE

Banded and **layered/laminated** **textures** exhibit a layered organization but differ in their **origin** and **scale**. Banding (often metamorphic or filonien) shows bands of varying compositions, often **thick**. Layering or lamination (sedimentary) corresponds to a thin alternation of parallel deposits.

1.4. Nodular texture

Nodular mineralization texture refers to spherical or irregular mineral aggregates, ranging in size from centimeters to decimeters, formed by chemical precipitation or diagenesis. These nodules often develop around a nucleus in sediments or by replacement, frequently occurring with phosphates, pyrite, or barite.

Main characteristics:

Shape: Rounded to irregular nodules, sometimes with concretions.

- **Origin:** Progressive accretion in a sedimentary environment (loose sedimentation) or diagenesis.
- **Examples:** Oceanic polymetallic (manganese) nodules, phosphate nodules, siderite nodules.
- **Context:** Often associated with reducing environments or chemical gradients.
- **Composition:** The nodules may be rich in silicates, oxides, or phosphates.

These structures bear witness to specific environmental conditions of formation, such as calm sedimentary environments conducive to precipitation, for example **siderite nodules** formed by freezing under reducing conditions.

Manganese nodules **Phosphate nodules**

1.5.Brecciated texture

The brecciated texture of mineralizations is characterized by angular rock fragments (clasts) cemented by ores and gangue, indicative of fracturing processes (tectonic, hydrothermal, or magmatic). It is common in veins, epithermal deposits, and pipe breccias (stockworks).

Main characteristics:

- **Composition:** Angular fragments (host rock) embedded in a finer-grained mineralized matrix.
- **Origin**: Often hydrothermal (fault opening, boiling) or magmatic.
- **Types of cement**: Quartz, carbonates (calcite, siderite), fluorite, sulfides.
- **Types of breccia**: Tectonic breccias, fault breccias, cemented breccias, ring breccias (zoned growth around the fragments).

Common Origins

- **Tectonic:** Formed in fault zones due to grinding and breaking of rocks.
- **Sedimentary:** Formed by rapid accumulation of scree or talus at the base of cliffs.
- **Volcanic:** Formed during explosive volcanic activity or lava dome collapse.
- **Hydrothermal:** Formed in the subsurface by pressurized fluids fracturing rock.

Brecciated texture