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Department of Civil Engineering

GEOLOGY

Chapter 2: Minerals and rocks

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Geology

Content of chapter 2: Minerals and rocks
(4 weeks)

- 2.1 Concept of mineralogy
- 2.2 Loose rocks
- 2.3 Eruptive rocks
- 2.4 Sedimentary rocks
- 2.5 Metamorphic rocks

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MINERALOGY

- In general, "rocks" (and loose soils) are made up of an assembly of different elements, of very specific chemical composition, minerals.
- A mineral is a natural solid, macroscopically homogeneous, with an ordered atomic structure and a defined chemical composition.

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Main mineral species (1)

Among all the mineral species, only a small number are very widespread.

The **nine elements** that alone represent **99%** of the weight composition of the Earth's crust and mantle:

O: **Oxygen**, Si: **Silicon**, Al: **Aluminum**,
Fe: **Iron**, Ca: **Calcium**, Na: **Sodium**,
Mg: **Magnesium**, K: **Potassium**, Ti: **Titanium**

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Main mineral species (2)

Silicates and Aluminosilicates


(Quartz, Feldspars, Micas, Amphiboles, Pyroxenes, Olivines, Clays)

A Si atom in the center and O atoms at the four vertices, the tetrahedra being linked together by cations or by O atoms in common.

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Quartz (SiO₂)

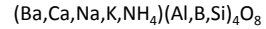
Varied color: colorless, white (most common), gray, yellow, purple, pink, brown, black, greenish, bluish, red, green



The only stable form of silicon dioxide at normal temperature and pressure is **quartz α**, which is the most common crystalline form of **SiO₂**.

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Feldspath



Color: variable, colorless, white, pink, green, blue, brown



Plagioclase feldspar

Orthoclase n. f. (French: orthose) $KAlSi_3O_8$ potassium feldspar that forms at intermediate temperatures (intrusive igneous rocks)

Sanidine n. f. $(K,Na)AlSi_3O_8$ potassium feldspar that forms at high temperatures (phenocrysts in volcanic rock)

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Main mineral species (1)

Carbonates, sulfates, and phosphates are the major constituents of sedimentary rocks; from the first group, we will retain **calcite** – $CaCO_3$ - and **dolomite** – $(Ca, Mg)(CO_3)_2$. **Sulphides, oxides and hydroxides are abundant in metal deposits.**

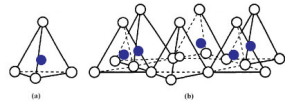
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Clay minerals (1)

Clay minerals are hydrated aluminosilicates with a lamellar structure (sheets). Two-layer sheets consist of a layer of tetrahedra, joined together by the three vertices of a base, and a layer of $Mg(OH)_2$ or $Al(OH)_3$ octahedra. Three-layer sheets have an additional tetrahedral layer.

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Clay minerals (1)

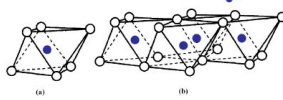


The tetrahedron sheet

Silica tetrahedron



● Silicon Atoms



The octahedron sheet

Aluminium (or magnesium) octahedron

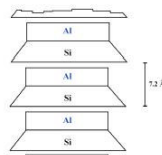


● Hydroxides or Oxygen Atoms
○ Atoms of Aluminium, Magnesium, etc.

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Kaolinite

It is a clay mineral composed of a single tetrahedral sheet and a single octahedral alumina sheet. Generally a low-swelling clay.

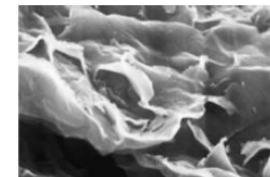
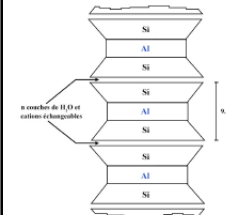


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Montmorillonite (or Smectite)

It is a clay mineral composed of a single octahedral sheet clamped between two tetrahedral sheets.

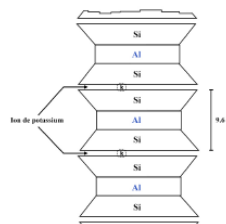
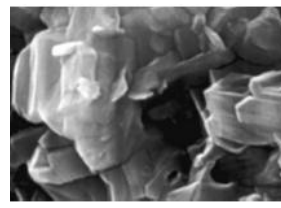
Clay with high swelling and shrinkage characteristics.



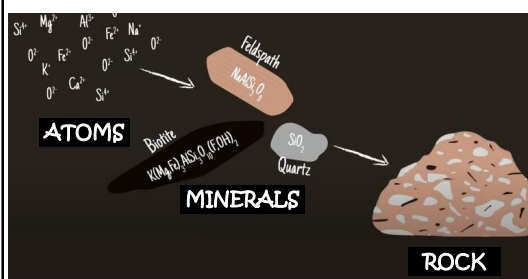
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Illite

Structure similar to that of montmorillonite, except that the spaces between the layers are connected by potassium ions (K+). Clays less sensitive to the phenomenon of swelling.

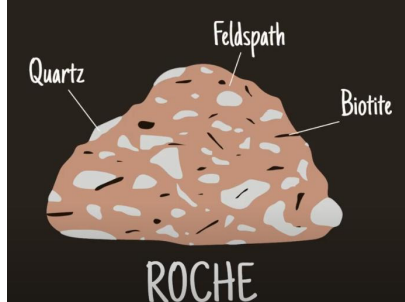
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ATOMS → **MINERALS** → **ROCK**

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Feldspar $\text{NaAlSi}_3\text{O}_8$ Biotite $\text{K}(\text{Mg, Fe})_3\text{AlSi}_3\text{O}_{10}(\text{F, OH})_2$



ROCHE


Quartz SiO_2

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MELTED

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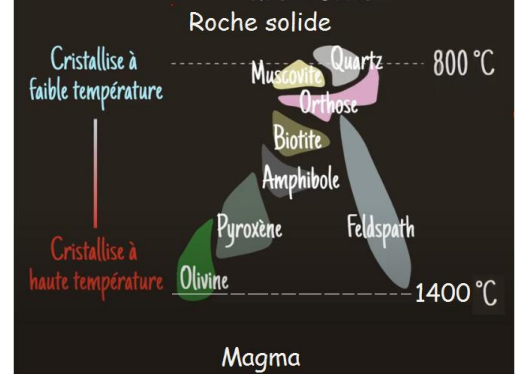


MELTED

SOLID

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Roche solide



Magma

Fractional crystallization

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Fractional crystallization

Cristallise à faible température

Cristallise à haute température

Pyroxène, Olivine, Biotite, Amphibole, Feldspath

MANTEAU

Different minerals will not crystallize at the same time (at the same temperature).

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Cristallise à faible température

Cristallise à haute température

Biotite, Amphibole, Pyroxène, Feldspath, Olivine

CROUTE OCEANIQUE

The composition of magma changes with cooling

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Cristallise à faible température

Cristallise à haute température

Quartz, Muscovite, Biotite, Amphibole, Pyroxène, Feldspath, Olivine

CROUTE CONTINENTALE

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MAGMA LAVE

ROCHE MAGMATIQUE

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Composition Manteau		Composition Cr. Océanique	
Element	%	Element	%
Oxygène	44.8 %	Oxygène	43.7 %
Magnésium	22.8 %	Silicium	22 %
Silicium	21.5 %	Fer	8.5 %
Fer	5.8 %	Magnésium	7.6 %
Calcium	2.3 %	Aluminium	7.5 %
Aluminium	2.2 %	Calcium	7.1 %
Autres	0.6 %	Sodium	1.6 %
		Titane	1.4 %
		Autres	0.6 %

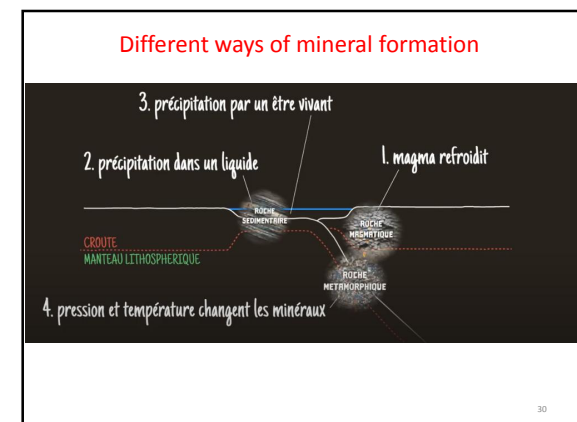
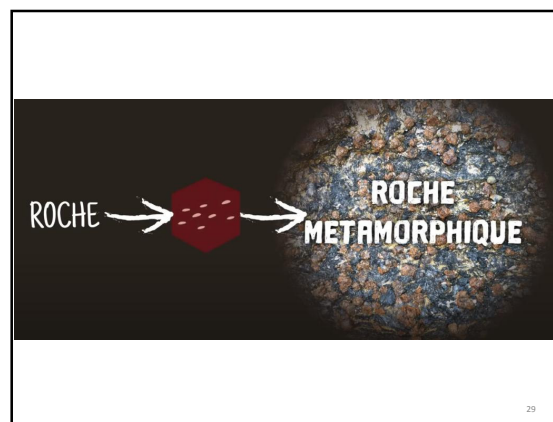
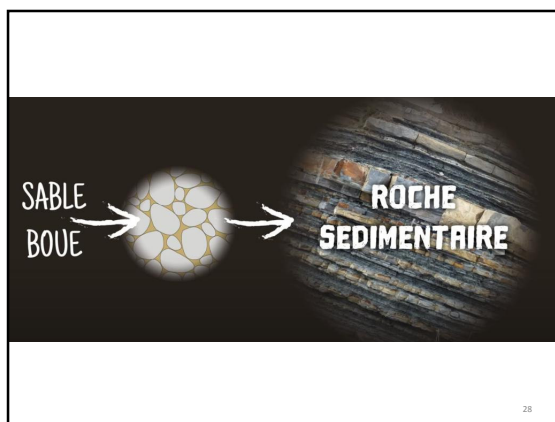
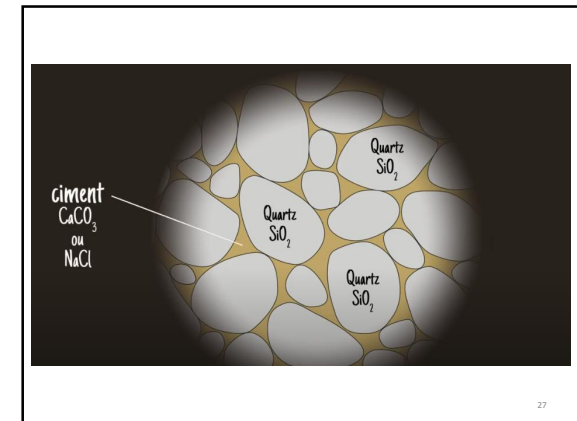
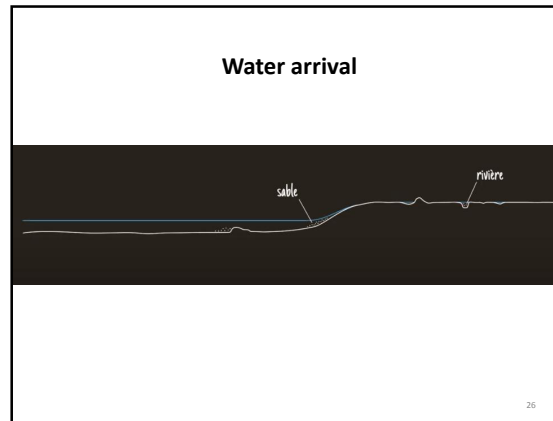
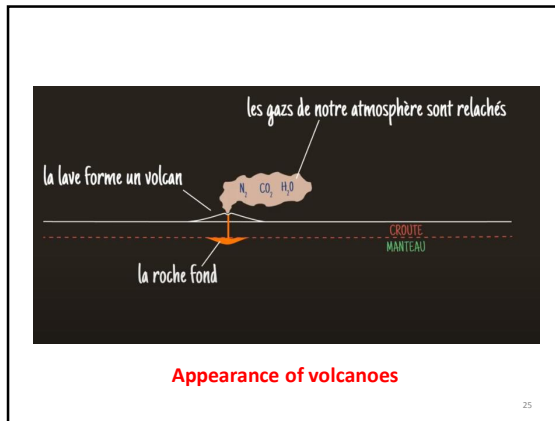
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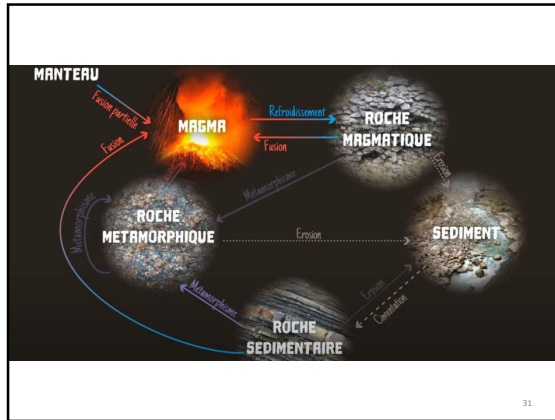
Some videos

<https://www.youtube.com/watch?v=uVwpPES-bvQ>

<https://www.youtube.com/watch?v=TQI-esWsTd8>

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PETROLOGY

MAGMATIC ROCKS

They were formed by the consolidation of magma (molten rock containing dissolved gases and crystals).

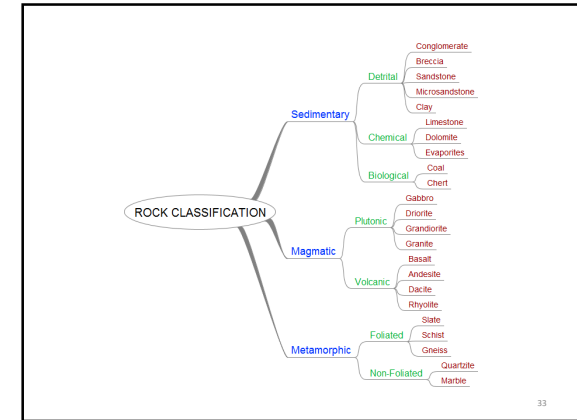
SEDIMENTARY ROCKS

Sedimentary rocks are exogenous rocks, i.e. formed on the surface of the earth where they sedimented.

METAMORPHIC ROCKS

It is a rock (sedimentary, magmatic or already metamorphic) that has undergone transformations of texture and mineralogy by increases in pressure and variations in temperature.

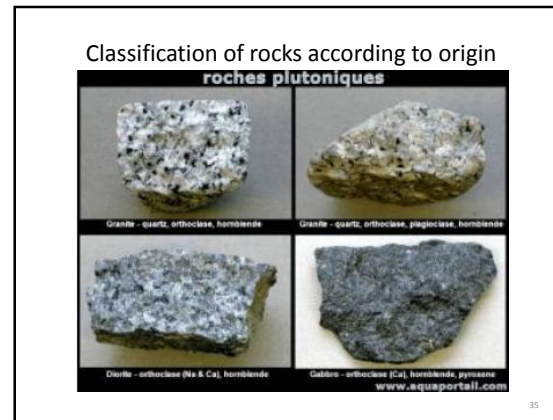
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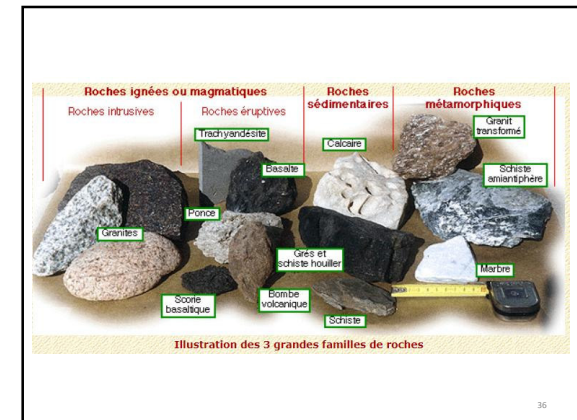
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- ### Classification of rocks according to origin
- Exogenous rocks (which originated on the **surface of the globe**), - **sedimentary rocks**.
 - Endogenous rocks (which originated **inside the globe**) - **magmatic rocks** (cooling and crystallization of a magma).
 - slow cooling: **plutonic rocks**
 - rapid cooling: **volcanic rocks**
 - Metamorphic rocks** (transformation by temperature and pressure of existing rocks) collective.

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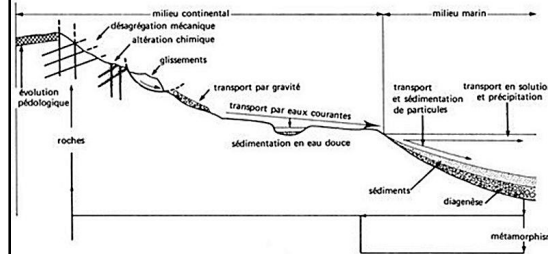
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SEDIMENTARY ROCKS [1]

- They generally appear as deposits in successive layers more or less parallel to each other; we say that there is **stratification**.
- Thus, **sedimentary rocks are anisotropic**.
- They constitute the bulk of the upper part of the lithosphere, hence the interest they present for the soil mechanic in particular and the builder in general.

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SEDIMENTARY ROCKS [2]



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Rocks in geotechnics _ GTR

Sedimentary rocks	Chalk	R ₁
	Limestone	R ₂
	Marl	R ₃
	Sandstone	R ₄
	Gypsum	R ₅
Magmatic and metamorphic rocks	Granites, basalts, schists	R ₆

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Rocks in geotechnics _ GTR _ 6 classes _ 29 subclasses

Classification according to nature (Petrographic nature of the rock)

Parameters used for the subclasses:

- Dry density.
- MDE (Micro-Deval test in the presence of water)
- LA (Los Angles test)
- FR (Fragmentation test)
- DG (Degradability test)
- soluble salt content



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THANK
YOU FOR YOUR
ATTENTION!

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