Salahaddin university
Engineering college
Civil department
1st class
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Engineering Geology
Rock minerals and Crystals

3rd lecture

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Rock minerals

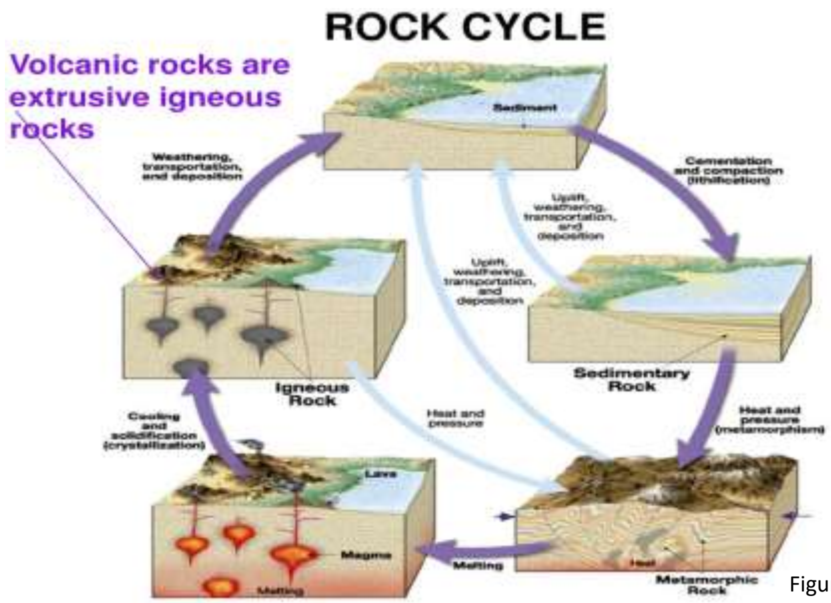

Figure 1

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Rock minerals

Engineering Definition of Rocks: Rock is the hard and durable earth materials that cannot be excavated without blasting.

Mineralogy Identification for Engineering Purposes:

From an engineering point of view, certain properties of minerals are of special concern to engineers. For example:

1. gypsum in a limestone can become swelling when water presents.
2. Pyrite (a shiny yellow mineral) in shale can be deteriorated by acid water.
3. Swelling clays in shale can become wetting and cause instability problem of a slope.

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Mineralogy Identification

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Minerals can be identified by its

1) Color; 2) Streak (strip);
3) Luster; 4) Hardness;
5) Specific weight; 6) Cleavage;
7) Fracture; 8) Crystal form.

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Mineralogy Identification

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1. Color

- Minerals are colored because certain wave lengths of light are absorbed, and the color results from a combination of those wave lengths that reach the eye.
- Some minerals show different colors along different crystallographic axes. Mineral identification by colors can be deceptive!

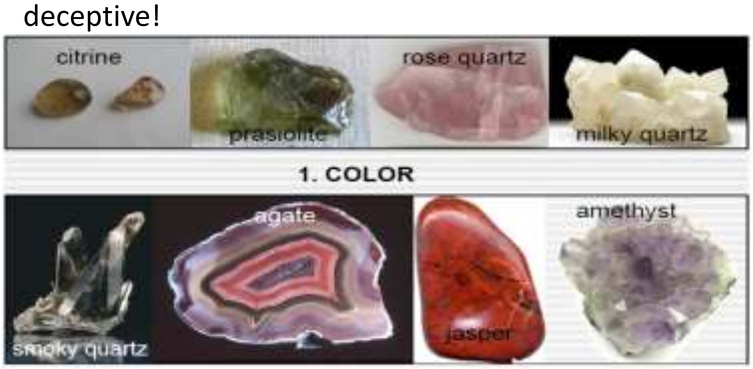

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Figure 2

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Mineralogy Identification

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2. Streak

The streak of a mineral is the color of the powder left on a streak plate when the mineral is scraped across it.

Figure 3

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Mineralogy Identification

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3. Luster

Luster refers to how light is reflected from the surface of a mineral. The two main types of luster are metallic and nonmetallic.

- Types of nonmetallic luster:

Adamantine, vitreous, pearly, greasy, silky, earthy.

Figure 4

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Mineralogy Identification

4. Hardness

The Mohs' hardness scale places ten common or well-known minerals on a scale from one to ten. One is the softest mineral and ten is the hardest. These are the minerals used in the Mohs' hardness scale:

Minerals	Level of Hardness	Tools
Talc	1	
Gypsum	2	Finger nail
Calcite	3	
Fluorite	4	Copper penny
Apatite	5	
Feldspar	6	
Quartz	7	Glass
Topaz	8	
Corundum	9	
Diamond	10	

Figure 5

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Mineralogy Identification

5. Specific Gravity

Specific gravity is the weight of a mineral divided by weight of equal volume of pure water at 4°C. (S.G. is unitless).

6. Cleavage

Tendency of a mineral to split along one or more planes.
Minerals tend to break along certain planes where atomic bonds are weak.

Figure 6

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Mineralogy Identification

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7. Fracture

A mineral that does not have cleavage, (break along irregular surfaces).

For example: curved fracture surface as in Quartz.

Figure 7

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Mineralogy Identification

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8. Crystal forms

Crystal faces formed during crystallization process vs. cleavage faces formed when mineral breaks.

Figure 8

- There are other mineralogy identification such as;

Magnetism, Tenacity, Diaphaneity, Striation and Chemical reaction.

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Rock Properties for Engineering

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Rocks are significant for two major reasons in engineering:

1. As building materials for constructions.
2. As foundations on which the constructions are setting.

- For the consideration of rocks as construction material the engineers concern about:
  - Density to some extent (for calculating the weight, load to the foundation, etc.).
  - Strength.
  - Durability.
- For the consideration of rocks as the construction foundation the geological engineers concern about the rocks;
  - Density.
  - Strength.
  - Compressibility.

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Rock Properties for Engineering

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- **Engineering Considerations of Igneous Rocks**

1. Fine-grained igneous rocks cannot be used as aggregates in Portland cement due to volume expansion caused by the Alkali-silica reaction.

Solutions include:

a) Can be used in low alkali cement.
b) Non-reactive aggregates go with the high alkali cement.
c) Add pozzolans, coal-ashes, etc. in the aggregate-cement mixture to minimize the reaction.

2. Coarse-grained igneous rocks (e.g., granite, syenite, etc.) are not aggregates for constructions because it’s low abrasion resistance; but fine-grained igneous rocks (e.g., basalt) are good for aggregates (e.g., basalt as paving aggregates goes with asphalt).
3. Siting of foundations needs to avoid weathered rocks (e.g., dams, bridge piers (الركائز الطافية فوق الماء), etc.).
4. Igneous rocks are good for dimension stone (tombstone etc.) because their resistance to weathering but need avoid fractures.

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Rock Properties for Engineering

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- **Engineering Considerations of Sedimentary Rocks**

1. The sedimentary rocks also have the Alkali-silica reaction problem when used as aggregates with Portland cement. The sedimentary rocks with this problem are chert and greywacke.
2. Fine-grained sedimentary rocks like limestone and dolomite are the best for being used as aggregates; siltstone, shale, conglomerate, quartz and sandstone are not acceptable.
3. Stream and terrace gravel contains weak pieces, they are not good for aggregates in concrete. Weathered chert, shale, and siltstone can cause pop-outs at the concrete surface after freeze-thaw cycles;
4. Coarse-grained limestone is not good for aggregates by reducing particle size.
5. Sinkhole problem in carbonate terrains due to the high dissolvability of limestone and dolomite.

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Rock Properties for Engineering

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- **Engineering Considerations of Metamorphic Rocks**

1. The metamorphic rocks also have the Alkali-silica reaction problem when used as aggregates with Portland cement. The metamorphic rocks with this problem are argillite, phyllite, impure quartzite, and granite gneiss.
2. Coarse-grained gneiss can be abraded severely when used as aggregates.
3. For metamorphic rocks the stability of rock mass greatly affected by the foliation orientation.

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Crystal

A solid which possesses a regular geometrical shape, is called a crystal. A crystal is bounded by faces which lie parallel to the planes of atoms in the crystal structure. In addition to faces, crystals contain edges and solid angles arranged in a regular order. Edges are formed where two adjacent faces meet and a solid angle is formed where three or more edges meet.

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Crystal

Crystallographic axes:

In order to describe the faces and symmetry of crystals, a set of three or four reference axes are established. These imaginary reference lines are called crystallographic axes and are generally taken parallel to the intersection edges of major crystal faces. In fact, crystallographic axes are the reference lines which run parallel to the edges of the unit cell and their lengths are proportional to the lengths of the unit cell edges.

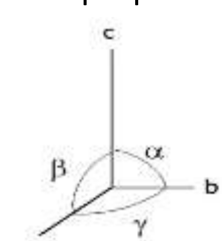

Figure 9

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Crystal

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- **Crystal Systems**

All crystals that occur in nature can be grouped into six major crystal systems. These crystal systems are as follows:

1. Cubic System: The crystals belonging to this system have three mutually perpendicular axes of equal lengths.
2. Tetragonal System: The crystals of this system are referred to three mutually perpendicular axes. The two horizontal axes are equal and the vertical axis is longer or shorter than the other two.

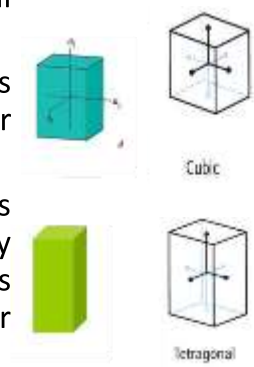

Figure 10

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Crystal

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3. Hexagonal System: In the crystals of this system, there are four crystallographic axes. Three of these are of equal length and lie at angles of 120 to each other in the horizontal plane. The fourth axis is vertical and is either longer or shorter than the other axes.
4. Orthorhombic System: The crystals of this system have three mutually perpendicular axes of different lengths.
5. Monoclinic System: In the crystals of this system, there are three unequal crystallographic axes. Two axes are inclined to each other at an oblique angle and the third axis is perpendicular to the plane of the two.

Figure 11

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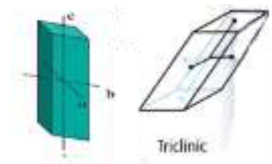
Crystal

6. Triclinic System: There are three unequal axes all intersecting at oblique angles.



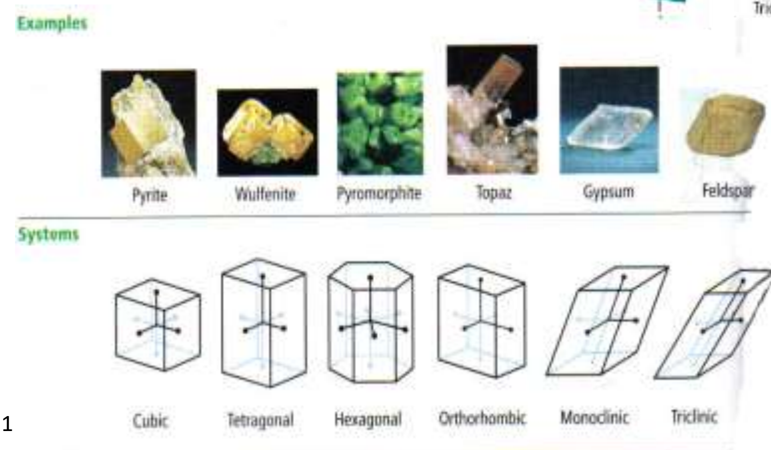


Figure 12

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