Salahaddin university
Engineering college
Civil department
1st class
2020_2021

Engineering Geology
Introduction, earth structure and rock minerals

1st & 2nd lecture

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Class rules

While in lecture, please:

- Turn off cell phones.
- Do not talk and have conversations.
- Do not eat (water allowable).
- Ask questions when anything is not clear.
- Engage in the discussions.
- Fully participate in in-class exercises.

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Outcomes

- Students will learn what are Principals of Engineering Geology (Earth structure, Rocks Minerals, Crystals, Ground water, etc…).
- How to apply these principals in the field (in construction engineering projects).

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Introduction

- **Geology literally means:** "study of the Earth".
- **Course Objectives:** Understand basic geologic processes with applications to Civil Engineering topics.

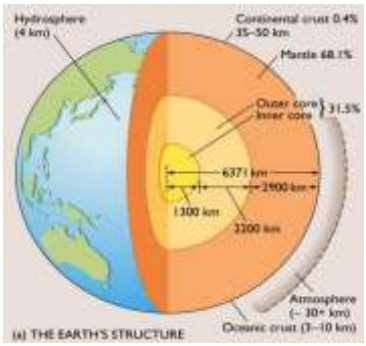

Figure 1

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Introduction

What is Engineering Geology?

- Engineering geology is the application of geological data, techniques and principles to the study of rock and soil, surficial materials and ground water.
- This is essential for the proper location, planning, design, construction, operation and maintenance of engineering structure.

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Introduction

- **What does Engineering Geology study?**

Rock, soil, water and the interaction among these constituents, as well as with engineering materials and structures.

- **Why engineering geology matter?**

Serve civil engineering to provide information in three most important areas:

1. Resources for construction; aggregates, fills and barrows.
2. Finding stable foundations;
3. Mitigation of geological hazards; Identify problems, evaluate the costs, provide information to mitigate the problem

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Introduction

Engineering Geology was established in US after the St. Francis Dam near Los Angeles, the dam failed on March 12, 1928. Engineering community realized the importance of Geology factor in civil engineering.

Figure 2

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Introduction

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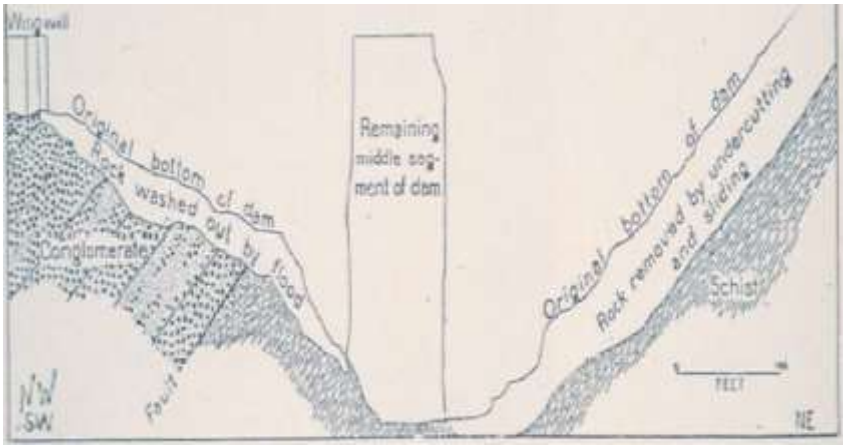

Figure 3

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Introduction

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- **Main reasons for dam failure:**

1. Sedimentary rocks on the west lost strength when it is wet;
2. The fault separating the west and east rock formations started to leak water;
3. Schist on the east increases pore pressure and lost shear strength after wet

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Introduction

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- **Schist:**

A metamorphic rock containing abundant particles of mica, characterized by strong foliation (The planar or layered characteristics of metamorphic rocks), and originating from a metamorphism in which directed pressure plays a significant role.

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Introduction

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- **Engineering geology is the application of geological concepts of problems in civil engineering:**

1. Site appraisal and investigation.
2. Foundation and excavation design.
3. Slope stability.
4. Environmental protection.

- **Geology provides a way of thinking about:**

1. The types of material.
2. How they are arranged in 3D.
3. What are their properties.
4. What processes have operated in the past and present days.

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Earth structure

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- Age of the Earth

Estimated age for the Earth and the rest of the solar system is about 4.55 billion years comes from Lead Isotope measurements.

- Oldest Earth rocks: 3.8 to 3.9 billion years,
- Oldest Earth minerals: 4.2 billion years,
- Oldest Moon rocks: 4.44 billion years.

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Earth structure

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- Earth Materials

Elements combine a variety of Earth materials:

1. Organic compounds – Carbon – containing compounds.

- Most are residue from once-living creatures Include wood, peat, lignite, coal, and oil.

2. Minerals – Inorganic crystalline solids.

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Earth structure

3. Glasses – Non-crystalline mineral.
- Cool the Lava too quickly to form structure.
4. Rocks: There are many types.
- Igneous – Cooled from a liquid melt.
- Sedimentary – Debris cemented from pre-existing rock.
- Metamorphic – Rock altered by pressure and temperature.
5. Metals – Solids made of metallic elements.

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Earth structure

6. Melts – Rocks that have been heated to a liquid.
- Magma – Molten rock beneath the surface.
- Lava – Molten rock at the surface.
7. Volatiles – Materials that turn into gas at surface temps.
- H_2O, CO_2, CH_4, and SO_2
- Volatiles are released from volcanic eruption.

Metals Lava Volatiles

Figure 4

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Earth structure/ layers

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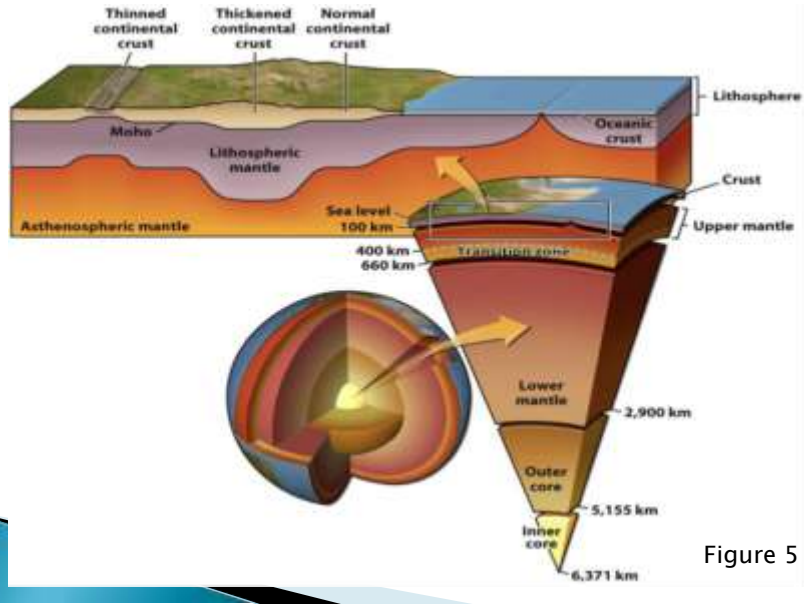

Figure 5

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Earth structure/ layers

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- Layers of the Earth

The earth is divided into three main layers: core, mantle and crust.

1. The core is composed mostly of iron (Fe) and is so hot that the outer core is molten, with about 10% Sulphur (S). The inner core is under such extreme pressure that it remains solid.

2. The mantle, Most of the Earth's mass is in the mantle, which is composed of iron (Fe), magnesium (Mg), aluminum (Al), silicon (Si), and oxygen (O) (silicate compounds). At over 1000 degrees, the mantle is solid but can deform slowly in a plastic manner.

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Earth structure/ layers

- The mantle can be thought of having three different layers:

a) The upper layer is stiff. This stiff layer of the mantle and the overlying crust are referred to as the **lithosphere**. The lithosphere is approximately 80-km thick

b) Beneath the lithosphere there is a soft layer of mantle called the **asthenosphere**. Its thickness is inferred to be several times of the lithosphere.

c) The **mesosphere** is the lowest layer of the mantle. It would be expected that the thickness and material properties of the mesosphere are not well known.

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Earth structure/ layers

- THE MOHO
- The Moho, refers to a zone or a thin shell below the crust of the earth that varies in thickness from 1 to 3 km.
- The Moho is considered to be the boundary between the crust and the mantle.

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Earth structure/ layers

1st & 2nd lecture

3. The crust is much thinner than any of the other layers, and is composed of the least dense calcium (Ca), sodium (Na) and aluminum-silicate minerals. Being relatively cold, the crust is rocky and brittle, so it can fracture in earthquakes.

- The shell of the earth, the crust, can be said to have two different thicknesses.

a) Under the oceans, it is relatively thin. It varies in thickness from 5 to 8 km.

b) Under the land masses, it is relatively thick. The thickness of the continental crust varies from 10 to 65 km.

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Earth structure/ layers

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- The eggshell analogy for the crust is not an exaggeration. It is paper thin compared with the radius of the earth which is approximately 6400 km.
- The total weight of the continental crust is less than 0.3% of the weight of the earth.

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Rock minerals

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- What is a 'rock'?

In Geology, 'Rock' is defined as the solid material forming the outer rocky shell or crust of the earth. There are **three** major groups of rocks by its origin:

1. **Igneous rocks.**
2. **Sedimentary rocks.**
3. **Metamorphic rocks.**

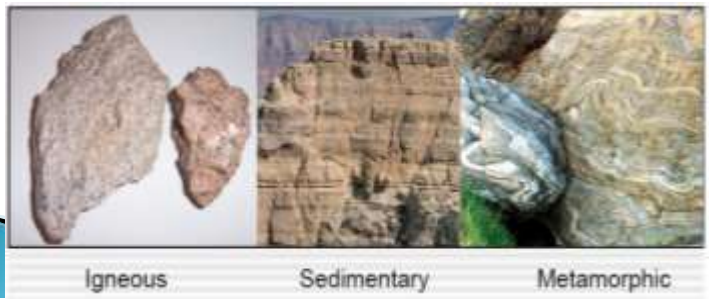

Figure 6

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Rock minerals

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- Igneous rocks:

Molten rocks called magma is found under high temperatures in the Earth's interior. Some of this molten rock remains inside the Earth and some is ejected as lava onto the Earth's surface during volcanic eruptions. When the molten rock cools and solidifies, it becomes mineral crystals. The process of forming mineral crystals is called crystallization. As the mineral crystals form, they join together or interlock into masses of igneous

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Rock minerals

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- **Igneous rocks include:** Granite, Basalt, Obsidian, and Pumice.
- Crystal size is determined by the rate of cooling:

a) Slow rate forms large crystals.
b) Fast rate forms microscopic crystals.
c) Very fast rate forms glass.

Fine-grained igneous texture | Coarse-grained igneous texture | Porphyritic igneous texture | A glassy igneous rock

Figure 7

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Rock minerals

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- **Sedimentary rocks:**

1. One-way Sedimentary rocks are formed by; Compacting Sediments:

Sediments may be rock particles such as mud, sand or pebbles, which are usually deposited in the sea by rivers and waves. They can also be remains of living things such as plants and animals. Gradually, over thousands or even millions of years, these sediments accumulate layer-by layer, forming thick deposits on land or on the sea floor. The weight of the overlying sediments will compact those found below. Over time, the compacted sediments become sedimentary rocks.

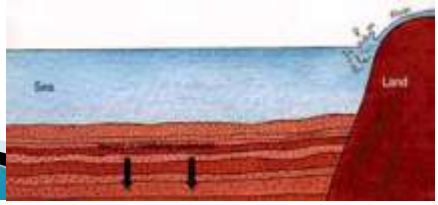

Figure 8

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Rock minerals

2. Another way Sedimentary rock are formed by; Crystallization from Dissolved Minerals:

The process of forming crystals from dissolved minerals usually occurs in the shallow parts of the sea or in lakes, in desert areas where evaporation is much higher than precipitation. The sea or lake contains dissolved minerals such as calcium bicarbonate and calcium Sulphate. As evaporation takes place, water is lost and the dissolved minerals form crystals which settle on the bottom of the sea or lake. As evaporation continues, more crystals form and accumulate on the sea or lake floor, becoming sedimentary rocks.

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Figure 9

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Rock minerals

- Features of sedimentary rocks:

1. Strata, or beds.
2. Bedding (the stratification or layering of rocks) planes separate strata.
3. Fossils (1).

- **Sedimentary rocks include**: Limestone, Jasper, Gypsum, Sandstone (2) and Conglomerate(3).

(1)

(2)

(3)

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Figure 10

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Rock minerals

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- **Metamorphic rocks:**
- The temperatures and pressures inside the Earth are much higher than those on the Earth's surface. When rocks are subjected to greater heat and pressure inside the Earth, they are changed into rocks, which are different from the original. This change occurs while the original rocks are still in a solid state. The new rocks that are groomed by changing existing rocks under heat and pressure are called metamorphic rocks.
- **Metamorphic rocks include:** Quartz, Amethyst, Marble, Slate, Gneiss, Graphite, and Coal.

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Rock minerals

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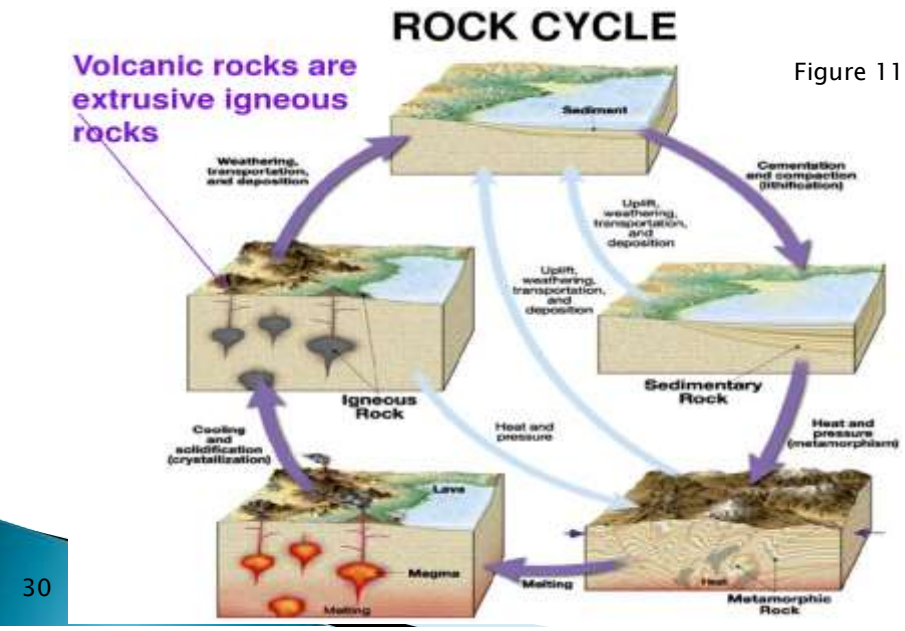

Figure 11

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