Geotechnical Engineering I
CE 341

What do we learn in this course?

- Introduction to Geotechnical Engineering
- Formation, Type and Identification of Soils
- Soil Composition
- Soil Structure and Fabric
- Index
- Properties of Soil
- Engineering Classification of Soils
- Compaction
- Principles of Total and Effective Stresses

What do we learn in this course?

- Permeability and Seepage
- Stress-Strain-strength Characteristics of Soils
- Compressibility and Settlement Behaviour of Soils
- Lateral Earth Pressure
- Stress Distribution

Geotechnical Engineering

- A specialty of civil engineering
- Deals with

Properties, behavior and use

of **Earth Materials** in engineering works

Geotechnical Engineering

- Requires the integrated knowledge from
  - Geology
  - Material science and testing
  - Mechanics and hydraulics
  - Environmental science and engineering

Multidiscipline co-ordination

- **The knowledge and their application is required for**

Design → • Foundation
• Retaining and earth structures

Geotechnical Engineering

- Includes several aspects
  - Soil Mechanics
  - Rock Mechanics
  - Engineering Geology
  - Soil Engineering
  - Rock Engineering
  - Foundation Engineering
  - Geo-environmental Engineering

Basic, Elementary or Introductory Geotechnical Engineering

Geotechnical Engineering is a universal set of related subjects.

Geotechnical Engineering

Subject	Concerns with
Soil Mechanics	Engineering Mechanics + Properties of soil
Rock Mechanics	Engineering Mechanics + Properties of rock
Engineering Geology	Formation and features of earth crust + earthquake
Soil Engineering	Geology + soil mechanics + structural engineering

Geotechnical Engineering

Subject	Concerns with
Rock Engineering	Geology + rock engineering + structural engineering
Foundation Engineering	Soil engineering + Rock Engineering
Geo-environmental Engineering	Environmental effects (earthquake, rainfall, ground water, gravitational movements, waste disposal, chemical, etc.) on Soil and Rock.

Scope of Soil Mechanics (I)

Subject	Scope of Soil Mechanics
Foundation of Structures	Type, dimension & details of foundation will depend on the strength and deformation characteristics of supporting soil
Underground & Earth Retaining Structures	Loading on structures such as tunnels, earth retaing structures, sheet piles, etc.

Scope of Soil Mechanics (II)

Subject	Scope of Soil Mechanics
Embankment, Excavation & Dam	Requires the knowledge of slope stability (involving soil behaviour). For dams, consider seepage problem.
Pavement	Design of rigid or flexible problem depends on the behaviour of subgrade soil (related to settlement, swelling, repetitive loading, frost action, etc.)

Scope of Soil Mechanics (III)

Subject	Scope of Soil Mechanics
Special Problems	Collapse, shrinkage, swelling, soil subsidence, soil heave, frost action, soil erosion

Development of Soil Mechanics

- Before 18th century, no documented / systematic knowledge
- List of recorded events since 1776
- In 20th century, soil mechanics receives much attention and disseminated various publications
- An excellent account of earliest documented works of geotechnical by Skempton (1979)

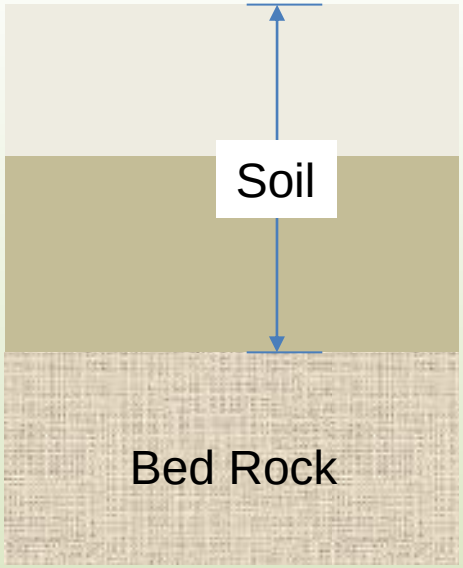
Father of soil Mechanics

Terzaghi

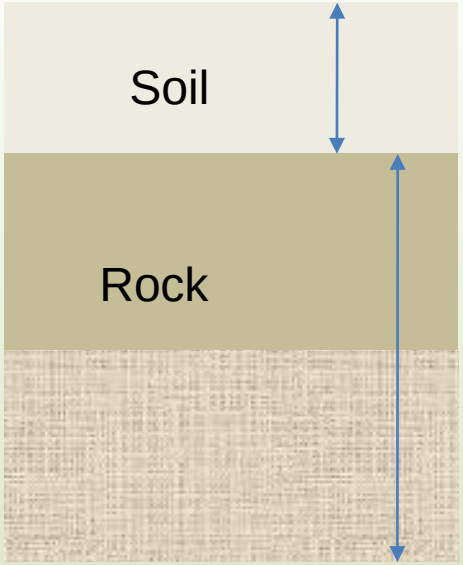
Soil

- The term derived from the Latin word ‘Solium’
- Solium: upper layer of earth crust that may be dug or ploughed
- Soil is used by
  - Geologists (unconsolidated sediments overlying solid bed rocks)
  - Agronomists, Agroculturist, Soil scientist (thin layer of loose surface materials of the earth crust)
  - Civil engineers (Soil defined by agriculturist is known as top soil)

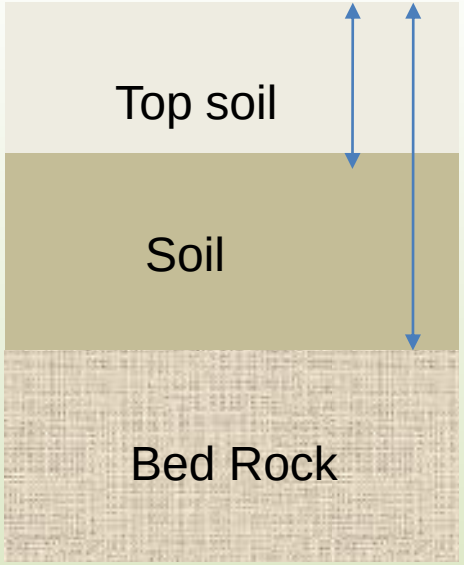
Soil



Geologists



Agronomists



Geotechnical Engineer

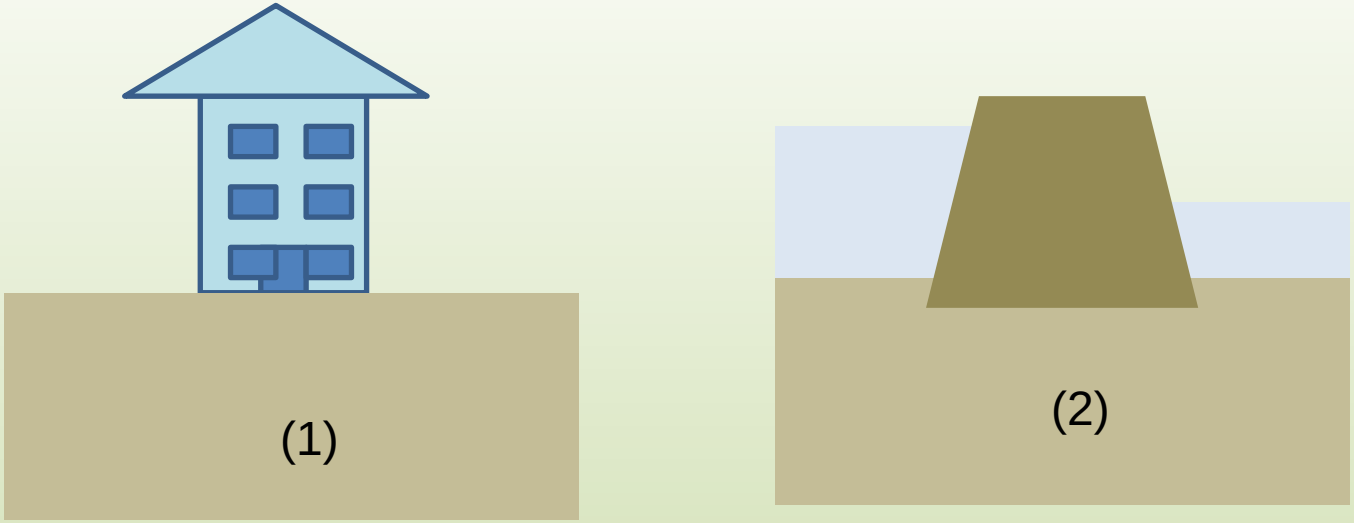
Top soil removed before construction

Earth Crust

Earth Crust:
Rock +
Weathered Rock
(Soil)

Engineering use of soil

1. Supports the foundation of structures



2. Construction material (Dam)

Definition of Soil

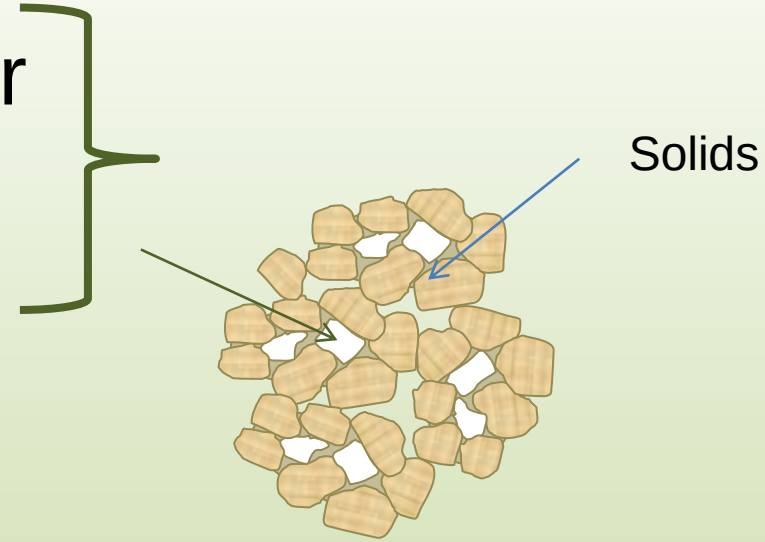
- According to civil engineers,

Soil includes all naturally occuring loose o soft deposit overlying the solid bed rock.

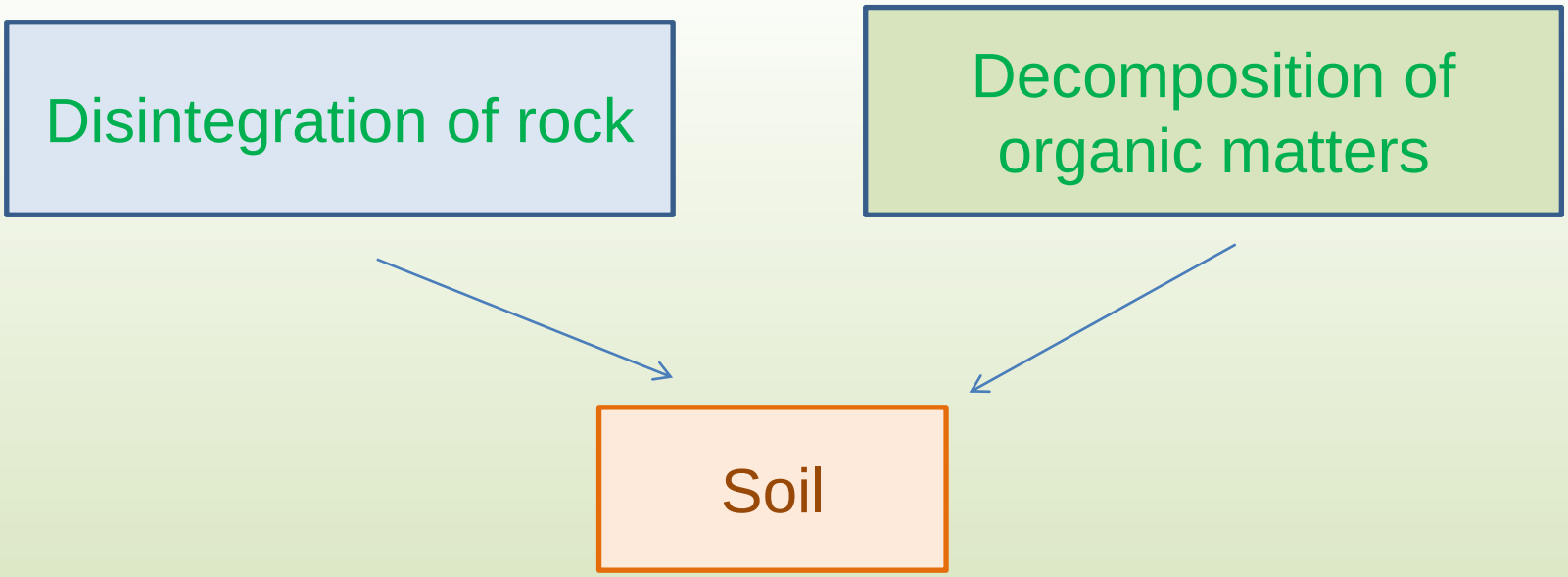
Soil is formed due to disintegration and decomposition of rocks by the process known as weathering. It may also be formed by decomposition of organic materials.

Soils

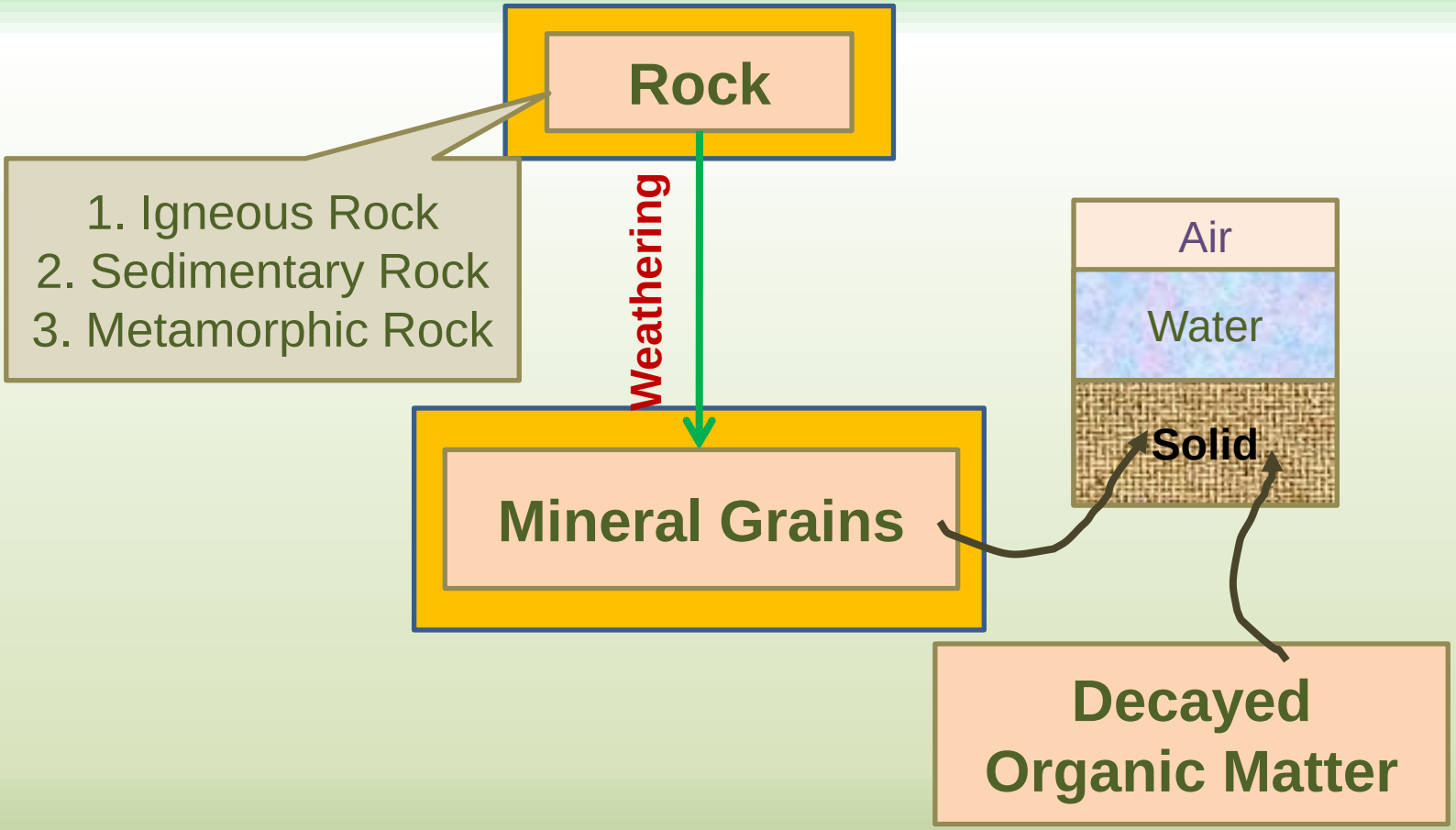
- Three phase system
- Solid Phase
- Liquid Phase: Water
- Gas Phase: Air



Formation of Soil



Soil Formation



Soil Forming Rocks

- Rock: Outer rocky shell or crust of the earth
- Igneous Rock: cooled from molten state
  - Example: Granite, Diorite, Basalt, etc.
- Sedimentary Rock: deposited from a fluid medium
  - Example: limestone, sandstone, shale, etc.
- Metamorphic Rock: formed from a pre-existing rock by the action of heat and pressure
  - Quartzite, Schist, Slate, etc.

Soil Forming Minerals

- A naturally occurring crystalline material formed

by inorganic processes

with a definite chemical composition

with **an ordered internal arrangements of atoms** having a definite crystal structure

Most rock forming minerals are silicates. Subgroups of silicates are developed on the basis of their silicon to oxygen ratio.

Restricted definition of minerals

- The following are not mineral
  - Oil
  - Coal
  - Volcanic ash
  - Manufactured glass
  - Blast furnace slag (by-product of steel making)
    - Is glassy and not naturally occuring

Internal arrangements of atom

- Ordered in a mineral: mineral structure
- Non-ordered: amorphous
  - Occurs in liquids and super cooled liquids (glass)

Crystalline

Minerals

Amorphous

glass

Rock forming Minerals

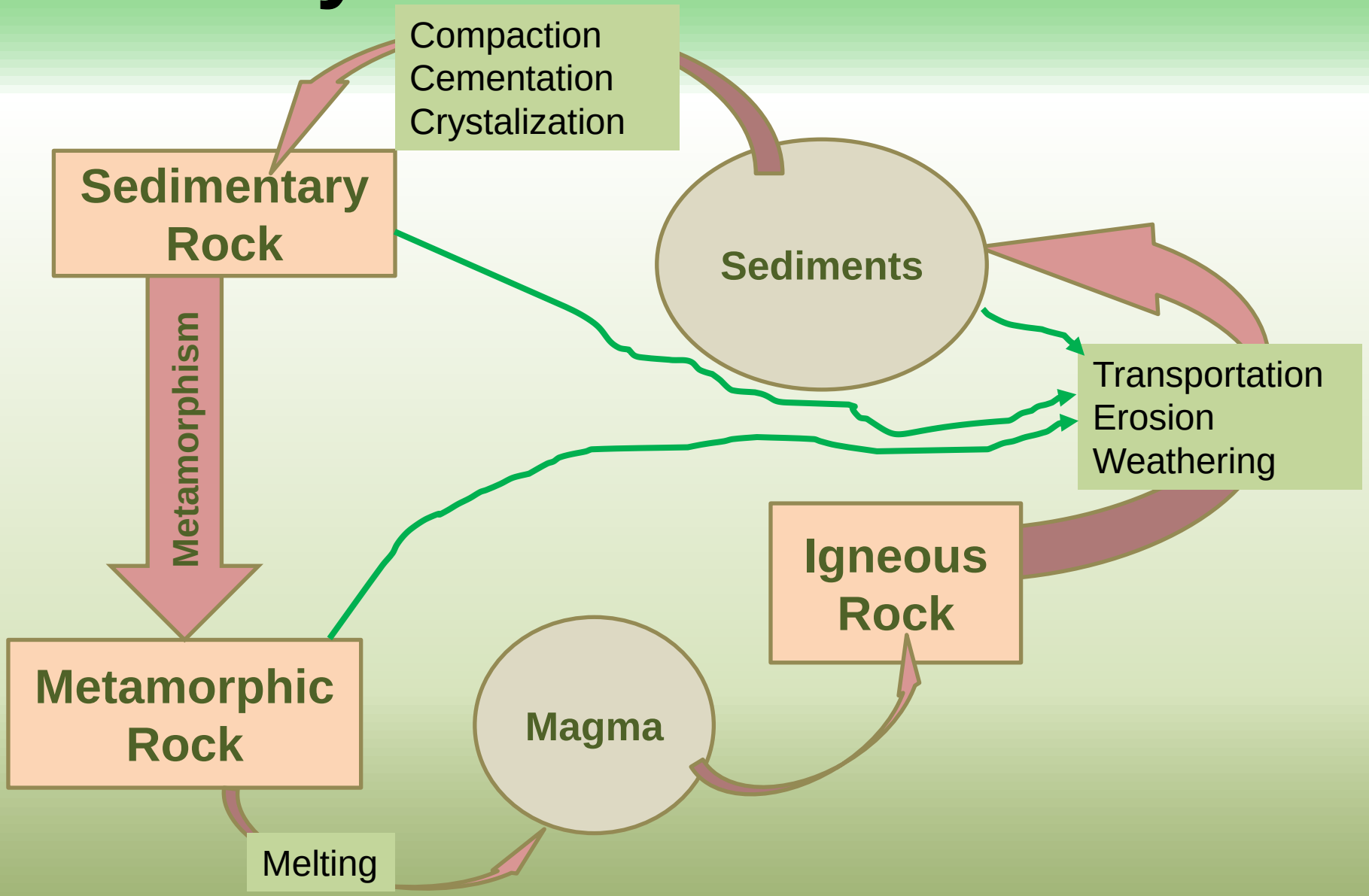
- There are many minerals, but only few of these commonly occur as rock forming minerals.

- Common rock forming minerals are
  - Feldspar
  - Mica
  - Amphibole
  - Pyroxene
  - Olivine
  - Clays (primary or secondary mineral)
  - Carbonates

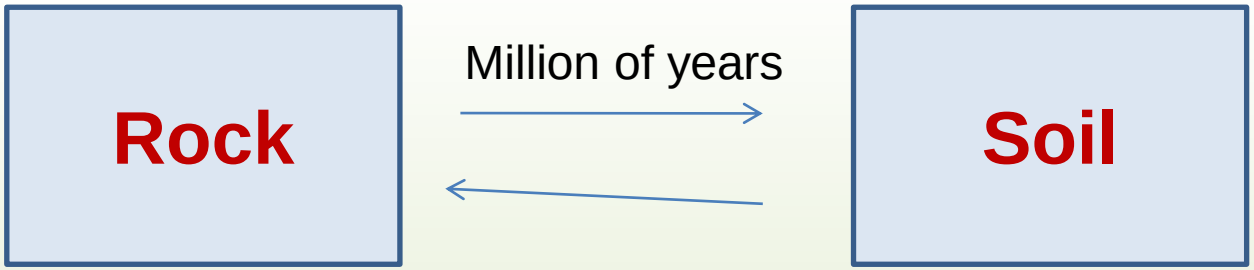
Primary mineral: essential constituent of rock

secondary mineral: results of decomposition of primary minerals

Rock Cycle


Compaction
Cementation
Crystalization
Sedimentary Rock
Sediments
Transportation
Erosion
Weathering
Metamorphism
Igneous Rock
Metamorphic Rock
Magma
Melting

Geologic Cycle



- Modify the earth's surface
- Destroy old rocks
- Create new rocks
- Add complexity to the ground surface
- Form soils

Weathering

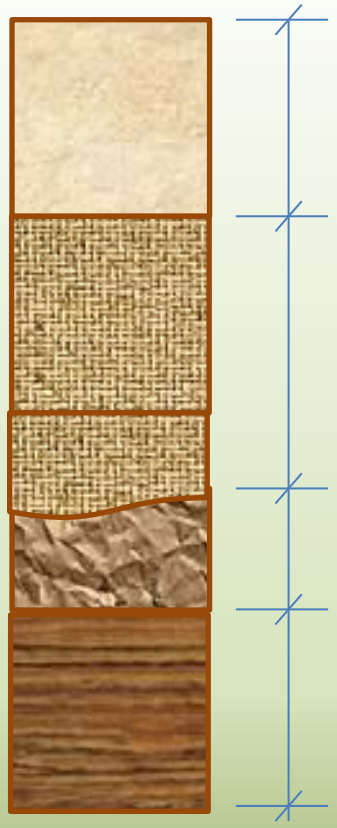
- The process of disintegration and decay of rock
- Results from exposure to the atmospheric agent (e.g., pressure and temperature) and also for their influences
- Controlling factors:
  - Climatic condition of the area
  - Temperature and precipitation

Type of Weathering

- Physical or mechanical weathering
  - …
  - …
- Chemical weathering
  - …..
  - ……..
- Biological weathering
  - ……
  - ….

Soil Profile and Soil Horizon

Soil Horizon:
Vertical changes caused in residual soil



Horizon A

Horizon B

Horizon C

Horizon D

Soil Profile:
The set of horizon (from soil surface to the original or physically unaltered parent rock

Soil Horizon

Horizon	Weathering	Accumulation	Characteristics	Stability
Horizon A	intensive	organic	undesirable	Very compressible, elastic and unstable
Horizon B	moderate	Many products (clay, small particle aggregates)	Some undesirable	Relatively stable
Horizon C	Slightly weathered parent material	Parent material	desirable	Relatively stable
Horizon D	Zone of massive rock		,,	stable