Introduction to Geology

ACWADAM
PUNE
Rocks: the framework for groundwater

- All the rocks make the crust of earth display some texture and structure.
- We shall consider only the ones which have some bearing on ground water and its movement.
Basic rock types

1. Igneous rocks: Rocks formed from the consolidation of “magma” or molten rock material. Magma, when brought to the surface is called ‘lava’. Lava forms volcanic rocks.

2. Sedimentary rocks: Rocks formed from the weathering, erosion and deposition & compaction of rock material through agents like wind, water, ice and chemical precipitation.

3. Metamorphic rocks: Existing rocks that undergo changes due to pressure and temperature – undergo metamorphosis – get transformed into metamorphic rocks.
Rock cycle

1. Igneous Rocks
   - Weathering & Deposition
   - Cooling & Consolidation
   - Burial and melting

2. Sedimentary Rocks
   - Burial and melting
   - Heat & Pressure

3. Metamorphic Rocks
   - Heat & Pressure

4. Igneous Rocks
   - Burial and melting
   - Heat & Pressure
- Indo-Gangetic plains – sediments carried by Himalayan rivers
- Sedimentary rocks
- Basalts – Deccan Volcanic Province
- Hard rocks of peninsular India
A dark coloured, fine-grained, ‘extrusive’ igneous rock composed of plagioclase feldspar, pyroxene, and magnetite, with or without olivine, and containing not more that 53 wt.% of SiO$_2$. 

BASALT
GRANITE

A light coloured, coarse-grained, **igneous rock** consisting essentially of quartz (at least 20%), alkali feldspar, mica with or more commonly without amphibole and accessory apatite, magnetite and sphene.
SANDSTONE

It is a sedimentary rock formed from lithified sand, comprising of grains between 63µm and 1000µm in size, bound together with a mud matrix and a mineral cement formed during burial diagenesis.
LIMESTONE
It is a sedimentary type of rock composed mainly of calcite and/or dolomite, which is often of organic, chemical or detrital origin.
GNEISS

General petrological term applied to coarse-grained, banded rocks that are formed during high-grade, regional metamorphism.
SCHISTS

A regional metamorphic rock of pelitic compositions which displays a schistosity. They are coarse grained, having a grain size greater than 1mm.
LATERITE

Weathering product of rock, composed mainly of hydrated iron, aluminium oxides, hydroxides, clay minerals, and also containing some silica.
CONGLOMERATE

Coarse grained (rudaceous) rock with rounded clasts that are greater than 2mm in size.
SHALE

Fine grained fissile, sedimentary rock, composed of clay sized and silt sized particles of unspecified mineral composition.
Joints and Fractures
Fractures may be associated with movement within the earth or they may not be associated with movement.

Irrespective to their association with movement they may be opened by decay; thereby making them channels, through which water may move and may be stored.
Openings in rocks

- The attitude of joints and fractures determine the direction in which the water will move.

- The size of openings made by joints and fractures often would decide the ease with which water would move in the rock.

- Ease of movement of water in the rock is termed permeability.
Metamorphic rocks have similar characteristics as igneous rocks but have structures similar to the sedimentary rocks. They show a prominent schistosity similar to the stratification in sedimentary rocks.
Secondary porosity developed during the decay and structural deformation may allow water to move and get stored in metamorphic rocks.
Sedimentary rocks exhibit a variety of textures and structures which allow storage and movement of ground water.
The most common texture exhibited by sedimentary rocks is the clastic texture or fragmental texture.

The clasts are arranged in different ways and are of assorted sizes and shapes which gives the texture a large variety.

The main pore space is the intergranular space which forms the porosity. The nature of this varies with the size and shape of the clasts.
Secondary porosity in sedimentary rocks is important in the chemical sediments (limestones/carbonate rocks). Meteoric waters which come in contact with limestones have weak carbonic acid in them. The calcium carbonate is slowly dissolved, forming voids (Pore spaces).
This secondary porosity varies as the solution pores vary in size from pin point to caverns. Thereby porosities and permeability vary.
Bedding

- Layers of sediment consolidate to form a bed of rock.
- Many beds or layers lie one below the other in a simple sequence of sediments.
- The beds may be horizontal or...
**Bedding**

- Sometimes beds dip, i.e. they become inclined with respect to the horizontal. The **dip** is an angle of the bed with the horizontal plane.
- The line of intersection of a dipping bed, with the ground surface is called strike. Strike has a direction.
Faulting

- Faults are planes (usually fractures in the ground) along which blocks of earth move relative to one another.

- Sometimes, these blocks move vertically; at other places...
Faulting

- ...blocks of earth move horizontally wrt each other

- Faulting alters the landscape and creates complex situations for groundwater accumulation and movement.
- Faults are ruptures in the rocks.
- Fault planes may be vertical or inclined.
- There are various varieties of faults; the major ones for our purpose are:
  - Normal fault - vertical, inclined
  - Reverse fault - high angle and thrusts.
Folding

- Rocks may undergo folding.
- Folded rocks give rise to diverse situations of groundwater accumulation and movement.
- Folds need to be understood with respect to their relationship with the topography.
Folding

- Study of folds involves a study of the different lithologies that constitute folded rocks.
- Study of the dips of the different limbs of folds.
Folded Beds, simple deformation of sedimentary rocks, leads to folding.

There are two basic types of folds: Anticline (antiform) and Syncline (synform).

There is a wide variety of these, depending on the geometry of the folds.
- Structural features often control groundwater movement in rocks...e.g. dykes and faults
Unconformities are a pause in deposition of sediments. They are expressed as a structure. There are three main types of unconformities:

1. Angular unconformity
2. Nonconformity
3. Disconformity.
Angular unconformity

Non conformity

Disconformity
• Unconformity may often act as

A channel for the movement of water or

A barrier for the movement of water.
THANK YOU