GROUND WATER MOVEMENT

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INTRODUCTION

- Groundwater is subsurface water which absolutely saturates the pore spaces above an impermeable layer. Water found in the pore spaces, cracks and crevices beneath the surface has been termed as groundwater.
- Sources of Groundwater- Connate (at the time of rock formation water is trapped in the interstices of sedimentary rocks), Meteoric(atmospheric water which falls as rain and becomes groundwater by infiltration), Juvenile(originates in the earth’s interior and reaches the upper layers as magmatic water)and Condensational(atmospheric water vapour penetrates the rocks and gets converted into water)

MOVEMENT OF GROUNDWATER

- Groundwater movement takes place through pore spaces at extremely slow velocity.
- Ground water moves from higher elevations to lower elevations and from locations of higher pressure to locations of lower pressure. Typically, this movement is quite slow, on the order of less than one foot per day to a few tens of feet per day. In groundwater hydraulics (the science of groundwater movement), water pressure surface and water table elevation are referred to as the hydraulic head. Hydraulic head is the driving force behind groundwater movement. Groundwater movement is always in the downward direction of the hydraulic head gradient. If there is no hydraulic head gradient, there is no flow. The hydraulic gradient is often but not always similar to that of the land surface
- Groundwater movement in gravels and sands is relatively rapid, whereas it is exceedingly slow in clay or in tiny rock fractures. The ability of geologic material to move ground water is called hydraulic conductivity. It is measured in gallons per day per square foot (gpd/ft2) or in feet per day (ft/day).
- The hydraulic conductivity of sandy or gravelly aquifers typically ranges from 100 to 10,000 gallons per day (gpd) per square foot (approximate equivalent: 10 to 1,000 ft/day). On the other hand, the hydraulic conductivity of clays, which consist of tiny particles that stick together and block water movement, is a tiny fraction of the hydraulic conductivity of a sandy aquifer: 0.001 gallon per day per square foot or less. The hydraulic conductivity of fractured rock depends greatly on the degree of fracturing. It may be as high as 10 to 100 gpd per square foot (approximately 1 to 10 ft/day).

- The movement of groundwater is governed by Darcy’s Law.
- Henri Darcy, a French Engineer in 1856 discovered a mathematical relationship that governs the flow of groundwater.
- Darcy’s law is an equation that defines the ability of a fluid to flow through a porous media such as rock. It relies on the fact that the amount of flow between two points is directly related to the difference in pressure between the points, the distance between the points, and the interconnectivity of flow pathways in the rock between the points. The measurement of interconnectivity is called permeability.
- In the subsurface, rock is deposited in layers. Fluid flow within and between the rock layers is governed by the permeability of the rocks.
- Permeability has to be determined in horizontal and vertical directions. For instance, shale consists of improbabilities which are less vertically. This indicates that it is not easy for liquid to flow up and down via shale bed but easier to flow side to side.

DARCY’S EQUATION

- **Q = KA dh/dl**
- Wherein:
- **Q** is the rate of water flow
- **K** is the hydraulic conductivity
- **A** is the column cross section area
- **dh/dl** indicates hydraulic gradient

- Hydraulic conductivity describes how easily water can move through spaces within the aquifer. Sand aquifers tend to have a higher hydraulic conductivity than rock aquifers.
- Hydraulic gradient describes the difference in groundwater height (or pressure) between two points. A steeper gradient results in greater pressure difference between two points and means that the water can move more quickly through the aquifer.