- 3. Pipeflow
 - even larger underground channels than macropores, which can be formed by burrowing animals, or by water flow through desiccation cracks (common in semi-arid environments, e.g. South-East Spain and Arizona)
 - pipes can be several metres in diameter and can transport water, chemicals and sediment
 - turbulent flow in pipes increases diameter and can result in collapse, a major contributor to land forms in arid regions

(b) Groundwater Flow

- Groundwater water in the saturated zone below the land surface, in bedrock and/ or soil
- The top of the saturated zone is the water table, which can be measured with boreholes and wells
- Groundwater acts as a water store
 - It represents 97% of Earth's non-saline and non-frozen water resources
- Groundwater also represents a flux, i.e. a flow if water, as it moves through saturated soil and bedrock, very slowly
 - This is referred to as groundwater flow (also called groundwater discharge)
- Groundwater flow moves through saturated soil via matrix, macropore and pipe flow (throughflow)
- In bedrock, the rock must be porous and permeable for groundwater flow to occur
 - Such conditions create aquifers



Summary of sub-surface runoff

- Throughflow is movement of water through the soil only (not bedrock)
- · Groundwater flow is movement of water though bedrock and/or soil in the saturated zone
- Groundwater flow is slower than throughflow
- Groundwater flow and throughflow = sub-surface runoff (also called baseflow)

4. Surface runoff (overland flow)

- There are two types of overland flow, dependent upon the method of generation:
 - (a) Infiltration-excess overland flow ('Hortonian' OLF)
 - (b) Saturation-excess overland flow

2. Surface runoff

(a) Infiltration-excess overland flow

- Infiltration rate:
 - The rate at which water is actually being absorbed by the soil (mm/hr)