Chapter 2 Occurrence of GW

- where and how GW exists
- subsurface distribution
- geology formation (water-holding, water yielding capabilities)

2.1 origin and age of GW

Meteoric (surface and atmospheric) waters
Connate water (fossil interstitial water)
Magmatic water (water from magma, plutonic)
Volcanic water (shallow water 3-5 km)
Oceanic water
Juvenile water (new water)
Metamorphic water (water with rocks)

→ Fig 2.1.1

Residence time of water underground (isotope)

→ Equation 2.1.1

(e.g., hydrogen-3, carbon-14, tritium, O14 (for young water)

2.2 Rock Properties

→ aquifer = groundwater reservoir / water bearing formation

aquiclude	}	(saturated, clay)
aquifuge	}	(impermeable, granite)
aquitard	}	(saturated, sandy clay)

Porosity
effective porosity : space available for fluid flow
primary / secondary porosity
granular sedimentary deposited → Porosity

Eq. 2.2.1, 2.2.2
shape, arrangement of individual particles
distribution by size , degree of compaction , cementation
Fig 2.2.1
Table 2.2.1
sample

Soil Classification

- partical size
- uniformity coeff.
- Specific surface (m^2/g)
- Area per unit weight

Uniformity coefficient
Table 2.2.2
Fig 2.2.3, 2.2.4 (representative)
Surface area (Table 2.2.3)
Sample

<u>2.3 Vertical Distribution</u>
Fig 2.3.1 divisions of subsurface water
(saturation, unsaturation, vadose, gw)

<u>2.4 Zone of aeration</u>
Soil water zone
Capillary zone
Water content measurement

- Available water
- Field capacity
- wilting pt

Specific retention $(S_r) = \frac{W_r}{V}$

Specific yield $S_y = \frac{W_y}{V}$

Total 2.5
Well pumping

2.5 Zone of saturation

Specific retention
Specific yield (Table 2.5.1)

2.6 Geologic Formation as aquifers

Alluvial deposits
- water courses
- abandoned or buried valleys
- plains

intermontane valleys
Limestone
Volcanic
Sandstone
Igneous
Clay
(see Thailand hydrogeologic map)

2.7 Types of Aquifer

Unsaturated aquifer
Confined aquifer
Leaky aquifer
Idealized aquifer
Fig 2.7.1

2.8 Storage coefficient

Volume of water that an aquifer releases or takes into storage per unity surface area of aquifer per unit change through a confined aquifer (see Fig 2.8.1 a)
Values fall in the range of 0.00005 – 0.005
Rule-of-thumb relationship for a confined aquifer

$S = 3x\ 10\text{-}6\ b$ (2.8.1)

Storage coefficient for an unconfined aquifer
(Fig 2.8.1 b)

2.9 groundwater basin

Hydrologeologic unit containing one large aquifer of several connected and interrelated aquifer.
(Fig 2.9.1) Thailand case

2.10 Springs

A concentrated discharge of groundwater appearing at the ground surface as a current of flowing water.
(different from seepage areas).
5 types (Fig 2.10.1)
Classification by discharge (Table 2.10.1)
Sample of gaining/losing streams by dye tracers or water balance.

2.11 Hydrothermal phenomena

Thermal springs (warm or hot springs, geyser)
Geothermal Energy springs
(dry, wet, low temperature, dry rock)

2.12 Groundwater in permafrost regions

Perennially frozen ground (unconsolidated deposits or bedrock that continuously have had a temperature below 0 degree C for two years to thousands of years.
Creates an impermeable layer --- acts as a confining layer.

2.13 Groundwater in US

Productive aquifer, withdrawals from the wells in the US
Aerial distribution of groundwater in the US

2.14 Groundwater in Thailand

(Ms. Somkid's presentation)

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