GEOLOGICAL SOCIETY
CENTRAL COLLEGE, BANGALORE

DR. DUSAN DUBA, D.Sc.,
F.A.O. Sr. Hydrogeologist,
S.G.C. Department of Mines & Geology, Bangalore - 1.

will deliver a lecture on

"METHODS AND PROCEDURES APPLIED IN GROUND WATER RESOURCES EVALUATION IN KARNATAKA STATE"

You are cordially invited.

Place: Geology Gallery Hall
Time : 4.00 P M
Date : 1st February 1974

MEMBERS
of the Geological Society
Central College, Bangalore

Notes on Ground water

(1) This Changing Earth by Johnson Shimer – Chap VI – Underground water

only 30" rain, 24" return directly to the atmosphere by evaporation & transpiration (evaporation from vegetation – 9" flow back to sea & most of water at least part of the journey underground. At any time vol of ground water is 3000 times > vol of water in all the rivers – Perennial streams continue to flow because they are fed from underground sources

Distribution — Vol (cubic mts)

Surface water — Fresh Lakes 30,000
Salt Lakes 25,000
Stream Channels 300

Underground water — less than ½ mile deep – 1,000,000
over " = "

Glaciers 7,000,000
Atmosphere 3,000
Oceans 317,000,000
Total 326,000,000 (nearest to 1,000,000)

Presence & motion of water underground – flow under surface very slow, water may remain from hours to years & in deeper parts of crust perhaps thousands of years – Distribution from uniform – Ground water moves under crust less than a mile.

Water table – area of the underground surface separating water-belt (saturated) Zone from zone of aeration – ~~water~~ Table rises after heavy rain & with wet after a time of drought rate of sinking depending on permeability of the rocks – Effect of man on water table, in many arid & semi-arid areas the table has been artificially lowered many tens of feet by pumping water from wells; Deforestation will lessen amount of water returning underground which irrigation projects will increase amount of percolation underground – Hot springs & geysers, Bunsen's theory of 1846 – Erosion by ground water in limestone areas; cave deposits, gallery 4000 ft. long & max. ceiling height 400 ft.; sinkholes; formation of natural bridge; Effect of Chalk vs limestone (harder) – Underground deposits, sedimentary particles of silt, sand & gravel – formation of a concretion; discovery of a stone forest, the forest once existing & flourishing buried under sand & water and the wood changed to stone! – Economically useful mineral concentrations may be produced by groundwater & minerals weathered along with the host rock & certain elements dissolved & transferred in solution to a lower level where they are redeposited, often in the form of a new mineral; Important deposits of Copper in an enriched form have thus origin, for eg. in at Bisbee, Arizona deposits enriched by ground water circulation have yielded over 2½ million tons of copper & large amounts of silver

(2) The Earth Sciences by Arthur N. Strahler

Part IV p. 439 – Soil water & ground water.

Hydrological cycle – Infiltration & run off. – Evaporation and transpiration & evapotranspiration – Retention of moisture in the soil – annual cycle of soil moisture – The soil-water budget +

Ground water (Zone of saturation & aeration) – water table – Ground water motion (not horizontal, curved flows) – Ground water recharge – Effluent and influent streams, stream proving water by seepage to the water table below is called influent stream; a stream that receives water by seepage is effluent; eg. of desert streams tends to disappear – Porosity & permeability – Aquifers and aquicludes; a sandstone layer being high in porosity & permeability can hold & transmit large quantities of water & is called aquifer, a ~~shale~~ shale layer impermeable in nature preventing flow of ground water through itself is called aquiclude – Artesian flows, water forced upward under natural pressure – Pump wells (gravity wells), deep below water table, cause depression in water table due to pumping, sometimes extending several miles; replenishment of pumping & recharge – Relation between salt & fresh ground water.

(3) Elements of Geology by J. H. Zumberg (Deptt Geology, Univ of Michigan)

§ 8. Ground water. (p. 128).

– He dug the hard rock with iron, and made wells for water" – Ecclesiastes – Belief by ancients that ground water can be used ~~found~~ found by use of forked twig

Origin of ground water; Hydrological eqn:

Precipitation = Run off + Infiltration + Transpiration + Evaporation

Occurrence of ground water; outer portion of earth's crust made up of material ranging from dense granite with almost no pores & unconsolidated gravel with many voids in between mineral grains; Vol of pores as % of total vol. of rock is porosity & Porosity = $\frac{\text{Vol. of voids}}{\text{Total Vol}} = \frac{1 \text{ gallon}}{5 \text{ gallon}} \times 100 = 20\%$; belt of soil moisture, the intermediate belt & capillary fringe these three constitute the zone of aeration (Vadose zone); below is the zone of saturation (phreatic zone); undulating plane separating the vadose zone from the phreatic zone is the water table – Movement of ground water; ability of rock to transmit ground water is its permeability; coeff of permeability – Aquifers & wells; geological material yielding water to the well is an aquifer – Pumping of wells – Ground water problems:–

(a) Problems of supply – Conservation of ground water is one of the fundamental problems facing many countries or parts thereof; necessity for artificial recharge methods

(b) Finding new supplies – Rapid increase in search by human agencies to locate heretofore unknown aquifers; geologists & the magic twig;

(c) Geological work of ground water; limestone caverns, Karst topography; Karst applies first to Yugoslavian plateau which is underlain by soluble rocks; geysers & hot springs; travertine (carbonate deposits in caves); concretions & geodes (miniature caves) (nodular mass); petrifaction (eg: forests → stone).

(d) Cave theory.

* (consists of belt of soil moisture, intermittent belt & Capillary fringe)

Technical terms

(1) water table – separating saturation zone (phreatic) (below) from aeration zone (vadose) – table not everywhere horizontal – undulating plane separating vadose & phreatic zone.

(2) Aquifer & Aquicludes – stratum highly porous & permeable can hold & transmit large quantities of water are aquifers; shale layers preventing flow of groundwater through them aquicludes.

(3) Effluent & influent streams – Province water by seepage to the table below is influent; stream receiving water by seepage is effluent. Freq. desert streams.

(4) Cone of depression – caused in water table by digging of wells & pumping

(5) Hydrological eqn – Precipitation = run off + infiltration + transpiration + evaporation

$$p = r + i + t + e \quad (p = \text{rite}) \quad [a = b + c + d + e]$$

(6) porosity = $\frac{\text{Vol of voids}}{\text{Total vol}}$ freq = $\frac{1 \text{ gallon}}{5 \text{ gallons}} \times 100 = 20\%$

(7) Permeability – Ability of rock to transmit ground water

(8) Karst topography – karst in Yugoslav plateau underlain by soluble rocks

(9) Travertine – Carbonate deposit in caves

(10) concretions – nodular mass

(11) geodes – miniature caves

(12) petrifaction – forests → stone.

(13) Magic twig – Used by water diviners.

Problems: (1) Conservation of ground water (2) finding new supplies of aquifers 3) artificial recharge methods (4) halting deforestation (5) Perennial streams & ground water (6) Salt & fresh g.w.

(14) water distribution table – mid ground water ≤ ½ mile deep = 1,000,000 (1 million cubic miles

(15) mineral deposits caused by ground water eg of Arizona. (16) Artesian flows,