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Occurrence of Ground Water in Basaltic Rocks of Malwa Plateau Region, Madhya Pradesh, India

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Abstract : The Malwa Plateau, covering the western part of Madhya Pradesh north of the Narmada Valley mostly covered by the basaltic lava flows of Deccan Trap igneous activity.This plateau characterized by flat topped hills and step like terraces. The groundwater which encountered in basaltic rocks generally occurs in the joints and fissures. These structures mostly provide the secondary porosity and permeability.The Deccan Traps formations can be tapped by dug-cum-bore and drilled wells.It is observed that the yield increased by 5-10 times when 10-15m bores extending down to the lower vesicular zone are drilled at the base of dug wells.Yields of 400-600 m^3/d can be obtained in this way.

Introduction - The Deccan volcanic province covers four prominent lava plateaus viz. the Deccan proper including the Western Ghats in Maharashtra, the Malwa Plateau in the north separated from the former by Satpura range and the Narmada and Taptiriver areas. The Saurashtra or Kathiawar Peninsula and the smaller Mandla Plateau in the east.

The Malwa Plateau is a rather ill-defined region, covering the western part of Madhya Pradesh (Malwa Plateau covering Nimuch, Mandsaur, Indore, Dhar, Ratlam, Shajapur, Sagar, Rajgarh, Sehore, Badwani, Khargone, Khandwa and Burhanpur Districts and extends in parts of Jhabua,Guna, Ashoknagar,Sehore, Bhopal,Raisen and Vidisha) north of the Narmada Valley mostly covered by the Deccan Traps. The volcanic rocks of the Narmada Valley region are originally known as Malwa Traps.

Geology : Malwa Plateau consists of basaltic lava flows of the Deccan Trap igneous activity. The geology of the Malwa Plateau was first studied by Blanford, who had mapped the area for the first time during '1882-86', this plateau characterized by flat topped hills and step like terraces. The topography is a result of variation in hardness of the different flows. The lava flows may be distinguished on the basis of the following criteria:

i. The colour and lithology of the flows.
ii. Presence of prominent thick weathered zone at the top of individual flows.
iii. Presence of highly vesicular tops.
iv. Presence of distinct platforms.
v. Presence of pipe amygdules in the bottom of each flow.
vi. Mode of weathering and
vii. Joint pattern

The contrasting water bearing properties of different flow units control groundwater occurrence in Deccan Traps. The Deccan Traps have usually poor to moderate permeabilities due to the presence of primary and secondary fractures. The most common litho-unit is tholeiitic basalt with an average specific gravity of 2.78.

Megascopically the rock is melanocratic, hard, compact,massive in nature. The rock sometimes shows vesicular nature, the vesicles are generally filled by the secondary minerals like Zeolites, Calcites and Quartz.The amygdaloidal tendency in the flow is more towards their top portions.

The main assemblage of the minerals found are plagioclase feldspar, pyroxene, glass, opaques and few other secondary minerals like zeolite, calcite, quartz, agate etc. Basalts readily weather to give rise to black cotton soil called 'regur', Black cotton soil has the property of swelling greatly and become very sticky when wetted by rain.
Another product of weathering is laterite, from which Silica, Alkalies and Alkaline earths have been leached away leaving behind alumina, iron, manganese and titanium. It has Pisolitic structure and contain much water,due to higher permeability.In these basaltic rocksgroundwater occurs only along joint planes, vesicular tops and in the weathered zone/ intertrappean beds in between two individual flows.

Groundwater Occurrences : The occurrence of groundwater in these formations depends upon number of factors which control the movement of groundwater. These factors are -

1. Depth and nature of the material constituting the over-burden.
2. Depth of weathering.

3. Size intensity, and interconnecting nature of the vesicles.
4. Thickness of vesicular Zone.
5. Source of Recharge.
6. Density and size of joints, fractures etc.

The main source of all the surface and sub-surface water resources is precipitation. The water that infiltrates down through the pore spaces of the rocks under the earth surfacebecomesgroundwater which represents a part of the hydrological cycle. The depth of water table is a variable factor and depends upon the topography and geology of theunderlying formations and climate. Water table is deep in mountainous and dissected country and shallow in moderate relief areas. The groundwater which encountered in hard rocks (Lunkad et al., 1978; Adyalkar et al., 1973)generally occurs in the joints and fissures. These structures mostly provide the secondary porosity and permeability.It is interestingto record that at times these conduits disappear at greater depth and due to hydration weathered zones are formed at shallow levels.In the zone of permanent saturation, which ' extends from 150-300 feet, in case of Deccan Traps. Water is held under pressure mostly in the joints and fissures traversing the rock. The quantity of water held in the zone of hard rock is much less percubic feet thanthat of water held in the weatheredzone. Wells intersecting this permanent saturation zone yield water throughout the year and are not affected by seasonal fluctuation as is the case in shallow wells.

In Deccan Traps weathering is critical phenomenon and the occurrence, movement and storage of groundwater in this geologic material depends upon the zone of weathering present. In Deccan Trap, the zones of weathering are -

1. The upper most layer is constituted by ''black cotton soil" (Regur) intermingled with red or yellowish clay with Kankar and extended from 2 to 6meter depth.
2. Weathered basalt, locally distinguished as "Copra" which Is yellowish, brown or greenish in colour. The nature of layer is soft, loose and less permeable. The layer penetrates the formation over a depth of 3 to 10 meters.
3. Jointed and fractured basalt which are highly permeable.

The open joints and fractured zone in basalt possesses high transmissibility when these openings are not plugged with the weathering product.

Conclusions : Basaltic rocks form the most important aquifers in the region. The weathered, fractured, joined and vesicular units of basalts form moderate to good aquifers. The formations have highly variable yields ranging from 10 to 750 m^3/d. Dugwells range in depth from 4 to 20 m with water level varying between 2 and 14 mbgl. The specific capacity ranges from 50 to 150 lpm/m of drawdown, hydraulic conductivity varies between 5 and 15 m/d and the specific yield is 5-10%. The Deccan Traps formations can be tapped by dug-cum-bore and drilled wells. It is observed that the yield increases by 5-10 times when 10-15 m bores extending down to the lower vesicular zone are drilled at the base of dugwells. Yields of 400-600 m^3/d can be obtained in this way. In some areas the control of doleritic dykes on occurrence of groundwater was observed. Wells located on the upstream side of these dykes gave better yields. Also wells located on tectonic lineaments gave better yields.

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