

Fracture pattern and its relationship to groundwater in hard rocks of Negeri Sembilan

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Granite and metamorphic rocks in Negeri Sembilan and in other parts of Peninsular Malaysia have been considered to be of poor aquifer. The hydrogeologic map of the Peninsular, 1975, shows the area underlain by the hard rocks as having poor to moderate potential for groundwater production ($< 230 \text{ m}^3/\text{well}/\text{day}$).

This paper presents a new finding about productive hard rock aquifers in Negeri Sembilan. Data from tubewell drillings in the past four years were analyzed. The drillings for groundwater were carried out mostly to meet the growing industrial water demand in the state. It was found that the hard rocks could yield fresh water more than $300 \text{ m}^3/\text{well}/\text{day}$. Discharge rates up to $890 \text{ m}^3/\text{well}/\text{day}$, $408 \text{ m}^3/\text{well}/\text{day}$, $590 \text{ m}^3/\text{well}/\text{day}$, $545 \text{ m}^3/\text{well}/\text{day}$.

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well/day and 960 m³/well/day were found in Seremban, Kuala Pilah, Lenggeng, Tampin and Rembau respectively. The wells were between 50 m and 200 m deep.

High discharge rates of groundwater above 300 m³/well/day were encountered from wells that penetrate major fracture zones. Both the granite and metamorphic rocks are generally fractured at various depths. Groundwater in interconnected fractures has a steady flow that sustained production during pumping tests and actual usage of the wells. This phenomenon indicates that the groundwater is being recharged by infiltration of rainwater through the overlying weathered rocks and soils. Tubewells in granite of Sungai Gadut, Kuala Pilah and Tampin areas were found to have average discharge rates of 650 m³/well/day, 408 m³/well/day and 500 m³/well/day respectively. Shallow tubewells in Tampin, of less than 50 m deep, penetrated only weathered granite, are generally non productive (< 70 m³/well/day). Limited fracture openings at shallow depth and restricted recharge areas are likely to be the reason for the low discharge.

The fracture patterns inside the wells could not be ascertained although it was assumed that the patterns follow the major regional N-S and NW-SE structural trend of the Main Range granite. Topographic features and lineaments of the valleys and ridges were used for locating productive sites. About 90% deep tubewell drilling (100 to 200 m) in granitic areas of Sungai Gadut, Tampin and Kuala Pilah was successful in obtaining discharge rate more than 100 m³/well/day. In contrast, only 30% success rate was obtained from drilling in metamorphic rocks of Linggi area. Clay particles in fractures was observed to be the factor for the low success rate and poor quality of the water.
