

Artesian Flowing Wells Field of Phu Tok Aquifer

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Abstract: Phu tok Aquifer is the most productive water bearing rock in the Northeastern region of Thailand. Generally, well drilled in this aquifer yields approximately 20–50 m³/hr with some wells yield over 150 m³/hr. This aquifer characterized both unconfined and confined aquifer. Data collected from core sampling and TV bore hole show water bearing fractures in the fine grained massive sandstone intercalated with thin shale layers. These intermittently bedding plane fracture zones were found vertically at 60-65 and 95-110 m below ground surface. Three directions of vertically fractures were also found at 10³-10⁴ m in the test well with underlain densely sandstone until 120 m of depth. Wells drilled to 60-70 m fractures at the area where surface elevation between 150 and 170 m above mean sea level were artesian well with rising water about 1-3 m. Natural discharge rate from 2-5 inches of diameter casing is 5-10 m³/hr. Fractures at 90-110 m yield 150 m³/hr through 6 inch casing well with 5-6 m of risen water above the ground. It is found from pumping test of Phu Tok Aquifer that hydraulic conductivity of unconfined aquifer at shallower than 50 m is 0.005-17 m/d. Transmissivity and storage coefficient are 0.05-20 m²/d and 7×10⁻³-0.725 respectively. The confined aquifer at depth not exceed 90 m has hydraulic conductivity value of 0.2-10 m/d while transmissivity and storage coefficient are 3.19-150 m²/d and 1×10⁻¹⁰-1.6×10⁻². Another confined aquifer at 90-120 m of depth have hydraulic conductivity value of 0.08-15 m/d and transmissivity and storage coefficient values of 1.7-178 m²/d and 4×10⁻⁷-4.5×10⁻³ respectively.

Keywords: Northeastern Thailand, Phu Tok aquifer, Flowing well

Introduction

Mun-Chi Basin supported by clastic sedimentary rocks of Khorat Group, which age is in early Triassic to Cretaceous and the rock group cover on the Khorat Group, consist of Mahasarakham formation (salt layer) and Phu Tok formation, which age is in Cretaceous to Tertiary (Consisted of shale, siltstone, sandstone, mudstone, conglomerate and rock salt). The top is covered with Quaternary sediments, that unconsolidated and semi-consolidated sediments. Data from drilling groundwater well found that about 80 percent of well get water from rock aquifer and 20 percent of well get water from unconsolidated sediment aquifer (Hydrogeological map of northeastern Thailand, 1983). Source of groundwater in Mun-Chi Basin Such as:

(1) Unconsolidated sediment aquifer that orientation parallel to the long side of Mun River. And parallel to the left side of Chi River. The topography is hilly. Drilling at Ratsamakkee Temple (Nongsongmaw Village, Tambon Candong, Amphoe Candong, Buriram Province) at depth 210 meters, drill through thickness of the old river sediment. Found that the old river sediment thickness about 205 m and below is supported by Khok Kruat formation (The Khok Kruat formation consists of sandstone, shale and siltstone, grayish red to reddish brown, very fine to fine grained, medium hard and contains some iron cementing). From lithological logging, borehole sample, and electric logging, found 4 layer of aquifer. The top is unconfined aquifer depth about 10-20 m and the 3 layer below are confined aquifer. Three layer depths are 40-60 m, 80-100 m and 120-140 m. Only depth 120-140 m has salt water. Groundwater

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head is about 2-4 m above the ground level. Free flow is about 3-7 m³/hr in pipe diameter 6 inch.

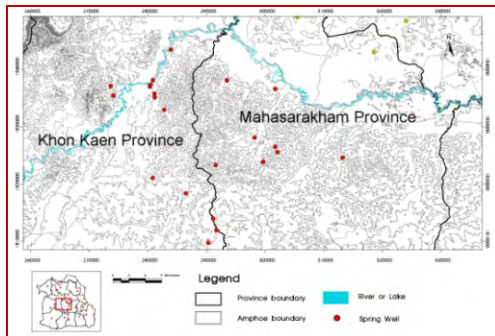


Fig.1 Groundwater Springs in the Study Area and Outcrop Location (Phu Tok Aquifer)

(2) Phu Tok Aquifer is an aquifer in hard rock that the highest yield in Mun-Chi basin. Phu Tok Aquifer can be developed to solve the shortage of potable water. There are plenty enough to have developed and used in agriculture. Especially type of Artesian Flowing wells in Khon Kaen Province and Mahasarakham Province. When drilling at a depth of 30-60 m. In appropriate areas at altitudes between 150-170 m above sea level, it has artesian well spring 1-3 m above ground level, free flow 5-10 m³/hr in pipe diameter 2-6 inch. Drilling an exploratory well depth 120 m at Nonsomboon village, Tumbon Nonsomboon Amphoe Banhat KhonKaen Province found confined aquifer at depth 90-110 m. Artesian well spring 5-6 m above ground level and free flow is over 170 m³/hr in pipe diameter 6 inch.

Geology

Phu Tok formation during the Late Cretaceous to the early Tertiary and unconformably overlies the Mahasarakham formation. Phu Tok formation consisted of coarse grained sandstone, various size of cross-bedding. Sediment was deposited by eolian (Fig.2). Next, consisted of siltstone and the bottom is mudstone (deposited in close marine). Mudstone cover on first rock salt layer. (Sattayarak and Sutheetorn, 1983). Phu Tok formation have a big fracture, high porosity and poor adhesion of the sand grained that make it to the best aquifer. Phu Tok formation can be divided into 3 sub-units. Upper Phu Tok, Middle Phu Tok and Lower Phu

Tok (Pajon, 2003)

Upper Phu Tok unit consisted of fine to medium grained sandstone, orange red and reddish brown colour, cross bedding. Found large fracture on the surface of the outcrop.



Fig.2 Outcrop of Middle Phu Tok at Nongsaphang Village Mahasarakham Province

Middle Phu Tok Unit consisted of fine grained sandstone and siltstone, reddish brown colour interbedded with thin shale. Have larger cross bedding. Represents the rock deposited in the arid climate.

Lower Phu Tok Unit consisted of reddish brown mudstone or claystone. This unit covers Mahasarakham formation and interbedded with anhydrite and gypsum on the bottom of the unit (Geological map of north-eastern Thailand, 1999).

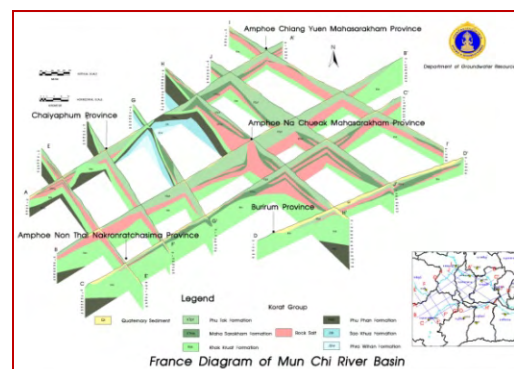


Fig.3 Geologic Section of Mun-Chi River Basin

Hydrogeology

Interpret data from the study of the rock samples from drill holes, Electrical Logging and pumping test found that Phu Tok aquifer consisted

of unconfined aquifer at 20-50 meters and confined aquifer at 90-300 meters, transmissivity from 0.05 to 178 m^2/day , Hydrogeological conductivity from 0.005 to 15 m/day and storativity from 1×10^{-10} to 0.725. The rock has the potential for high water. Normally, the water yield is from 5 to 10 m^3/hr . Some place yield is over 100 m^3/hr . If drilling wells in the elevation is range of 160 to 165 meters above sea level, it has springs such as well at kham Pia village, nong Pak tup village, Nonsomboon village, Nong Kham village, Amphoe Ban Hat and Nong Waeng Noy village, Amphoe Nong Song Hong, Khon Kaen province.



Fig.4 Spring, Yield is Over 170 m^3/hr . At Khon Kaen Province

Springs are generally the free flow rate between 70 to 200 m^3/day and head level 2-7 m above ground level.



Fig.5 Spring, Yield 50 m^3/hr . At Amphoe Nong Song Hong, Khon Kaen Province

Verified from the drilling data collected by the Department of Groundwater Resources and Exploratory potassium well by the Department of Mineral Resources, found that fracture allow water to flow through a fracture in a massive sandstone.

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Phu Tok unit has interbedded with thin shale and bedding plane fracture. Fractured zones are located at a depth between 64-68 m, 91-92 m and 104-108 m. They also found a large vertical fracture in core sample and outcrops, which is structured to allow water to flow through the Phu Tok unit. For the lower Phu Tok placed a layer of mudstone on the Mahasarakham formation. It serves as an aquiclude or aquitard. This layer makes it possible to resist salt water from the Mahasarakham formation (S.Punjasuthalos, 1995; Department of Groundwater Resources, 2006).



Fig.6 Fracture Zone in Massive Sandstone, Interbedded with Thin Shale

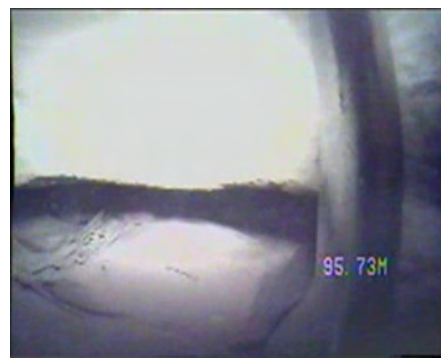


Fig.7 Horizontal Fracture at 95-96 m

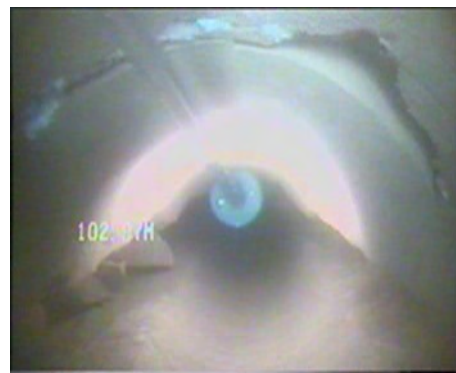
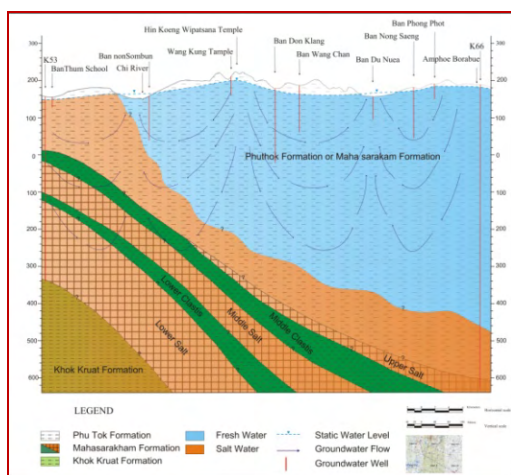


Fig.8 Vertical Fracture at 101-104 m

Groundwater flows along fracture in the Phu Tok aquifer. The flow likes the jet flow. Flow from high pressure water through the vertical fracture and the fracture by the contact between shale and sandstone tracks to an area with low water pressure. Flow like an open-channel (Pajon, 2003).



Hydraulic Properties of Phu Tok Aquifer

The confined aquifer at depth not exceeds 90 m. When drilling in areas that have a height of 150-160 meters above sea level, it has artesian flowing well and the head is 1-3 m above ground floor. Free flow through the 6 inch pipe 5-10 m³/hr. Head of the confined aquifer at 90-120 m is 5-6 m above ground floor. Free flow through the 6-inch pipe over 170 m³/hr.

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