TEMPERATURE LOGGING AND THERMAL DATA IN MEKONG DELTA

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ABSTRACT

The type of temperature logging in a borehole of Mekong Delta is continuous recording of temperature using a sensor lowered into the borehole. This type of measurements provides a lot of temperature versus depth.
Using the temperature log, thermal gradient can be estimated and contouring temperature value at different depth. From the results of this works the areas with high temperature (representative of hot water) and low temperature (representative of cooler water) can be distinguished. The direction of temperature change is also clear shown.
The main meanings of these results is for different purposes specially for geothermal study.

Keywords: Mekong Delta, Temperature logging, temperature sensor, geothermal gradient, temperature contour.

1. INTRODUCTION

Mekong Delta is low plain located at utmust south of Vietnam (fig. 1). The depth of the boreholes in the area are of about 80 – 500 m penetrated Quaternary and Neogen unconsolidated rocks contained predominantly clay, sandy clay, clayey sand and sand. The boreholes drilled mainly for hydrogeological study.

Recording temperature variations in a borehole provides useful information to geothermal researcher such as a lot of temperature versus depth. Temperature logging in Mekong Delta carried out using temperature sonde connected to poly resistivity probe 2PEA-1000 and digital MGX II console.

The temperature data is used for thermal gradient estimation and Identifying temperature change with depth ≤ 250 m and > 250 m in the whole Mekong Delta.

The results show that the thermal gradient K/100 m varies significantly from borehole to another with value of 0 to 11.9. The temperature contours of the two depth intervals show different pictures distinguishing the areas with hot and cooler water and direction of temperature change.

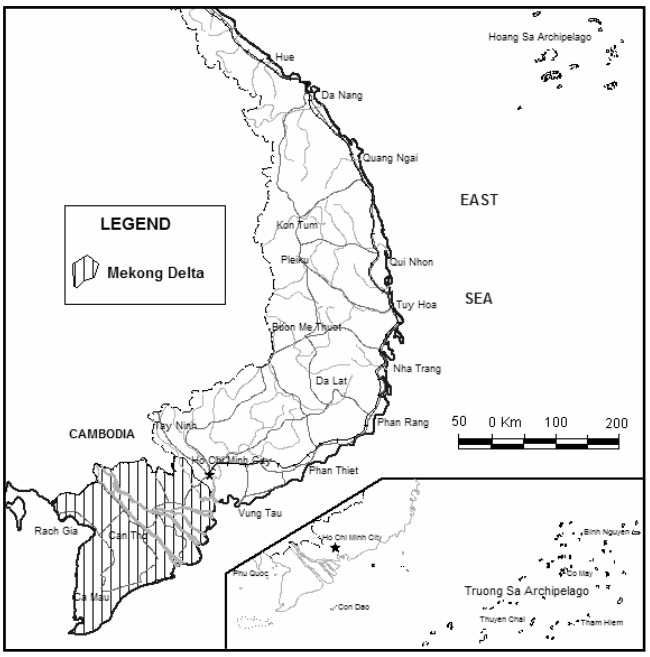

Figure 1: Location of Mekong Delta

2. PRINCIPLES

In hydrology, the available instruments are generally of continuous recording of temperature using a sensor lowered into the borehole. This type of measurements provides a lot of temperature versus depth.

Modern instruments generally have a thermistor whose internal electrical resistance varies with changes in temperature. The sensor is mounted on a tube that allows the fluid to flow past it as the probe is lowered into the borehole.

A temperature that is representative for the surrounding rock can usually be measured in the borehole fluid only, as considerable air circulation may take place above the fluid level in the hole. For this reason one mostly observes a temperature step with the entry of the probe into the fluid.

Due to the annual temperature wave the natural temperature increase with depth (geothermal gradient: on average 3 degr. C/100 m) can first be observed at a depth of about 20-30 m. Deviations from the normal temperature rise can indicate vertical water movements in the borehole or in the surrounding rock.

3. MEASUREMENT AND INTERPRETATION

a) Measurement: The instruments are MGX II console with digitally recording and poly resistivity probe 2PEA-1000 with connected to them temperature sonde. The temperature sensor has a certain response time and hence the speed of logging should be constant and very slow so that measurements reflect with precision the temperatures at different depth. On the other hand, the log is recorded as the instrument is lowered so that the temperatures are not altered due agitation of the fluid when the cable and probe pass through it. For the same reason, the temperature log should be programmed before other measurements. Figure 2 illustrates the temperature log and resistivity, gamma ray logs of borehole "Pataya" in Can Tho city located at the south bank of the Mekong river.

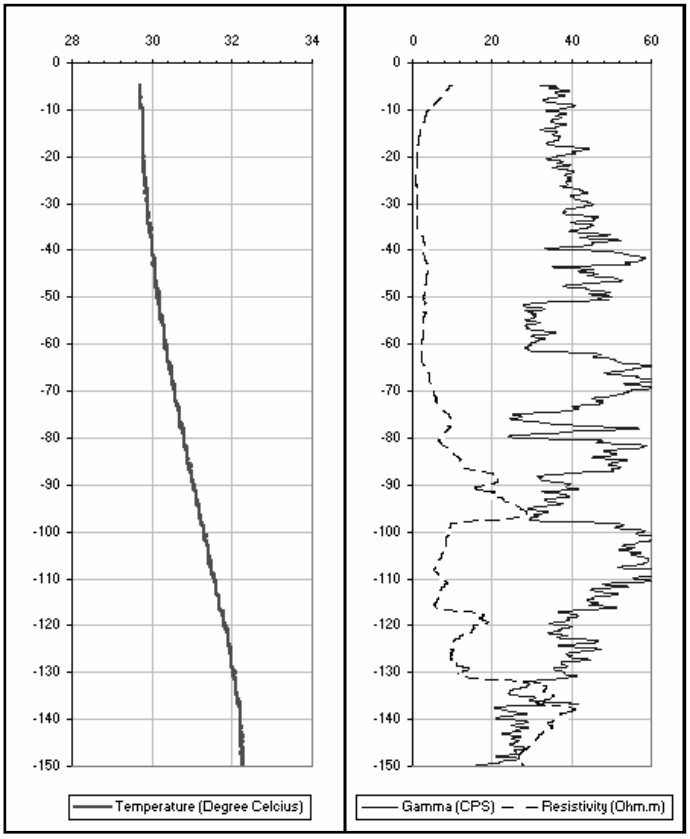

Figure 2: Temperature log at Pataya borehole, Can Tho city

b) Interpretation: When the depth of investigation is limited, the temperature recorded will be that of the fluid surrounding the sensor and it should be representative of the temperature of the rock formations.

In this topic, the temperature recordings are used for:

- Estimating the thermal gradient of the Mekong Delta area
- Identifying temperature change with depth

Estimation of thermal gradient

The subsurface temperature increases in a very irregular manner in relation to depth, on average, it increases by 1°C for every 30 m. This is know as the geothermal degree. The geothermal degree varies from one place to another depending on the topographic conditions, the rock types present and the geological history of the region. While drilling, the temperature of the mud remains uniform due to circulation. When drilling operations are terminated, the mud at rest reaches a temperature equal to that of the thermal gradient of the site. Hence temperature increases with depth.
The thermal gradient is estimated using the temperature log. The surface temperature of the mud can easily be measured or using annual average temperature of the Mekong Delta area (28°C). The temperature value at depth can be taken from the temperature log at the deepest aquifer, then thermal gradient can be calculated for every borehole. Total of 210 boreholes in Mekong Delta have thermal gradient estimation and Figure 3 below shows these value per 100 m for every borehole.

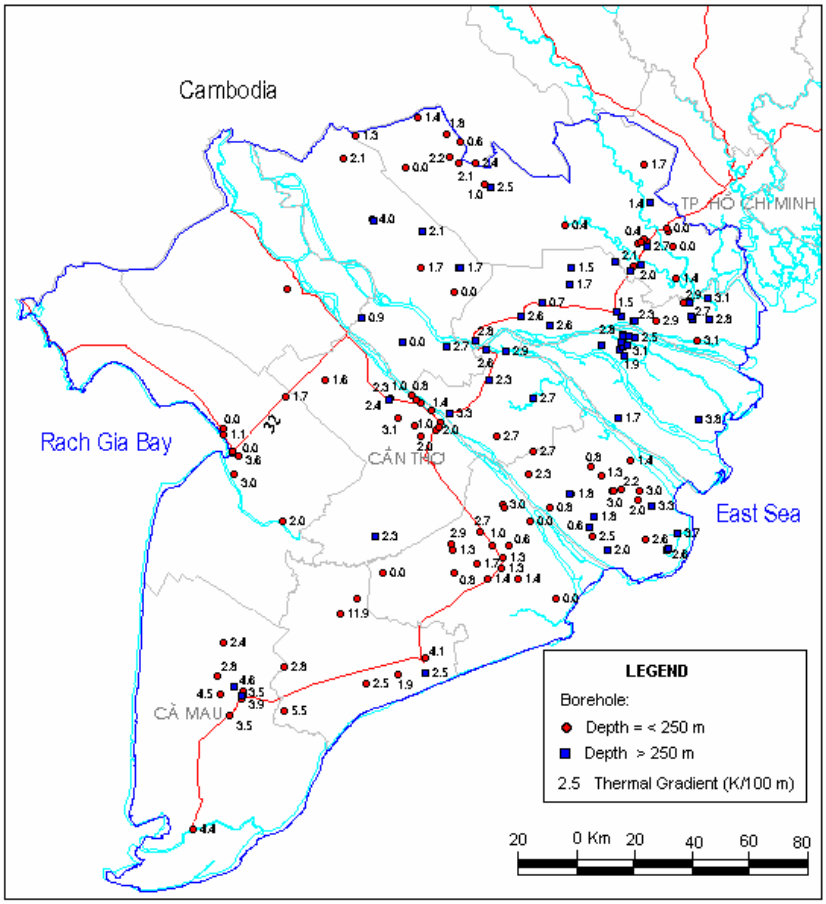

Figure 3: Temperature gradient (K/100 m) at borehole in Mekong Delta

Identifying temperature change with depth

Two intervals of depth divided are ≤ 250 m and > 250 m for identifying temperature change. Aquifers representative for the intervals of depth can be distinguished by synthesis of different logs. Then, the temperature value of the aquifers is taken from temperature log. These values of temperature are of water in the aquifers and also should be representative of the temperature of the rock formations.

Kriging method is used for contouring the temperature in Mekong Delta area.

Figure 4 and figure 5 are showing the shape of temperature contours for two depth intervals ≤ 250 m and > 250 m respectively.

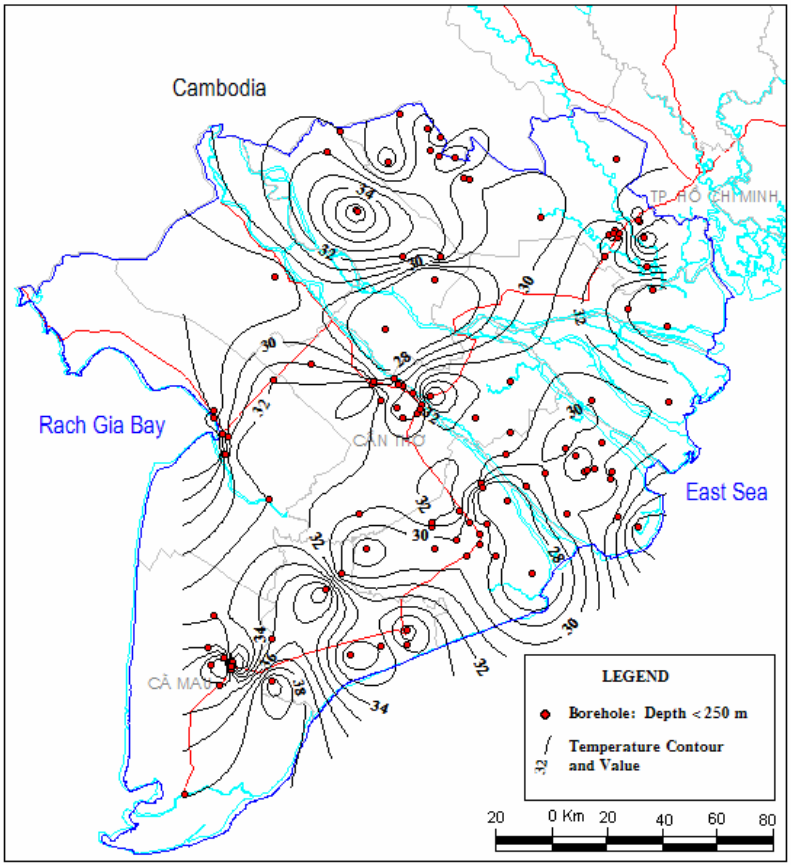

Figure 4: Temperature contour map of the depth interval ≤ 250 m

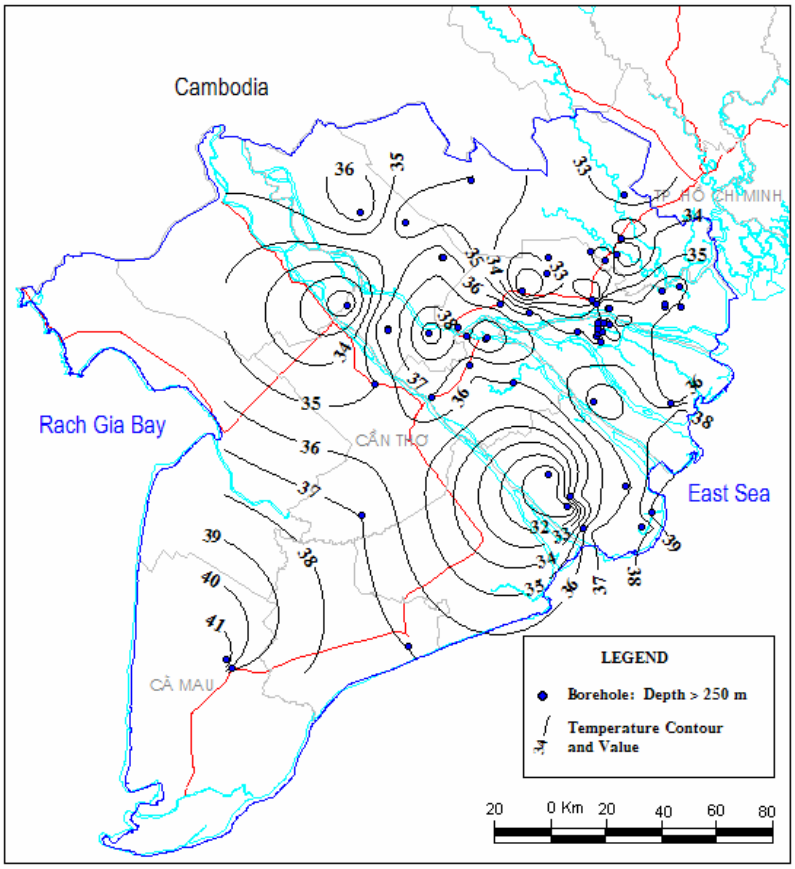

Figure 5: Temperature contour map of the depth interval > 250 m

4. DISCUSSION

Thermal gradient K/100 m varies from borehole to another with value of 0 to 11.9. This means temperature change with depth significantly in Mekong Delta. Not much boreholes have thermal gradient value of about 0-1 and they can be explained by getting cold water from river or from hydraulic window to aquifer. Almost these boreholes are located near rivers and the depth of them is < 250 m (fig. 3).

The contours for borehole depth ≤ 250 m (fig. 4) shows two higher temperature areas at north near border with Cambodia and south-east near the coast. The temperature in these areas ranges from 31°C up to 38°C. In the middle of the areas there exists northeast-southwest band with temperature range 28 – 30°C from north Ho Chi Minh city to Rach Gia bay. The cooler water band may be generated from the rock.

For the depth > 250 m, the contour shows generally that temperature increases from north to south and southeast with temperature range of 32 to 42°C (fig.5).

5. CONCLUSIONS

Measurements of temperature are pontentially valuable as it provides a lot of temperature versus depth and these data can be interpreted for geothermal purpose.

The thermal gradient estimated from temperature log proves significant change of temperature with depth at every borehole location in the Mekong Delta. The temperature contour shows not only temperature change trend in the whole area, also indicates the areas with hot and cooler water.

Identified temperature change with depth and with area and it value have big meanings for different purposes specially for geothermal study.

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