25th WEDC Conference Addis Ababa, Ethiopia, 1999

INTEGRATED DEVELOPMENT FOR WATER SUPPLY AND SANITATION

Tem for well siting at Hilton Addis

Seleshi Mekonen, Ethiopia

A SUCCESSFUL THERMAL water well drilling site was selected using Professional Transient Electro-Magnetic Sounding survey at Hilton Addis. The survey is conducted using GEONICS PROTEM 47 and 57 transmitters and Digital receiver. A total of three TEM sounding surveys were carried out based on priory information found from gravity and magnetic survey data. An anomalous low apparent resistivity response in the order of magnitude of 10 WW-m is exhibited below a depth of about 340 meters and interpreted as thermal ground water bearing horizon. Based on which a potential deep water well is drilled to a depth of 420 meters and is in conformity to the TEM survey results.

Methodology

From potential field methods it is found that the thermal ground water is controlled by a geological structure which is bounded by a NE-SW running fault. The TEM survey is conducted along this fault line. The main purpose of the TEM survey was in order to outline the vertical stratigraphic section of the subsurface and pinpoint potential aquifer bellow the ground. Based on which three TEM soundings where done with a transmitting loop size of 100m X 50m, 100m X 100m and 150m X 25m respectively. Two different receiving loops where set at the center of the transmitting loop for each transmitters respectively. Six different sweeps, u,v,h,H,M,L, were recorded for a single TEM sounding. However, only three selected sweeps where interpreted using the one dimensional forward and inverse modeling software, the TEMIX-GL.

Results

Generally, the area is covered by Paliocene Basalt of Addis Ababa, Tuff and Inter-flow sediments. The major aquifers, water bearing strata are fractured Basalt and inter-flow sediments. A geological fault is identified from the Gravity and Magnetics Profiling surveys which presumably controls the flow of thermal ground water in the area. This fault and fracture zone runs in the NE-SW direction down to Filwoha area. The orientation of the geological structure is the same as that of the Main Ethiopian Rift Valley.

Moreover, the vertical stratification of the sub-surface geology is understood from the One-Dimensional PROTEM sounding models. Forward modeling of the Transients (Voltage/ time derivative of the induced magnetic field) were interpreted from prior geologic information. Moreover, the Professional Transient Electro-Magnetics sounding survey delineated plausible aquifers, water bearing geological strata.

Spectacular anomalous conductive layer is observed at Hilton TEM sounding #2. This layer is found below a depth of 340 meters and extends to a depth of about 400 meters. Moreover, enhanced apparent resistivity response in the order of magnitude of 10,000 ohm-m is apparent above and under this conductive 5 ohm-m layer. These envisage the presence of fresh volcanic rock mass above and bellow this anomalous causative horizon. It is interpreted that this anomalous conductive layer is due to thermal ground water in fractured Basalt and Trachyte sandwiched between fresh and massive volcanic rocks. The details of the apparent resistivities and thickness parameters of the one-dimensional model are illustrated in the following table.

From the model curve and general geology of the area the interpreted apparent resistivities the first, top layer is attributed to top dry unconsolidated sediment. The second and third strata are interpreted as Clay dominated inter-flow sediment. The fourth and bottom sub-surface layer stratification envisages the presence of massive, fresh and dry Tertiary Volcanic rock Basalt and Trachyte. The anomalous fourth layer in the order of magnitude of 5 ohm-m is attributed to fractured thermal water bearing stratum and is about 60 meters thick. The law apparent resistivity of the layer is due to the brackishness of the ground water at this column. Thus, this fractured Basalt/Trachyte aquifer has a relatively high ionic conductivity and recharged from the surrounding high topographic area along a major NE-SW trending fault. In general, the percolation of ground water along magma heated fresh volcanics along fault and fracture zone and its confinement from the top

Table 1. Apparent resistivities and thickness of Hilton TEM sounding #2.

	Resistivity (ohm-m)	Thickness (m)	Depth (m)
1	209	1.4	1.4
2	4	43.7	45.1
3	0.12	240.0	285.1
4	10000	57.3	342.4
5	5	59.5	401.9
6	10000	—	—

and bottom with same rock makes it thermal and semi-artesian.

Discussion and conclusion

Based on the PROTEM survey result of the Addis Hilton specially, from the result of one-dimensional model TEM Sounding #2, thermal water well drilling is commenced to a depth of 420 meters. Based on which the deepest well in Addis was drilled by Hydro Construction and Engineering Co. Ltd. and a potential thermal water bearing aquifer is encountered at the anticipated depth.

From this result the author of this paper commend the application of Transient Electro-Magnetics Sounding survey to explore for cold and thermal ground water where the conventional Electrical method (Vertical Electrical Sounding survey) is not practicable specially, in densely populated areas, where there is no sufficient space to lay long electric cables, and also on asphalt ground. Moreover, the time required to carry out TEM survey is very much less than conducting VES survey.

Reference

Hydro, Hydrogeological and Geophysical Surveys for Water Well Drilling Site Selection, Addis Ababa, 1996.

KAUFMAN, A.A. and G.V. Keller, Frequency and Transient Soundings. Elsevier, Amesterdam, 1983.

TESFAYE C., A.A. Ground water Investigation for water supply of Hilton Hotel, Addis Ababa, 1982.

WAIT, J.R. Geo-Electromagnetism, Academic Press, New York, 1982.

Watenco, Well Construction and Evaluation Report, Hilton Well Well No. 1., Addis Ababa, 1967.

SELESHI MEKONEN, Ethiopia