IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 6, Issue 5 Ver. III (Sep. – Oct. 2018), PP 56-60
www.iosrjournals.org

Ground Water Potential Zones Mapping by 2D-Euler Deconvolution and Forward Modeling: Kilango Area-Machakos County, Kenya

Mwanzia Dorothy K., K'Orowe Maurice O. and Githiri John G
Department of Physics, Jomo Kenyatta University of Agriculture and Technology, Kenya.

ABSTRACT: *Chances of ending up with a dry well are high when drilling for ground water before carrying out correct and accurate preliminary processes. In this research, the main aim was to delineate ground water potential zones within KilangoMatuu –Machakos County, Kenya. In order to achieve this objective, a proper understanding of the subsurface formation and faults/fractures, which are the main ground water conduit, was inevitable. Ground physical observation method in siting boreholes has proven to be insufficient due to the many times that drillers have drilled wells that have dried up within a short period. In order to avoid all these setbacks, Gravity survey was carried out over a 25 square kilometer area within the region. Several corrections were carried out on the observed gravity data and a qualitative analysis of the data was carried out which involved generation of a complete bouguer anomaly contour map; that showed presence of a formation with low density along the western side of the study area. A cross-section AA' was cut across the zone of interest and imported to 2D Eulerdeconvolution software and generation of Euler deconvolution curve was attempted. Thegenerated Euler curve showed discontinuity covering a distance of 600meters approximately. In order to understand the stratigraphy of the study area, the obtained data from cross-section AA' was uploaded to Grav2dcsoftware and a forward model was created. In Matuu-Kilango, the aquifer suspected was found to be having a width of 600meters and a depth of 70meters .Ground water potential zone within this region covers a small area because the region receives low amounts of rainfall and is dominated by hard rocks.*

Keywords-*Aquifer, Bouguer Anomaly, Fault, Gravity, Groundwater*

Date of Submission: 20-10-2018 Date of acceptance: 03-11-2018

I. Introduction

The study area is located in MachakosCounty, Kenya and the specific region of interest isfound within the Eastern Mozambique Belt Segment. The area is bounded by latitudes 1° 5'S and 1°8'S and Longitudes 37° 31'E and 37° 33'E zone 37M as illustrated in the (Figure.1)

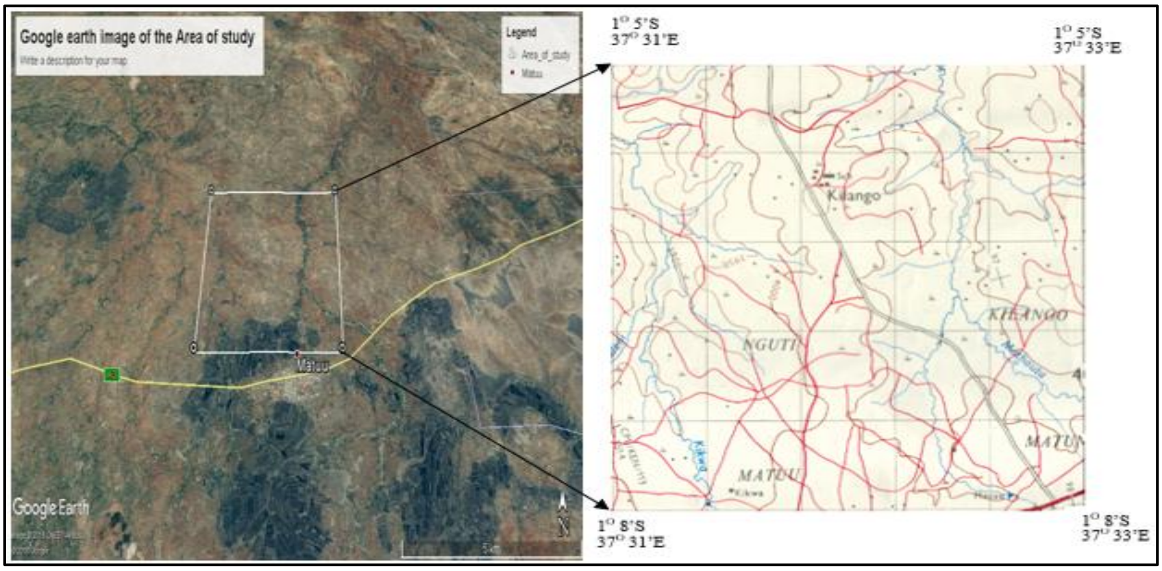

Figure1: Location of the study area [1]

The area receives minimal amounts of rainfall ranging from 371 to 912 millimeters (mm) annuallyon average [2]. According to the geological report, the region lies in the eastern side of Gregory rift valley and igneous rocks characterize it[3]. With these characteristics, the porosity of the area can only be secondary, indicating that the subsurface of the area could be having a fractured aquifer[4].

The surface rocks found within this region comprises of mainly the metamorphic rocks with an underlying rock system of Mozambique belt segment that has undergone several cycles of Metamorphism. Since metamorphic rocks are impervious, geological system of the region is only capable of holding water in a network of fractures and faults[5]. In a geophysical research, gravity method is applied to enable detection of the faults and fractures.Faulted zones normally have low-density values, which depends on the nature of the material filling the faults/fractures.

II. Material and Method

2.1 Gravity measurement control

Prior to commencement of gravity survey, a control station within the study area was located and a measurement was taken. The control station reading was utilized during equipment calibration. Calibration constant given for the Worden gravimeter by the manufacturer is 0.1004 mgal/div [6], but this value is subject to change due to aging, usage, and vibrations due to transportation of the equipment. Therefore, it is important to determine the equipment calibration constant before using it to carry out any survey to improve on the accuracy of the data.

2.2Gravity Survey

In this survey, Worden gravimeter was used in data collection. One hundred and fifty six gravity stations including the base stations were established using a handheld Global Positioning System (GPS). Across the study area, six transects were ran covering 5km distance each in east-west direction. A separation distance of one kilometer between each transect was maintained (Figure.2).

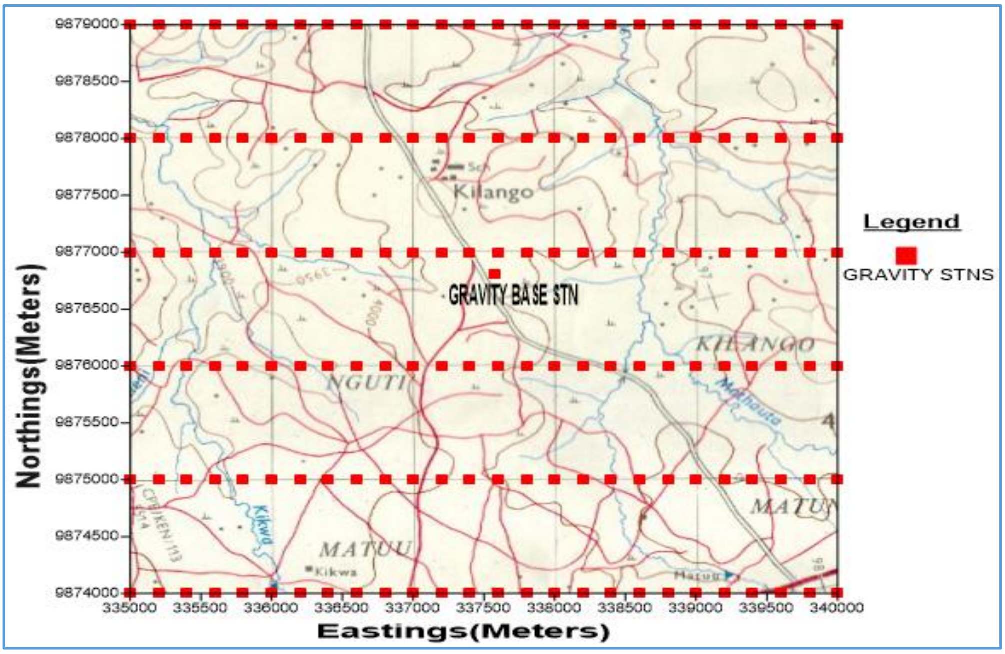

Figure.1: Topographic map of the area showing location gravity survey stations [7]

A separation distance of 200meters between each established consecutive gravity stations was kept. For each station, gravity meter reading, latitude and the time were recorded.

III. Data Analysis and Discussion

The acquired gravity data was corrected and processed for effective interpretation of the subsurface faults and fractures. The major corrections carried out on the absolute values of the gravitational field included drift, latitude, free air, bouguer slab and terrain. The goal of data reduction was to remove the known effects caused by predictable features that are not part of the "target" [8]. The remaining anomaly was then interpreted in terms of sub-surface density variations. This was done by uploading the corrected gravity data on a worksheet in Surfer 10 software. Using this software, a completebouguer contour map was generated that showed specific areas of distinct gravity anomalies within the study area. Surfercontour map was created from gridded complete bouguer data. Kriging method was used to control the interpolation procedures. This method produced visually appealing map from irregularly spaced gravity data. According to [9], geo-electrical resistivity carried out on the same area of study showed a porous zone along the same region where gravity method showed presence of alow-density rock (western side).

The two methods applied showed presence of a material of low resistivity and low density along the western side. This region was suspected to be dominated by a fractured rock, filled with a low-density material that could possibly be either water or sediments. The qualitative description given was backed up by the geological report of the area, which showed that metamorphic rocks overlain by a plateau cover the entire region. Meta-intrusive mafic and ultramafic rocks that include diorites, Gabbrosanorthosites, peridotites and picrites [2] describe the study area. Such a geological system hold water in a network of fractures and faults since metamorphic rocks are non-porous and impervious. Therefore, the zone of interest in this study was detected along the western side of the survey area (Figure.3).

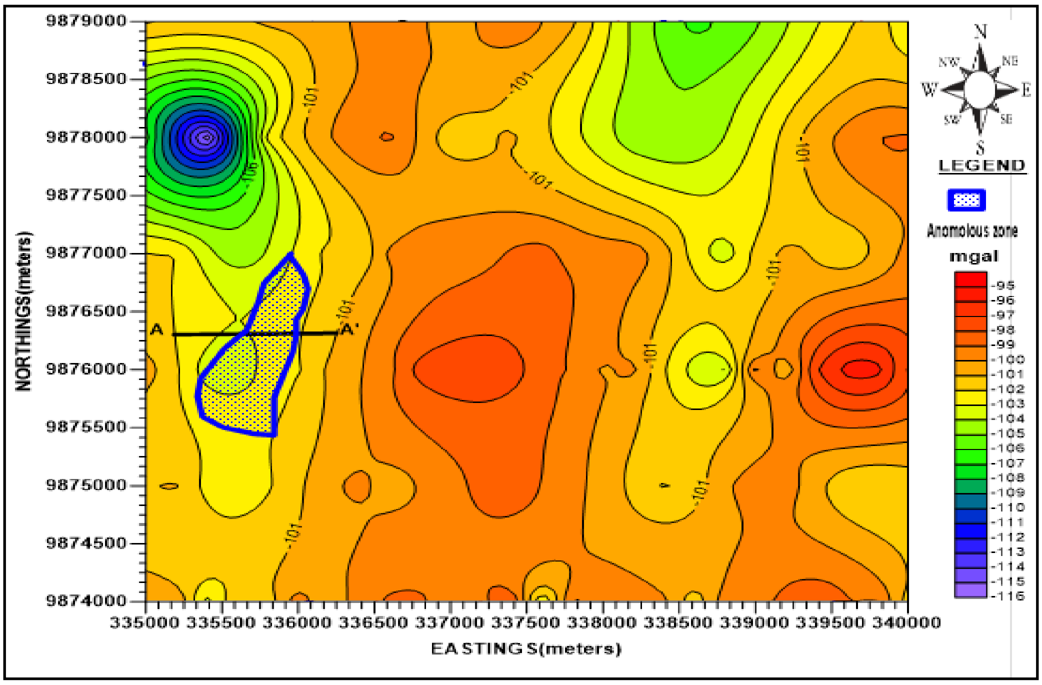

Figure.3: Completebouguer anomaly map

The visual inspection of completebouguer anomaly map showed a linear trend elongated in North-South directions along the western part of the study area. In general, the anomaly map of the investigated area showed low gravity gradient zones in the western parts relative to the Eastern parts. An insight that could be drawn from the complete bouguer anomaly map was that, along the specified regions, rock beneath could be fractured. In addition, when a geo-electrical resistivity method was brought into consideration, a consistency was observed. To determine the distance covered by the gravity anomaly depicted, residual data from cross-section AA' was utilized.

Table 1: Residual data from cross-section AA'

Distance(Meters)	Completer Bouguer anomaly (Residual data)
0	-000004382000000
16.6495888074	-0.085295842291345
67.157756812	-0.34672056844579
117.665924816	-0.6003251645997
168.174092821	-0.83539083375449
218.682260826	-1.0421015109093
269.19042883	-1.2128031980632
319.698596835	-1.342693921218
370.206764839	-1.4298318063719
420.714932844	-1.4748751645267
471.223100848	-1.4808258156806
521.731268853	-1.4525354708354
572.239436857	-1.3957185049893

622.747604862	-1.3156906921441
673.255772866	-1.216384035298
723.763940871	-1.1000977184528
774.272108876	-0.96804978260759
824.78027688	-0.8213594217615
875.288444885	-0.66188597291629
925.796612889	-0.4924675150702
976.304780894	-0.316475403225
1026.8129489	-0.13700083638071

Euler deconvolution curve covering a kilometer distance was generated using residual data obtained from cross-section AA' and discontinuity was observed within a region covering 600 meters distance (Figure.4).

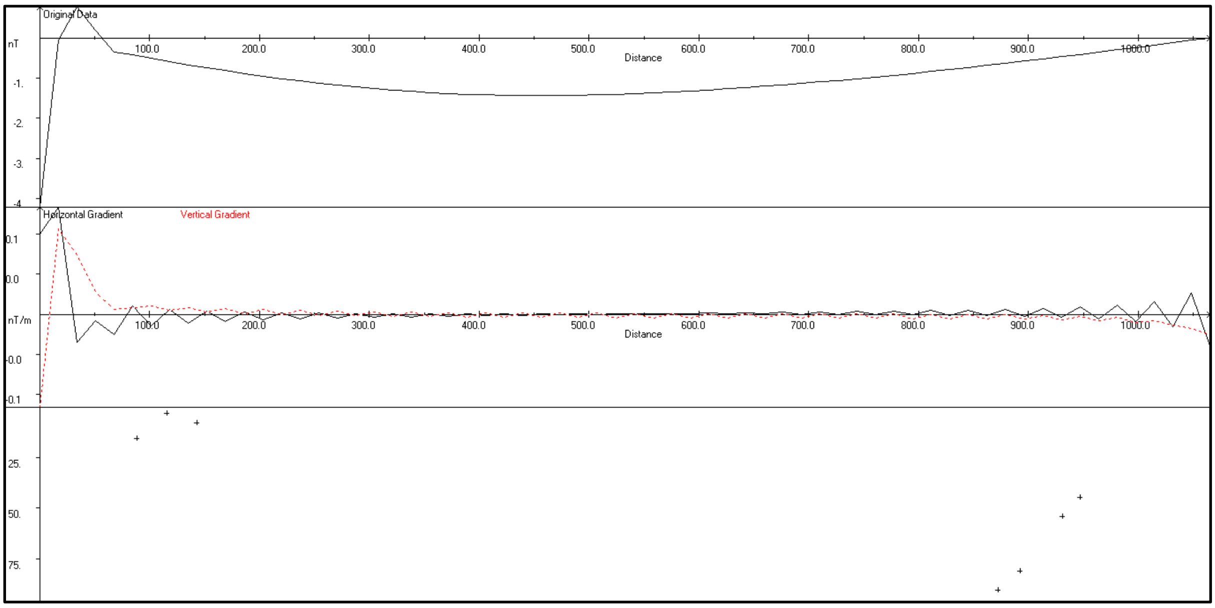

Figure.4: Euler Deconvolution curve AA"

Constraint parameters applied were the Structural indices of 0.5, which best represents faults and 100 meters depth. This Euler curve showed presence of a substance of low density below the subsurface along the region where discontinuity was observed. In an attempt to clearly understand the causative of the anomaly depicted, cross-section AA' datawas uploaded in Grav2dc software and a forward model was created (Figure.5). Along the same region where discontinuity was observed using Euler software, a body of low density was detected. It was noted that the region that showed presence of a low-density substance covered 600 meters distance penetrating up to a depth of 70 meters approximately.

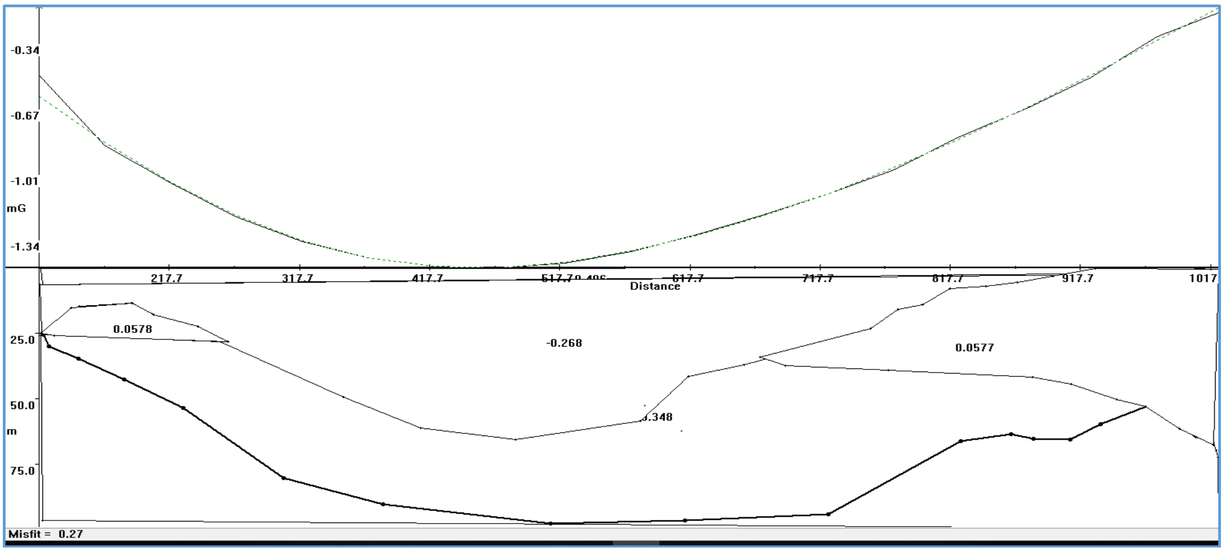

Figure.5: Grav 2DC forward model for curve AA"

IV. Conclusion

Gravity results showed presence of a low-density substance along the western side of the study area. This indicated the inferred fractured zone. Data analysis using Grav2dc and Eulerdeconvolution software displayed an aquiferous region with a width of 600 meters and a depth of about 70 meters within the weathered Micaceous layer on the western side of the study area. In summary, it was possible for us to delineate regions with highest possibility of having ground water, which can be harnessed for domestic use.

Acknowledgment

We would wish to thank The Society of Exploration Geophysicists for financial support, Jomo Kenyatta University geophysical society members for data collection assistance, Department of Physics, Jomo Kenyatta University of Agriculture and Technology for assisting us withsurvey equipments.

References

[1] Survey of Kenya, (2005). Topographical map of Matuu area. Report Survey of Kenya 150/1. The government Printer, Nairobi.
[2] B. Baker, Geology of the Southern Machakos area, Geological Survey report Kenya, (27),1954 , 13.
[3] C. Nyamai, E. Mathu,N. Opiyo and E.Wallbrecher, A Reappraisal of the Geology, geochemistry, structures and tectonics of the Mozambique belt in Kenya, East of the Rift system. *African Journal of Science and Technology Science and Engineering Series, 4(2),2003,* 51-71.
[4] R. Ndeto,Water projects in Yatta District.. Tanathi Water Services Board, Kithimani, Kenya. Projects brief reports ,2011,WD/YAT/1/4/21.
[5] B.Singhal and R.Gupta, Applied hydrogeology of fractured rocks. Springer Science & Business Media, 2010.
[6] E. Mathu,The Mutito faults in the Pan-African Mozambique Belt, Eastern Kenya. In Mason R. (Ed.), Basement Tectonics. Kluwer Academics Publishers, Netherlands.1992, 61-69.
[7] G. Woollard, The gravity meter as a geodetic instrument. *Geophysics*, *15(1)*, 1950, 1-29.
[8] Survey of Kenya, Topographical map of Matuu area.. The government Printer, Nairobi, Survey report of Kenya ,2005, 150/1.
[9] B. Murty and V. Raghavan,The gravity method in groundwater exploration in crystalline rocks: A study in the peninsular granitic region of Hyderabad, India. *Hydrogeology Journal*, *(10)*,2002, 307–321.
[10] E. Odero, M. K'Orowe and J. Githiri, "2D-Euler Deconvolution Technique and Electrical Self Potential analysis for subsurface structures delineation in Matuu, Machakos County, Kenya," IOSR Journal of Applied Geology and Geophysics, *3(6)*,2015, 30-36.

Mwanzia Dorothy K. "Ground Water Potential Zones Mapping by 2D-Euler Deconvolution and Forward Modeling: Kilango Area-Machakos County, Kenya.." IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG) 6.5 (2018): 56-60.