A Preliminary Assessment of the Hydrocarbon Potential of Kerio Valley Basin: Gravity and Magnetic Interpretation*

Abiud W. Masinde[1], Cleophas W. Simiyu[1], Innocent K. Murunga[1], George Muia[2], Aaron K. Waswa[2], and Justus Barongo[3]

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[1]National Oil Corporation of Kenya, Nairobi, Nairobi, Kenya (amasinde@nockenya.co.ke)
[2]Kenya Pipeline Company
[3]University of Nairobi, Nairobi, Kenya

Abstract

The aim of the study was to assess the hydrocarbon prospectivity of the Kerio Basin in the Kenya Rift. An Isostatically corrected anomaly map produced from a Bouguer anomaly grid was filtered using a Hanning low pass filter of order 2 to remove low wavelengths. Four profiles were extracted from the grid to give 1D interpretation along straight lines. The magnetic grid was corrected for IGRF, diurnal, filtered using a 1 Hz low pass 10 km Hanning filter to reduce noise, later reduced to equator to place all anomalies directly over underlying sources and make anomalies less complicated. Tilt derivative of the magnetic grid was used to estimate depth to basement. The residual analytic signal anomaly map derived from the magnetic grid was used to capture the response of existing near surface magnetic signatures, even the reversely magnetized ones.

The Kerio Basin is characterised by low gravity anomalies ranging between 35 mGals to -100 mGals related to variations in quantities of sediments deposited. Gravity profiles show that sediment thickness gradually increases to the south where we expect hydrocarbon accumulation. The magnetic anomaly map reveals low susceptibility rocks of between -20 nT to -200 nT to the south of the basin. Magnetic tilt depth indicates sediment thickness of 2.0 to 3.5 km above the basement. This corresponds to both gravity and magnetic interpretation of the same area. Integration of these data with seismic and other constraints may help gauge the hydrocarbon potential and reduce exploration uncertainty in the southern area of the Kerio Basin.

References Cited

Fairhead, J.D., A. Salem, L. Cascone, M. Hammill, S. Masterton, and E. Samson, 2011, New developments of the magnetic tilt-depth method to improve structural mapping of sedimentary basins: Geophys. Prospect., v. 59, p. 1072-1086.

Kucks, Robert P., 1999, Isostatic residual gravity anomaly data grid for the conterminous U.S.: U.S. Geological Survey Digital Data Series, DDS-9.

Roest, W.R., J. Verhoef, and M. Pilkington, 1992, Magnetic interpretation using the 3-D analytic signal: Geophysics, v. 57/6, p. 116-125.

Salem, A., S. Williams, J.D. Fairhead, D. Ravat, and R. Smith, 2007, Tilt-depth method: A simple depth estimation method using first-order magnetic derivatives: The Leading Edge, v. 26, p. 1502-1505.

Verduzco, B., J.D. Fairhead, C.M. Green, and C. MacKenzie, 2004, New insights into magnetic derivatives for structural mapping: Leading Edge, v. 23, p. 116-119.

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Introduction

- The aim of the study was to assess the hydrocarbon prospectivity of the Kerio Basin in the Kenya Rift.
- Regional gravity and magnetic data sourced from the International Gravity Bureau (BGI) and Earth Magnetic Anomaly grid (EMAG2) respectively are used.
- The data are processed and analyzed for major structures and geological anomalies based on variations in density magnetism and or chemistry of the rocks.

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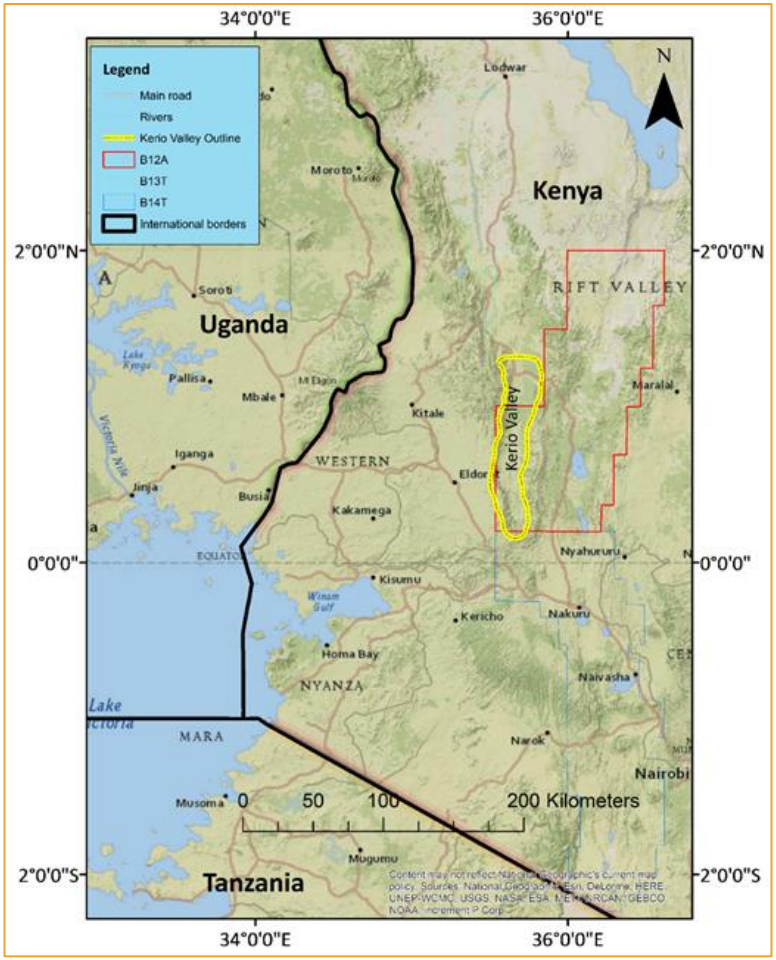
Study location



- The study area, located within the southern part of the Kenyan Tertiary rift.
- The basin falls between the Cheranganyi hills and the Tugen Hills.

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Data processing

- An Isostatically corrected anomaly map produced from a Bouguer anomaly grid was levelled, filtered using a Hanning low pass filter of order 10km and a Gaussian high pass of 10Km to remove low and high wavelengths respectively.

- Isostasy is often preferred to a Bouguer anomaly grid because it reveals more clearly the density distributions within the upper crust which is of interest to geologic and tectonic researchers (Kucks, 1999).

- The Isostasy map was used to delineate the basin boundary and identify highly prospective areas.

Data processing

- Four profiles were extracted from the grid to give 1D interpretation along straight lines.
- Magnetic grid was corrected for IGRF, diurnal, filtered using a 1 Hz low pass 10km Hanning filter to reduce noise, then reduced to equator.
- Tilt derivative of the magnetic grid was used to estimate depth to basement (Fairhead et al., 2011; Verduzco et al., 2004; Salem et al., 2007).
- The analytic signal is calculated as the “square root of the sum of the squares of the data derivatives in the X, Y and Z” directions (Roest et al., 1992).

Data processing

- The analytic signal of the gravity vertical gradient is given by;

$$|A(x,y)| = \sqrt{\left(\frac{d^2g}{dxdz}\right)^2 + \left(\frac{d^2g}{dydz}\right)^2 - i\left(\frac{d^2g}{dz^2}\right)^2}$$

- Residual analytic signal anomaly map calculated from the Bouguer grid was used to capture the response of existing near surface volcanic signatures and map the near-surface distribution of the volcanic layers (Purucker and Clark, 2011).

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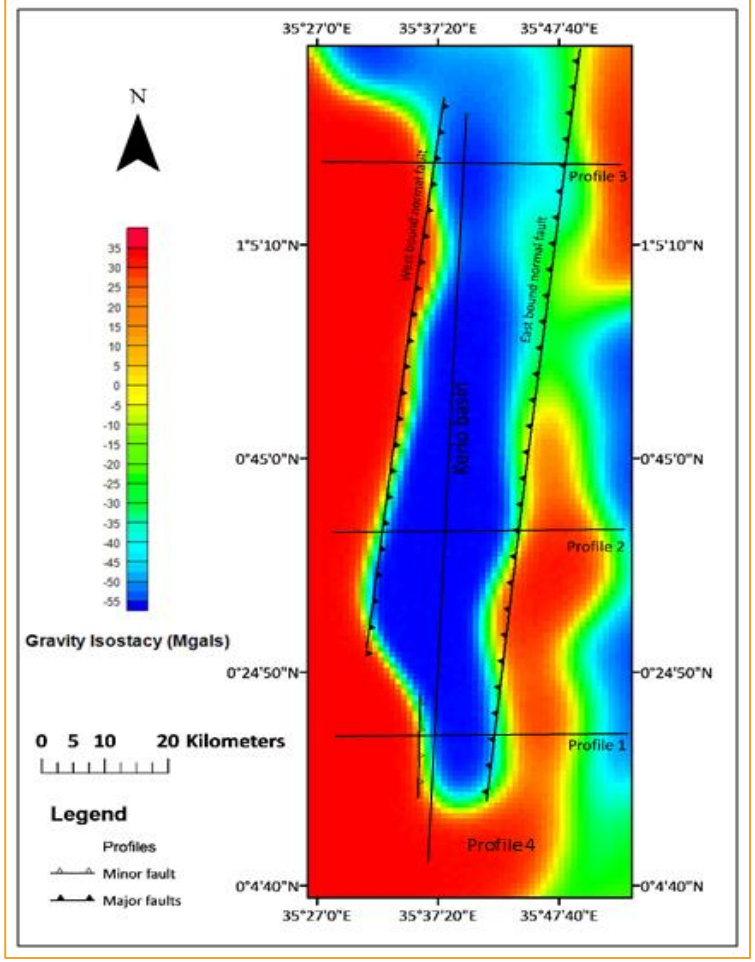
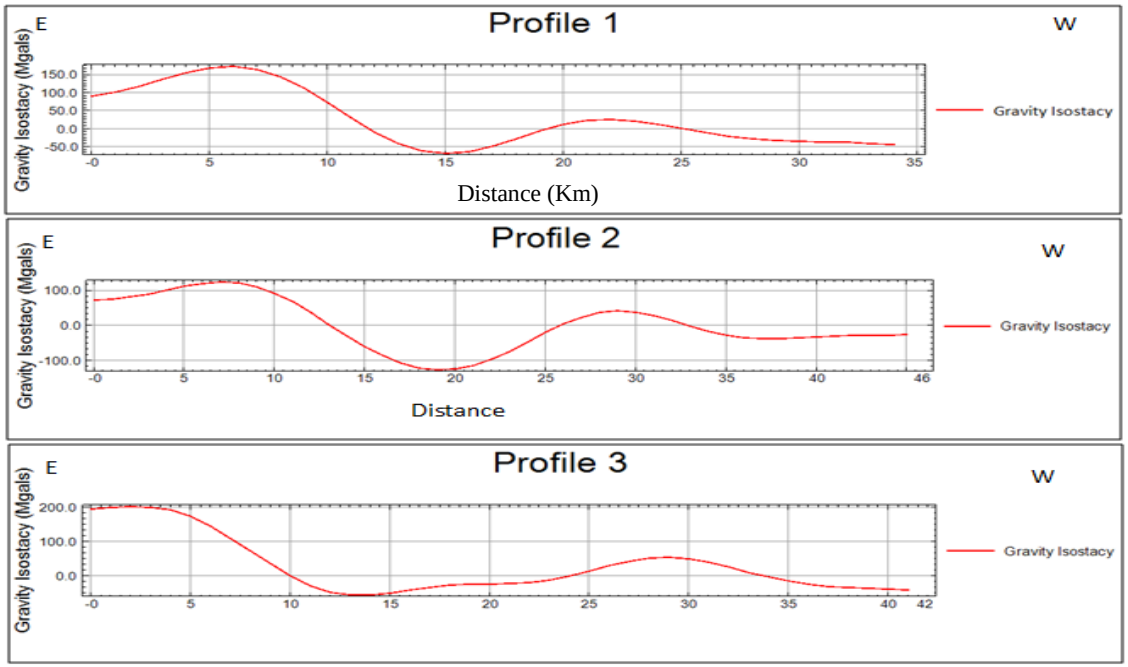
Results: Isostatically corrected gravity anomaly



- Kerio basin is characterised by low gravity anomalies ranging between 35mGals to -55mGals.
- The basin deepens towards the west, this is shown by the overall unclosed east-extending low gravity anomaly.
- The west bound fault (Elgeyo border fault) is a basement fault influences sedimentation.

Results: East-West gravity profiles

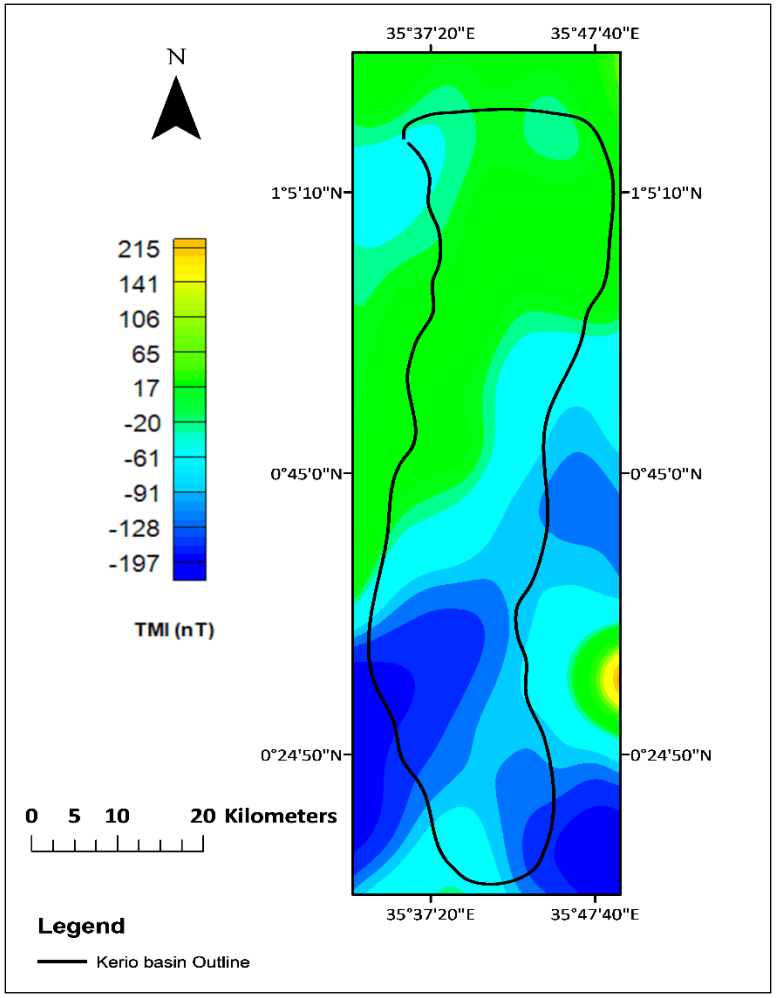
- Profile 1 south of the basin indicates gravity variation of 50mGals-150mGals.
- About 5km in breath of middle section of the basin is covered by low gravity deep sediments up to -50mGals.



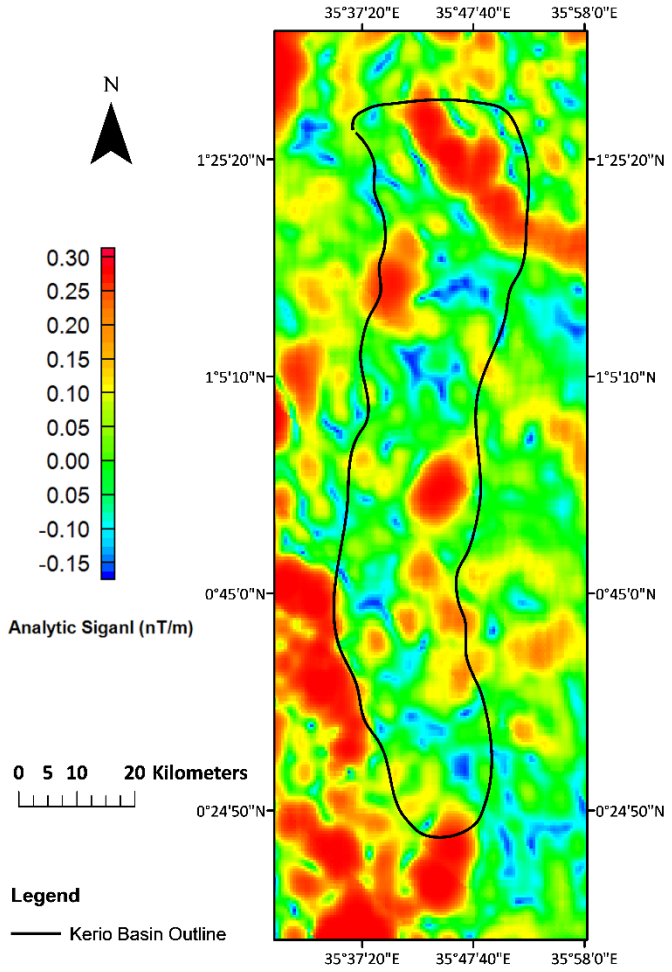
- Profile 2 depicts lowest gravity of about -120mGals. More than 10km in width of the basin is covered by low gravity sediments of about -100mGals.
- This is the location of the largest depocentre and with the deepest section of the basin.

Results: Magnetic profile

- Magnetic anomaly map reveals low susceptibility rocks south-west.
- This is the largest depocentre filled with low susceptible sediments of 20nT to about -197nT.
- Low magnetic signatures extends east of the Kerio basin to Baringo basin.



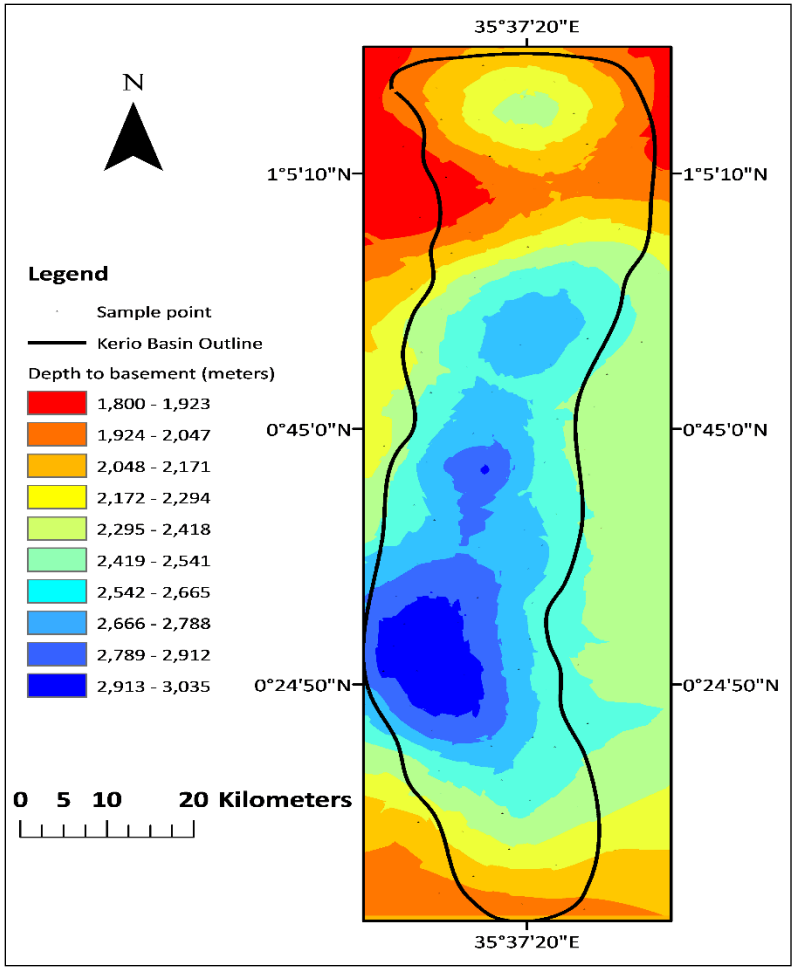
Results: Analytical signal



- The analytical signal anomaly map shows presence of basaltic signatures.
- They are identified as the high amplitude signatures on the near surface.
- The northern section is dominated by these basalts compared to the southern section

Results: Depth estimation

- Tilt depth predicts deep basement at 3 to 3.5 Km bellow mean sea level.
- The south-west section is estimated to be 2km-3.5km in depth representing the deepest depression of the basin.
- This corresponds to both gravity and magnetic interpretation of the same area.



Conclusion

- The study reveals a dominant gravity anomaly trending north-south, related to the major rift axis.
- Sedimentation is constrained by the two major normal faults on either side of the basin.
- Sediment thickness to the southern region is about 3km, with the basin being 10km wide, hence the area has highest potential for hydrocarbon.