Vol. 3, No. 1, pp. 46-55, (June 2025)
DOI: 10.21608/astb.2025.341123.1013
ASWAN SCIENCE AND TECHNOLOGY BULLETIN (ASTB)
Online ISSN: 3009-7916, Print ISSN: 1110-0184
Journal homepage: https://astb.journals.ekb.eg/ E-mail: essamshaalan@sci.aswu.edu.eg
Original Article

Analysis of Geophysical Data for Evaluate Basement Uplift and Sedimentary Basin Structures

Mohamed Mahran[1*], Ahmed M. Meneisy[1], Sayed Issawy [2], Karrar Omar El-Faragawy[1]

[1] **Department of Geology, Faculty of Science, Aswan University, Aswan, Egypt 81528**
[2] **National Research Institute of Astronomy and Geophysics. Egypt EG 11421**

Received: 02/12/2024 Revised: 23/12/2024 Accepted: 04/01/2025

Abstract

Upward continuation maps at a depth of 50 m were generated to analyze how anomaly characteristics evolve with increasing observation distance, revealing strong similarities to the Bouguer anomaly map. This similarity suggests that most of the anomalies originate from deep sources. Low-pass filtering was employed to isolate regional anomalies, showing gravity values ranging from 1156.5701 mGal in the northeastern, eastern, and southeastern regions to 1149.6192 mGal in the western and northwestern regions. These variations are attributed to the uplift of denser basement rocks and the presence of sedimentary basins, respectively. High-pass (residual) filtering further highlighted local anomalies, with gravity values ranging from 0.0076 mGal to -0.0103 mGal, identifying areas of basement uplift and localized basin structures. A series of upward continuation maps has been created to eliminate residual sources and achieve a more reliable regional surface that aligns with the regional map obtained through the separation process. An upward continuation filter was applied to the map at a depth of 50m to illustrate how anomaly characteristics change as the observation distance from the source increases. Examination of the upward continuation maps reveals a strong similarity to the Bouguer anomaly map, suggesting that most of the anomalies likely originate from deep sources.

Keywords: Low-pass filtering; Upward continuation; High-pass (residual) filtering; Bouguer anomaly map.

1. Introduction

The study area situated the north of Aswan City, extending west of the Nile River. This region falls within the Nile Valley province, as shown in the location map (Fig. 1).

Corresponding author*: E-mail address: mohamedmahran562@gmail.com

Online ISSN: 3009-7916, Print ISSN: 1110-0184. https://astb.journals.ekb.eg/

The Study area includes the site designated for a new administrative capital.
This location has been chosen for the construction of several important buildings, making a detailed study of the area imperative. The Study area plays a vital role in Egypt's development. This initiative aims to transform Aswan by creating extensive housing opportunities, addressing various national challenges, and offering a modern, smart lifestyle at premium standards. It is designed to accommodate population growth and support Egypt's move toward modernization. The reflecting it's potential to support significant urban expansion. Given the scale of the construction projects and the substantial investments involved, the state has prioritized the study of subsurface geological structures and seismic activity in the region. These investigations are critical for implementing safety measures during infrastructure development, ensuring the security and longevity of these transformative projects.

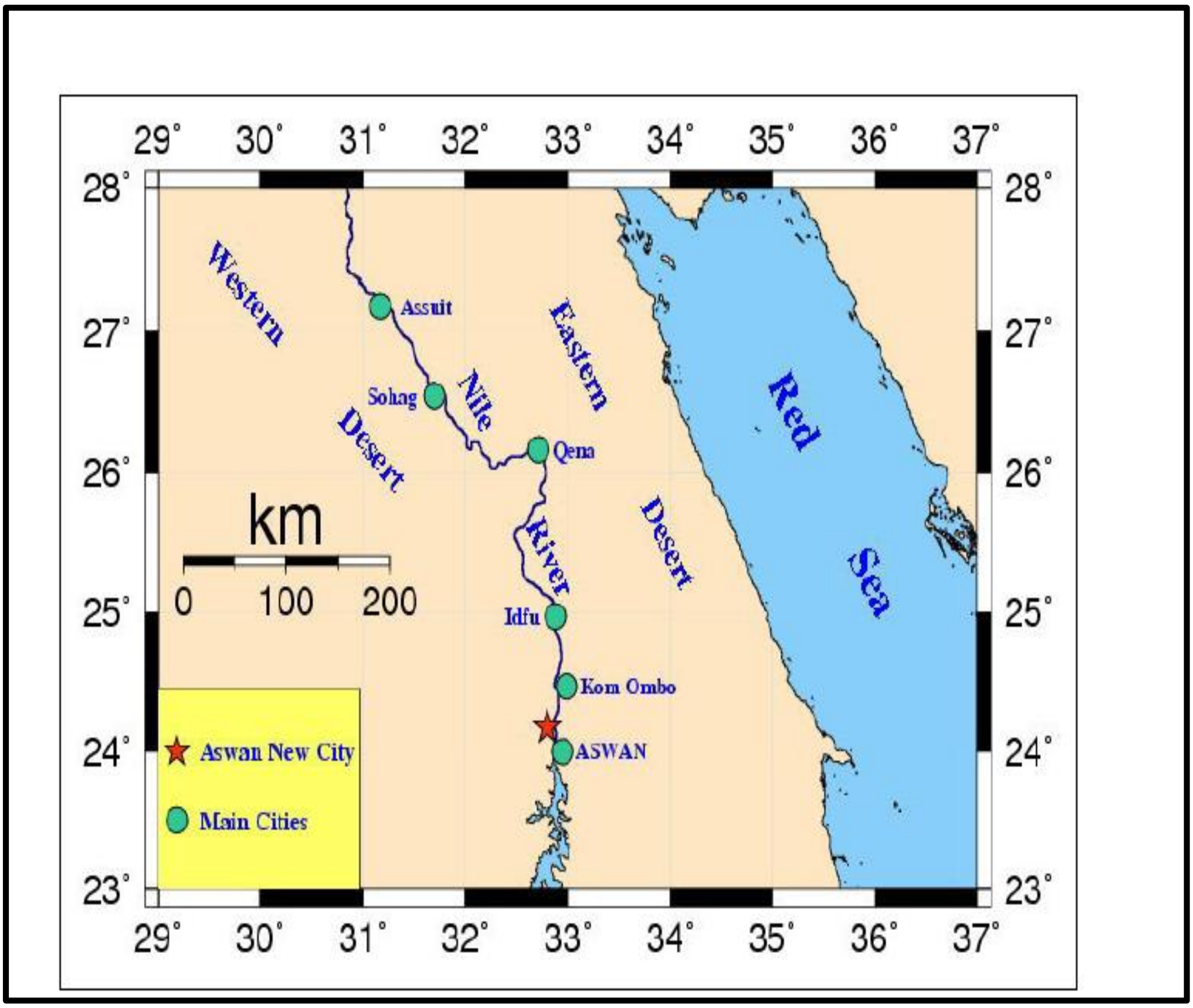

Figure. (1): Location map of the study area.

2. Materials and methods:

The study area is located in Egypt's southwestern desert and is predominantly composed of rocks from the Nubian Sandstone Formation. The geology of this region has been extensively researched by scholars such as (Issawi, 1968; El Shazly et al., 1974; Van Houten &

Bhattacharyya, 1979; WCC, 1985; Butzer & Hansen, 1968; El Ramly, 1973; Klitzsch & Wycisk, 1987; Hendriks et al., 1987). While (Butzer & Hansen, 1968) referred to the Nubian Formation as the Kalabsha Plain, (Issawi, 1968) named it the Nubian Plain. The geology of the Aswan area (Fig. 2) primarily consists of Precambrian crystalline igneous and metamorphic rocks, which are overlain by the Cretaceous Nubian Sandstone Formation (Meneisy, 2020; Youssef, 2003; Gahalaut & Hassoup, 2012). The stratigraphy of the study area starts with basement rocks at the base, which are overlain by weathering products. These, in turn, are generally covered by sandstone sequences. (Hendriks et al., 1987) divided the Nubian Sandstone sequence in the Aswan area into three formations: (Abu Aggag Formation) the basal unit, consisting of sandstones primarily composed of quartz arenites with minor quartz wackes. (Timsah Formation) This formation overlies the Abu Aggag Formation and includes sandstones and shales with iron deposits. (Umm Barmil Formation)The uppermost unit comprises alluvial plain deposits, capped by Upper Cretaceous mudstone. It is characterized by intercalations of medium-grained sandstone and clay stone. Understanding the location and seismic activity of these structures is essential for assessing the stability and geotechnical safety of major infrastructure projects, including dams, nuclear power plants, and new cities, as highlighted in studies by (Fat Helbary et al., 2019a, b; Hamed, 2019; Dahy et al., 2008; El-Bohoty et al., 2024). The primary objective of gravity surveying is to differentiate between various rock types by identifying density irregularities through measurements of gravitational attraction. These irregularities in density are detected using portable instruments called gravimeters. The final outcome of a gravity field survey, after applying the necessary corrections, is typically a contoured anomaly map. This map is used to analyze the characteristics of subsurface bodies by examining the shape, amplitude, sharpness, and frequency of both residual and regional anomalies. The gravity method is particularly effective for mapping sedimentary basins, as basement rocks generally exhibit higher densities than overlying sediments.

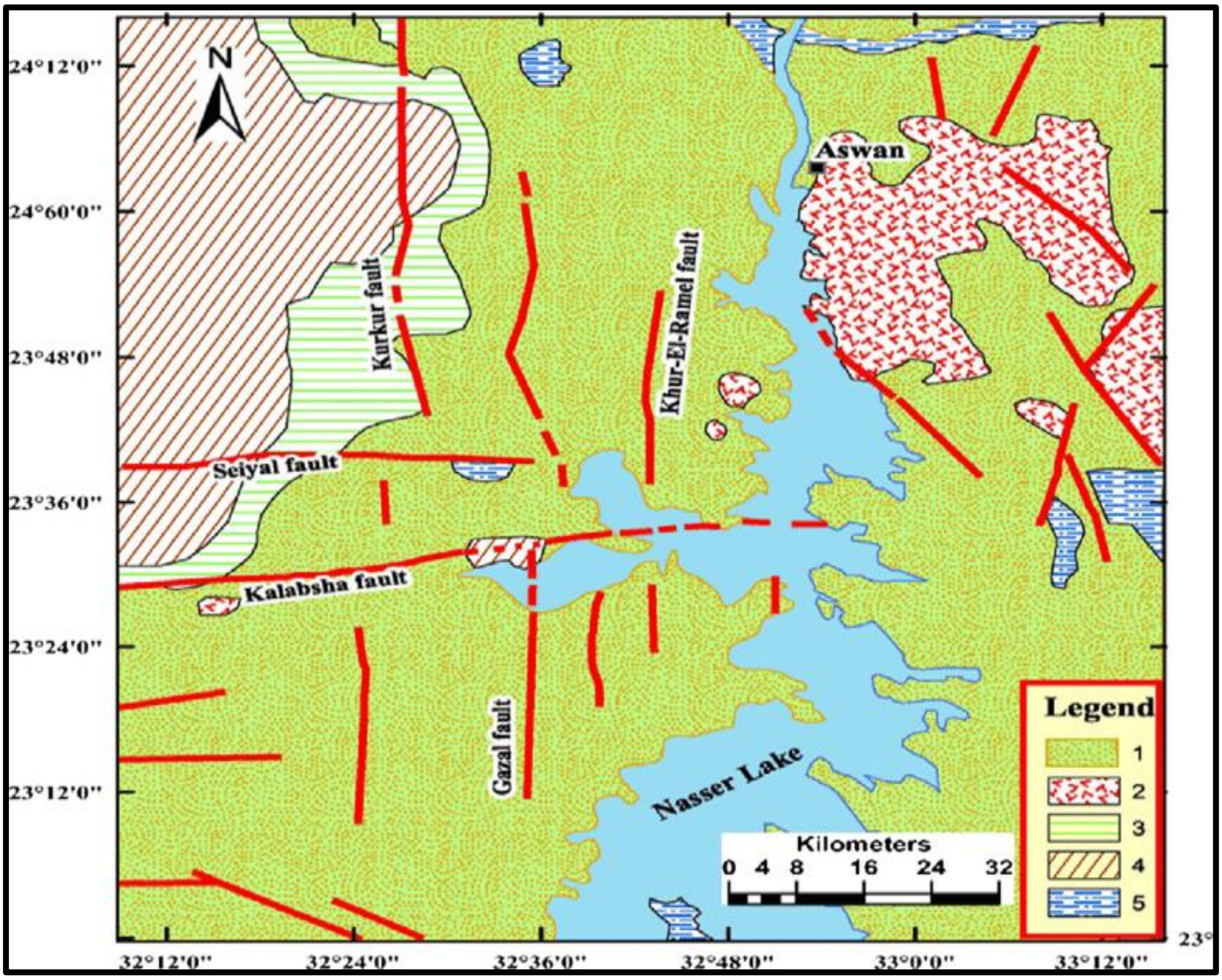

Figure. (2): Geological map of the study area.

3. Results and discussion:

3.1. Qualitative Interpretation of the Gravity Data:

The qualitative interpretation of the Bouguer anomaly map relies on visual inspection, supported by adequate knowledge of the study area's geology. Gravity highs are evident in specific regions. The linked to anticlines or uplifted blocks where older, denser rocks are nearer to the surface. Conversely, gravity lows, corresponding to sedimentary basins. Pronounced gradient zones often indicate steep contacts between contrasting rock types, typically along fault planes. Interpreting gravity data qualitatively can provide valuable information about the extent and orientation of faults. In some cases, the primary goal is to identify sedimentary basins within the study area. These basins generally exhibit smooth contours and low gravity relief, whereas regions with high gravity relief suggest a shallow basement. Such contrasts are often sufficient to delineate the boundaries of sedimentary basins. The interpretation process involves analyzing specific characteristics of individual anomalies, such as their shape, sharpness, amplitude, relative positions of positive and

Online ISSN: 3009-7916, Print ISSN: 1110-0184. https://astb.journals.ekb.eg/

negative sections, and overall trends. These features are influenced by factors like the depth of causative bodies and the density contrast between them and the surrounding rocks. The magnitude of an anomaly reflects the volume of the causative body but does not directly indicate its depth. However, the anomaly's shape, which reveals the geometry of the subsurface structure, can provide clues about the dip and depth of the causative body. Additionally, the elongation direction of an anomaly often corresponds to the orientation of the source body's long axis. The terms "short" and "long" are relative to depth: shallow bodies tend to create elongated anomalies, while deeper bodies of the same size produce more circular patterns. Resolution depends on the depth and spacing of buried geological bodies. One significant challenge in gravity anomaly interpretation is overcoming gravity ambiguity, which arises when gravitational effects from multiple sources overlap. In the study area, substantial negative gravity anomalies are interpreted as indicative of sedimentary basins. To address these ambiguities and improve the accuracy of interpretation, significant efforts were made to analyze the surface and subsurface geology. This included reviewing prior geological studies, conducting field observations. Based on this information, the primary lithological units in the study area were identified. A gravity stripping technique was then employed to remove the gravitational effects of sedimentary and basement rocks, enabling a more accurate interpretation.

3.2. Upward Continuation:

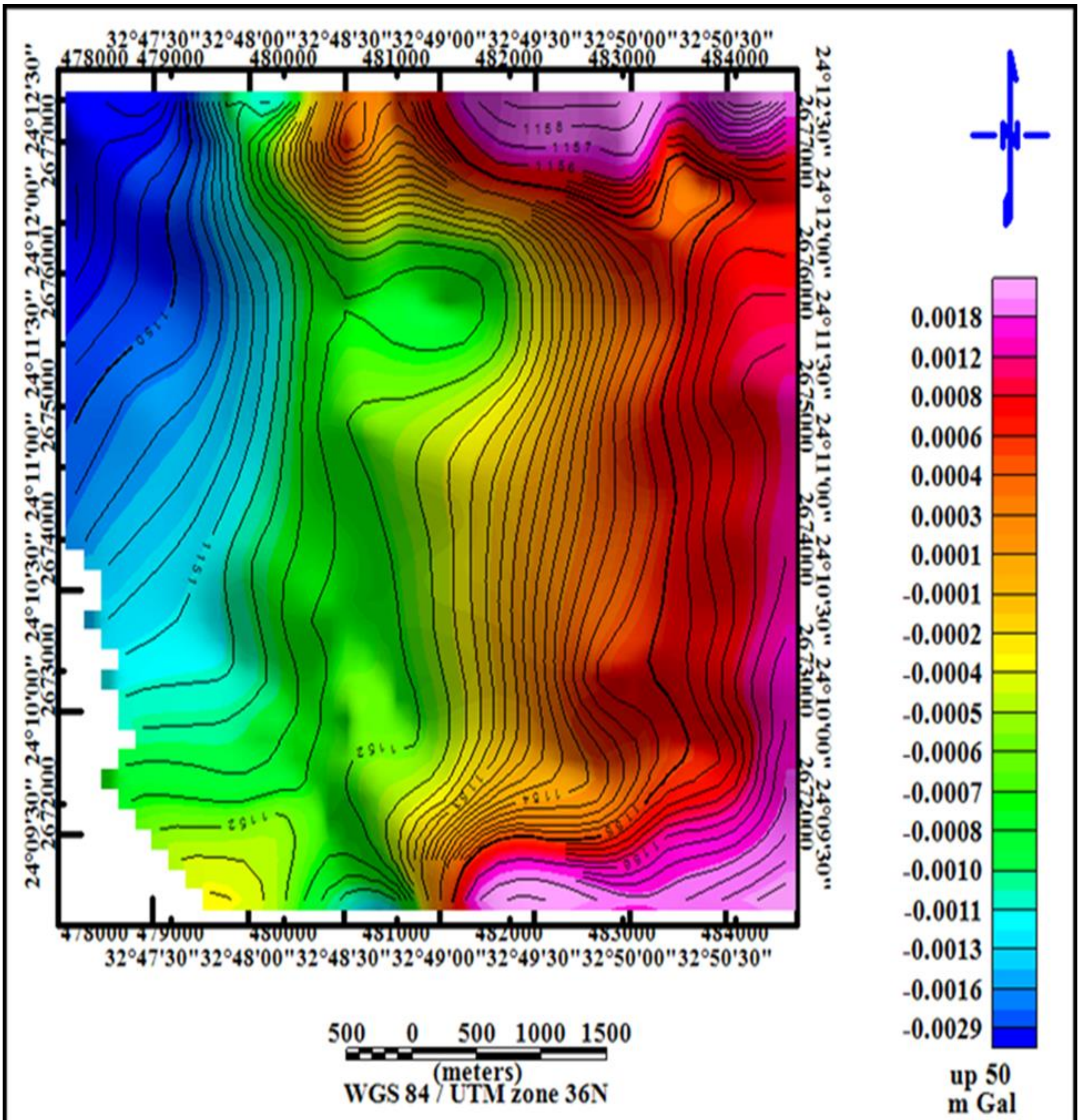

Figure. (3.2): Upward Continuation of Bouguer Anomaly Map.

A series of upward continuation maps has been created to eliminate residual sources and achieve a more reliable regional surface that aligns with the regional map obtained through the separation process (Geosoft, 2014). An upward continuation filter was applied to the map at a depth of 50m to illustrate how anomaly characteristics change as the observation distance from the source increases. Examination of the upward continuation maps (Fig. 3.2) reveals a strong similarity to the Bouguer anomaly map, suggesting that most of the anomalies likely originate from deep sources.

3.3. (High-Low) Pass Filter:

3.4. Low-Pass Filter:

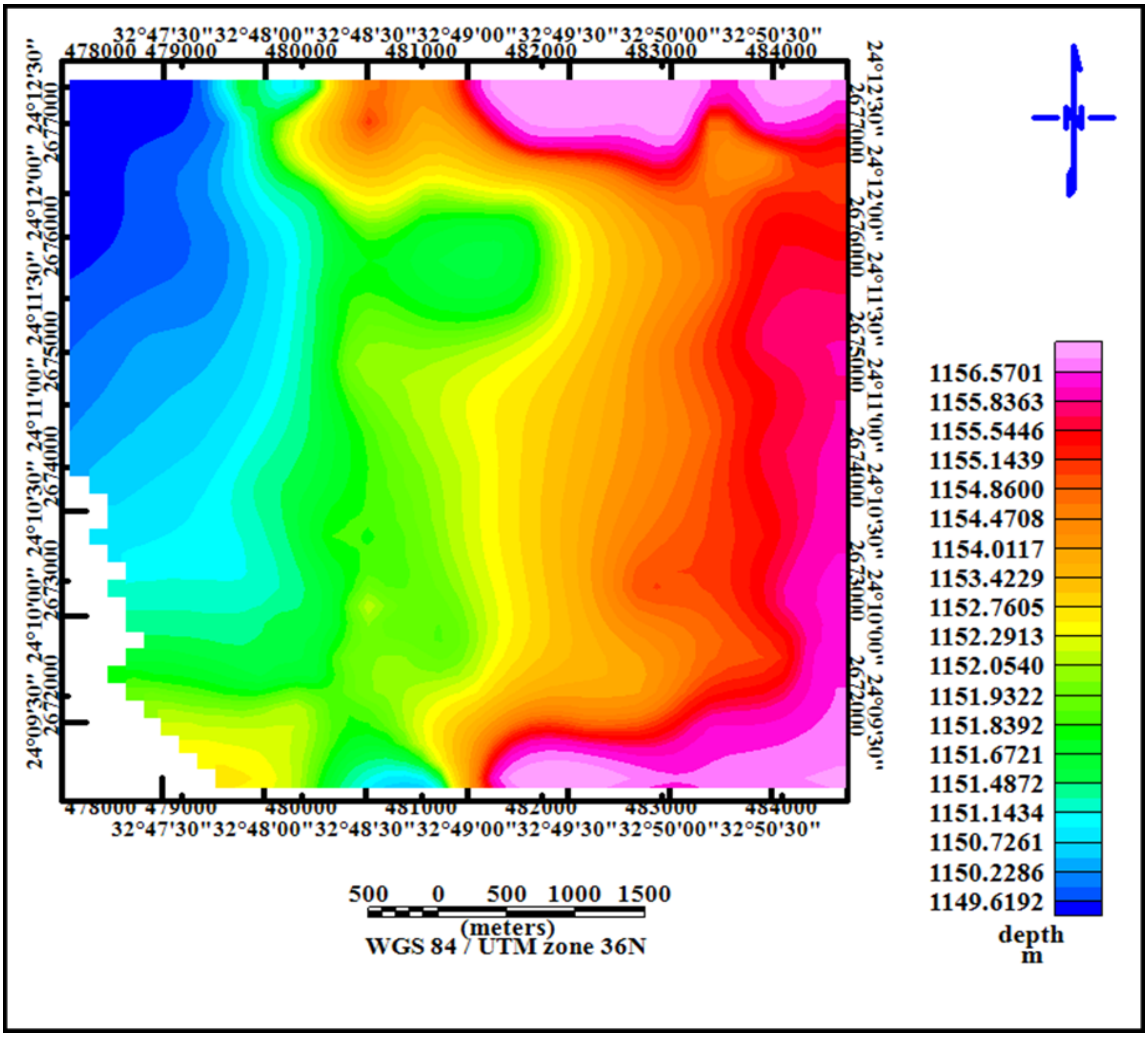

Figure. (3.4): A Low-Pass Filter (Bouguer Anomaly Map).

A low-pass filter was applied to the Bouguer anomaly map (Fig. 3.4). The resulting low-pass filter map shows that the gravity anomaly field in the area varies, with a maximum relative value of 1156.5701 mGal in the northeastern, eastern, and southeastern regions and a minimum relative value of 1149.6192 mGal in the western and northwestern parts of the study area. The high gravity anomaly is primarily attributed to the uplift of denser basement rock, while the lower gravity values indicate the presence of sedimentary basins.

Online ISSN: 3009-7916, Print ISSN: 1110-0184. https://astb.journals.ekb.eg/

3.5. High-Pass Filter:

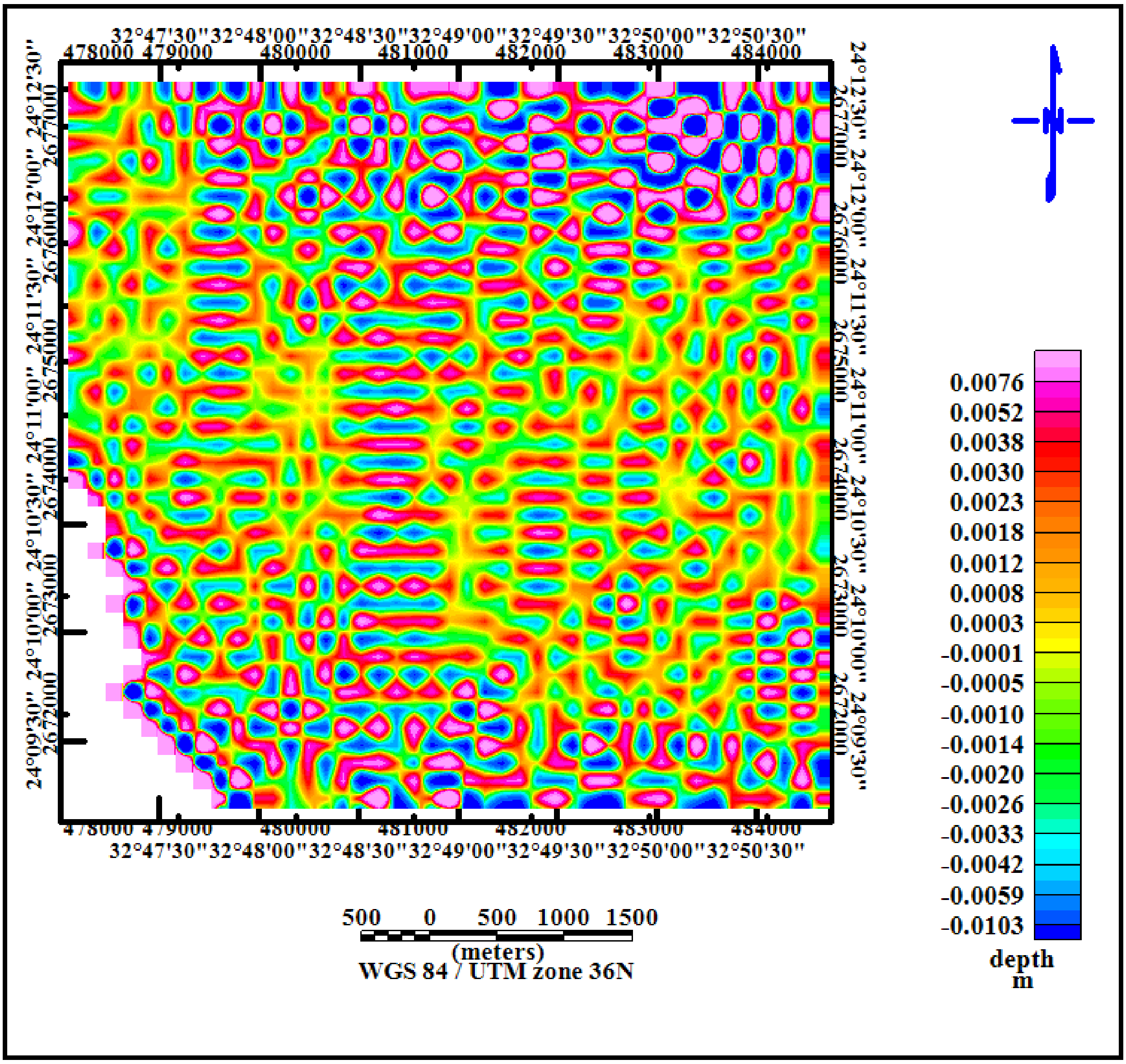

Figure. (3.5): A High-Pass Filter (Bouguer Anomaly Map).

A high-pass filter was applied to the Bouguer anomaly map (Fig. 3.5). The resulting high-pass filter map indicates that the gravity anomaly field in the study area reaches a maximum relative value of 0.0076 mGal in the northern and eastern regions, as well as in the central and southwestern parts, and a minimum relative value of -0.0103 mGal in the northeastern, southwestern, southern, and eastern regions. The positive gravity anomaly is primarily associated with the uplift of denser basement rock, while the lower gravity values correspond to sedimentary basins.

Conclusion:

A total of gravity stations were surveyed using a gravimeter, the purpose of the gravity method is to identify subsurface structures. The regional-residual separation technique was

Online ISSN: 3009-7916, Print ISSN: 1110-0184. https://astb.journals.ekb.eg/

applied to isolate the regional component associated with deep-seated sources and the residual component linked to local sources, the qualitative interpretation results by (Upward Continuation, Low-Pass Filter and High-Pass Filter) indicate that The elevated gravity anomalies are mainly associated with the uplift of dense basement rocks, whereas the lower gravity values suggest the existence of sedimentary basins.

Acknowledgement:
I would like to sincerely thank my supervisors for their invaluable guidance, feedback, and support throughout my research. Their vast knowledge and expertise have been crucial to the successful completion of this work.

Conflict of Interests: The authors declare that they have no conflict of interest.

ORCID: Mohamed Mahran[1] https://orcid.org/0009-0009-7590-2109.
Ahmed M. Meneisy[1] https://orcid.org/0000-0001-6029-2736.
Sayed Issawy [2] (Not available).
Karrar Omar El-Faragawy[1] **(**Not available).

Author contribution:
All sections of the research were conducted by the authors through diligent effort, including a comprehensive review of relevant references and contributions in the field of geophysics. The authors have read and approved the final manuscript.

References:

Butzer, K. W., &Hansen, C. L. (1968). Desert and Rivers in Nubia, Geomorphology and prehistoric Environment at Aswan Reservoir, University of Wisconsin presses. Madison, Milwaukee, U.S.A.

Dahy et al. (2008).Identification of Local Seismicity Observed South of Aswan City-EGYPT, Acta Geoph. Hung., Vol. 43(1), PP. 93-103. https://doi.org/10.1556/AGeod.43.2008.1.7.

El Bohoty, M., Ghamry, E., Hamed, A., Khalifa, M., Taha, A., & Meneisy, A. (2024). Surface and subsurface structural mapping for delineating the active emergency spillway fault, Aswan, Egypt, using integrated geophysical data. Acta Geophysica, 72(2), 807-827.https://doi.org/10.1007/s11600-023-01133-1.

EL-Ramly, I., M. (1973). Final report on Geomorphology, Hydrology, planning for groundwater resources and land reclamation in Lake Nasser region and its Environs, Regional planning of Aswan, Lake Nasser development center and Desert Research Institute, Cairo, Egypt.

El Shazly, E. M., Abdel Hady, M. A., El Ghawaby, M. A. and El Kassas, I. A. (1974). Geologic interpretation of ERTS-1 satellite images for west Aswan area, Egypt. Proceedings of the ninth international symposium on remote sensing of environment, 15-19 April (1974), Arbor. Michigan, U. S. A., pp. 119-131.

Fat-Helbary, R. E. S., El-Faragawy, K. O., & Hamed, A. (2019). Application of HVSR technique in the site effects estimation at the south of Marsa Alam city, Egypt. Journal of African Earth Sciences, 154, 89-100. https://doi.org/10.1016/j.jafrearsci.2019.03.015.

Gahalaut, K., & Hassoup, A. (2012). Role of fluids in the earthquake occurrence around Aswan reservoir, Egypt. Journal of Geophysical Research: Solid Earth, 117(B2). https://doi.org/10.1029/2011JB008796.

Geosoft (2014). Geosoft mapping and application system, inc,suit 500, richmond st. West Toronto, on Canada n5siv6.

Hendriks, F., Luger, P., Bowtiz, J. and Kallenbach, H. (1987). Evolution of the Depositional Environments of SE-Egypt during the Cretaceous and Lower Tertiary. - Berliner geowiss. Abh. (A), 75 (1), (49- 82), Berlin.

Issawi, B. (1968). The geology of Kurkur-Dungle area: Geol., survey, Egypt, paper No. 46, 102 p., Cairo.

Klitzsch, E. and Wycisk, P. (1987). Geology of the sedimentary basins of Northern Sudan and bordering areas, Berliner geowiss. Abh. (A), 75 (1), 97-136, Berlin.

Meneisy, A. M. (2020). Impact of subsurface structures on groundwater exploration using aeromagnetic and geoelectrical data: A case study at Aswan City, Egypt. Arabian Journal of Geosciences, 13(22), 1213. https://doi.org/10.1007/s12517-020-06201-0.

Van Houten, F. B. and Bhattacharyya, D. P. (1979). Late Cretaceous Nubia Formation at Aswan south Eastern Desert, Egypt. Annals of the Geological Survey of Egypt, Vol. IX, pp. 408-431.

WCC (Woodward-Clyde Consultants) (1985). Earthquake activity and dam stability evaluation for the Aswan High dam, Egypt.

Youssef, M. M. (2003). Structural setting of central and south Egypt: an overview. Micropaleontology, 49(suppl_1), 1-13. https://doi.org/10.2113/49.Suppl_1.1.