International Journal of
Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

DOI: http://dx.doi.org/10.7324/IJASRE.2018.32686

Volume 4, Issue 4
April - 2018

Interpretation of Ground Magnetic Data, Over Suspected Gold Deposit in Gwam, Paikoro LGA Niger State.

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ABSTRACT

An interpretation of the ground magnetic data over suspected gold deposit using proton procession magnetometer and to determine the depth of gold deposits was carried out in Gwam area of Paiko LGA, Niger State. The Geotron Model G5 Proton Memory Magnetometer was used in interpreting the data of two hundred and nine (209) magnetic stations in twenty-six (26) profiles, while the Garmin(Oregon 550) GPS was used in measuring direction and orientation of profile lines. The survey area was 500m and twenty six (26) profiles were created with a spacing of 20m. On every profile line, a magnetic base station was established, total magnetic field reading and time were measured after every 1minute 30seconds on every station. Raw Magnetic data collected on the field sheet were transferred on the excel sheet for diurnal and IGRF corrections and the residual anomaly and the latitude and longitude was transferred into the originpro8 software for the production of a colored contour map. The colored map aided the visibility of a wide range of anomalies in the magnetic map and the ranges of their intensities were also shown. The result shows that low magnetic intensities dominated the entire study area and it also correlates with properties of a diamagnetic material. Since gold is a diamagnetic material, it means that the probability of finding gold in the study area Gwam is high. The obtained depth to the magnetic source of the study area Gwam along the profiles ranges from 6.57m to 543.33m and the averaged depth obtained is 93.12m for the entire region.

Keywords: Ground Magnetic Data, Depth to Magnetic Source (Gold Deposit), Interpretation of Magnetic data.

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1. INTRODUCTION

Magnetic methods depend on the fact that different rocks, particularly buried ore bodies, locally affect the earth’s magnetic field and produce anomalies of either a positive or a negative kind thus indicating a possible exploration target. Most distinct anomalies are due to the presence of iron ores that contain magnetite or other iron minerals with some degree of remnant magnetism. Many magnetic minerals are weathered to yield oxides of gold that are detectable magnetically. The magnetic method maps changes in the earth’s magnetic field attributed to variation of structure, magnetic susceptibility or left overs in certain near surface rocks (Keary and Brooks, 1984). This method is employed for direct location of ores containing magnetic minerals such as gold. Iron ore reserves are plenty in wild mines but would get depleted within a few years (Bogdandy and Engel, 1971).

The method used to ascertain the power to the earth’s magnetic field is the magnetic method It is also the process of finding the magnetic elements at different part on the earth's surface including nearby variations (as methods for prospecting for mineral).

Most geophysical explorers make use of magnetic survey in their search for mineral bearing ore bodies or oil sedimentary structures and in finding map of the remaining parts of covered structures by archaeologists. The fundamental element of the magnetic field is to estimate the intensity and sometimes the magnetic inclination, declination and dip. If a quick reconnaissance of an objective survey of an area is to be made; only the magnetic intensity of the target area is made. If the objective of the survey is to determine already discovered structures, a grid is set up by the surveyor across the area and makes measurement in every station on the grid. Correct data is entered into a scale drawing of the grid, magnetic map of the target area that gives the size and extent of the anomalous body is obtain when contour line are drawn between points of equal intensity. It can likewise be utilized to decide the depth to covered magnetic sources.

2. GEOLOGY OF THE STUDY AREA

Within the north-central portion of the Nigerian Basement Complex rocks the Gwam study area is located (Figure 1). This Basement Complex is characterized by three lithofacies: The Schist Belt, The Migmatite-Gneiss Complex, and The Older Granite (Olarewaju et al., 1996; Olasehinde, 1999).

The Migmatite-Gneiss Complex is the oldest basement rock and it is most type of rock found in the Nigerian Basement complex. It contains genesis of two types: the banded gneiss and the biotite gneiss. Largely distributed, fine-grained with strong foliation caused by parallel alignment of altering dark and light minerals are refered to as the biotite. While the one that shows an alternating light-coloured and dark bands and exhibit intricate folding of their bands are the banded gneisses.

The schist belts rock happens transcendently in Nigeria Western portion. Their lithologic composition ranges from schists through phyllites to pelitic, semi-pelitic, and psammatic rocks as well as marble, quartzite and amphibolite (Obaje et al., 2006). The Schist belts fall into two age groups: The prior gathering contains arrays of mafic molten rocks, phyllites and peliticschists, joined iron development and, carbonate rocks and locally, coarse grained clastics. These belts indicate complex structural styles and are extensively intruded by granitic plutons belonging to the widely distributed Pan-African magmatic suite. The last gathering of schist belts is described by mafic volcanic rocksandcoarsed to fine grained clastics.

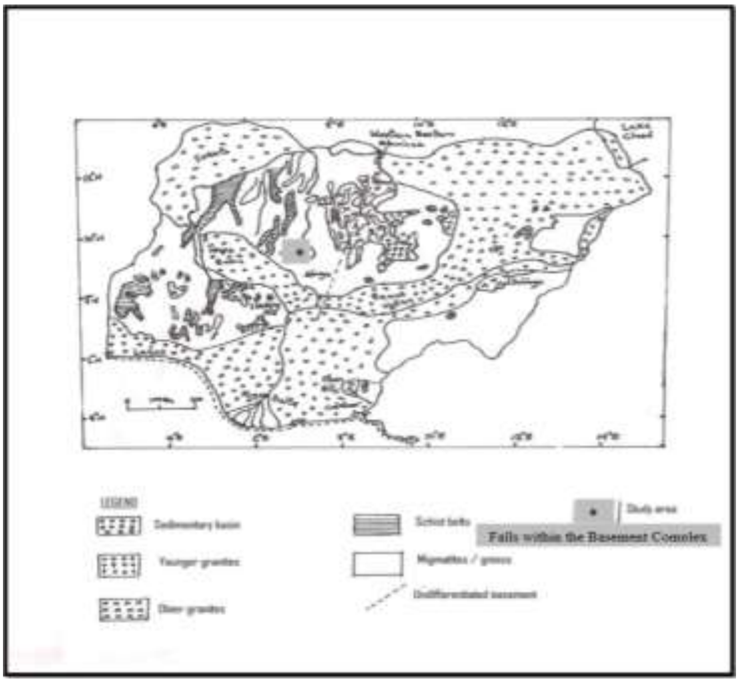

Figure 1: Nigeria Geological Map showing the Study Area (Adapted and modified from the Geological Map of Nigeria, Ajibade et al., 1983).

Throughout the Basement Complex the Older Granites are distributed all round and within the schists and the migmatite-gneiss complex occur at large circular masses. granite, granodiorites, diorites, charnokitic rocks and gabbros which intruded during the Pan-African Orogenic Cycle and formed part of the Precambian Basement Complex are contained in the older granite series. The investigation region, Gwam, consists predominantly of medium to coarse-grained biotite granite and granodiorites which varies from medium dark coloured to light coloured (Kogbe, 1976) as shown in Figure 2. The granite types Older Granite is formed by the combination of the granodiorite and the granite types (Rahaman, 1988). Peculiar to the area, is outcropping at different sizes, shapes and locations with noticeable fractures and joints.

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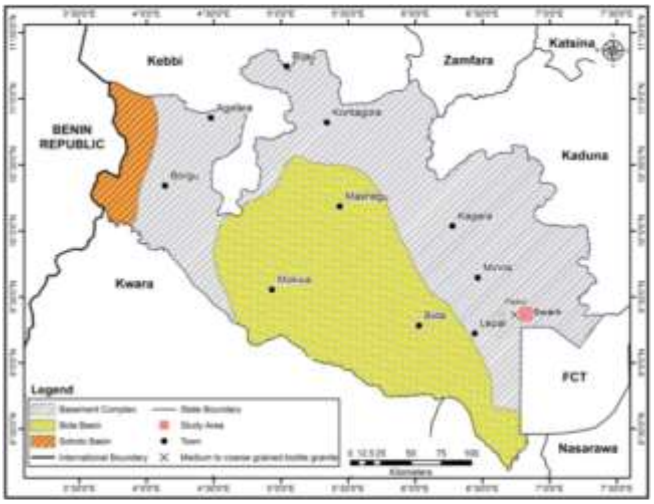

Figure 2: Niger State Geological Map showing the Study Area (Adapted and modified from Niger State Geological Map).

3. MATERIALS AND METHODS

3.1 Magnetic Data Acquisition

In this study the survey covered an area of approximately 500m square located within Latitude 9^{0}24'59.51"N and 9^{0}27'17.49"N and Longitude 6^{0}38'40.58"E and 6^{0}38'50.01"E. This was done in June 2017. A total of two hundred and nine (209) magnetic stations were established in the area of the study, with spacing between the lines is about 20m and distance between stations was measured using 1min 30sec except where the area was inaccessible due to dense forest cover, deep valleys and overcrowded human habitation. In places with high magnetic gradient of the magnetic anomaly reading, stations were made much closer.

The magnetic data were collected perpendicular to the strike along twenty six (26) selected lines in the study area oriented approximately North- East in direction. A total of twenty six (26) profiles were made inside a 500m square area. Note, all profiles were run in north-east direction.

Before and after any measurement was taken, the base station reading was taken for all profiles that was established at a location of latitude N09 24.675ˈ and longitude of E006 48.232ˈ and the instrument was checked for batteries, then test two or three measurements to check if there was a magnetic storm in that day. However, throughout the measurement there was no storm at all. In this survey, one magnetometer was used for the field and several base station readings were taken. The reading was taken on foot at 1minute 30seconds interval. Two hundred and nine (209) data were collected from the twenty six (26) lines with 20m spacing. The accurate positions of the magnetic data points were determined using the latest version hand-held GPS (Global Positioning System). The GPS used was Garmin (Oregon 550). This GPS can locate the coordinate of the area along with the elevation.

3.1 Data Processing

The collected data was processed for proper interpretation of the subsurface mineralized zones (faults and fractures) geometry. Thus, the raw Magnetic data collected on the field sheet were transferred on the excel sheet for diurnal and IGRF corrections.

3.2 Data Interpretation

There are several ways to present data for post processing and interpretation. The corrected data conveniently called diurnal corrected can be presented or visualized in the form of contour maps, images and stacked profiles (Milligan et al, 1997) or bipolar plots (Gyngell, 1997). In profiles and 3D maps, magnetic anomalies are indicated by peaks, and in the case of the contour maps, close and high contour values indicate magnetic minerals (Keary et al., 2002).

In data interpretation, smooth contours usually reflect sediments covered areas with relatively deep basement. Igneous and metamorphic terrains are identified by their more complex magnetic anomalies. In areas that have magnetic minerals, the contours are close with successive contours decreasing or increasing anomaly values toward a centre. Strike directions are determined with the direction of closed elongated curves. Places that have high horizontal anomaly gradient are often indicative of rocks with different susceptibility values. Shallow contact lying have steeper gradient, circular contours indicate circular features, and elongated dikes may be indicated by long narrow anomaly. Faults are indicated when one part of a magnetic signature is displaced with respect to others (Keary et al., 2002).

4. RESULT DISCUSSION

For the interpretation of the ground magnetic data over suspected gold deposit in Gwam area, we made use of two method of presenting magnetic data and they are as summarized as follow:

Contour: - These are grid-based (contour map) presentation used to produce scaled 2D contour maps of the subsurface. For a qualitative analysis a contour map was used to present the magnetic data of the study area Gwam.

The raw Magnetic data collected on the field sheet were transferred on the excel sheet for diurnal and IGRF corrections. After the diurnal correction was carried out, the IGRF for the duration of the survey and for that specific location was determined from the online geomagnetic data centre [NOAA,(http://ngdc.noaa.gov/geomagmodels)]. The IGRF magnetic field reading of the specific location is 33712.4nT and it was subtracted from the diurnal correction result to give the residual anomaly. SavitzkyGolay filter was use to smoothen the residual data from the originpro8 software before the total magnetic intensity map was developed. The TMI map was developed by creating a table containing X, Y and Z column, the X contained the longitude in degrees, Y contained latitude in degrees and Z contained the smoothed residual anomaly in nano tesla (nT). They were plotted together to form the TMI map as shown in figure 3.

Originpro8 was used to produce the contour map for this study as shown in figure 3.The map is presented as colour map for easy interpretation. The coloured map aided the visibility of a wide range of anomalies in the magnetic map and the ranges of their intensities were also shown.

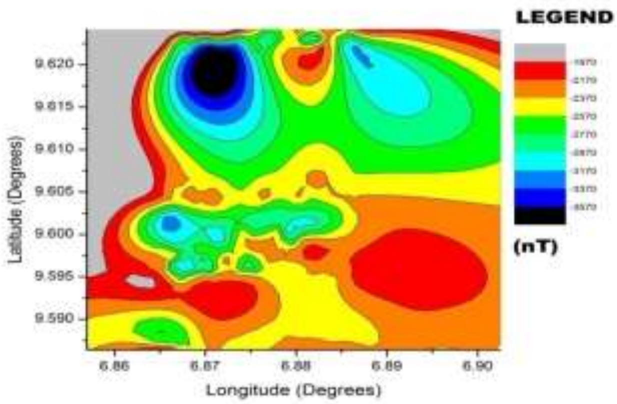

Figure 3 Total magnetic intensity map of the study area Gwam, Paiko Niger state.

Profiles:-The slope method is one of the oldest magnetic depth estimate techniques that can show the depth to the top of magnetic basement, this is the oldest form of data presentation but yet it can help in showing details that cannot be shown in a contour map.

The distance and the residual anomaly was use to plot the half-width method graph which helped in determining the depth to the top of geologic sources that produced the observed anomalies in the ground magnetic map as shown in profile 1-26(Appendix A).

The total magnetic intensity map usually gives lineation as magnetic contours and accentuates the regional geology of the study area useful in mapping structural trends (Dobrin and Savit, 1988).

The contour map was produced using the total magnetic intensity values as shown in figure 3 of the Gwamarea, it has different colour. The ranges of the total magnetic intensity of the area are -3570 to -1970nT. The area is marked by the high (grey colour) and low (black colour) magnetic signatures. The change in magnetic intensity may be as a result of change in depth, degree of strike, difference in magnetic susceptibility, difference lithology, dip and plunge. The legend is the rectangular shape attach to the map with different colour, it gives information about the map. Since all the values on the legend are negative, it shows that the magnetic bodies in the area lie deep within the earth.

The light black to deep blue colours at the end of the legend depict areas of thicker sediments or deeper lying magnetic bodies. The upper colours (grey and red) at the other end of the legends show areas of shallower sediment or near surface magnetic bodies. In low latitude magnetic region specifically around the equator of which Nigeria is situated, a low or negative magnetic peak values represent typical anomalous signatures (Parasnis, 1986; Fieberg, (2002). Low magnetic intensities dominated the entire study area. The magnetic lows are suspected to be due to the presence of fault, fracture, crack or contact between two rocks. Negative anomalies are associated with greater thickness of cretaceous rocks contained within the fault-bounded edges and depicting isolated structures and these are well distributed across the study area. Low magnetic intensities are the suspected areas for hydrogeologic purposes (Sunmonu et al, 2012). It further shows that the study area Gwam is a promising area for hydrogeologic prospect because of low magnetic intensities.

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Diamagnetic materials have a weak, negative susceptibility to magnetic fields. Diamagnetic materials are slightly repelled by a magnetic field and the material does not retain the magnetic properties when the external field is removed. A material in in which all its electron are paired so that there is no permanent net magnetic moment per atom is diamagnetic material. Under the influence of external field there is a rise in the realignment of the properties of a diamagnetic. In the periodic table elements like copper, silver, and gold are diamagnetic. The result correlates with properties of a diamagnetic material, since gold is a diamagnetic material; it means that the probability of finding gold in the study area Gwam is high.

Observed anomalies in the ground magnetic map (figure 3) weredeterminedwith half-width method. Every depth for each anomaly on each profile were determined through the graph plotted, the reading obtained from the graph was arranged in a table as shown in table 1 and was averaged to get a representative depth estimate for the profiles in the study area Gwam. The obtained depth to the magnetic source of the study area Gwam along the profiles ranges from 6.57m to 543.33m and the averaged depth obtained is 93.12m for the entire region as shown in table 1.

Table 1: Depth Estimates From The Ground Magnetic Data From The Half-Width Method Applied To The Profiles

Profiles	FWHM (m)	Depth (m)
profile1	1086.66	543.33
profile2	180.11	90.05
profile3	19.02	9.51
profile4	301.04	150.52
profile5	167.86127	83.93
profile6	205.69766	102.84
profile7	16.70	8.35
profile8	136.73	68.36
profile9	44.01	22.00
profile10	271.22	135.61
profile11	39.43	19.71
profile12	40.55	20.27
profile13	43.20	21.60
profile14	88.75	44.37
profile15	45.36	22.68
profile16	42.01	21.00
profile17	441.49	220.74
profile18	178.94	89.47
profile19	58.28	29.14
profile20	1106.94	553.47
profile21	40.73	20.36
profile22	29.82	14.91
profile23	51.79	25.89
profile24	43.83	21.91
profile25	13.14	6.57
profile26	149.05	74.52
average depth		93.12

5. CONCLUSION

Interpretation of ground magnetic data of the Gwam area has been analysed qualitatively and quantitatively. The ground magnetic method employed in this survey was successful in interpreting the data of two hundred and nine (209) magnetic stations which offered complimentary solution to the interpretation and determination of depth to gold deposit in the study area Gwam. From the result it shows that the study area Gwam has low magnetic intensities and has diamagnetic material which is properties associated with gold. it has also helped in determining the depth to the possible gold deposit in the Gwam area . Ground magnetic method is best for this kind of survey because it can be use in any weather condition and it has proven to be very useful in this research.

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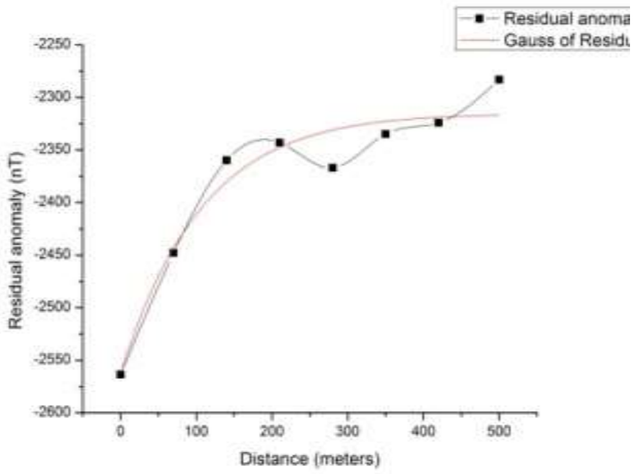
Appendix A: Graph of Distance against Residual anomaly.



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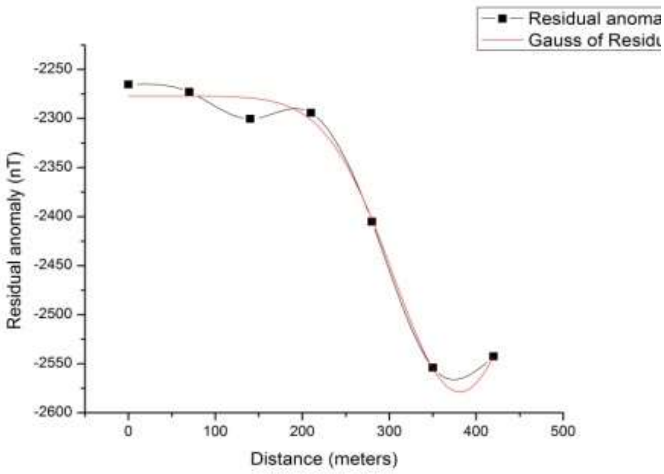

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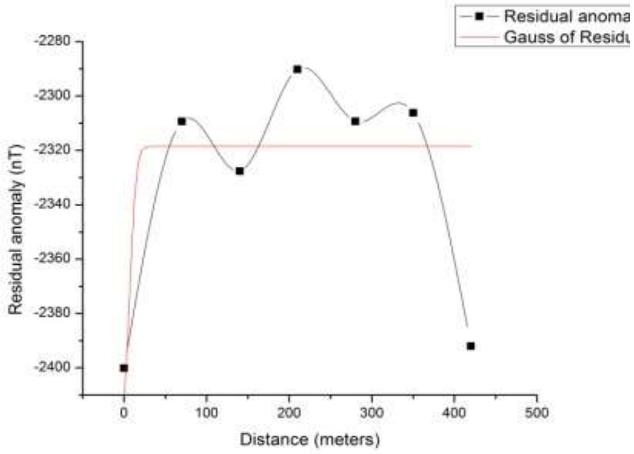

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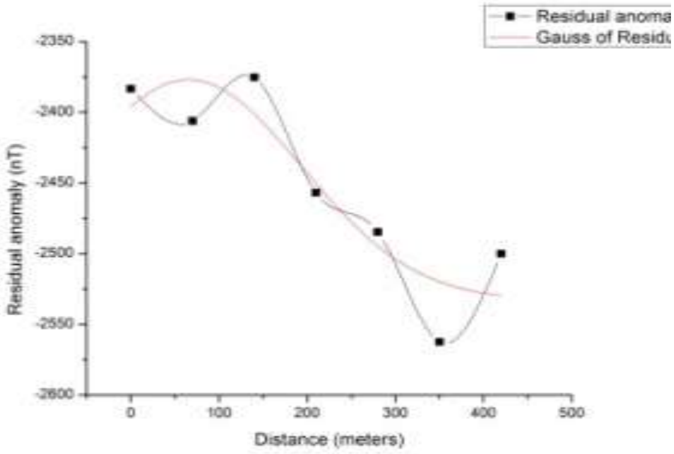

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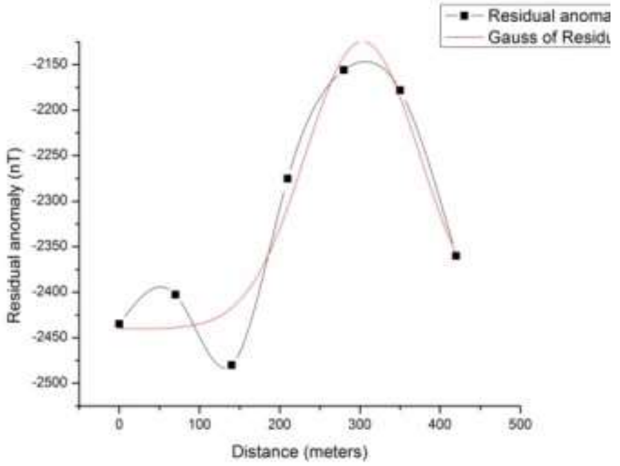

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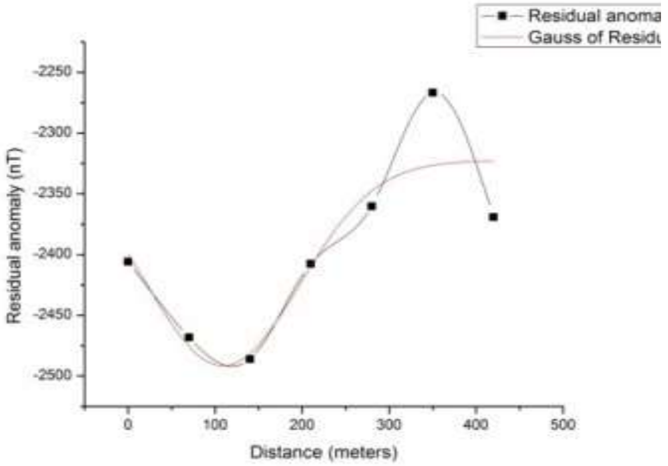

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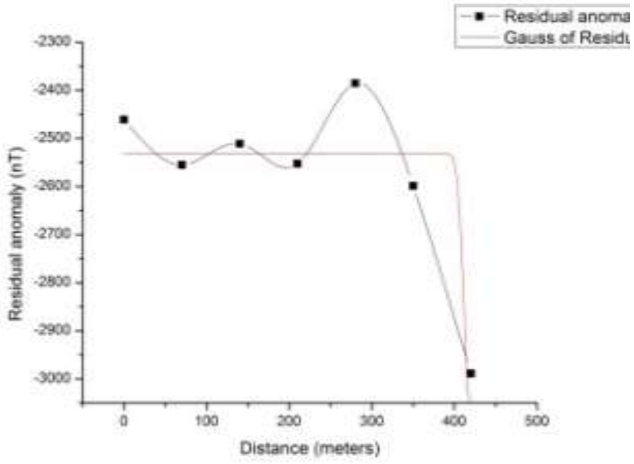

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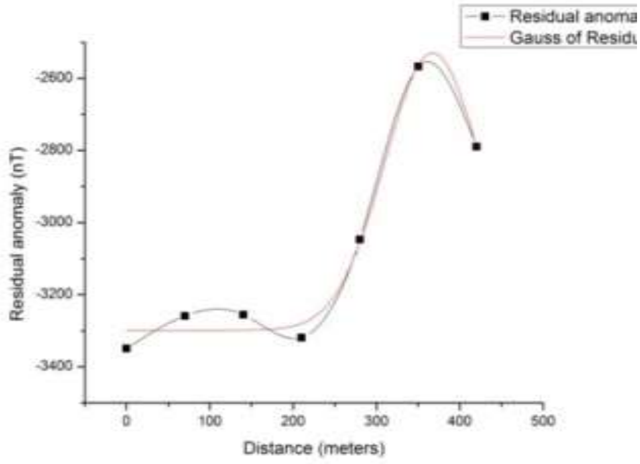

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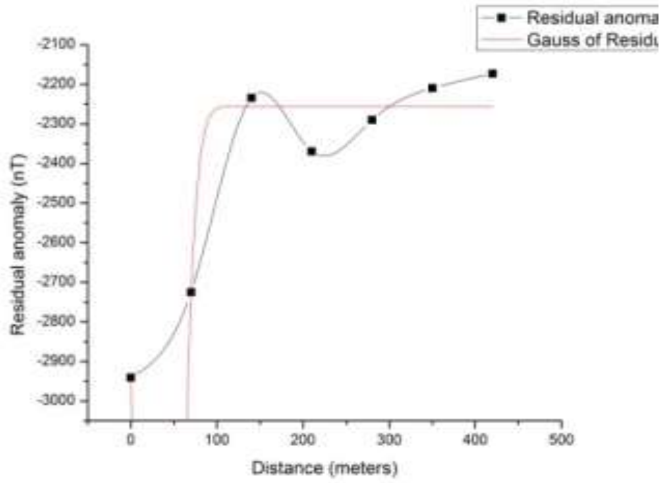

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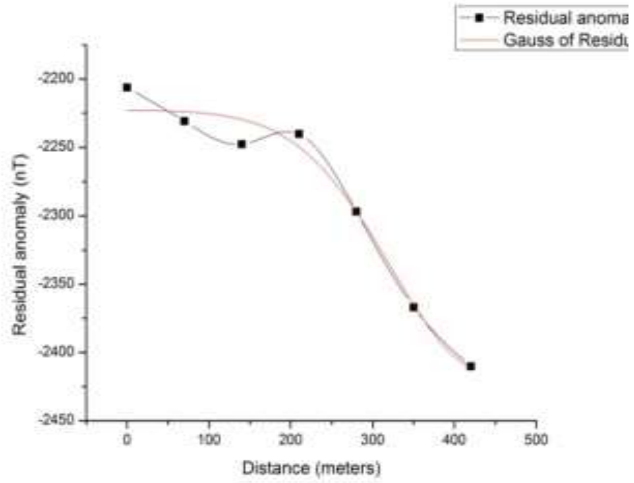

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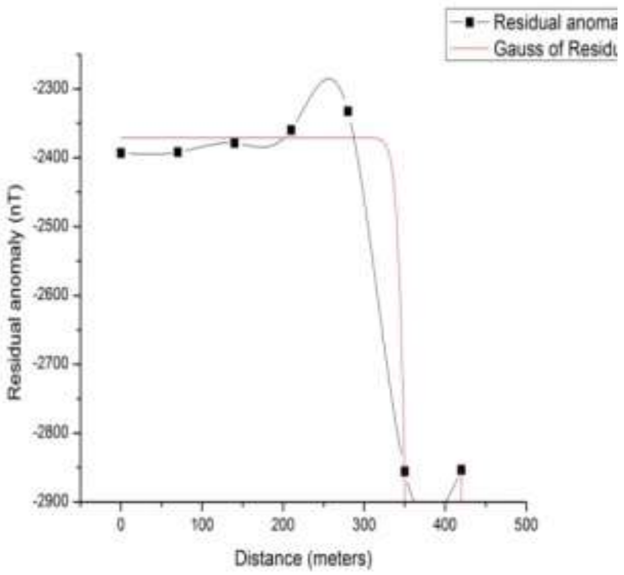

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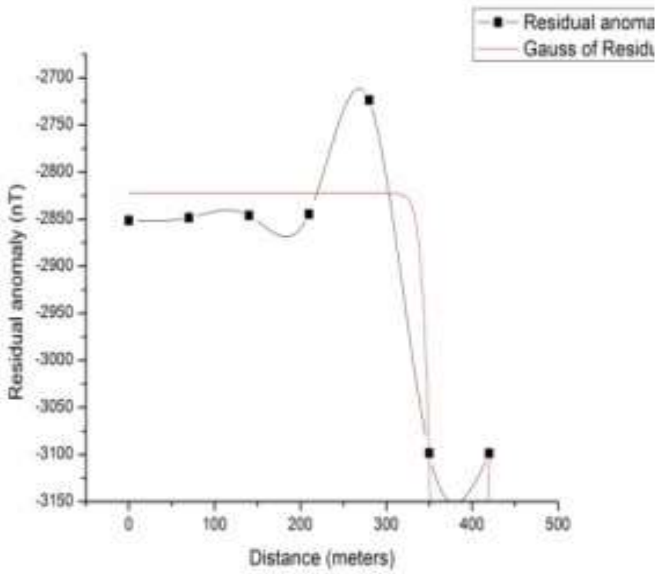

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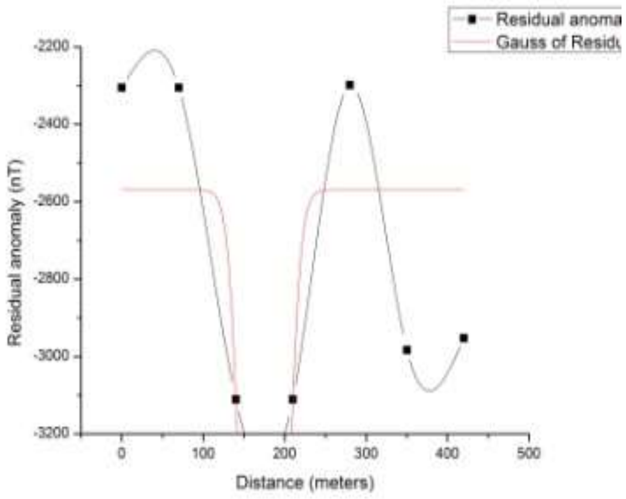

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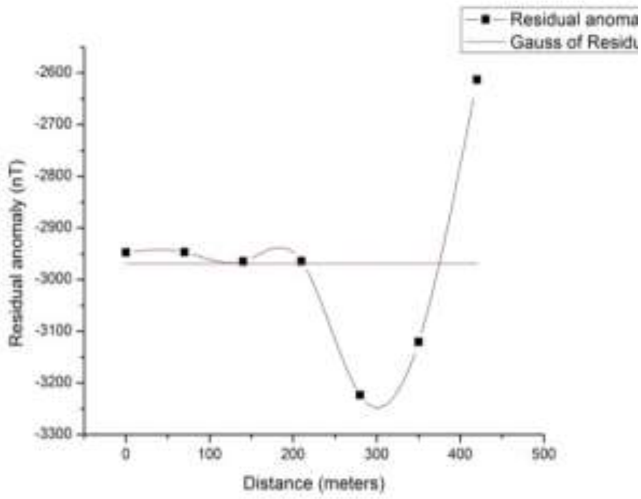

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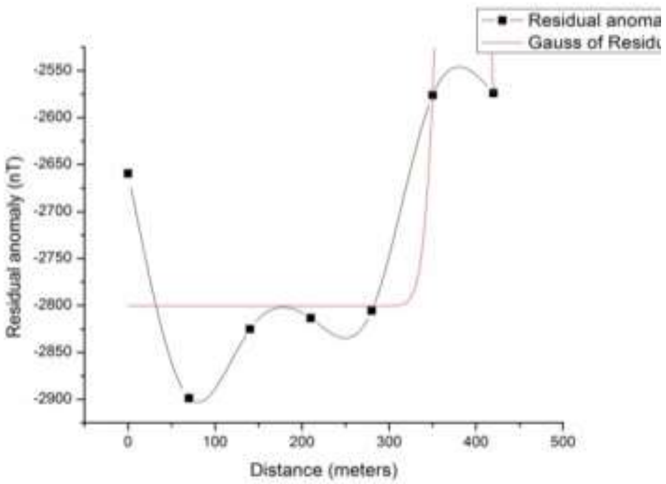

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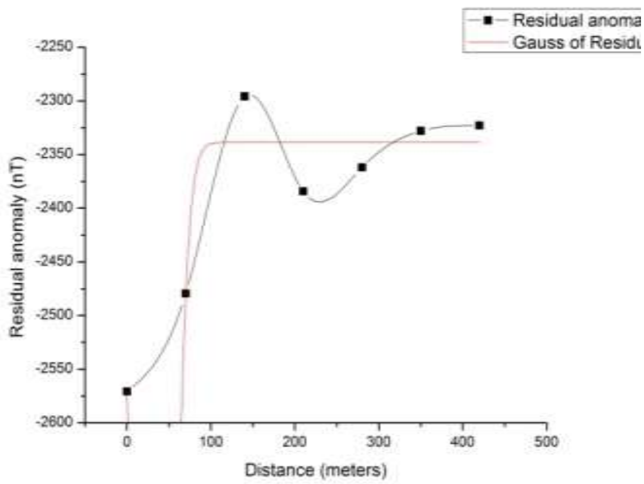

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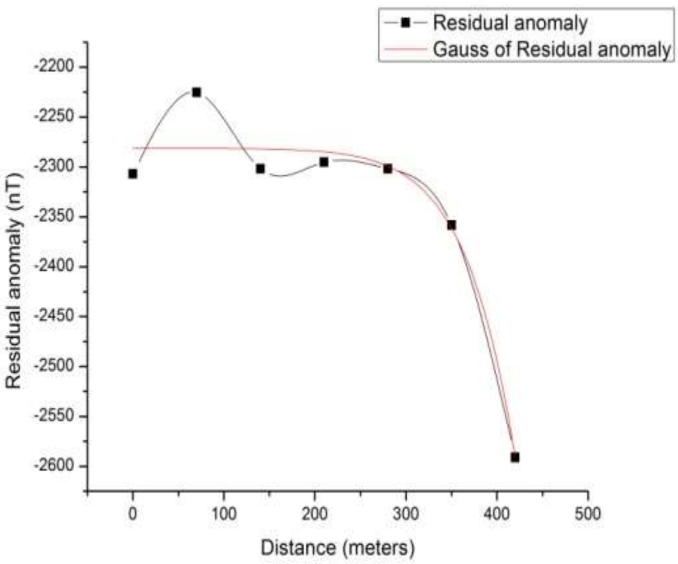

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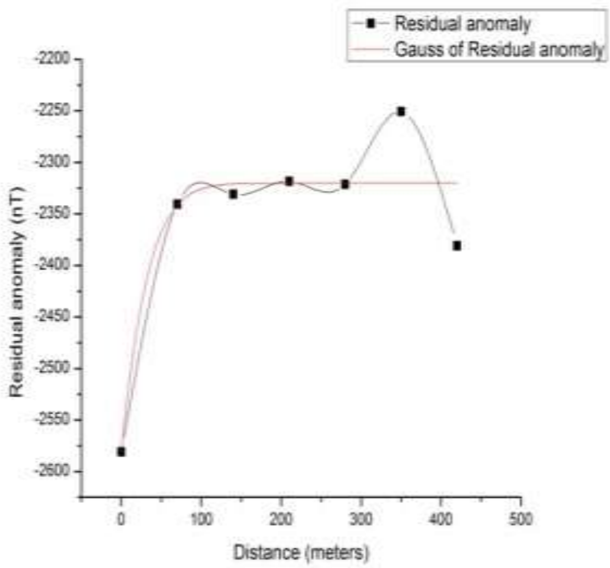

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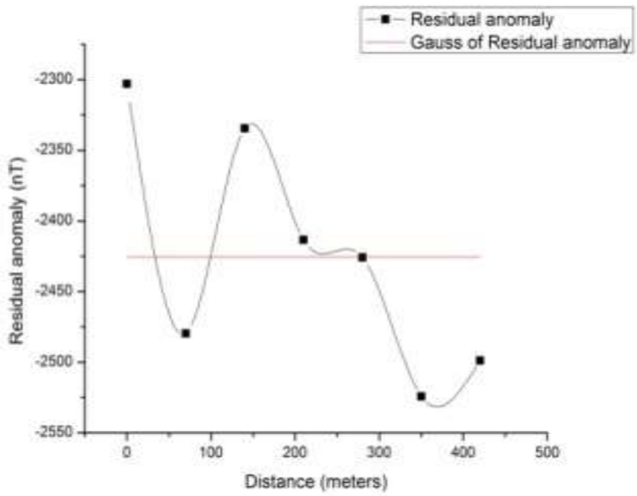

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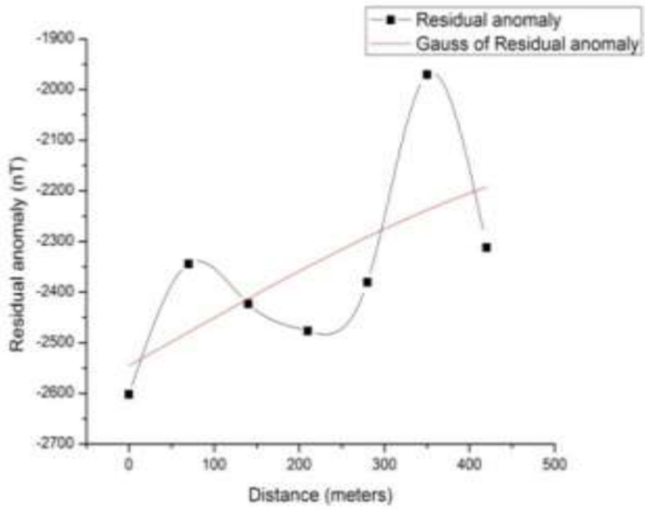

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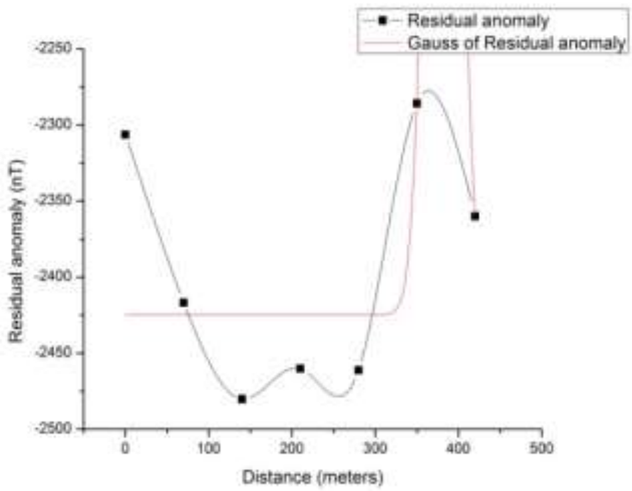

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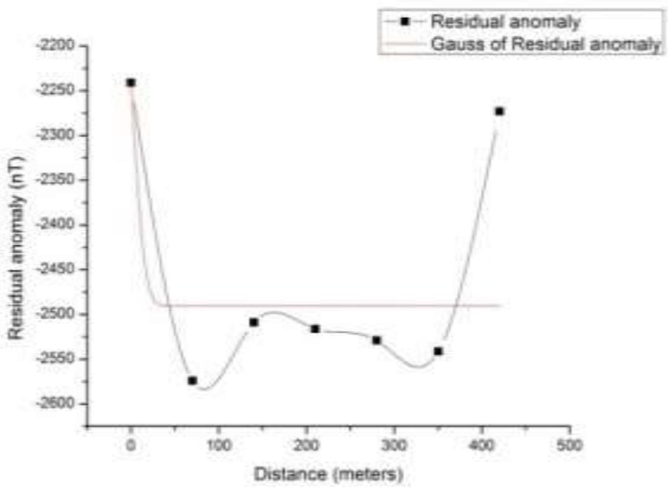

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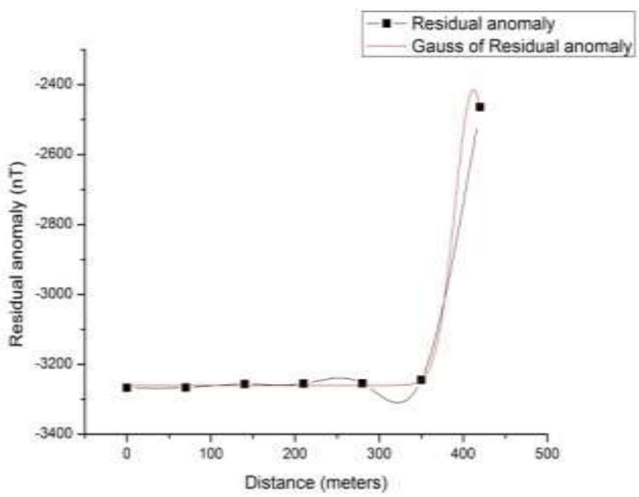
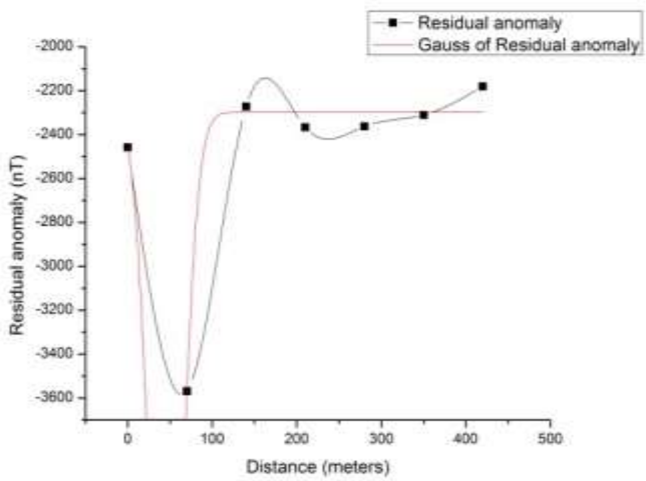
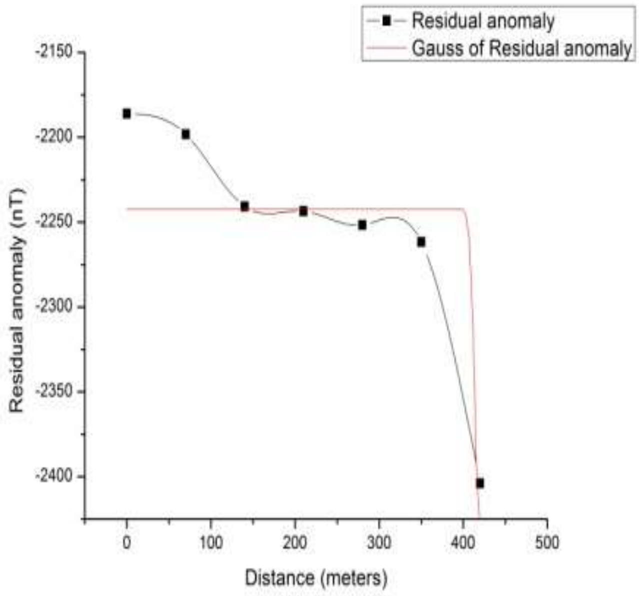


Profile23

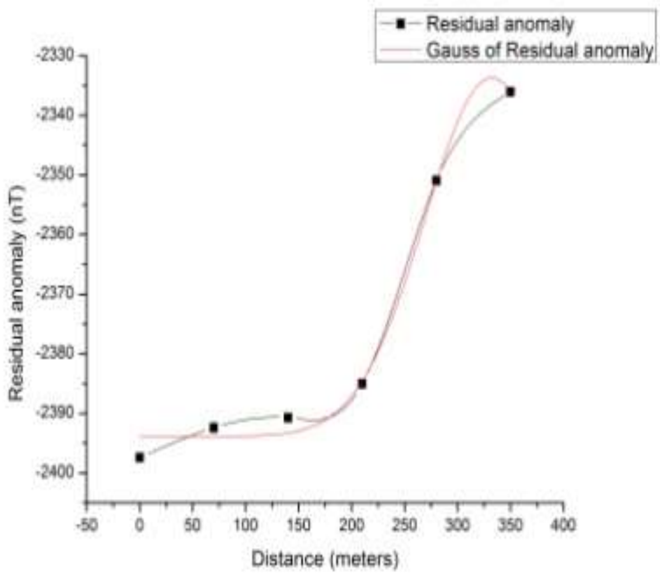


Profile24

DOI: dx.doi.org/10.7324/IJASRE.2018.32686



Profile25



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