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RESEARCH ARTICLE

TOTAL MAGNETIC INVESTIGATIONS FOR IDENTIFICATION OF PERMEABLE GROUNDWATER ZONES IN HARD ROCK TERRAIN, O.U CAMPUS, HYDERABAD, TELANGANA STATE, INDIA

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ABSTRACT

The present investigation consist of vertical magnetic investigations in the Osmania University Campus (78^0 31 00 E longitude to 78^0 32 26 E longitude and 17^0 23 45 N latitude to 17^0 25 42 N latitude) is situated in an area of approximately 6.58 sq kilometers (1627.32 acres) in a granitic terrain. Taking 20m station interval along the traverses trending Six traverses (FF^1, II^1, NN^1, OO^1, QQ^1, and RR^1) were approximately in E-W direction and remaining three traverses (AA^1, BB^1, and CC^1) were approximately in N-S direction were carried out for structural configuration of the region. Qualitative analysis of vertical magnetic data using gradient techniques of coefficient of variation has been performed to anticipate the subsurface structures and assemblages of groundwater aquifer zones and derive several lineaments and magnetic linear features (Magentic Highs and Lows) suggesting the presence of vrious geological lineaments. From coefficent of variation map eight non permeable zones (A,B,C,D,E,F,G,H) and five (1,2,3,4,5) permeable zones were identified which compare with the borehole data showing as groudnwater occurrence and aquifer magnetic characters of the study region.

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INTRODUCTION

The magnetic method holds an important position among the various geophysical techniques used for groundwater exploration even though the method is suited more for iron ore minerals, areal mapping and profiling rather than studies of structure layer by layer. Furthermore, since, variations in susceptibility are more useful for obtaining information on the tectonic/structural features, intrusives and magnetic linear that contribute to the structural configuration of the study region. At the same time, this is a relatively fast and inexpensive method of survey requiring little by way of manpower or instrumentation. An additional advantage of magnetic methods is that they are equally well applicable for identifying subsurface structures.

Data Base

Magnetic investigations were conducted to identifying the groundwater potential zones. These studies were then supplemented by hydrogeological data to evolve an integrated exploration strategy for groundwater.

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The studies as investigated thus combined reconnaissance, semi-detailed and detailed investigations. Magnetic studies corresponding to a part of the map, were carried out roughly in comprising the Osmania University campus area, 78^0 31 00 E longitude to 78^0 32 26 E longitude and 17^0 23 45 N latitude to 17^0 25 42 N latitude total area of 6.58 square kilometers (1627.32 acres). The survey were directed towards tracing out and verifying the detailed geological setting and identifying different tectonic structures in the area which could have a definite bearing on potential zones for groundwater.

Magnetic Survey

To find out the relative variation in the magnetic field, it is necessary to select a convenient point as the base, all the readings are referred to this point. The first reading was taken at the base station. After several readings are taken, a check is made at the base. The Magnetic survey was carried out with appropriate measurement of geometrics and procedure using IGIS Proton Precession Magnetometer–600 instrument at 20m interval along eleven traverses which give a direct measure of ground magnetic field. Six traverses (FF^1, II^1, NN^1, OO^1, QQ^1, and RR^1) were approximately in E-W direction and remaining three traverses (AA^1, BB^1, and CC^1) were approximately in N-S direction (Figure: 1).

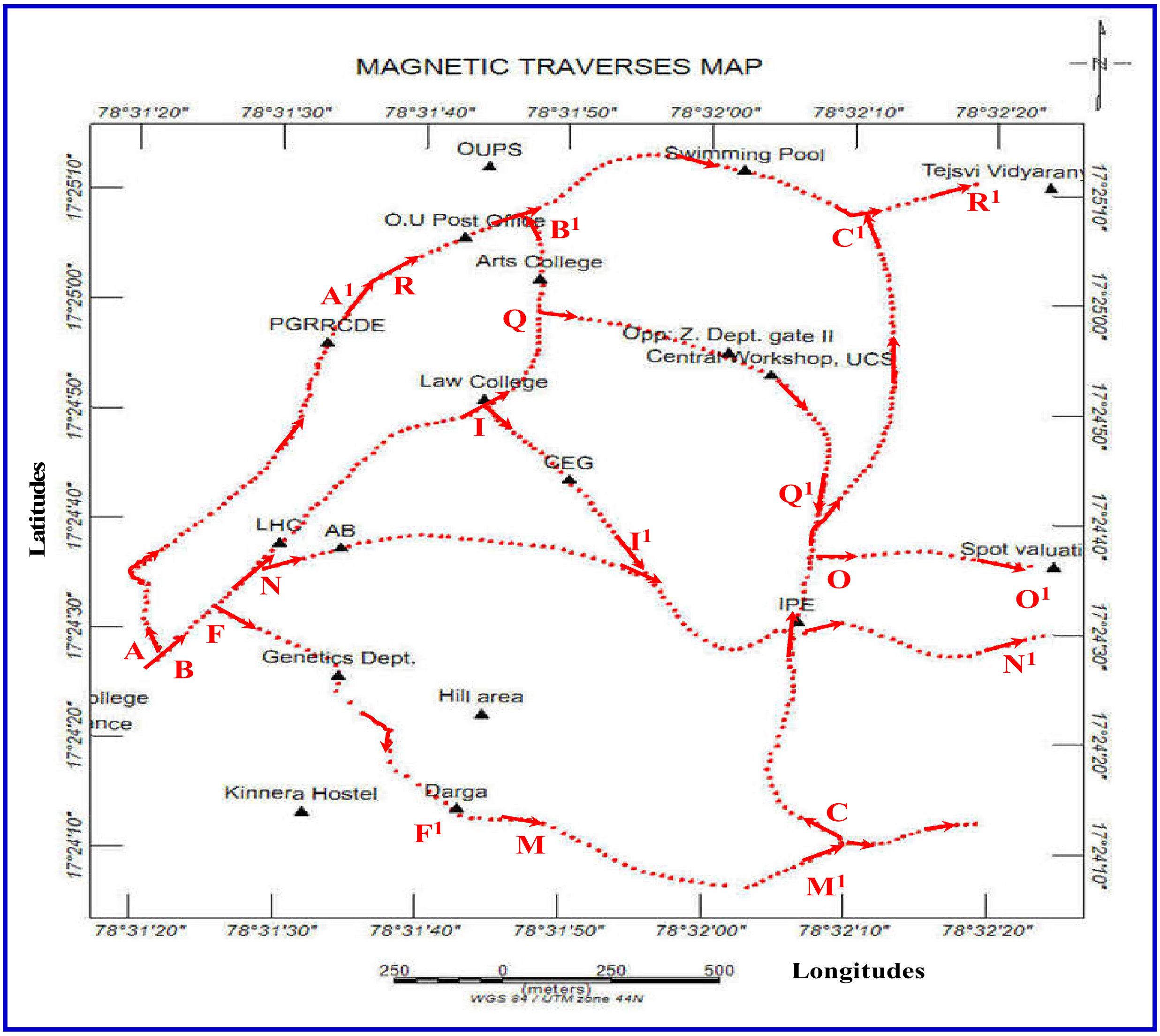


Figure 1. Map of Locations of Magnetic Traverses (AA^1, BB^1, CC^1, FF^1, II^1, MM^1, NN^1, OO^1, QQ1 and RR^1)

The first step in the reduction of the field data is to convert the scale readings recorded in the field at various stations into vertical force values or units of gammas. Frequent repeat observations at the base were made to account for the diurnal variations and also to ensure the reliability of observations.

The reduced scale readings were converted into magnetic intensities of gammas using the scale constant (10gammas/sd). The reading of magnetometer is affected by the sum of all contributions to the magnetic field at the time and place of observation. While taking magnetic observations at the field stations, 20% of the stations were required for repeatability of observation. The accuracy of magnetic measurements as obtained from the eq.

$$R.M.S = \sqrt{\frac{\sum\delta^2}{m-n}} \quad (1)$$

Where **δ** is the difference between the first and second observation values, m is the number of observations and n is the number of repeated stations. In the present work, the accuracy was obtained as 1 -2 gammas. All these stations are connected through primary field base station (I/O).

Magnetic Analysis

Qualitative Analysis

Magnetic data collected in the study area are corrected for diurnal and normal correction. Recognition of characteristic patterns and shapes of anomalies in relation to particular rock units or geologic structures is one of the first step, in the qualitative interpretation of a magnetic map. With the advent of detailed surveys, many near-surface geologic features are so clearly expressed that their geologic origin is obvious in colour shaded-relief images. In the shaded-relief (Gunn, 1997, Davies *et al*., 2004, Gay, 2004), folds look like folds, fault expressions can exhibit an echelon and anastomosing behavior (Grauch *et al*., 2001, Langenheim *et al*., 2004) and individual dikes within swarms are clearly resolved (Hildenbrand and Raines, 1990, Modisi *et al*., 2000).

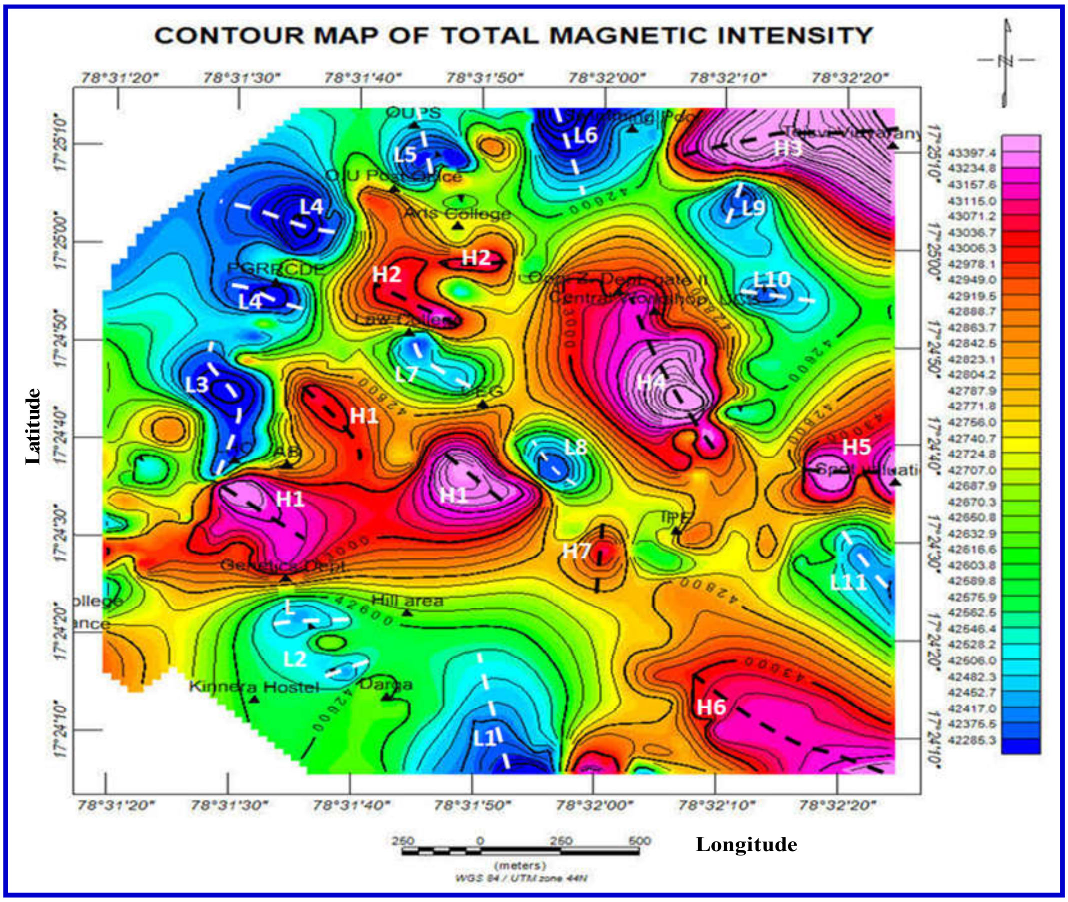


Figure 2. Contour Map of TMI Trends (Contour Interval 60 nT)

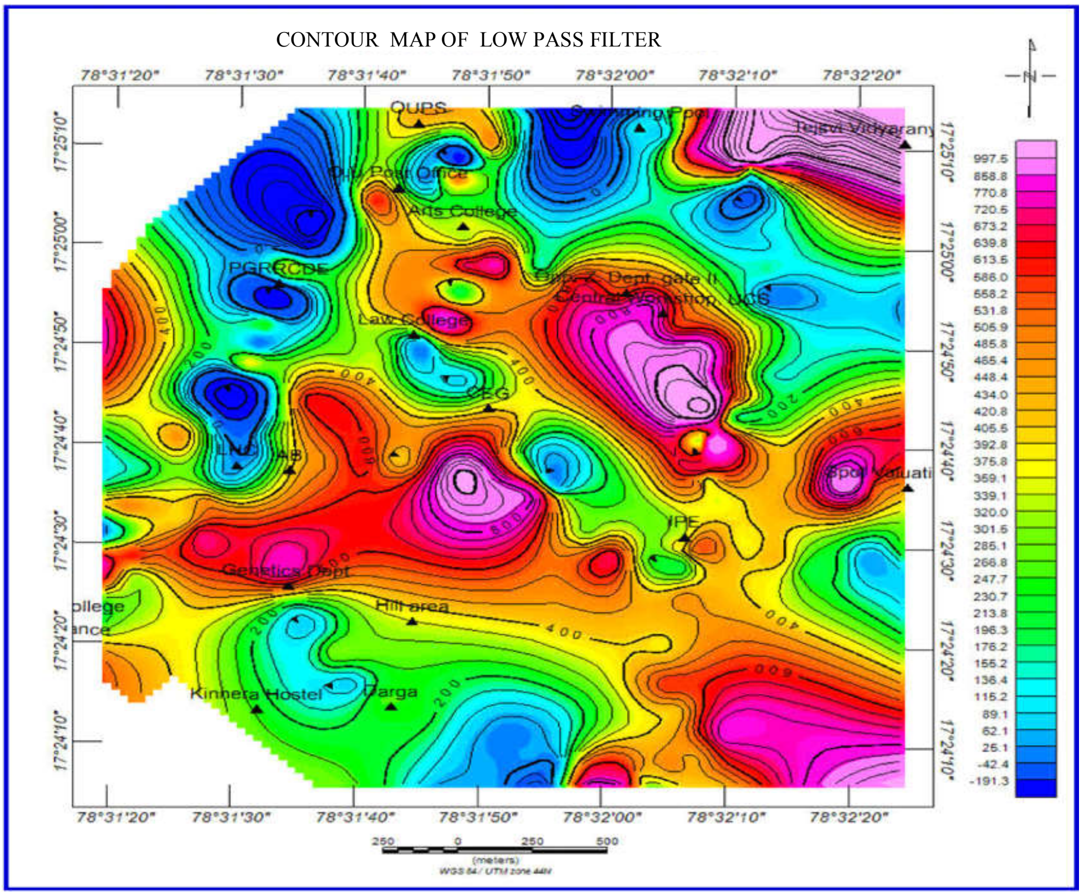


Figure 3. IGRF Corrected Total Magnetic Intensity Contour Map (Contour Interval 60 nT)

Magnetic anomalies produced by rocks with strong, reverse-polarity eminence display characteristic, high-amplitude negative anomalies (Books, 1962, Grauch *et al*., 1999) that, without high-resolution data, might be confused with magnetic lows caused by a lack of magnetization, which are also negative but generally featureless (Airo, 2002). The present detailed magnetic investigations make a significant contribution for the fine elucidation of the subsurface magnetic structures in the hard rock terrain in Osmania University campus. The following section gives detail results of qualitative and quantitative analysis of the data.

Total Magnetic Intensity

Figure: 2 in the contour map of the study area contoured with an interval 60 nT. The magnetic signature range from a low of 42285 nT at the Northern, Northern-Western and Southern part of the study area, to a high of greater than 43397 nT at the Northeastern, Southeastern and Central part of the study area, near Tejasvi Vidyaranya School, High Tech Hostel, College of Technology and Central Workshop, University College of Science, other significant anomaly trends barely discussed. Therefore, with the objective of improving the quality and accuracy of data. Figure: 2 show the distinct pattern of highs and lows. At some places, steep gradients between them are described as prominent magnetic lineaments, which are attributable to the complex assemblage of features of varied dimensions and directions from different phases of magnetic activity. Some of the features are associated with basic/ultra basic/younger acidic intrusive that indicate zones of magnetic permeability (Sinha *et al*., 2003).

IGRF Corrected Total Magnetic Intensity

To determine the magnetic intensity at a station, the magnetic field of the earth at that location (absolute field) has to be subtracted / added from the measured field, especially in area of the appreciable N-S extent of the study area. This normal correction was made using the IGRF software, is a supporting software of the Oasis Montaj V.8.3, processing and analysis module. The contour map of IGRF corrected total magnetic intensity in the study area with a contour interval of 60 nT (Figure:3),while the contour maps of variation in the absolute field, inclination and declination in the study area are found to vary over a very small range in the study area, from 22.29^0 to 22.31^0 and -1.21^0 respectively. After IGRF corrected the magnetic data showed a range of -250 nT to 500 nT.

While comparison of the magnetic signatures with geology of the region not many inferences are made because the various forms of granites (migmatites, gneisses, pink/grey granites and /or biotite granites) are magnetically not much distinctive. The magnetic highs and lows are in conjunction of subsurface faults in the granitic terrain, not with the composition of the granites. The study area covers various forms of granites. Few basic/ultra basic dykes are available as intrusive rocks. NW-SE trends to NE-SW trends of fault axes are evident in six highs and seven lows in Figure: 2. Two other trends of magnetic high responses are also running in the same direction. Seven magnetic highs and eleven magnetic lows remarked in Figure 2.

Vertical and Total (Analytical) Gradients

Vertical derivatives (Gunn *et al*., 1996) on the other hand, are based on the concept that the rate of change of magnetic field is much more sensitive to, therefore such maps constitutes a useful technique for demarcation of geological boundaries, details of which are obscured in the original map. Figure: 4 is a plot of the vertical derivative of the total magnetic intensity (with a contour interval of 0.1nT/m) of the study region. This map is dominated by essentially NW-SE and NE-SE striking anomalies. Most of the high-frequency anomalies have seen in the vertical derivative map.

The analytical signal (Nabighian, 1972, 1974, 1984; Craig, 1996) (Figure: 5 contour interval 0.1 nT/m) gives finer resolutions of magnetic anomaly trends and locations and disposition of causatives (Ramadass *et al*., 1992) the anomaly square root of the (Nabighian, 1972, 1984) sum of squares of the horizontal (X and Y) and vertical derivatives (Z) along the orthogonal axes of the anomaly resolves the anomaly maps. It encompasses information of the magnetic field variation along the orthogonal axes completely defining it. Consequently, structural features and boundaries of causative sources can be determined more accurately. From the analytical signal map of the magnetic in the signal shaded anomaly map of study area is represented in Figure: 5 of the study region is reflecting similar trends observed in total magnetic intensity map, which suggests that the magnetic basement occurs at shallow depth.

Tilt Derivative

The tilt derivative was applied to magnetic data, the result of the tilt derivative of magnetic data shown in Figure: 6 with a contour interval 0.1 nT/m and exhibiting narrow over merging for minimum and maximum values of the tilt, therefore the edges of the magnetic anomalies are better resolved over magnetic lineaments that is fractures intrusive, trends are resolved. The magnetic lineaments reveal a wealth of structural details of Osmania University Campus area Figure: 5, oriented in NW-SE direction and NE-SW direction, N-S direction (G. Ramadass *et al*., 1997). Many of the lineaments were observed in the central part of the study region form a rhombic factor. The lineaments in the study area are three types (E-W, NE-SE and NNE-SSW) and observed first one consists of dominant northeastern part low with an associated with south high. Type two shows a dominant northerly high with which sub dews low. Third type is essentially a southward increasing gradient associated with low values.

Coefficient of Variation

Coefficient of Variation can be computed by the relation

$$C.V = \frac{\sigma}{\overline{X}} X\ 100\% \qquad (2)$$

Where $\overline{X}$ stands for mean and
σ is the standard deviation.

On a chosen segment (5–points) of the observations of magnetic detail traverses, the coefficient of variation was computed and presented in Figure: 7.

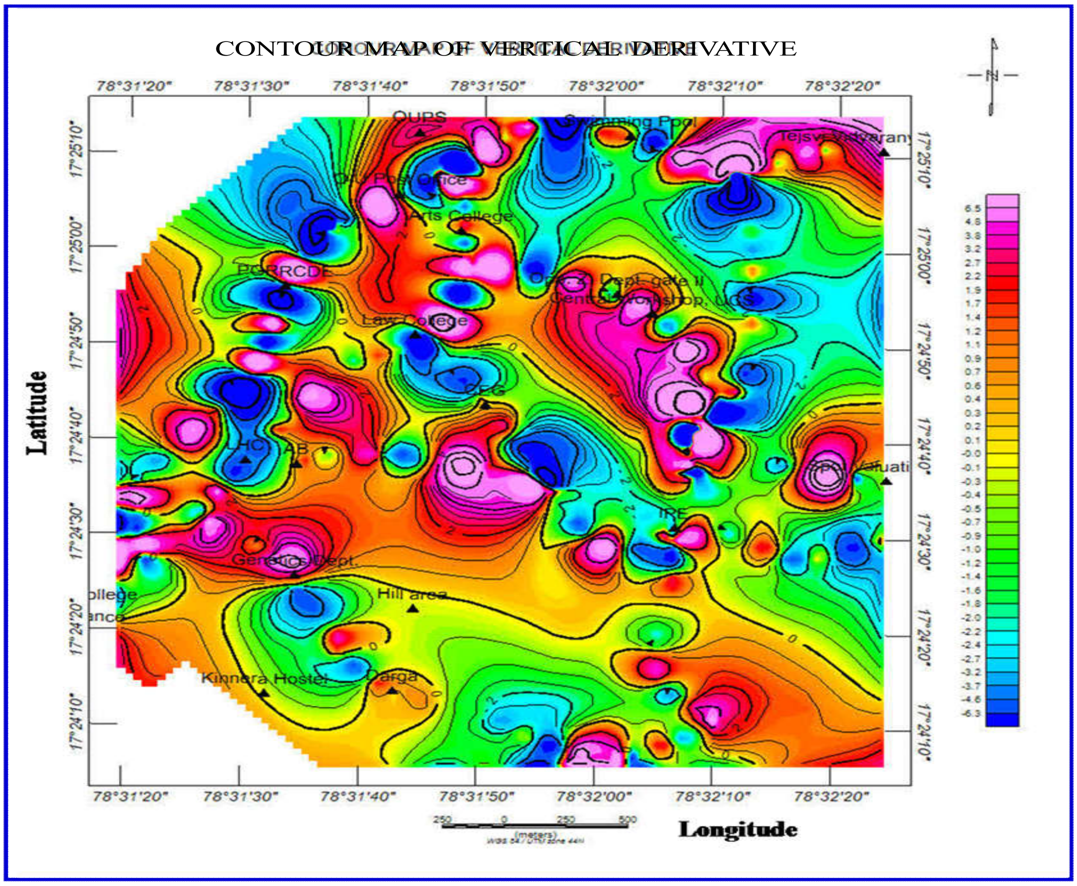


Figure 4. Contour Map of Vertical Derivative (Contour Interval of 0.1 nT/m)

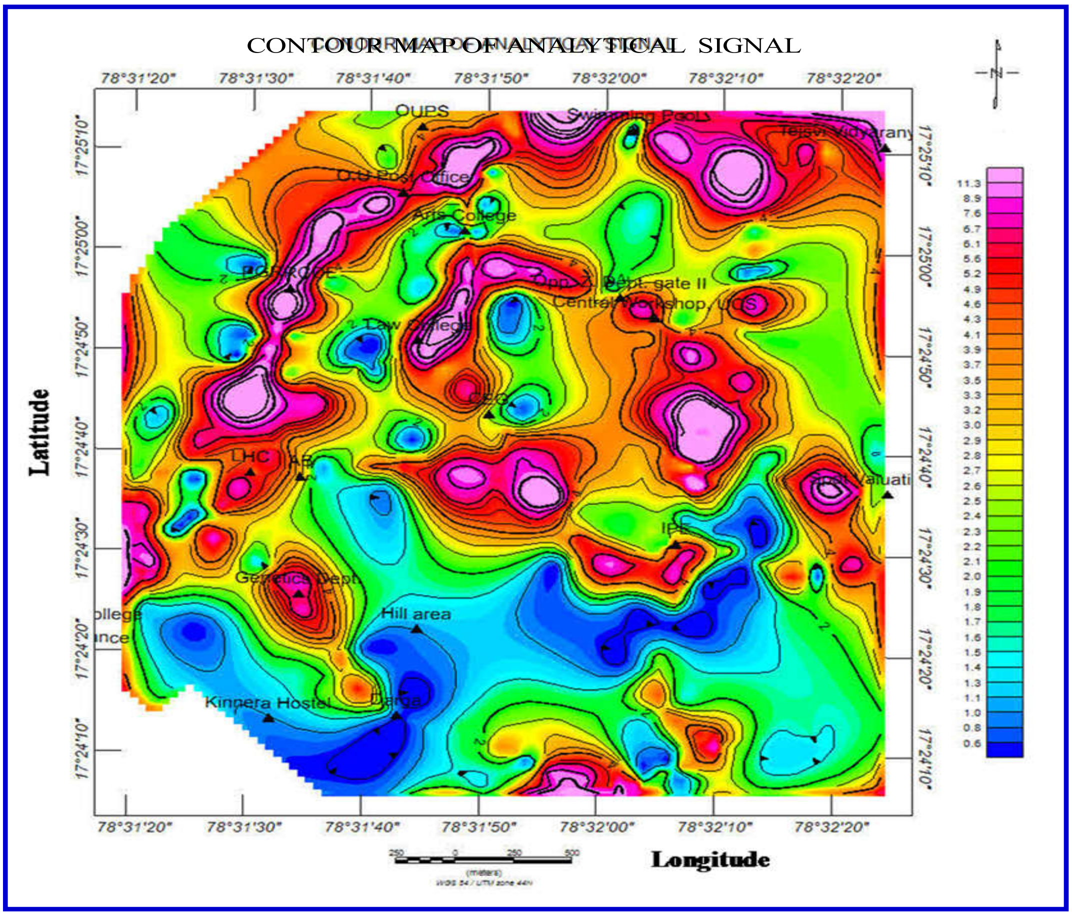


Figure 5. Contour Map of Analytical Signal (Contour Interval of 0.1 nT/m)

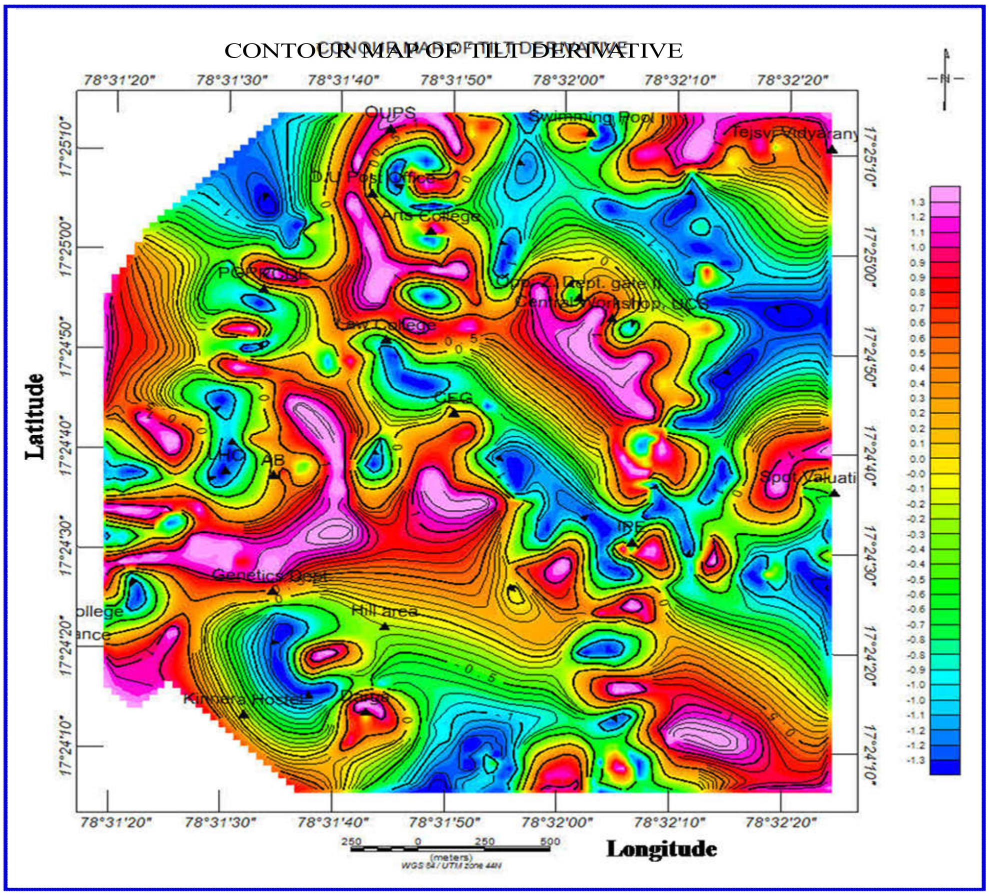


Figure 6. Contour Map of Tilt Derivative (Contour Interval of 0.1 nT/m)

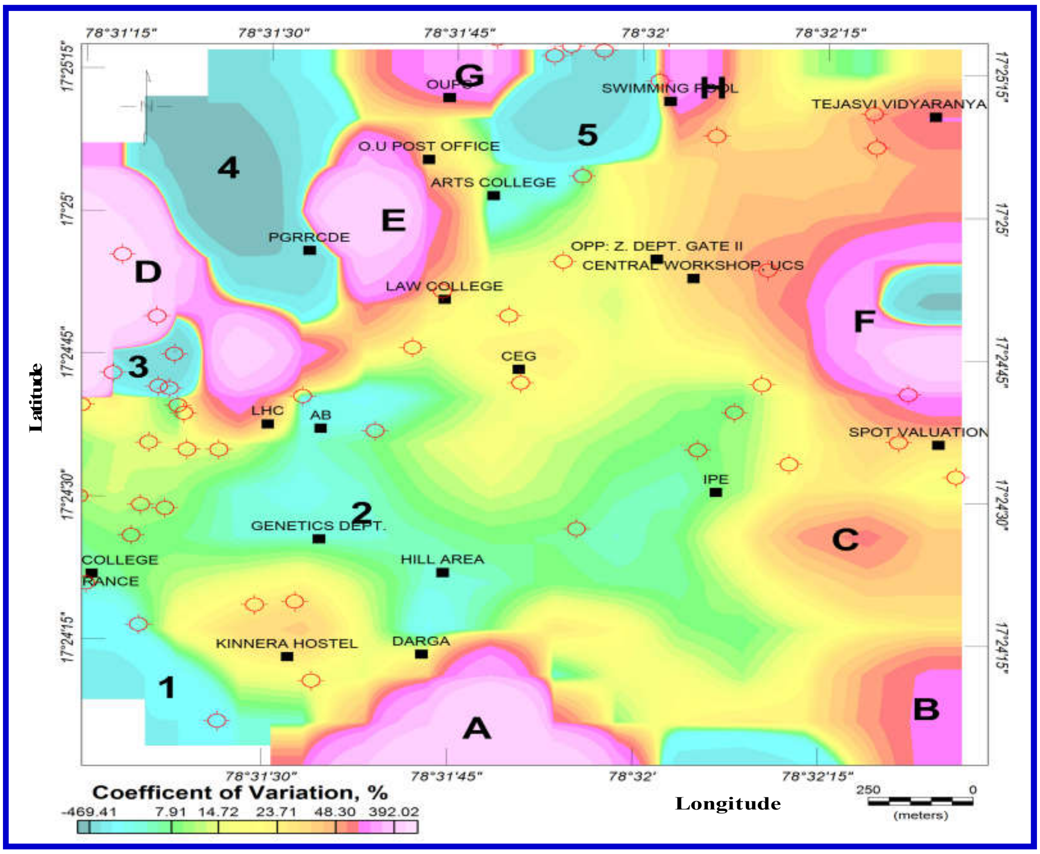


Figure 7. Contour Map of Coefficient of Variation Non Permeable Zones (A, B, C, D, E, F, G and H) Permeable Zones (1, 2, 3, 4 and 5)

Table 1. C.V of Magnetic along the traverses

S.No.	Magnetic Traverse	Identified zones	Zone width (m)	Remarks
1	AA[1]	1	525 -820	
2		2	900 – 960	
3		3	1025 – 1330	Tectonic disturbed zone
4	BB[1]	1	405 – 610	Tectonic disturbed zone
5		2	990 – 1100	Tectonic disturbed zone
6		3	1215 – 1300	
7	CC[1]	1	0- 105 m	
8		2	185 – 300	
9		3	400 -545	
10		4	545 – 680	
11		5	680 -880	
12		6	880 – 970	
13		7	1550 – 1640	
14		2	1770 – 1970	
15	DD[1]	---	---	---
16	EE[1]	---	---	---
17	FF[1]& MM[1]	1	820 – 1025	Fault
18	GG[1]	---	---	---
19	HH[1]	---	---	---
20	II[1]	1	0 -85	
21		2	170 -300	Tectonic disturbed zone
22	JJ[1]	---	---	---
23	KK[1]	---	---	---
24	LL[1]	---	---	---
25	MM[1] (Extra Part)	1	0 – 40	Tectonic disturbed zone
26		2	80 – 250	Tectonic disturbed zone
27		3	460 – 585	
28	NN[1]	1	200 - 350	
29		2	480 – 645	Dyke
30		3	645 -790	Tectonic disturbed zone
31		4	890 – 1000	Tectonic disturbed zone
32		5	1175 – 1300	
33		6	1300 – 1500	
34		1	0-50	
35		2	135 – 270	Tectonic disturbed zone
36		---	---	---
37		1	0 – 120	
38		2	120 – 250	Tectonic disturbed zone
39		3	335 – 475	Tectonic disturbed zone
40		4	675 – 820	Lineament
41		5	820 – 930	
42		1	25 – 70	Tectonic disturbed zone
43		2	230 – 430	
44		3	520 -630	Dyke
45		4	780 – 950	Tectonic disturbed zone
46		---	---	---

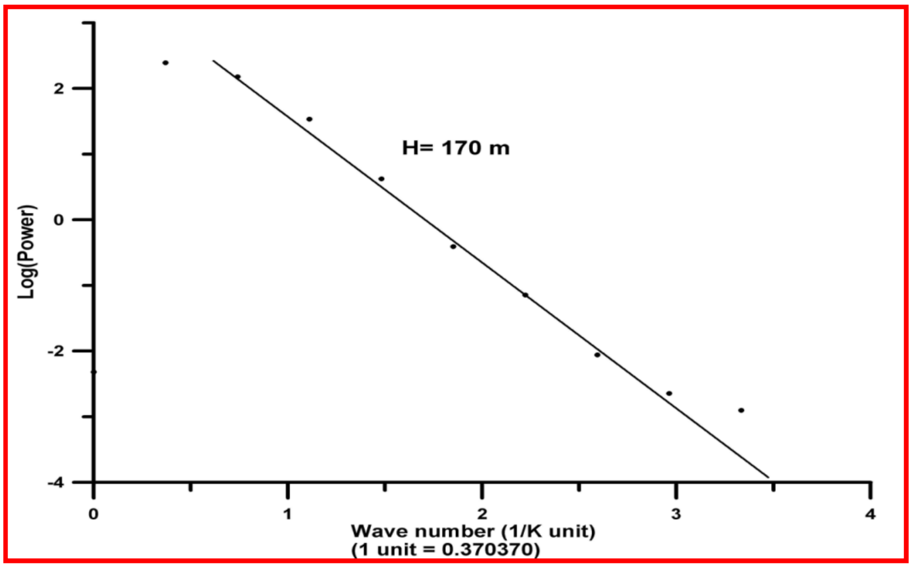


Figure 8. Radially Averaged Power Spectrum

This coefficient of variation is useful in picking up the geological contacts and the tectonically disturbed zones along the traverses are shown in Table: 1. The contour map of a coefficient of variation is shown in Figure: 7, from this figure eight non-permeable (A, B, C, D, E, F, G and H) zones and five permeable (1, 2, 3, 4 and 5) magnetic zones are traced. It may be noted that since the susceptibility depends only on the presence, distribution and nature of ferromagnetic minerals, important hydrogeological properties of rock such as porosity, hydraulic conductivity etc., do not show and direct relationship with magnetic susceptibility.

Hence, application of magnetic methods of geophysical prospecting is confined to the delineation of structure and lithology. The magnetic surveys at station interval of 10m find the response of fracture zone, and also shown on the topography of granitic basement in the O.U campus area.

However, in the study region magnetic values decrease considerably in the A, C, D, E, F and G reaching a value of 0 - 200 nT over the permeable zones/fracture zones which are good yielding compare to 400 -800 nT (Figure: 7) in the zones 2, 4 and 5 zones which are not permeable zones.

Table 2. A zero Index

Geologic Model	Number of Infinite Dimensions	Magnetic SI	Gravity SI
Sphere	0	3	2
Pipe	1 (z)	2	1
Horizontal Cylinder	1 (x-y)	2	1
Dyke	2 (z and x-y)	1	0
Sill	2 (x and y)	1	0
Contact	3 (x, y and z)	0	NA

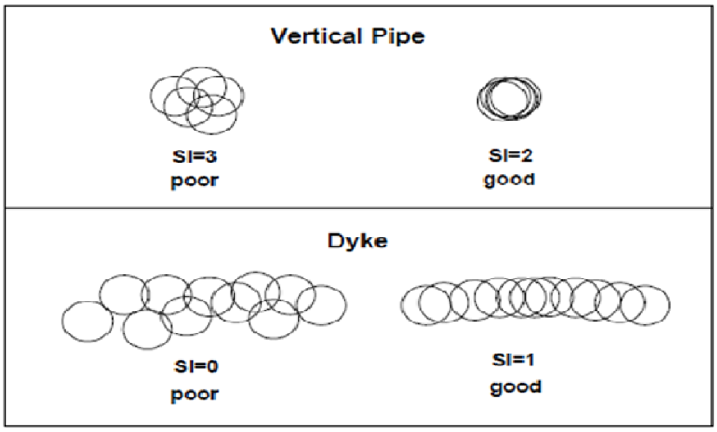


Figure 9. The Euler Solution on the Right Represent the Correct SI for a Magnetic pipe-like Body (top) and a Dyke (bottom) (after Reid et al., 1990)

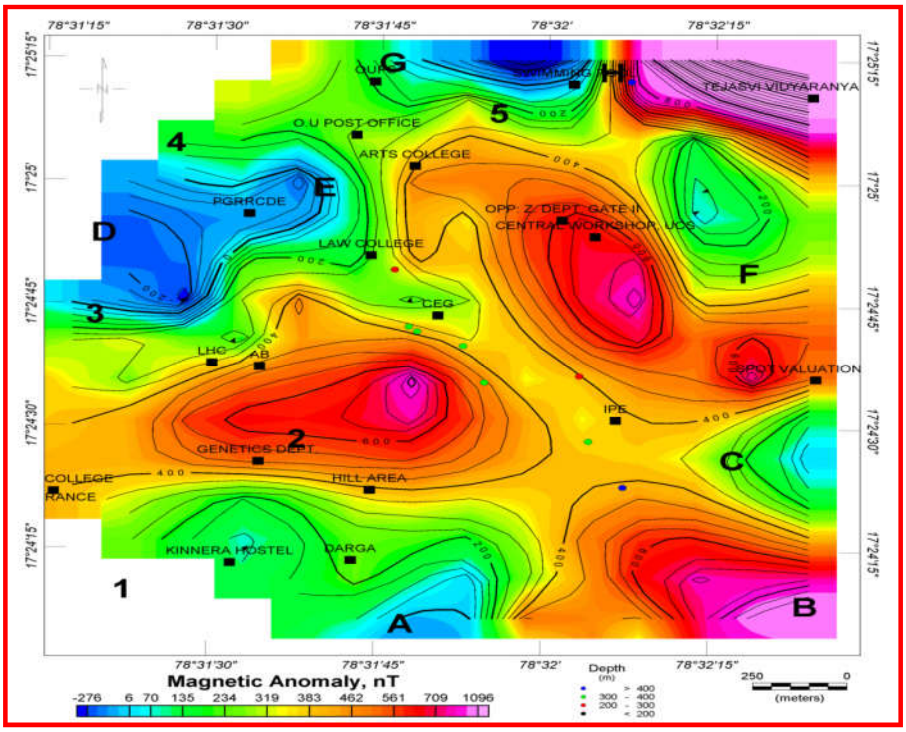


Figure 10. Contour Map of Magnetic Anomaly (Euler Solution) (Contour Interval 65nT)

On drilling (Borehole data), the results of interpretation was proved to be correct, and accordingly a thick fractured zone was estimated at a depth of 5m which graded in the fresh ground about 25m (permeable zones).

Quantitative Analysis

Though there are many ways to attempt quantitative estimates of depth to an intracrustal magnetic interface. Therefore, in the present studies Power Spectrum method and Euler deconvolution methods were performed on eleven traverses (AA^1, BB^1, CC^1, FF^1 & MM^1, II^1, MM^1, NN^1, OO^1, QQ^1 and RR^1).

Power Spectrum

Spector and Grant's, 1970 stated that the depth factor invariably dominated the shape of the radially averaged power spectrum of magnetic data. Here, 'radially averaged' means that the powers for equal lengths of the wave vector are averaged. This statement has proved the way for a very convenient interpretation of the power spectrum of potential field data. The radially averaged power spectrum of the field in a 2D observation plane decreases with increasing depth to source t by a factor e^{-2tr}, r being the wave number. Hence, if the depth factor dominates the shape of the power spectrum, the logarithm of the power spectrum should be proportional to -2tr and the depth to source can be derived directly from the slope of the log radially averaged power spectrum.

Spector and Grant's, 1970 understanding of the power spectrum has another widespread application. If the slope of the log power spectrum indicates the depth to the source, then a section with constant slope defines a spectral band of potential field originating from sources of equal depth. Hence, it appears to be possible to separate the contribution of these particular sources from the rest of the field by band-pass filtering (Spector and Grant, 1970, Jacobsen 1987, Cowan and Cowan 1993, Pawlowski, 1994, 199). Since the low wave number (long-wavelength) portion of the power spectrum is usually rather steep, this implies that the long-wavelength anomalies necessarily originate from deep-seated sources.

In the current study, Fast Fourier Transform (FFT) filter is used to calculate the depth. The data is transformed from the space domain to the wave number domain using an FFT. The wave number increment of the resulting transform will be 1/ (line-length) (Figure: 8). In the study area, only one segment corresponding to a depth of 170m in the lower wave number, which represents subsurface magnetic interface.

Euler Deconvolution

Thompson, 1982 proposed a technique for analyzing magnetic profiles based on Euler's relation for homogeneous functions. The Euler deconvolution technique uses first-order x, y and z derivative to determine location and depth for various idealized targets (sphere, cylinder, thin dyke, pipe and contact), each characterized by a specific structural index. Reid *et al*., 1990 extended the technique to 3D data by applying the Euler operator to windows of gridded data sets. Mushayandebvu *et al*., 2000 and Silva and Barbosa, 2003; among others, helped in understanding the applicability of the technique.

Hansen and Suciu, 2002; extended the single-source Euler Deconvolution technique to multiple sources to better account for the overlapping effects of nearby anomalies. Keating and Pilkington (2000) and Salem and Ravat (2003) proposed applying Euler Deconvolution to the amplitude of the analytic signal, while Zhang *et al*., (2000[l]) showed how the technique could be applied to tensor data.

Phillips (2002) proposed a two-step methodology for 3D magnetic source locations and structural indices using extended Euler or analytic signal methods. Finally, Mushayandebvu *et al*., (2004[l]) showed that eight values generated in the grid Euler solution could be exploited to decide automatically whether an individual anomaly was 2D or 3D and in the former case, could be exploited to deduce strike and dip.

The Euler Deconvolution system (Figure: 9) is based on Euler's homogeneity relationship, which does not assume any particular geologic model. Therefore, Euler deconvolution can be applied in a wider variety of geologic situation than conventional model-dependent techniques. The homogeneity of N (-n in the Euler's equation) may be interpreted as a structural index – a measure of the rate of change with distance of the field.

A '0' (zero) index implies that the field is a constant regardless of distance from the source model. In case of a gravity contact, the field would be infinite. These situations are physically impossible for real data and a zero index represents a physical limit, which can only be approached as the infinite dimensions of the real source increase. In practice, an index of 0.5 can often be used to obtain reasonable results when the index of 0 would otherwise be indicated (Table: 2).

For TMI (Total Magnetic Intensity) map are generated for the study area are one at southeastern part located depth is < 200m, one locating at opposite of law college (red colour) 200-300m, five located in the central part (green colour) 300-400m and one at east of swimming pool (blue colour) is greater than 400m (Figure: 10).

Analysis along the traverses

Traverse AA^1 shown in Figure: 11(a), is running in the N-S direction about 2000m long towards west of the study area and it traverse from UFRO - under the Adikmet flyover – PGRRCDE – EFLU – B.Ed College to Tarnaka Junction.

Series of highs and lows were observed at response 620, 500, -800, 600 and 400nT with corresponding distances 0-180, 180-620, 620-800, 800-970, and 1180-1300 respectively. Coefficient of Variation is on the magnetic traverse three zones (1, 2 and 3) were identified.

Traverse BB^1 shown in Figure: 11(b)**,** running 2200m and trending in N-S direction , lies towards west of the study area and it traverse from O.U Main Entrance - Engineering College - Ladies Hostel - Law College - Arts College to O.U Police Station.

Figure: 11(b), magnetic highs in the region 400-600, 1000-1100 and 1200-1300m, magnetic response 900, 250 and 100nT respectively from opposite to UFRO to 'B' Hostel junction road, from the geology map the highs can be inferred to correspond to a basic intrusion.

The response of coefficient of variation a series of highs and lows three zones (1, 2 and 3) were identified (Table: 1), which are low to moderate susceptibility can be attributed to the fracture granite are found in fair quantities, whereas 400 to 600m data.

Traverse CC[1] shown in Figure: 11(c) is situated east of the O.U Campus, about 2140m long and it runs from a point towards IPE, in N-S direction nearby Darga which is behind the Genetics Dept. – IPE - behind the residences of Maneru Hostel to Professors Quarters.

The magnetic response in traverse CC[1] is 800, 300 and 750nT and also 990, 500, 320 and 200nT. Correspond coefficient of variation six zones (1, 2, 3, 4, 5 and 6) are traced, shown in Table: 1.

Traverse FF[1] & MM[1] shown in Figure: 11(d), has the path in E-W directions and it starts from Ganga Hostel - Genetics and Microbiology Departments to Darga - inside the Forest to a road up to a N-S direction with total length of 1180m and lies towards south of the study area.

Here magnetic highs at starting 0-250m and 1000- end of the traverse were 600nT to 700nT. In between these two magnetic high minor responses are recorded. Figure: 11(d) coefficient of variation is a significant variation at 800-1000m is marked, whereas two other 200-250m, 450-500m were noticed and three zones were identified.

These two lows responses are not very clear as the geology indicated. The highly disturbed zone were traced 800-1000m varying to 200m width might be fault zones, and also an indication of groundwater potential zones.

Traverse II[1] shown in Figure: 11(e), runs from opposite to Law College (Adjacent to Landscape Garden)-'D' Hostel-Geophysics Department to a junction road towards O.U Press, in E-W trending with a total length of 620m and lies middle of the study area.

Figure: 11(e) only one 500nT was observed at 480m varying with width is 200m variation. From the coefficient of variation map, only two disturbed magnetic zones were noticed at 0-85m and 170-300m. 0-85m width (Table: 1) is the turning point of the road that is situated N-W part corner of the landscape garden, this may be attributed to the highly fractured zone whereas 200-330m very shallow conductive zone were observed.

Traverse MM[1] (Extra part) presented in Figure: 11(f) is a total length of 620m, starts from N-S direction, the magnetic response is very low at start 250m a step model response is observed, on coefficient of variation there are three zones were identified.

Traverse NN[1] shown in Figure: 11(g), this 1560m and trending in an E-W direction lays towards below middle part of the study area and it traverse from Renuka Yellamma Temple - Administrative building - College of Technology – IPE to Dead End of the Residences Area.

Figure: 11(g), magnetic highs in the region 350-450, 500 and 750-850 and 1050m, magnetic response1000, 750, 520, and 490nT respectively from Yellamma temple to IPE, from the geology map the highs can be inferred to correspond to a basic intrusion.

The response of coefficient of variation a series of highs and lows six zones were identified (Table: 1), which are low to moderate susceptibility can be attributed to the fractured granite are found in fair quantities, whereas 480 to 645m data in dyke.

Traverse OO[1] shown in Figure: 11(h) starts from O.U Darga (Near Maneru Hostel) to Spot Valuation Building running a total length of 440m to the east of study area.

Figure: 11(h) shows broad two high magnetic pairs observed in between 250 - 350m, the magnetic response 600 and 1100nT respectively. This might be interpreted as thick dyke; however the response on the coefficient of variation is not much. As per groundwater concerned the contact between either sides is a very good aquifer zone are traced.

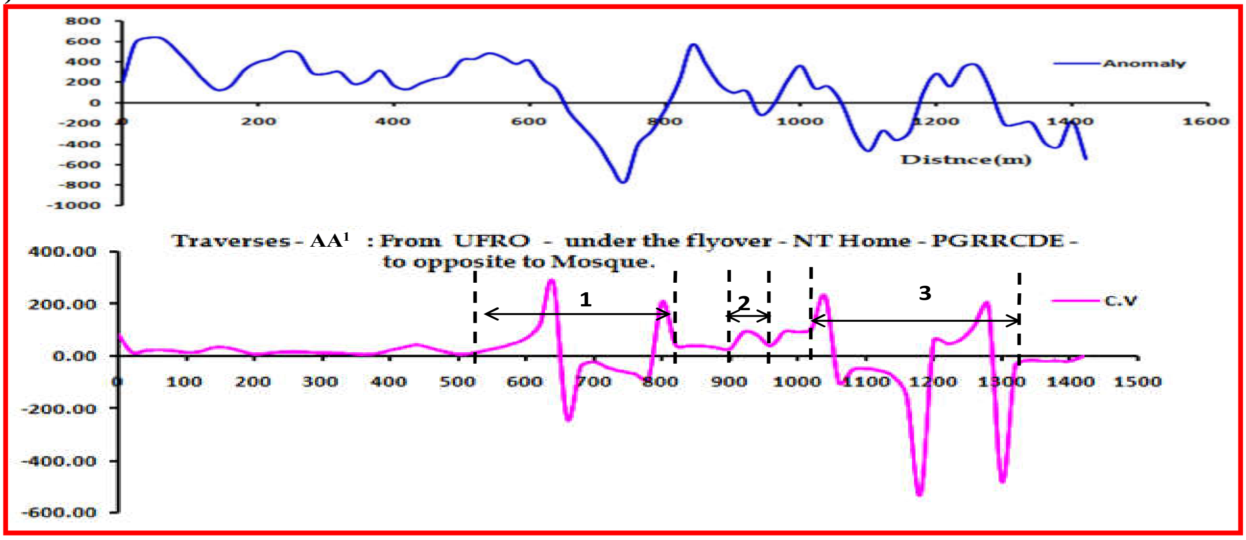
Traverse QQ[1] shown in Figure: 11(i) indicates the path in E-W direction all along the 980m length to above middle of the study area and it starts from a junction road after Central Workshop, UCS - Botany and Zoology Departments towards to Arts College road.

There are four magnetic highs at distances 0-180m, 180-400m, 400-580m and 800-980m, the magnetic response1400, 1000, 825, and 780nT respectively. Similarly the trends high and lows were also seen on the coefficient of variation. Along this traverse five broad zones were identified distances 0-120m, 120-250m, 335-475m, 675-820m and 820-930m correlating interestingly opposite to the Botany Department i.e., east side of the glass room, there was a big fracture has been traced at distance. Remaining zones were tallying the lineaments and tectonic disturbances.

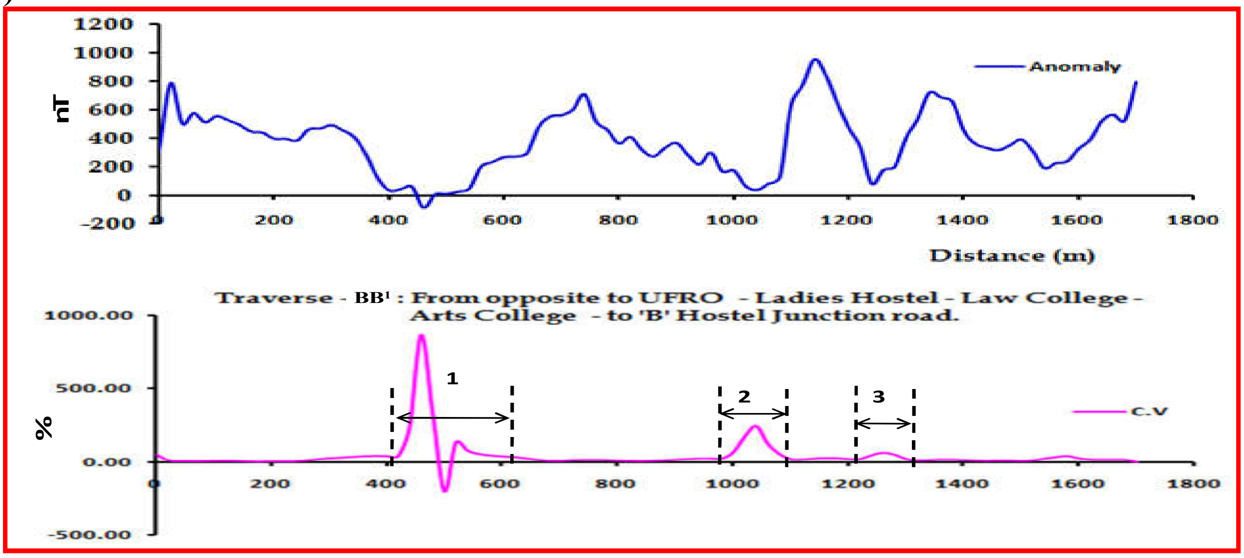
Traverse RR[1] shown in Figure: 11(j) is E-W with a trending, 1400m long traverse lies to the north part of the study area and it starts from opposite to Directorate Admissions - Post Office - 'B' Hostel - Swimming Pool to Professors Quarters.

Figure: 11(j) total magnetic intensity field is a sequence of alternating highs and lows the first arranging this is high at 150m, four tectonic zones were delineated, the zone (1) 25-70m, (2) 30-430m, (3) 520-630m and 780-950m, the magnetic response is 750, 525, 800nT respectively along conductive zones were traced. (1), (2), (3) and (4) coefficient variation zones also traced at the distances at the same distances coincide with the tectonically disturbed zones, whereas at 950m that is opposite to NRS hostel, a fault traced.

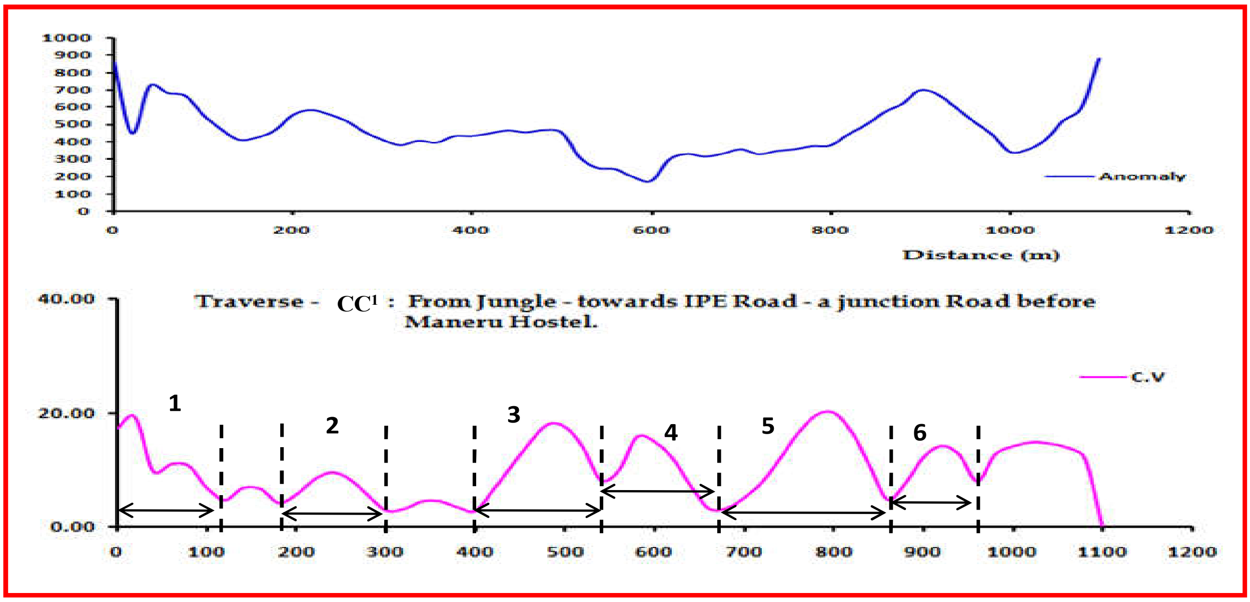
(a)


Anomaly
Distnce(m)
Traverses - AA[1] : From UFRO - under the flyover - NT Home - PGRRCDE - to opposite to Mosque.
C.V
1
2
3

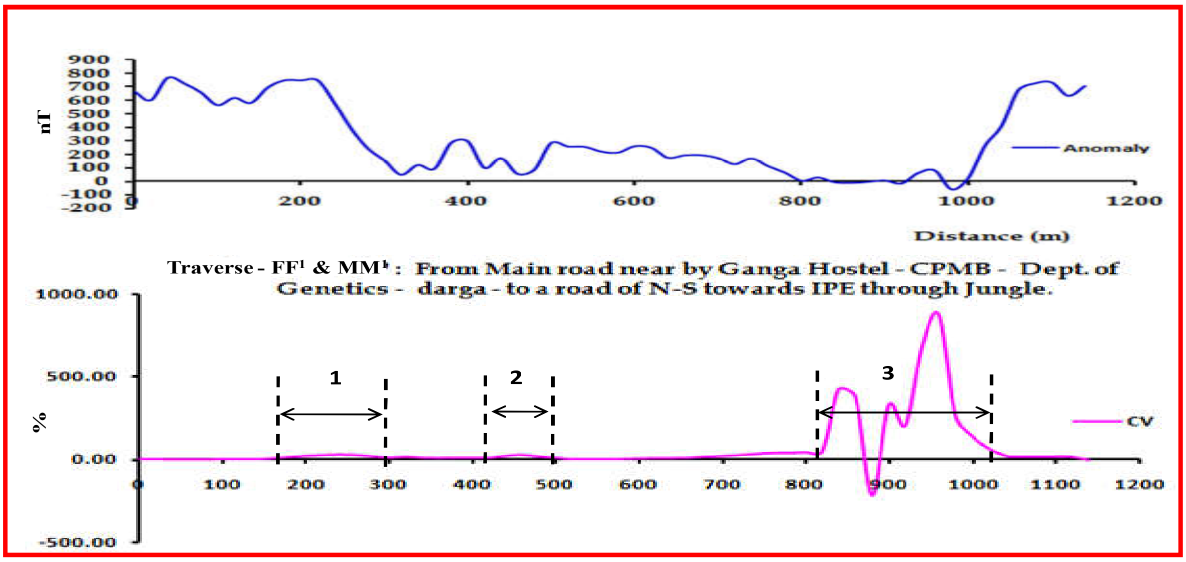
(b)


nT
Anomaly
Distance (m)
Traverse - BB[1] : From opposite to UFRO - Ladies Hostel - Law College - Arts College - to 'B' Hostel Junction road.
%
C.V
1
2
3

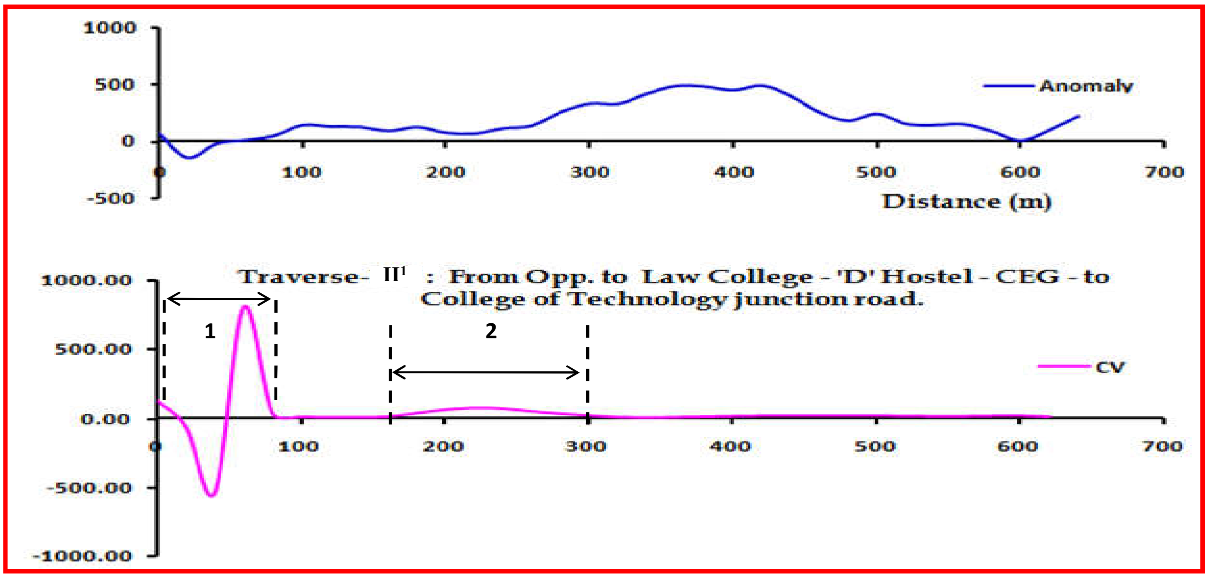
(c)


Anomaly
Distance (m)
Traverse - CC[1] : From Jungle - towards IPE Road - a junction Road before Maneru Hostel.
C.V
1
2
3
4
5
6

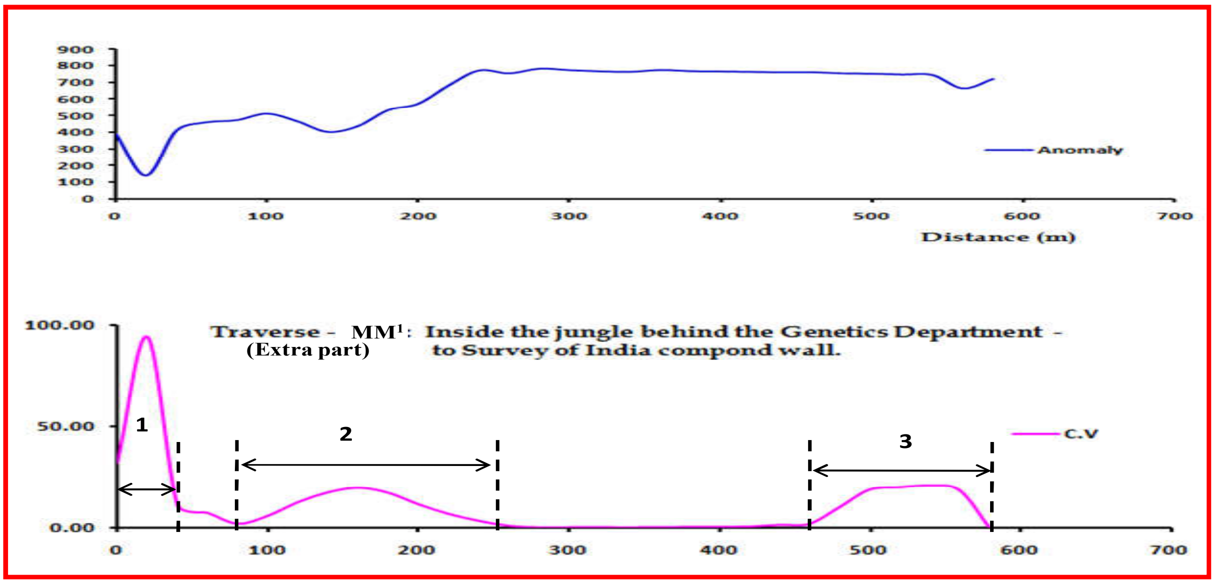
(d)


nT
Anomaly
Distance (m)
Traverse - FF[1] & MM[1] : From Main road near by Ganga Hostel - CPMB - Dept. of Genetics - darga - to a road of N-S towards IPE through Jungle.
%
1
2
3
CV

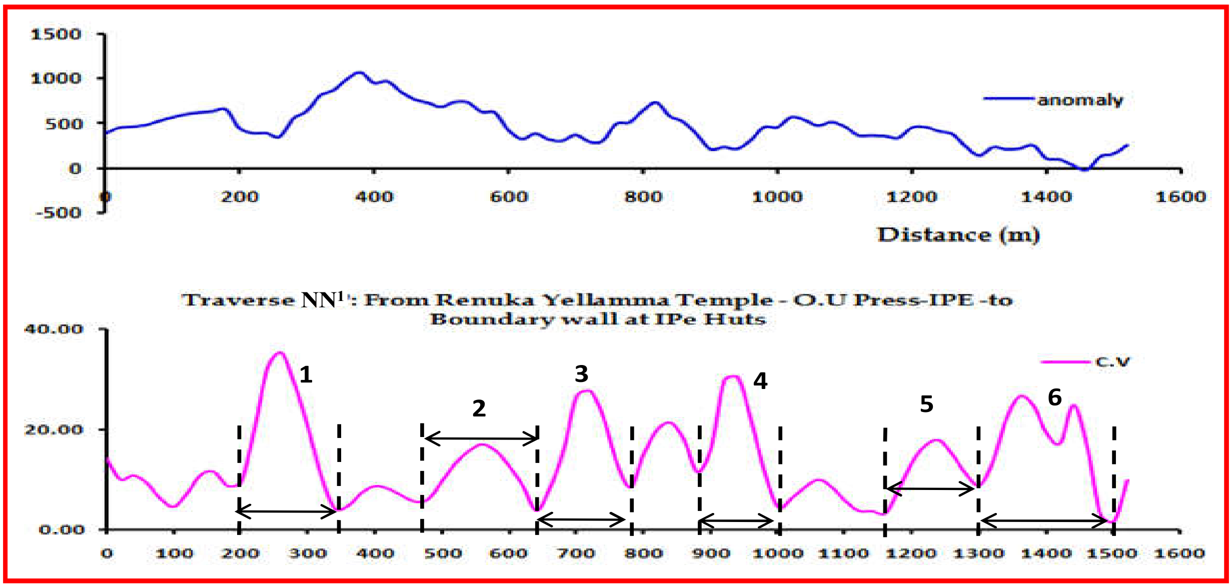
(e)


Anomaly
Distance (m)
Traverse- II[1] : From Opp. to Law College - 'D' Hostel - CEG - to College of Technology junction road.
1
2
CV

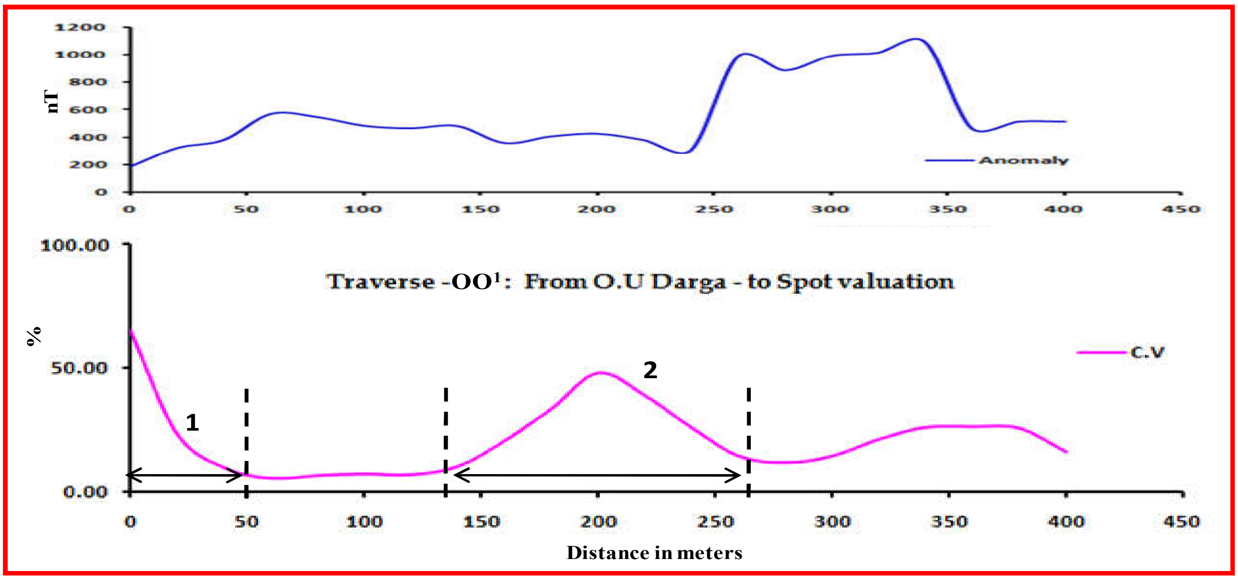
(f)


Anomaly
Distance (m)
Traverse - MM[1]: Inside the jungle behind the Genetics Department - to Survey of India compond wall.
(Extra part)
1
2
3
C.V

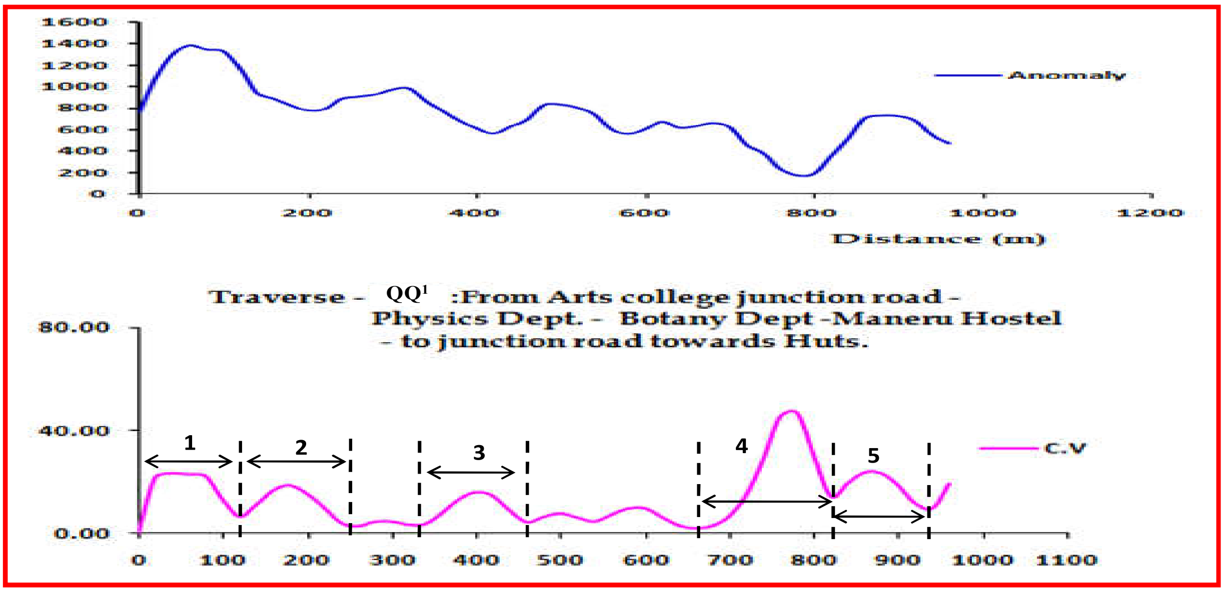
(g)


anomaly
Distance (m)
Traverse NN[1]: From Renuka Yellamma Temple - O.U Press-IPE -to Boundary wall at IPe Huts
C.V
1
2
3
4
5
6

(h)


nT
Anomaly
Traverse -OO[1]: From O.U Darga - to Spot valuation
%
C.V
1
2
Distance in meters

(i)


Anomaly
Distance (m)
Traverse - QQ[1] :From Arts college junction road - Physics Dept. - Botany Dept -Maneru Hostel - to junction road towards Huts.
C.V
1
2
3
4
5

(j)

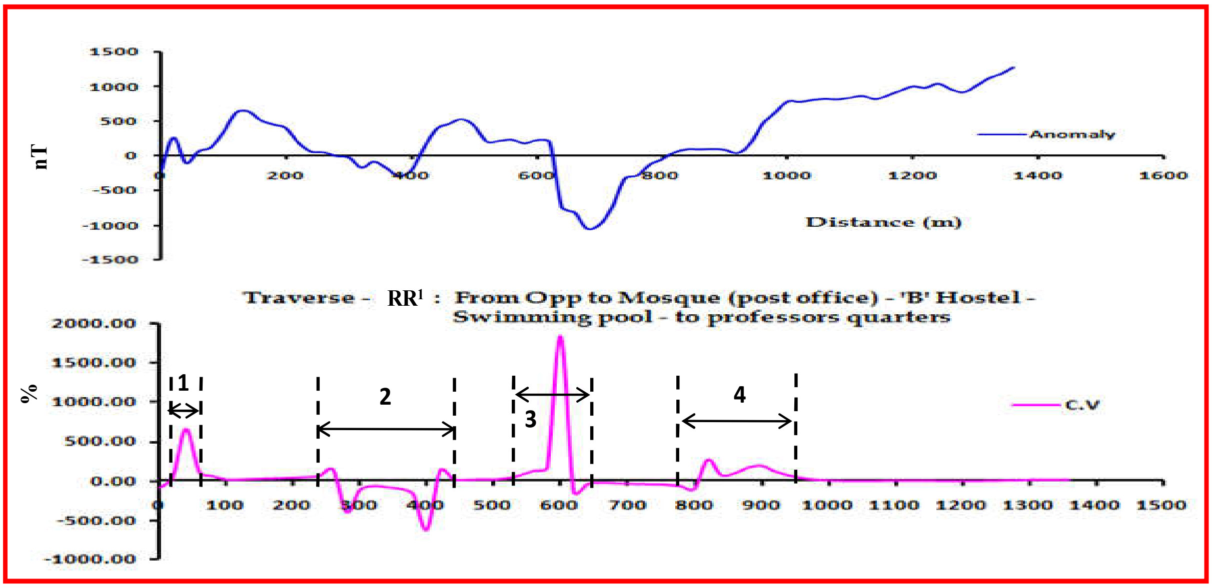


Figure: 11 Anomalies and Coefficient of Variation of Magnetic Traverses (a) AA[1], (b) BB[1], (c) CC[1], (d) FF[1] & MM[1], (e) II[1], (f) MM[1] (extra part), (g) NN[1], (h) OO[1], (i) QQ[1]and (j) RR[1]

DISCUSSION

A qualitative analysis of vertical magnetic data like analytical signal, derivative analysis (vertical and horizontal direction) has been performed to anticipate the subsurface structures and rock assemblages, where groundwater aquifer zones could be possible. Several magnetic linear features (magnetic highs and lows) suggesting the presence of various geological lineaments. These lineaments are trending N-S, NW-SE and NE-SW, E-W trends fall over the granitic terrain.

From coefficient of variation contour map (Figure: 7) eight (A, B, C, D, E, F, G and H) non-permeable zones and five (1, 2, 3, 4 and 5) permeable zones were identified, which is showing as the groundwater occurence and aquifer characteristics are magnetic response. Quantitative analysis of total magnetic intensity through Radially averaged Power Spectrum and Euler Deconvolution solution are obtained 170m and 200-400m for magnetic interface in the study area and permeable and non-permeable zones.

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