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GROUND MAGNETIC STUDIES FOR IRON ORE EXPLORATION IN NORTHERN PART OF THE MAYURBHANJ DISTRICT, ODISHA, INDIA.

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Abstract: The magnetic method is based on the measurement of earth's induced magnetic field and through the detection of magnetic anomalies that are generally caused by subsurface susceptibility contrasts. Generally the magnetic susceptibility varies significantly between different rock types. Sedimentary rocks have the lowest average susceptibility and the basic igneous the largest. The end product of a magnetic survey (land, sea or airborne) is a set of profiles or a contour map of magnetic features of subsurface targets and structures. Modeling of magnetic anomalies is similar in procedure to that in gravity as both these techniques utilize natural potential fields.

Keywords: Geophysics, Total Magnetic Intensity, Reduction to Pole, exploration, ground magnetic survey, GSM-19 WALKMAG magnetometers.

I.INTRODUCTION

The mineral exploration is one of the vital activities in the mining industry which helps to uncover the mineral potential so that a country can utilize its full mineral paternal. It helps in minimizing the risk of mining business by generating adequate information of the surface which is going to be mined. Mineral exploration having four essential stages namely, area selection, target generation, resource evaluation.

Exploration geophysics is one of the branches of geophysics which is used to identify the type and volume of mineral present under the earth surface. The exploration geophysics uses the physical method namely, seismic, gravitational, electrical, magnetic and electromagnetic to locate the position and volume of mineral by direct or indirect approach.

The best geophysical procedure for identification of Iron ore body is ground magnetic survey. As the hematite and Magnetite have Ferro-magnetic properties so the finding of probable iron ore reserves becomes easy by adopting the ground magnetic survey. The studied of ground magnetic surveys aids in understanding the behavior and complexity of sub surface thin layer.

The objective of magnetic studies is to understand the sub-surface implications of iron ore bodies like Banded Iron Formation (BIF), Banded Magnetite Quartzite (BMQ) deposits. This ground magnetic survey deals with naturally existed geomagnetic field. This method fallows the non-invasive nature of geophysical technique where it gathered the require information without affecting the surface condition. It is a low impact survey technique which is usage a measuring instrument called magnetometer.

The magnetometer instrument is lighter in weight and it can be transported by simply backpack mechanism. The measurement can be taken at one point or in a grid profile without disturbing the surface. The magnetometers are basically three types namely, fluxgate, proton-precession and Alkali-vapor magnetometer.

In the present research work the field study for identification of probable iron ore was carried out using ground magnetic technique in the field the proton precession magnetometer (WALKMAG) was used.

II.STUDY AREA

The ground magnetic survey was carried out on the mayurbhanj district northern part of Odisha which is situated between 22° 15’ 00'N and 86° 15’ 00’E and 22° 00’ 00”N and 86° 00’ 00”E. The study area having the key horizon of Banded Iron Formation (BIF) and iron ores and the more appropriate technique for the iron ore exploration is the ground magnetic survey. There are some exposures of basement rock belonging to OMG in the eastern and western part of the fault bounded basin, which include amphibolites, tremolite-actinolite schist and granite (Singh hum granite). The basin deposits are structured into series of anticlines and synclines by iron ore orogeny that run parallel in NE-SW in Badampahar and Sulaipat sector but loses symmetry in Gorumahisani sector. In the area under the study Some iron formations (Magnetite dyke) of later appearance owe to the igneous origin and maintain intrusive character with the rocks particularly in the Sulaipat sector.

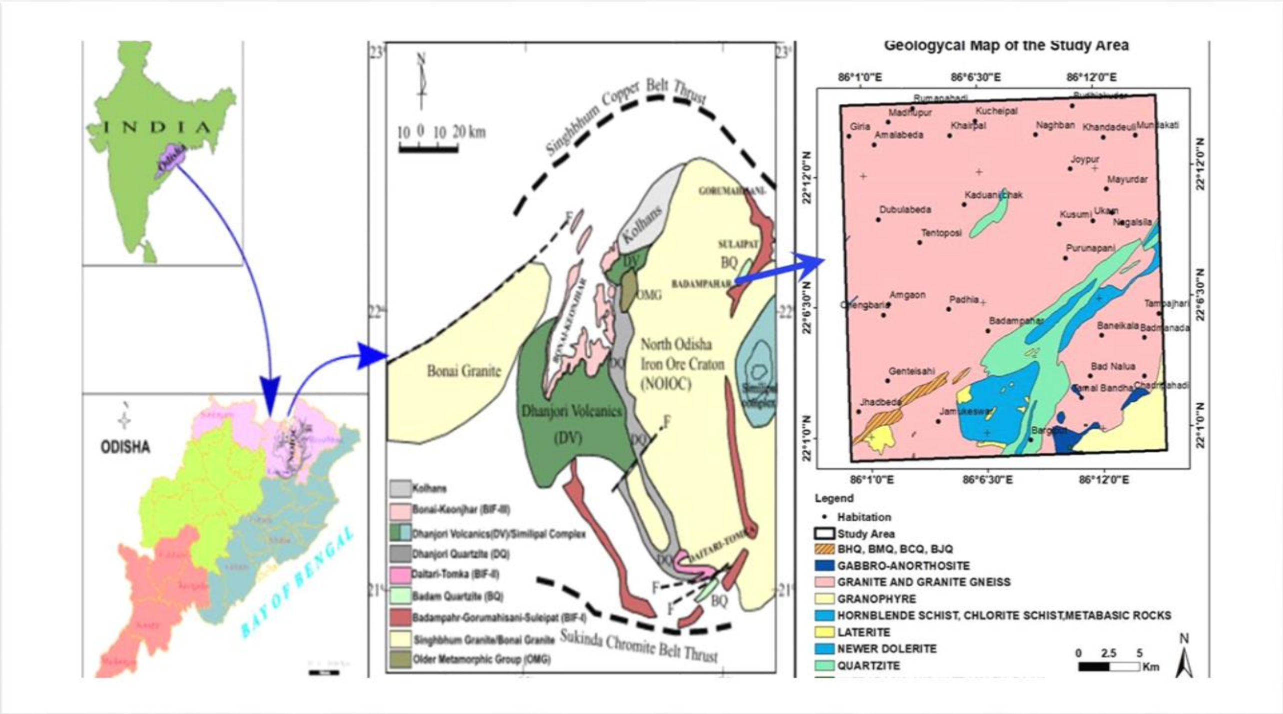

Figure 1: Regional geology of the study area

III.REGIONAL GEOLOGY OF THE STUDY AREA:

The Eastern Indian Carton is a Paleo-Mesoarchaean crustal block, bounded by granulite grade Eastern Ghat Mobile Belt in the south and North Singhbhum– Gangpur segment of Satpura Mobile Belt of greenschist-amphibolite grade in the north (Sarkar,2005). Singhbhum thrust/shear zone and Sukinda thrust/shear zone mark the craton mobile belt interfaces in the north and south respectively.

The cratonic block comprises a central granitic nuclei bordered by discrete greenstone Belts. Stratigraphic correlation between these descrete greenstone belts and their time relation with granitoids has remained a matter of intense debate. Banerji (1977), Murty and Acharya (1975), Iyengar and Murty (1982) and Banerjee (1982) consider the Singhbhum Granite to be the basement of the Iron Ore Group (IOG), while Dunn (1929), Dunn and Dey (1942) and Sarkar and Saha (1977,1983) regard the Singhbhum Granite to be younger. Based on the evidence of granitic provenance for the IOG sediments, the distribution of the IOG basins flanking the Singhbhum Granite on all sides and the curvature of the dominant fold axial traces round the Singhbhum Granite; Mukhopadhyay (1976, 2001), suggested Singhbhum Granite could be forming the basement of the Iron Ore Group (IOG).

Badampahar-Gorumahisani belt is a typical greenstone belt disposed in a NNE-SSW fashion in the northeastern part of the craton. It lies close to the northern fringe of the Similipal Complex and separates the western granite terrain represented by Singhbhum granitoids from Mayurbhanj Granite in east. The rocks form a contiguous, curvilinear hill range and are represented by supracrustals of the Iron Ore Supergroup and surrounded by granitoids of Singhbhum Granite Complex on all sides, part of which acted as the basement. Intermittently they are invaded by a variety of plutono-magmatic associations ranging from Mayurbhanj Granite to Mayurbhanj Gabbro. A large number of basic dykes known as Newer dolerite dykes are also exposed as intrusive into Badampahar Group of rocks as conjugate dyke sets. Sevaral laterite patches are found over granite and gabbro. The ore-bodies/bands are generally controlled by stratigraphy and structure in later stage. These are associated discretely with banded cherty quartzite of supracrustal group of rocks following the NE-SW trend of compositional S0 planes of the host rock.

3.1Regional stratigraphy:

The volcano-sedimentary rocks exposed as a narrow arcuate belt between Gorumahisani and Badampahar was designated as the Badampahar Group by Iyengar and Murthy (1982) and has an isochron age of 3071m.y. The association of iron formation with the volcanic rocks suggests that the BIF is of Algoma type. Various views have been put forward about the relationship between the Singhbhum granite and Badampahar Group. Iyengar and Murthy (1982) believed that the Singhbhum granite was the basement for the trench-like deposition of the Badampahar Group while Sarkar and Saha (1988) believed that the Singhbhum granite is partly intrusive into the Badampahar.

3.2Geology of the area:

The granitoids of Singhbhum Granite Complex (SBG-I) acted as the basement for the Badampahar supracrustal. The overlying NE-SW trending supracrustal sequence is classified asvolcano sedimentary rocks composed mainly of metabasic components with chemogenic precipitate represented by meta-chert and Banded Iron Formation (BIF). The later phase Singhbhum Granite (SBG-II), Mayurbhanj Gabbro and Mayurbhanj Granite are clearly intrusivein to the lithounits of Gorumahisani Group. A large number of NE-SW and NW-SE trending basic dykes known as newer dolerite dykes are seen intrusive into Badampahar Group and exposed in a linear fashion.

IV.GEOPHYSICLA STUDY METHODOLOGY

The best geophysical method for identification of Iron ore deposit is ground magnetic survey as hematite and Magnetite have ferro-magnetic properties. Ground magnetic surveys were carried out with 50m traverse interval and there is no station interval because the instrument which we used is a continuous recorder (sampling rate 0.5sec/reading). In this study, GemSystems GSM-19

WALKMAG magnetometers are used. Magnetometers are highly accurate instruments that measure local magnetic fields to a high degree of precision.

Figure 2: Magnetometer console and men in-action.

Base and rover data are the basic outputs from the location from where the instrument data is acquired. A base station magnetometer was used to record diurnal variations at a constant location with respect to time (readings are taken at a sampling rate of 1min/reading) are used as base reference during the entire period of survey.

The field acquired data is farther subjected to make necessary data reductions and corrections (diurnal/IGRF corrections) for varied locations as well as to obtain local magnetic anomalies. This base station is re-occupied daily throughout the survey. Rover Magnetometer is use to acquire magnetic data by moving along the traverse. This data is varied with location based on local magnetic intensity and is compared against base data and the anomaly is calculated.

4.1 Total Magnetic Intensity

Maps have been prepared after undertaking processes of base /regional corrections of the rover data. This resembles the high and low magnetic intensities of the study area based on the parameters like Latitude, Longitude, Inclination and Declination of the earth. Hence, the magnetic intensities are not truly higher as well as lower in Magnetic Intensity of the particular locations

The observed total magnetic intensities are corrected for International Geomagnetic Reference field and the total magnetic intensity maps so generated after IGRF corrected TMI (Total magnetic Intensity) maps.

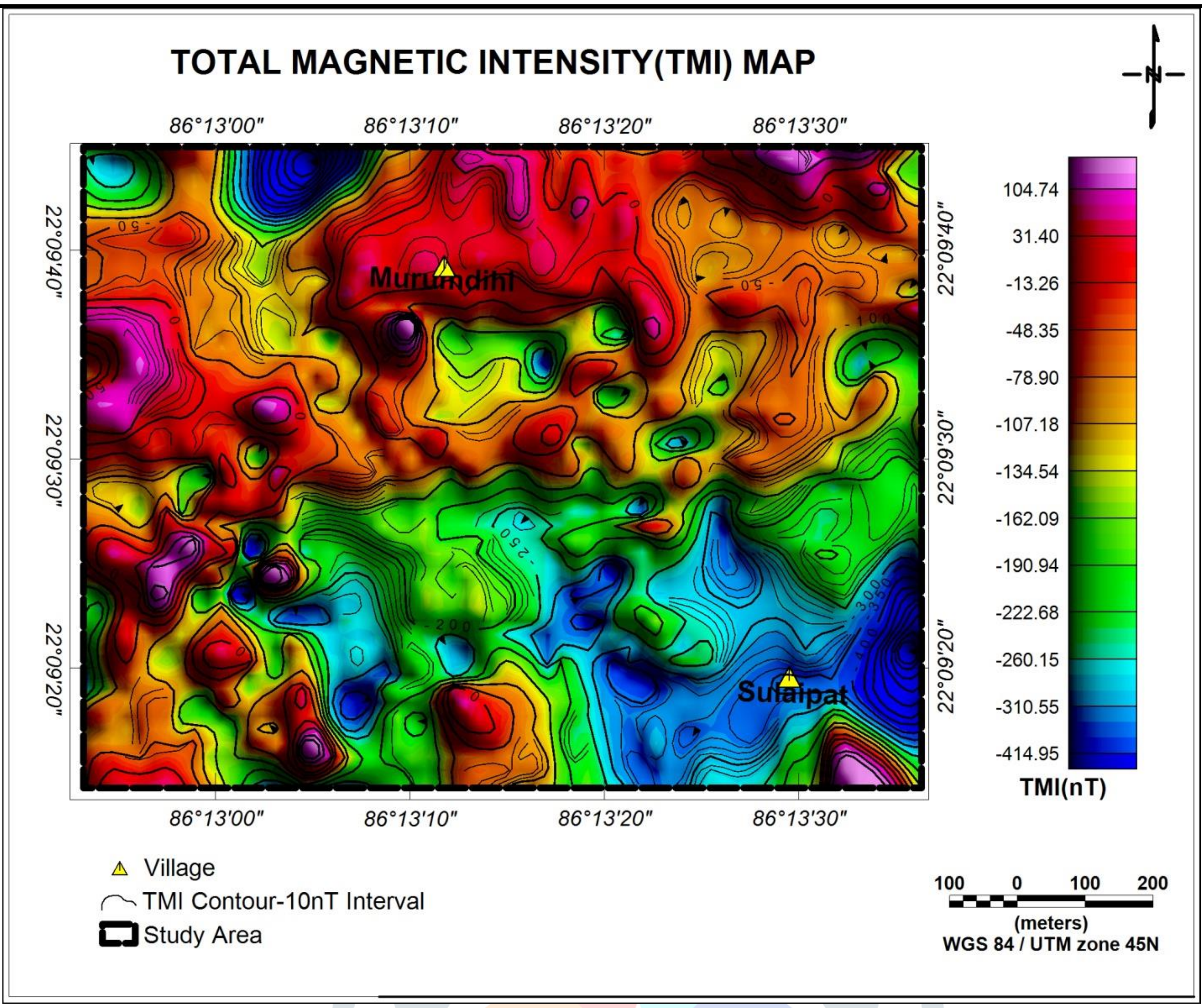

Figure 3: Showing the Total Magnetic Intensity (TMI) map of the Study Area after base and regional corrections

4.2 Reduce to Pole

The Total Magnetic Intensity (TMI) data has been subjected to a kind of mathematical processing called Reduced to Pole (RTP) to avoid ambiguity in analysis of magnetic anomalies. Mathematical algorithm of Reduction to the pole (RTP) transforms an observed TMI anomaly into an anomaly that would be measured at the north magnetic pole. As the study areas are falling near and over 20 degrees latitude. Therefore, it was essential to prepare RTP maps using TMI data as of the magnetite responses for such low latitudes are similar to the anomalous near equator with prominent negative predominance.

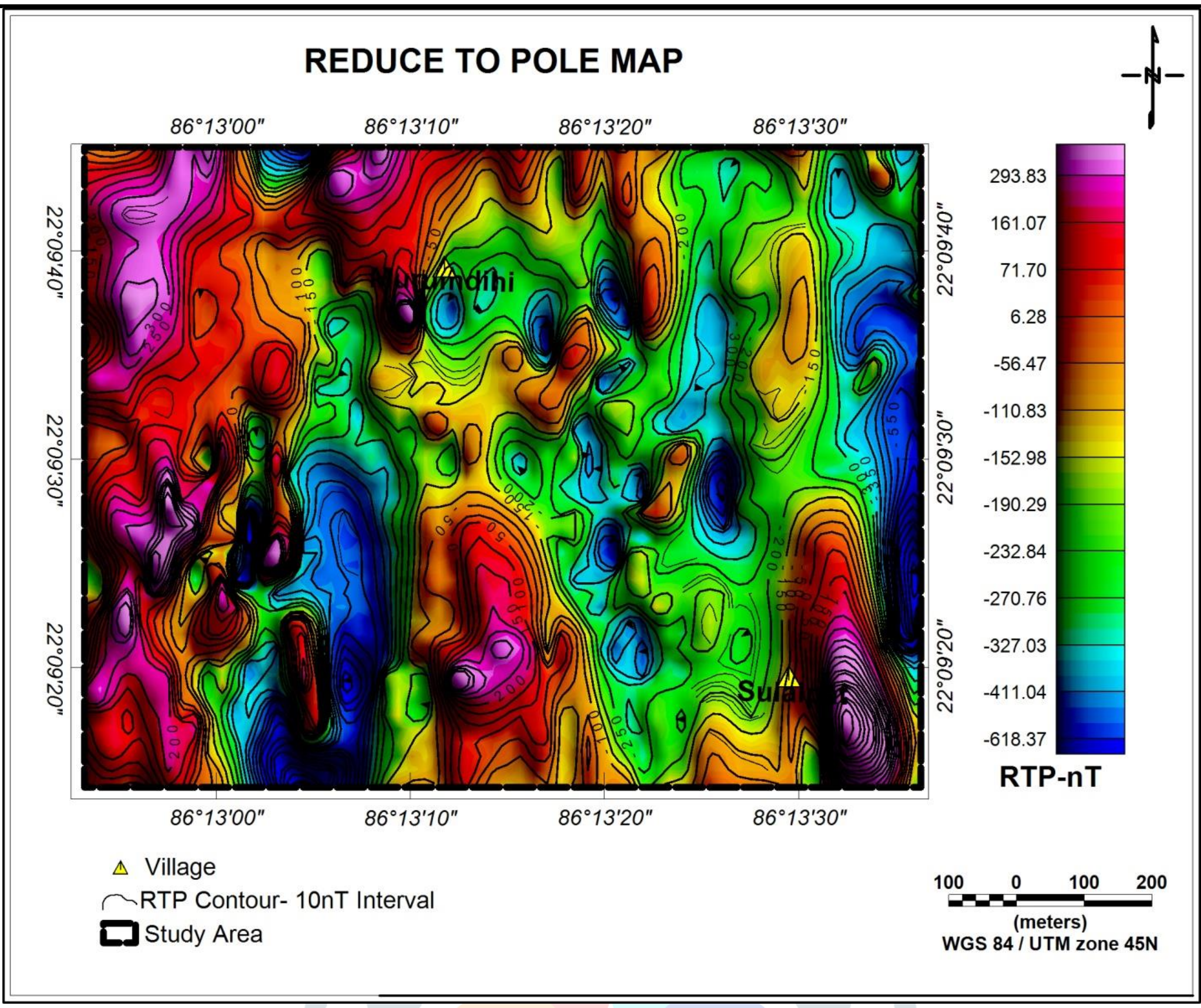

Figure 4: Reduced to Pole (RTP) Map of the Study Area.

V.RESULTS AND DISCUSSION

The current study area consists of supracrustal rocks with dominant deposits of banded iron formation (BIF) and iron ores. The BIF mainly contains banded cherty quartzite (BCQ), banded magnetite quartzite (BMQ) and banded magnetite grunerite quartzite (BMGQ). Iron ores (both Haematite and Magnetite) usually ferro-magnetic in nature and easily respond to magnetic survey. BMQ and BMCQ are more magnetized and more sensitive to magnetometers compared to BCQ in this area.

The Gem Systems GSM-19 WALKMAG magnetometers are very sensitive to acquire minute magnetic intensities while walking through a traverse. After processing the obtained magnetic intensities, some standard corrections (like diurnal and IGRF) applied to produce Total Magnetic Intensity (TMI) maps for analysis. But Reduced to Pole (RTP) maps are more accurate than TMI to analyses the ore deposits, as it corrects the deviations of Earth's Magnetic Pole effect.

In this study, Oasis Montaj Geosoft software's Euler Depth Convolution method used to know the probable ore body depth extinction and Volume Pixel (Voxel) method used to know the probable ore body volume. For analyzing Euler Depth Convolution and Voxel, many other maps like Analytical Signal (AS) map, Horizontal Derivative maps for both X and Y direction, Vertical Derivative map for Z direction, Upward and Downward Continuation maps were prepared.

5.1 3D diagram of the Study Area

The resultant ore body tentative depths are obtained using Euler Depth Convolution method in GEOSOFT. It is not necessary that all the values represent the iron ore bodies. Wherever Structural Index 1 or horizontal body is matching in the magnetic susceptibility the values are produced by the software.

Wherever depths shown in the non-priority areas (other than light pink and red colored zones), represent the flat or horizontal bodies of other minerals. The achieved probable depth of iron ore body from the software is plotted.

The main principle of this analysis is that all the Iron Ore bodies are ferromagnetic in nature. Hence whenever high magnetic intensities or positive anomalies are shown in the analyzed maps are considered as probable ore deposits. In other areas, ore deposits may be obtained, but in negligible quantities. But red colored zones may produce some quality amount of ore than other non-priority areas. All the light pink colored zones are delineated as probable high priority zones.

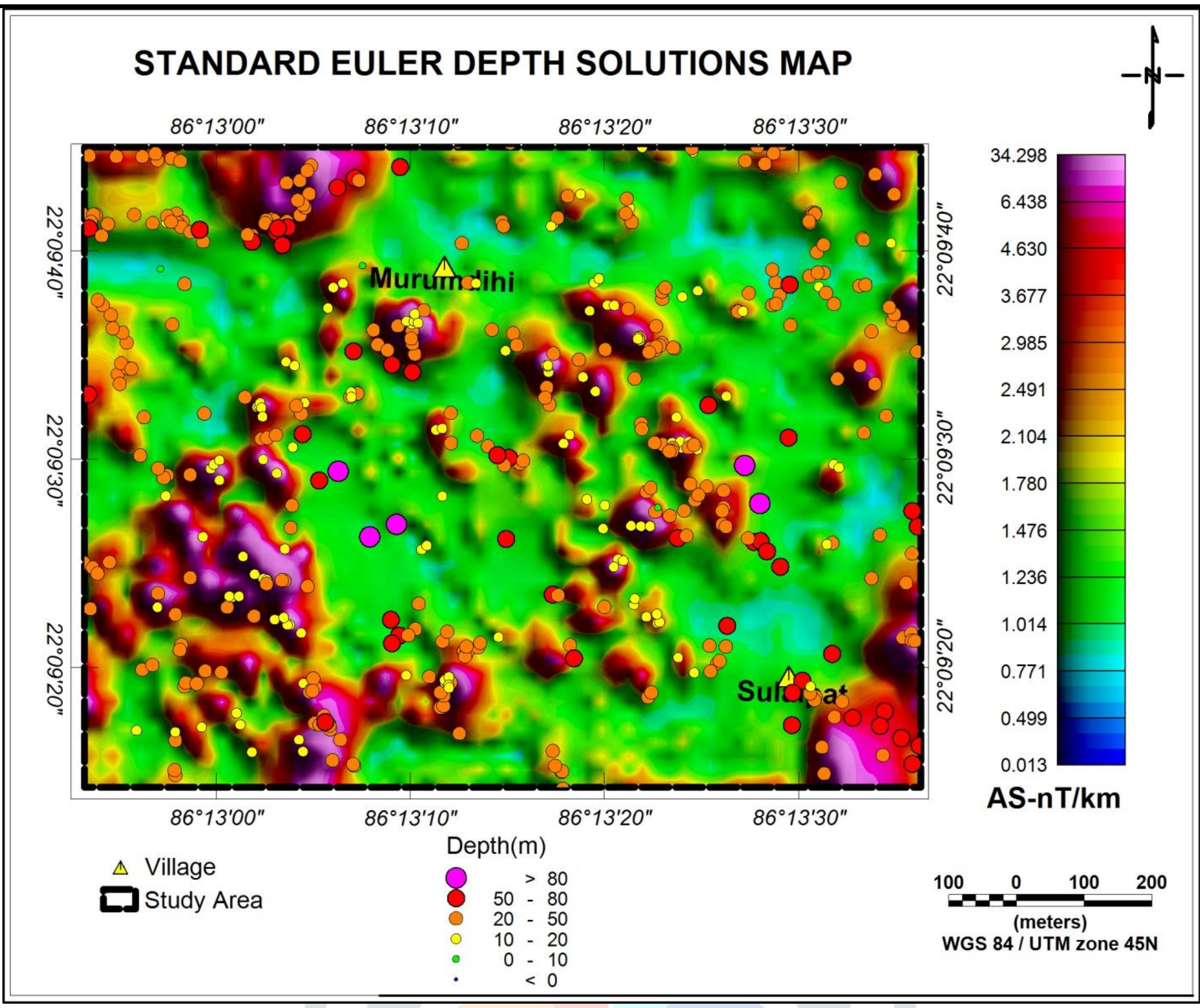

Figure 5:Standared euler depth solutions in the study area backgrounded by analyrtical signal map.

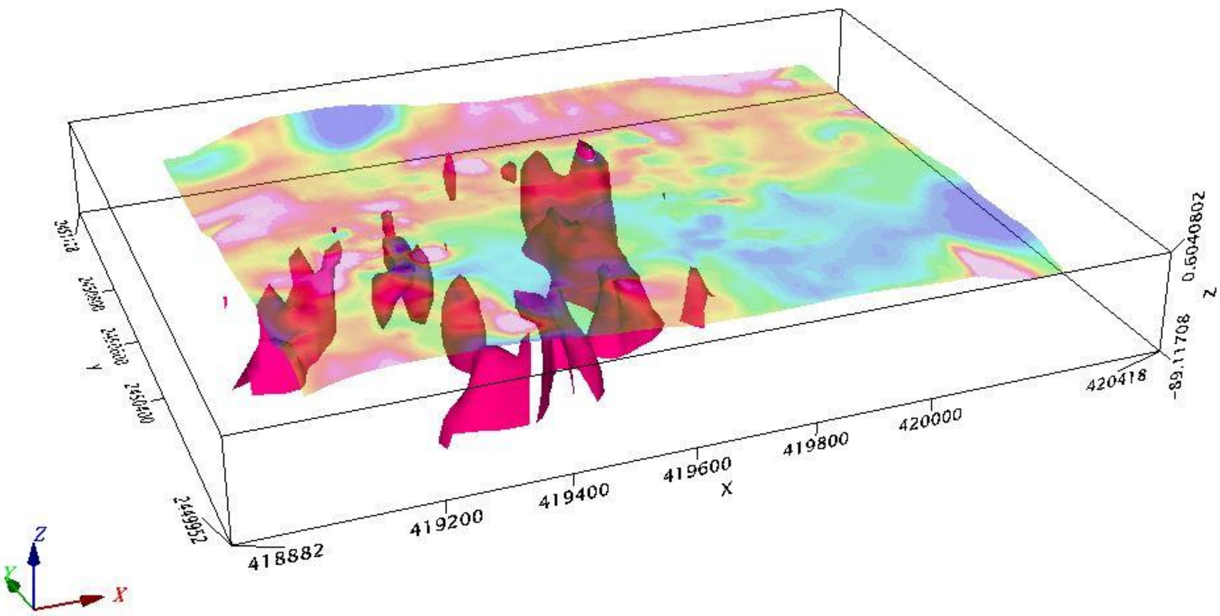

Figure 6: Reflecting 3D diagram of the ore bodies in the study area.

VI.CONCLUSIONS

The study of probable iron ore reserve was conducted using ground magnetic survey technique. After analyzing the magnetic data and with the primary field verification the following conclusions and recommendations are suggested to go for further exploration before any mining activities in considered site.

1. As per the current ground magnetic study, it is a confident suggestion that iron ore is available in this area. To arrive at the exact bottom depth of the ore body (in this study, only probable bottom depths are obtained), overburden thickness or to get exact thickness of the ore body, electrical dipole –dipole configuration suggested.

2. As per the field observations, the ore bodies available in this area are floats, deposited. To rule out this concept VES is recommended.
3. After getting the exact locations of the ore body and its thickness using VES, overburden etc. details, it can be recommended that the pitting and trenching locations can be planned. If required drilling locations also can be planned.
4. Pitting and trenching was recommended mostly in the SW corner of the study area.

VII. ACKNOWLEDGEMENT

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REFERENCES

[1] D. Beura. 2015. Superposed deformation fabrics in the Precambrian rocks of the Iron Ore Super Group of Odisha, with special reference to Badampahar-Gorumahisani-Suleipat belt. 13, pp. 10-17.
[2] S.C. Mahala. 2019. Geology, Chemistry and Genesis of Thermal Springs of Odisha, India. Springer.
[3] B. Satpathy and D. Beura. 2013. Establishment of lithostratigraphy of some banded iron formations of iron ore super group of Odisha, India. International Journal of Engineering and Innovative Technology, 2(7), pp.146-50.
[4] D. Beura, P. Singh and B. Satpathy, S. Behera and S.K. Nanda. 2016. Field relationship among the three iron ore groups of iron ore super group encircling the North Odisha Iron Ore Craton, India: a comparison study. Journal of Geosciences and Geomatics, 4(3), pp. 53-60.
[5] T. Wise, M.J. Pawley, R.A. Dutch. 2016. Preliminary interpretations from the 2015 Coompana aeromagnetic survey. ASEG Extended Abstracts, 16(1), pp.1-6.
[6] N. Belzile, Y.W. Chen and R. Xu. 2000. Early diagenetic behaviour of selenium in freshwater sediments. Applied Geochemistry, 15(10), pp.1439-54.
[7] P.C. Sahu. 2018. Studies on Geology And Mineral Resources of Mayurbhanj District, Odisha, India. 4 (1), pp 351 — 356.
[8] G.S. Plumlee. 1999. The environmental geology of mineral deposits, The environmental geochemistry of mineral deposits. Society of Economic Geologists, Part A. 71-116.
[9] Banerji, A.K. 1974. On the stratigraphy and tectonic history of the Iron Ore Bearing and associated rocks of Singhbum and adjoining areas of Bihar and Orissa.
[10] Banerjee, P.K. 1982. Stratigraphy, petrology and geochemistry of some Precambrian basic volcanic and associated rocks of Singhbhum district, Bihar Mayurbhanj and Keonjhar districts, Orissa. Mem.Geol.Surv.Ind, vol.111, /pp. 1-54.
[11] Bateman, A.M. 1951. The formation of late magmatic oxides. Econ. Geol., v.46, p. 404-426.
[12] Chakraborty. K L. 1958. Metamorphism of the banded iron formation of Badampahar, Mayurbhanj, India, and the origin of the cummmgtonite-magnetite rock. Proc. Nat. Inst, Sci. Ind., V: 24 A.
[13] Das G. C., Mohanty A. M., Das J. N., Patel S. N. 1993. Progress report on Search for gold in gorumahisani schist belt, mayurbhanj District, Orissa. GSI. (FS. 1992-93).
[14] Dunn,J.A. 1929. Geology of northern Singhbhum including parts of Ranchi and Manbhum districts. Mem. Geol. Surv.India. vol 54(2) pp.1-166.
[15] Dunn, J. A. 1935. The origin of iron ores in Singhbhum, India. Eeon. Geol., v. 30.
[16] Dunn,J.A. and Dey,A.K.. 1942. Geology and petrology of eastern Singhbhum and surrounding areas. Mem. Geol. Surv.India. vol 69(2) pp.281-456.
[17] Ghosh G. Bose S. 2011. Deformation and metamorphic history of the Singhbhum Cratonvis–à–vis peripheral mobile belts, eastern India: implicationson Precambrian crustal processes, Journal of Mineralogical and Petrological Sciences, J–STAGE, Advance Publication, March 11, 2020.