Journal of Mineral Resources Engineering, 7(4): 19-38, (2022)

Imam Khomeini International University
Vol. 7, No. 4, Winter 2022

نشریه مهندسی منابع معدنی
Journal of Mineral Resources Engineering
(JMRE)

Research Paper

Geophysical Investigation of Magnetometry in Zarnan-Chorenab Zanjan Menitite Iron Deposit

Geravandi E.[1], Modabberi S.[2*], Geravandi P.[3], Niroomand Sh.[2], Rajabi A.[4]

1- M.Sc Student, School of Geology, College of Science, University of Tehran, Tehran, Iran
2- Associate Professor, School of Geology, College of Science, University of Tehran, Tehran, Iran
3- M.Sc, Ahura Holding Industrial-Mining Group, Tehran, Iran
4- Assistant Professor, School of Geology, College of Science, University of Tehran, Tehran, Iran

Received: 19 Jun. 2021 **Accepted: 13 Oct. 2021**

Abstract: Zarnan-Chorehnab iron deposits are located at 5 km northeast of Zanjan city in the Tarom mountains, between Zarnan and Chorehnab villages. Mineralogical studies, as well as field observations show that iron mineralization is mostly magnetite type. However, hematite and goethite minerals are also formed to a lesser extent due to weathering and alteration. Iron ores in this area are formed as veins and lenses within Oligocene intrusive bodies. Inside the volcanic rocks, mineralization is also observed in the form of veins with small dimensions. The thickness of the veins can be traced between 0.5 to about 15 meters and their length up to about 200 meters. Iron deposits are one of the main stages of their exploration due to the presence of magnetite minerals with high magnetic properties and hematite with low magnetic properties. For this purpose, geophysical surveys were carried out by magnetometric method in 5240 stations in an area of 8 km2 to determine the potential areas of iron mineralization and to investigate the depth of mineralization. In this research, total magnetic maps, pole reversal, analytical signal, and upward continuation were prepared. The results obtained from the drilling finely correspond with the magnetometric survey. Based on the results of these studies, nine anomalies (An1-An9) were identified in the study area, anomalies of An3, An8, and An9 extend to a depth of about 40 m, and other anomalies are supposed to be found to a greater depth. The result of magnetic modeling data determines the position (location and approximate depth) and geometry of the masses causing magnetic anomalies.

Keywords: Geomagnetic method, Depth estimation, Euler method, Modeling of magnetic anomalies, Magnetite exploration.

How to cite this article
Geravandi, E., Modabberi, S., Geravandi, P., Niroomand, Sh., and Rajabi, A. (2022). *"Geophysical investigation of magnetometry in Zarnan-Chorenab Zanjan menitite iron deposit"*. Journal of Mineral Resources Engineering, 7(4): 19-38.
DOI: 10.30479/JMRE.2022.15699.1521

*Corresponding Author Email: *modabberi@ut.ac.ir*

INTRODUCTION

Geophysical methods are defined based on the physical properties of the minerals and their geological environs. Geomagnetic method of geophysical exploration can be useful when there are distinctions in magnetic feature of the rocks [1,2]. Geomagnetic studies are one of the low cost and practical methods for mineral exploration, especially for mineral with magnetic property. Correct data collection and interpretation may help to get valuable information about the location, depth and dimensions of hidden ore bodies [3]. In magnetic survey, the physical property of interest is magnetic susceptibility of subsurface materials. Indeed, magnetometry is one of the indirect exploration methods for magnetic minerals such as iron - titanium oxide (magnetite, hematite, ilmenite, …) and some sulfides, for example pyrrhotite [4,5].

This method can help reduce the exploration costs and optimize the drilling network, by specifying subsurface mineral resources. In order to investigate the potential of iron mineralization in depth and also to delineate ore bodies in Zarnan-Chorehnab, the geomagnetic method was used and data analysis was applied to the exploratory operation and delineation of iron ore deposit.

METHODS

Based on the field observation, preliminary geological and geochemical studies, the study area was selected for conducting geophysical survey to study the potential of iron mineralization. Considering the trend of mineralization and according to the geological map of the area, most geological structures have almost NW - SE as well as East - West trend. Therefore, the survey was performed along the profiles perpendicular to these structures with NE - SW and N - S trend which are each offset 30 to 50 meters and 15 to 25 meters station intervals, so a number of 5240 data measured. The GSM-19T instrument was used to record the magnetic data and subsequently, the necessary corrections were performed, Finally the data was plotted as magnetic field intensity contour map [6]. Reduction to the pole (RTP) filter [7] was applied to find out the pole in other to find anomalies on their origin. The data was interpreted qualitatively and quantitatively by softwares based on the existence or lack of the remnant magnetism [3,8].

FINDINGS AND ARGUMENT

In this survey the statistical analysis was performed in first step before any data preprocessing as well as data distribution type and their parameters are determined. The range of data indicates the absence of outliers and the highest value of earth magnetic field in this range is 62440 NT that can indicate the existence of large regional anomaly in the region. After the corrections were made, residual magnetic field map was prepared however because the locations of anomalies were not identical to the real locations, reduction to the pole filter was applied to resolve this problem [9]. The reduction to pole filter was used in order to reallocate the anomalies in the area. The maximum value of anomalies is 14040 NT and lowest of was found to be -3845 NT. This variation indicates the existence of magnetic minerals in the study area and showing nine anomalies located here.

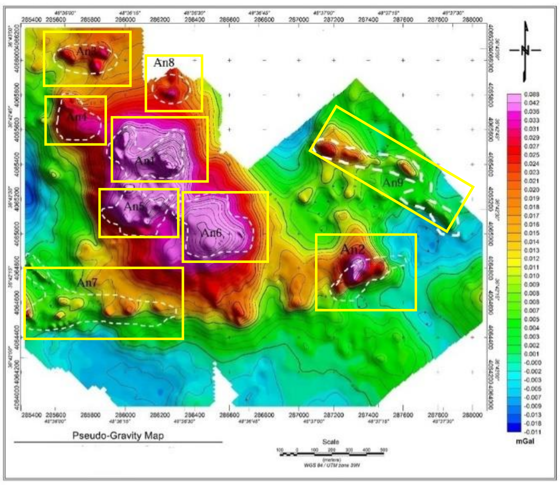

Figure 1. False gravity map

In order to better delineate the magnetic bodies, maps of the analytical signal and prospect areas and false gravity were plotted (Figure 1). In order to investigate qualitative distribution of anomalies and their depth extension, the upward continuation map was plotted. This shows that the anomalies of An3, An8 and An9 were shallower in depth located at about 40 meters, while the An5 anomaly had 50 meters deep extension and anomalies of An2 extends to about 100 meters. The important goals in interpretation of magnetic data are to find the location, depth and form of magnetic anomalies. In this research, analytical signal method was used to estimate the depth of anomalies. The estimated depths are summarized in Table 1. Then, inverse modeling of a simple form of magnetic dyke was performed. Accordingly, the proposed solutions for drilling were performed (Figure 2, Table 2).

Table 1. Depth probability of magnetic anomalies in their different locations

Anomaly	An1	An2	An3	An4	An5	An6	An7	An8	An9
Estimating depth(m)	10-30	5-30	10-20	20-40	10-40	+40	5-20	10-20	10-40

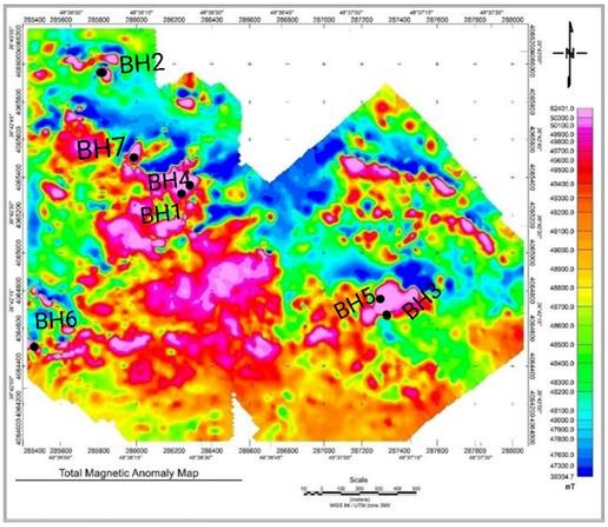

Figure 2. The location of the proposed boreholes on a map of the magnetic total field

Table 2. The coordinates for the recommended boreholes in the Zarnan-Chourehnab area

No.	Longitude	Latitude	Bottom depth (m)	Top depth (m)
BH1	286261	4065373	30	15
BH2	285833	4065960	30	20
BH3	287309	4064729	50	20
BH4	286296	4065390	60	15
BH5	287309	4064786	60	20
BH6	285438	4964531	40	12
BH7	285995	4065566	50	10

CONCLUSIONS

- According to highly magnetic anomalies observed and magnetic field obtained for the models, the study area is shown to have good potential for iron mineralization.
- Based on field observation, geological investigation and magnetometric surveys, nine magnetic anomalies (An1 to An9) were identified which it can be sown as lenses or veins on the magnetic maps.
- The total magnetic intensity map around the anomalies indicate that the mineralisation is not integrated as a large body and dissected by numerous faults in the region. Also the location of anomalies were

determined by applying reduction to the pole and the analytical signal and drawing the relevant maps of a particular anomaly.

- In order to estimate the depth of magnetic anomalies, two methods of Euler depth estimation and integrated method of Euler and Euler analytical signal have been used resulted in reporting An1, An2, An3, An7 and An8 anomalies.
- In this study, hidden ore bodies with high magnetic properties were identified. Based on the results of the classical interpretation (analytic signal map, pole reduction map, and false gravity map) as well as the results of modeling, few locations were proposed to perform drilling operations.

REFERENCES

[1] Donohue, J., Hil, Q., and Brewster, D. (2012). *"Geophysics at the Howsons Iron Project, NSW, Eastern Australia's new magnetite resource"*. ASEG Extended Abstracts, 1-6. DOI: https://doi.org/10.1071/ASEG2012ab210.

[2] Robinson, E. S., and Coruh, C. (1988). *"Basic Exploration Geophysics"*. John Wiley & Sons, New York, pp. 562.

[3] Ganiyu, S. A., Badmus, B. S., Awoyemi, M. O., Akinyemi, O. D., and Olurin, O. T. (2012). *"Upward continuation and reduction to pole process on aeromagnetic data of Ibadan Area, South-Western Nigeria"*. Earth Science Research, 2(1): 66.

[4] Spicer, B., Morris, B., and Ugalde, H. (2011). *"Structure of the Rambler Rhyolite, Baie Verte Peninsula, Newfoundland: Inversions using UBC-GIF Grav3D and Mag3D"*. Journal of Applied Geophysics, 75: 9-18.

[5] Calagari, A. A. (1992). *"Principals of geophysics exploration"*. Tabesh Press, Tabriz, pp. 588.

[6] Telford, W. M., Geldart, L. P., Sheriff, R. E., and Keys., D. A. (1988). *"Applied geophysics"*. Cambridge University Press.

[7] Baranov, V., and Naudy, H. (1964). *"Numerical calculation of the formula of reduction to the magnetic pole"*. Geophysics, 29: 67-79.

[8] Jacobsen, B. H. (1987). *"A case for upward continuation as a standard separation filter for potential-field maps"*. Geophysics, 52: 1138-1148.

[9] Clark, D. A. (1997). *"Magnetic petrophysics and magnetic petrology: aids to geological interpretation of magnetic surveys"*. Journal of Australian Geology and Geophysics, 17(2): 83-103.