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Investigating the effect of various parameters on the response of magnetic targets in magnetometry method using 2D and 3D forward modeling

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Abstract

In this research, 2D and 3D synthetic modeling of targets representing common geological structures was carried out using Encom ModelVision. In this regard, the effect of factors such as material type, size and dimensions, burial depth and geometrical shape of body as well as survey profiles interspacing on the response of spherical, elliptical and linear magnetic bodies representing geological structures was investigated. The results of synthetic data modeling showed that as expected, magnetic intensity is directly correlated with the size and dimensions of the buried bodies having reverse correlation with the burial depth of the body. Also the magnetic response of bodies containing regular and irregular arbitrary polygons, ellipsoid and vertical cylinder largely follows the geometric shape of the body. According to the effect of survey profiles spacing on the spherical, elliptical and linear bodies, a series of simple linear mathematical relationships with high correlation coefficient between survey profile interspacing and ratio of height to half width of magnetic anomaly, were obtained. These relationships can be used for prospecting and preliminary exploration of deposits. The results of field surveys on the buried metallic pipes at Arak University of Technology campus, revealed that despite the selection of fix small station intervals (1m) with employing appropriate transforms and filters on the data by Geosoft Oasis montaj, overally by reducing the number of profiles the response of the buried metallic pipes, gets wider and weaker. Therefore in some cases the trend of anomalies completely changes and even identification of target type is impossible.

Keywords: *2D and 3D modeling, Encom ModelVision, Magnetic survey profile, Arak University of Technology campus, Geosoft Oasis montaj*

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Extended Abstract:

1. Introduction

Synthetic forward and inverse modeling of magnetic data is the main steps needed to interpret them, which carried out to achieve the quantitative and more reliable results to determine the most appropriate location for magnetic anomalies associated with subsurface magnetic masses. The results of the modeling are used to determine approximate shape, spatial expansion and estimation of the depth of subsurface magnetic masses that are usually in good accordance with field observations and measurements. The advantage of 2-D modeling related to 3-D is possibility performing the modeling process immediately after 2-D data acquisition related to each of profiles (Mohammadi et al., 2016). Also acquiring more realistic responses and higher accurate results are from the advantages of 3-D modeling over 2-D ones. Using forward modeling, subsurface magnetic masses with the variety of material types, sizes or dimensions and burial depths can be modeled; the behaviour of subsurface geological masses and structures can be simulated and enough information about the effects of physical properties of the environment can be attained. In the present research, the effect of the most parameters of the model containing material type, size and dimensions, burial depth and geometric shape of the body over the response of the model was investigated through 2-D and 3-D synthetic forward modeling. In addition, the effect of the size parameter for exploration grid was studied by means of synthetic data forward modeling and inversion of real data.

2. Materials and methods

In this research, 2D and 3D synthetic modeling of various geometric targets representing common geological structures was carried out using Encom ModelVision software. In this regard, the effect of different factors such as material type, size and dimensions, burial depth and geometrical shape of body (Fairhead, 2015) as well as survey profiles interspacing on the response of spherical, elliptical and linear magnetic bodies representing all geological and mineral deposit shapes and structures was investigated. The effect of the size of survey grids on the response of magnetic anomalies was also investigated through magnetic surveys on the buried metallic pipes at Arak University of Technology campus.

To produce the synthetic models, a kind of limestone from sedimentary rocks with very low magnetic property (susceptibility of 0.0005 SI) was selected as the host medium for all models. Also for the comprehensiveness of the research results, prevention of excessive complexity, production of symmetrical responses and feasibility of comparing the results of modeling, the value of inclination and declination angles were set to 90 and 0 degrees, respectively. According to the size and dimensions of the designed bodies, the size of synthetic models was also set to 1000*1000 m and the size of traverse grids was set to 50*10 m (station interspacing on the traverse lines are 10 m).

3. Tests results

The results of synthetic data modeling showed that as expected, magnetic intensity is directly correlated with the size and dimensions of the buried bodies having reverse correlation with the burial depth of the body. Also the magnetic response of bodies containing regular and irregular arbitrary polygons, ellipsoid and vertical cylinder largely follows the geometric shape of the body. According to the study of the effect of survey profiles spacing on the spherical, elliptical and linear bodies, a series of simple linear mathematical relationships with high correlation coefficient

between survey profile interspacing and ratio of height to half width of magnetic anomaly (Telford et al., 1990; Parasnis, 1996) were obtained. These relationships can be used in practice to explore deposits with the variety of geometrical shapes especially in prospecting and preliminary exploration stages. The results of field surveys in Arak University of Technology campus revealed that despite the selection of fix small station intervals (1m) and employing appropriate transforms and filters on the data by Geosoft Oasis montaj software, overally by reducing the number of profiles (increasing profile interspacing) the response of the buried metallic pipes, gets wider and weaker.

4. Conclusion

The results of the research show that by reducing the number of magnetic survey profiles (increasing profile interspacing) in some cases the trend of anomalies completely changes and even identification of target type is impossible. In general the results of this research can be used to explore mineral deposits with the variety of geometrical shapes especially in prospecting and preliminary exploration stages or detection of diverse targets in various applications of magnetometry.

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