Qualitative and Quantitative Evaluation of Geophysical Data Accordance with Assay Data in Yazd Darreh-Zereshk Copper Deposit to Propose Optimal Location for new Exploration Boreholes

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Abstract

In Yazd Darreh-Zereshk copper deposit geophysical data containing magnetic, resistivity and induced polarization have been surveyed and 25 boreholes have been drilled in the area. In the present research, inversion and processing of geophysical data as well as their qualitative and quantitative accordance with boreholes assay data have been carried out. To achieve the goal first, total magnetic intensity map after applying necessary filters and processing, was mapped to identify surface and deep expansion of anomalies on it. Drawing the anomaly profile of magnetic stations surveyed along 4 geoelectric profiles shows that most of the magnetic anomaly zones have high chargeability and low resistivity that indicates the qualitative compatibility of magnetic and geoelectric data, as a result increasing the probability of mineralization in the area. Afterward on the basis of qualitative interpretation of geoelectrical sections, optimal locations of drilling on the each profile were proposed. Plotting mineral deposit cross-section along the geoelectrical profiles using the boreholes assay data, revealed that drilling of some boreholes located on the geophysical profiles haven't been based on the results of geophysical operation, carried out without any right logic, purpose and design. In general, the qualitative accordance of the results of geoelectrical operation with the boreholes assay data showed a pretty good qualitative accordance. Also investigation of linear correlation coefficient value between inverted geophysical data and borehole assay in a specific same range after a same definite gridding and interpolation of their values, overall indicated a relatively good quantitative accordance (between 0.4 and 0.7).

Keywords: Yazd Darreh-Zereshk copper deposit, Geophysical data, Smoothness inversion modeling, Assay data, qualitative and quantitative accordance

Extended Abstract

Introduction

In order to save the time and cost, generally during preliminary and semi-detailed exploration stages based on the results of processing and interpreting geophysical exploration data, exploration boreholes are proposed on geophysical anomalies as the most suitable drilling locations. In geophysical exploration methods, surveyed raw data are not usually directly applicable requiring a series of processing and modeling stages. Since geophysical raw data and pseudo sections are as an primitive decision making criterion without providing comprehensive, complete and reliable information about real burial depth, size, dimensions and physical properties of subsurface bodies, therefore geophysical data modeling is inevitable [1].

In the present research, modeling of Darreh-Zereshk copper deposit located in Taft district, Yazd province has been carried out. To achieve the goal, first inversion of geophysical data was performed. Afterward, required geophysical maps and sections especially metal factor sections were drawn and at the end, the optimum location of new drilling points were proposed using qualitative and quantitative accordance between geophysical data and existing exploration boreholes assay.

Darreh-Zereshk copper deposit is located in the south of central Iran and 65 km southwest of Yazd city, 45 km southwest of Taft township, on Yazd-Shiraz road and west of Darreh-Zereshk village, southern half of 1:100000 Khezr Abad geological sheet [2], southwest of 1:250000 Darreh-Zereshk topographic map, between 768800-770500 eastern longitude and 3494300-3496200 northern latitude. Darreh-Zereshk copper deposit is located on the Sanandaj-Sirjan tectonic zone and mostly outcropped rocks of the region belong to the second geological era. Porphyry diorite-granodiorite intrusive masses, which intruded along several major fractures and formed alteration zones of propylitic, sericitic and argillic, are the main mineralization factors in the deposit. Mineralization has been performed as three forms: impregnation into silicified limestones, fractures filling in intrusive igneous rocks and in deeper parts as dissemination in shale and sandstones of the Sangestan Formation and their conversion to quartzite [3]. In addition, 25

exploration boreholes (24 vertical and 1 inclined) scattered at the area with the total length of 4055.2 m. All acquired geophysical data and assay results (Cu and CuO grades) of the cores mainly with 2 m length from boreholes are available.

Materials and methods

In Darreh-Zereshk copper deposit, geophysical data acquisition containing magnetic, resistivity and induced polarization methods have been carried out in two phases. In the first stage, 1615 magnetic data points were surveyed in order to study and identify potassic and other altered zones, which are related to the mineralization zone. In the next step, to investigate deep anomalies spatial extension and determination of their dimensions, geoelectrical surveys containing induced polarization and resistivity along four geophysical profiles called 350 N, 500 N, 750 N and 1150 N with general strike of northwest-southeast was performed that at this stage overall 1816 stations were measured. Each profile was called based on its distance from the base point and total length of the profiles is approximately 3400 m. The array also used for surveyed profiles is dipole-dipole with an electrode spacing of 40 m and step length of 20 m. Figure 1 shows the location map of magnetic station points, geoelectrical profiles as well as location of spatial scattering of exploration boreholes on topographic map of the region.

In the studied area, magnetic data points were surveyed with profile interspacing of 40 m and station distances of 20 m in 1615 stations where processing operation and applying various filters in order to producing final maps have been performed by Oasis montaj software. In general, three zones are visible on the total magnetic intensity map: the zone with the least magnetic intensity, indicating lack of ore deposit in the region or its high depth in sedimentary bed rock. The zone with a moderate magnetic intensity, which can be dependent on mineralization of the region in the presence of acidic to intermediate igneous rocks. The zone with highest magnetic intensity probably related to the presence of intrusive igneous rocks and/or existence of masses with high magnetic intensity, which it can also be dependent on mineralization.

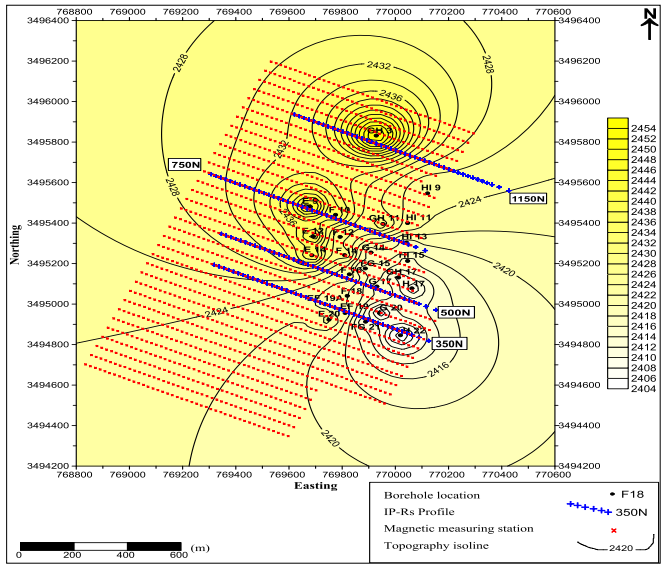

Figure 1. Location map of magnetic station points, geoelectrical profiles and exploration boreholes on topographic map.

For processing and interpretation of magnetic anomaly maps, reduction to magnetic pole filter was applied and upward continuation maps up to 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 m were plotted. Investigation of anomaly maps after employing upward continuation filter with the variety of elevations showed that the anomalies of western half are shallow whereas extended more than 100 m depth in the eastern half. In the present research, smoothed inverse modeling of all geoelectrical profiles surveyed in the region, was performed by Res2dinv software. To discovery metallic deposits, metallic polarization is very important. Metal factor is a qualitative parameter and in fact a combination of chargeability and resistivity, that partially separates metallic from nonmetallic polarization and in other words separates metallic mineralization origin from the nonmetallic. Metal factor indicated by MF abbreviation is calculated for induced polarization in the time domain using relationship (1):

$$MF = \frac{M \times 2000}{\rho} \quad (1)$$

where in this relation, M and ρ stand for chargeability in the time domain and apparent resistivity, respectively.

In order to validate performed geophysical operation and proposing optimum location of new exploration drilling operation in the region, qualitative comparison has been made for all chargeability, resistivity, metal factor and exploration cross-sections corresponding to 350 N, 500 N, 750 N and 1150 N geoelectrical profiles. For this purpose, assay data of exploration borehole cores located on the geoelectrical profiles has been used.

To compare exploration cross-sections with geoelectrical sections quantitatively and check their conformity with each other, linear correlation between inverted geophysical data containing chargeability, apparent resistivity and metal factor with assay data of drilling operation in a specific same defined area, after the same definite gridding and interpolation of their values has been determined.

Results and discussion

Plotting intensity map of total magnetic field and data processing using Oasis montaj software shows that intensity and continuity of the magnetic anomaly in the western half especially in the southern part is more than the others. Anomaly profile of surveyed magnetic stations along four-geoelectrical profiles of 350 N, 500 N, 750 N and 1150 N on the geology map of the region, revealed that areas with pretty high magnetic anomalies are mostly located on the lithology units from sedimentary rocks type.

Also drawing the anomaly profile of magnetic stations surveyed along geoelectrical profiles showed that most of the magnetic anomaly zones have high chargeability and low resistivity indicating the qualitative compatibility of magnetic and geoelectrical data, as a result of increasing the probability of mineralization in the area. Then based on qualitative interpretation of geoelectrical sections, optimal locations of drilling on the each profile were proposed. Plotting mineral deposit cross-section along the geoelectrical profiles using the boreholes assay data, revealed that drilling of some boreholes located on the geophysical profiles, have not been based on the results of geophysical operation, carried out without any right logic,

purpose and design. In order to evaluate the results of geophysical survey operation through their qualitative conformity with assay data of drilling operation, strip log of all drilled boreholes located on the geoelectrical profiles was also carefully examined and comparison of existing exploration information indicated that overall, there is a relatively good qualitative accordance between these data.

Conclusion

In general, the qualitative accordance of the results of geoelectrical operation with the boreholes assay data illustrated the relatively good status. Also investigation of linear correlation coefficient value between inverted geophysical data and boreholes assay in a specific range similar to the range after a same definite gridding and interpolation of their values, overall indicated a relatively good quantitative accordance (between 0.4 and 0.7). Therefore, for systematic exploration of the deposit, drilling the new proposed exploration boreholes based on the results of inverted geoelectrical pseudo-sections is necessary. Assay data of the new proposed boreholes, will be needed in the future to improve the trend of various stages of data processing and analysis, especially for mineral reserve estimation.

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