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(Research Article)

Exploration for iron ore in Marvar deposit using satellite image analysis and magnetic data inversion

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Summary

The ever-increasing demands of the steel industry for iron ore and the reduction in the grade and tonnage of existing large active mines raise the motivation for exploring small-scale or hidden iron deposits. The present research deals with prospecting a case of these deposits in Yazd province. The area is close to Marvar village in Meybod county, with an area of circa 720 m^2. The rock type in the study area comprises of andesitite, dacite, and riodacite volcanic rocks with Eocene age. The hematite and magnetite outcrops also mainly occur within the andesites and andesitic tuffs. Therefore, the first step was the remote sensing for reconnaissance of the iron oxide zones, and ENVI 5.3 software created false color composites and the band ratios of Aster and Landsat 8 satellite images. The band ratio of 2/1 and 4/2 revealed the ferric iron oxides in the Aster and Landsat 8 images, respectively. In contrast, calculated band ratios of 1/2+5/3 for Aster and 7/5 in Landsat images illustrated the ferrous iron oxide zones. Besides, a false-color composite consisting of R=4, G=6, and B=8 showed the propylitic and argillic alteration zones via green and yellowish-pink colors, respectively. Comparing iron oxides and alteration zones revealed a spatial correlation between propylitic alteration and magnetite mineralization and another correlation between argillic alteration and hematite mineralization. Meanwhile, the magnetic data were processed via subtraction of the IGRF from the magnetic data and removing small and noisy features with a low pass filter of 100 m. Then, an upward continuation to 250 m exposed the regional effects in data. The subtraction of the regional effect from the filtered data gave the residual magnetic anomaly. In addition, the reduction-to-pole filter was also implemented and revealed the actual location of magnetic anomalies. In the next step, calculating the analytical signal of magnetic data in the area illustrated the boundaries of magnetic anomalies. Comparing the analytical signal and iron oxide zone from the remote sensing studies illustrated a significant spatial correlation between the ferrous-iron oxide zones and the magnetic analytical signal. Furthermore, the results of Euler deconvolution and power spectrum techniques indicate that most magnetic sources have a depth of circa 65 meters. Later, the estimated depth was used to define depth weighting in a 3D inversion of the magnetic data. Using Li and Oldenburg's algorithm via UBC Mag3D software, this inversion gave a three-dimensional shape of the magnetic susceptibility distribution in depth. According to the estimated model, the zones with high magnetic susceptibilities commonly occur at 50 to 100 meters depths, and their locations coincide well with the reduced-to-pole magnetic anomalies. Besides, comparing the iron grade of the geochemical analyses along three exploratory core samples confirmed that the zones with the biggest estimated magnetic susceptibilities within the model match the position of high grades of iron along the exploratory wells. Therefore, the area's main type of iron ore is magnetite, not hematite.

Keywords: Remote sensing, Magnetometry, 3D Inversion, Susceptibility, Iron Deposit.

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