Research Advances

Application of the Gravity Method to the Iron Ore Exploration in Eastern Hebei Province

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The nation-wide iron ore exploration is primarily based on aeromagnetic survey, based upon which a series of ground follow-up and drilling examination were carried out, and then reconnaissance and detailed investigation and exploration were fulfilled. However, for some large, deeply buried and complicated iron deposits, the magnetic prospecting method alone is difficult to work effectively and satisfactorily. The gravity method is mainly used in exploration of oil and natural gas and solid minerals, as well as regional gravity survey. It was rarely used directly for iron ore exploration in the past. With the development of modern mathematical theories and computer technology, many types of corrections applied to the gravity method have been updated. In the 1990s, the gravity survey made a significant breakthrough due to the application of GPS to geodetic studies. It is now possible to detect small scale targets by means of microgravity, which expands the application scope of gravity exploration.

The aeromagnetic data show that the Luan County and Luannan County in the periphery of eastern Hebei iron deposits display low and gentle magnetic anomalies. The available gravity data in this area are few, all at scales of smaller than 200, 000, and are outdated with poor accuracies. Considering the benefits of the gravity method, China Geological Survey deployed the "1:50 000 gravity survey in the periphery of iron deposits in eastern Hebei Province" project in these low aeromagnetic anomaly areas. This high-precision integrated gravity survey at a scale of 1:50000 was conducted in the low and gentle aeromagnetic anomaly areas covered by the Quaternary sediments, with a station spacing of 500 m by 250 m. We

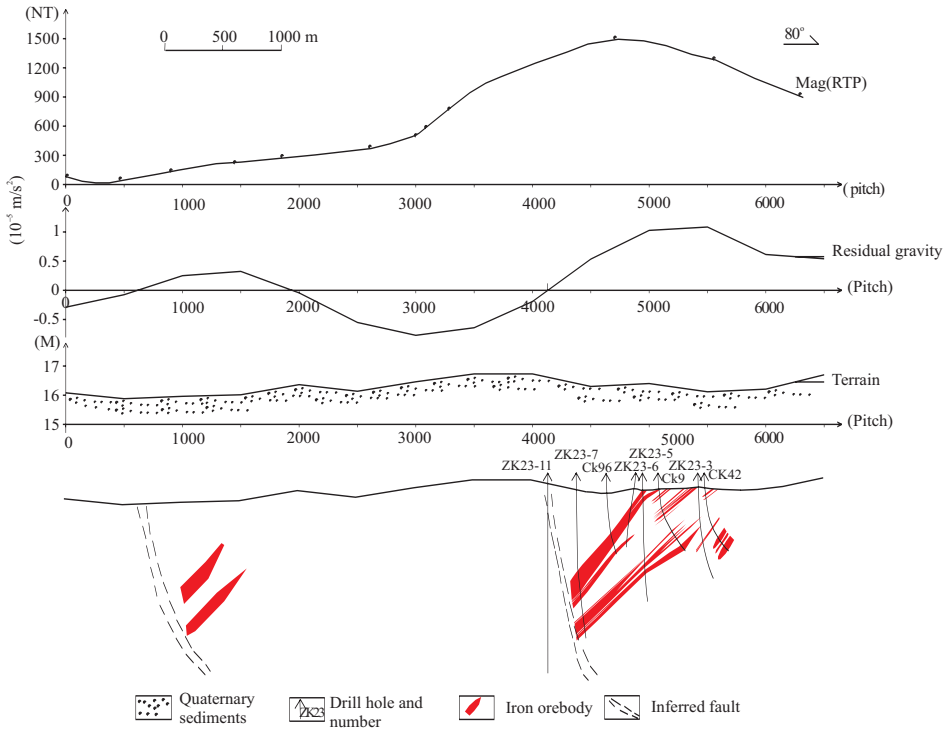

Fig. 1. Comprehensive geophysical profiles of the Sijiaying and Macheng iron deposits in Luan County of Eastern Hebei Province.

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systemically studied the three key techniques during the gravity survey, i.e., near-station terrain correction, distant terrain correction and height conversion, and obtained the resultant accuracy and precision as follows: near-station terrain correction with a resolution of 4 μGal , distant terrain correction with a resolution of 7 μGal, the same as precision inspection, geodesic surface error of 0.24 m, and a height error of 0.074 m. The total accuracy of the Bouguer anomaly is 55 μGal. Based on the processing result of high precision gravity data, the basic framework of regional geological tectonics was depicted according to the Bouguer gravity anomaly patterns; the systemic study on gravity data suggests that the area north of the Changli Fault is an Archean uplift zone, formed mainly by the Archean BIF-hosted sedimentary metamorphic basement (Qianxi group?), which hosted a large number of NS-trending concealed iron formations. Drilling examinations conducted by other geological exploration units in the anomaly area encountered iron ore layer at 739.31 m to 761.79 m, with an apparent thickness of 22.48 m, true thickness of about 17 m, TFe of 37.13%, and mFe of 33.29%. The joint inversion of gravity and magnetic data suggests that iron ore bodies are probably to be found in the region. The predicted iron resources are estimated to be 1.013 billion tons by means of the integrated information method.

A comprehensive analysis of geological setting, geophysical characteristics, ore-control stratigraphical and lithological characteristics and tectonic settings indicates that the study area has good mineralization geological conditions, and that nine gravity anomaly zones related to concealed iron ore deposits or iron formation were tentatively delineated or inferred. This area possesses a great potential for prospecting medium to large metamorphosed sedimentary type iron ore deposits.

The location of orebodies can be roughly determined by the joint inversion of two and one-half-dimensional gravity and magnetic anomalies using gravity anomalies and integrated gravity and magnetic anomaly profiles, in combination with geological data. This makes it possible to achieve a breakthrough in prospecting iron orebodies in the periphery of eastern Hebei Province. Thus, the high-precision gravity method integrated with gravity and magnetic profiles is an effective method for prospecting hidden magnetite orebodies.