Regional Gravity Survey Application in Geological Exploration in the Northwest Area

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Abstract

The application of regional gravity survey method to geological exploration in the northwest of Hebei Province is discussed in this paper. collected in the northwest of Hebei Province[1] (east longitude 114 degrees, 117 degrees, 40 degrees north latitude, 42 degrees) 1:20 000 regional gravity and aeromagnetic survey data, seismic and geochemical data, through data processing, qualitative interpretation, quantitative analysis and comprehensive research[2], on the basis of the Bouguer gravity anomaly map compilation, residual gravity anomaly plane the extended height map and Bouguer gravity anomaly map, plane layout, vertical direction derivative two derivative plan and a series of data processing and map T aeromagnetic anomaly map etc[3]. The application of regional gravity survey in regional gravity field zoning, division of tectonic units, inferred fault structural zones, delineation of concealed semi concealed rock masses, delineation of sedimentary basins and metallogenic prognosis of related minerals are studied[4].

Keywords

Regional Gravity Survey, Comprehensive Study.

1. Introduction

Regional gravity survey has the characteristics of deep exploration, accurate research of intrusive rock mass and fault structure. It is an indispensable basic geophysical work for studying regional geological structure, regional metallogenic environment and prospecting. Gravity exploration plays an important role in the aspect of intrusive deep production, the trend and extension of deep and large faults, the characteristics of density and interface of geological bodies, and the division and determination of tectonic units. In addition, no magnetic rock mass or stratum under shallow cover (such as acid intrusive rock, carbonate rock, etc.) can be trapped only by gravity. Therefore, in the geological exploration work[5], a comprehensive study of regional gravity and aeromagnetic survey data provide an important basis for the geological background, ore controlling structure research and concealed rock delineation, provide useful information for energy and minerals, metal mineral, metal mineral and non-metallic minerals etc.

2. Features

2.1 Geological Characteristics

The regional crustal evolution has experienced three stages: the basement formation period, the cap rock development period and the DIWA activation period. The basal nuclei built by dry mulberry metamorphic complex, Chongjin rock group, HONGQIYINGZI rock group and metamorphic plutonic rocks (hypersthene granodiorite, tonality, trondhjemite and motet)[6]; cover layer built by Middle Upper Proterozoic marine clastic rocks and carbonate rocks and Paleozoic piratic sedimentary layers (see table 1).

Table 1. Lithological table in the north of Hebei Province

Stratigraphic age			Main lithology	Distribution range
circles	Group (line)	Stratigraphic symbol		
Cenozoic	Quaternary	Q	Loess, clay, sand	The inter mountain basins of Shunyi, Changping, and other areas in the southeastern part of the region, the edge of the foothills, and the valley zones
	The tertiary	E	Clay rock, sandstone, Xuan Wuyan, Sha Liyan	Zhangbei - Kangbao - Guyuan area is located in the area of Bashang
Mesozoic	Cretaceous system	K	Sandstone, conglomerate, Sha Liyan	Wanquan basin and Guyuan Bashang area, Wan Shengyong, Senjitu
	Jurassic	J	Fine sandstone, volcanic rock, tuff, volcanic, tuff, rhyolite	It is mainly distributed in the Mesozoic basins in the north of Chongli to the north of Chicheng, and there are sporadic distribution in other places.
	The Triassic Period	T	Sandstone, shale and fine sandstone	Small area exposure in southern Shahe, Changping County, Beijing
Paleozoic	Permian	P	Mineral rock and quartz sandstone	Outcropping in the south of Huailai
	Ordovician	O	Limestone and dolomite	Out of the border between Huailai and Beijing in Hebei
	Cambrian	∈	Limestone and lead dolomite	Outcropping in the south of Huailai, Hebei
Proterozoic	Qingbaikouan	Qn	Sandstone, shale and dolomite	Distribution in the south of Chongli - Chicheng
	Jixian County Department	Jx	Dolomite, dolomitic limestone and limestone	Distribution in the south of Chongli - Chicheng

<table>
<tr><td rowspan="2"></td><td>The Great Wall Department</td><td>Ch</td><td>Quartz sandstone, coarse sand rock, schist</td><td>Distribution in the south of Chongli - Chicheng</td></tr>
<tr><td>Huade group</td><td>Pthd</td><td>Gravel, coarse conglomerate and schist</td><td>In Kangbao</td></tr>
<tr><td rowspan="2">Archaean</td><td>Single tower subgroup</td><td>Ardn</td><td>The amphibolite, biotite plagioclase leptynite, with magnetite quartzite</td><td>The distribution of the area of Chongli to the north of Inner Mongolia - Chicheng</td></tr>
<tr><td>Qianxi group</td><td>Arqn</td><td>Diagonal amphibolite, gneiss and magnetite quartzite</td><td>In Huailai, Xuanhua, Chongli, Tianzhen Yangyuan, Chicheng area south of distribution</td></tr>
</table>

If the Caijiaying Pb Zn Ag polymetallic deposit, Qing yang ditch lead-zinc polymetallic deposit, Xiaoyingpan - Dinging gold deposit, huangtuliang gold deposit, Xuanlong type iron deposit Sadaigoumen molybdenum mine and Xinhua area, in addition to various types of deposits above have been proved, there is need to strengthen the potential of census survey work, dig out more mineral resources[7].

Table 2. Bottom density list

<table>
<tr><td rowspan="2">circles</td><td rowspan="2">system</td><td rowspan="2">Code</td><td rowspan="2">lithology</td><td rowspan="2">Number of blocks</td><td colspan="4">103kg/m3</td></tr>
<tr><td>Range of change</td><td>Common values</td><td>Density difference</td><td>Density difference</td></tr>
<tr><td rowspan="2">Cenozoic</td><td>Quaternary</td><td>Q</td><td>Loose soil</td><td>31</td><td>1.70-1.89</td><td>1.80</td><td rowspan="2">First floor 2.00</td><td rowspan="2">0.52</td></tr>
<tr><td>The tertiary</td><td>E, N</td><td>Silt mudstone and conglomerate</td><td></td><td></td><td>2.23</td></tr>
<tr><td rowspan="2">Mesozoic</td><td>Cretaceous system</td><td>K</td><td>Continental clastic rock</td><td>275</td><td>1.80-2.83</td><td>2.41</td><td rowspan="3">second floor 2.52</td><td rowspan="4">0.17</td></tr>
<tr><td>Jurassic</td><td>J</td><td>Pyroclastic rock</td><td>1216</td><td>1.97-2.83</td><td>2.51</td></tr>
<tr><td rowspan="3">Paleozoic</td><td>Carboniferous and Permian</td><td>C, P</td><td>Altered andesite and tuff</td><td>22</td><td>2.47-2.77</td><td>2.63</td></tr>
<tr><td>Ordovician</td><td>O</td><td>Limestone</td><td>10</td><td>2.63-2.79</td><td>2.69</td><td rowspan="5">Third layers 2.69</td></tr>
<tr><td>Cambrian</td><td>∈</td><td>Limestone and dolomite</td><td>59</td><td>2.61-2.84</td><td>2.68</td><td rowspan="4">0.04</td></tr>
<tr><td rowspan="3">Proterozoic</td><td>Qingbaikouan</td><td>Qn</td><td>Dolomite, sandstone, shale</td><td>14</td><td>2.43-2.80</td><td>2.62</td></tr>
<tr><td>Jixian County Department</td><td>Jx</td><td>Dolomite, limestone and quartzite</td><td>185</td><td>2.40-2.9</td><td>2.73</td></tr>
<tr><td>The</td><td>Ch</td><td>Dolomite, limestone</td><td>287</td><td>2.40-2.80</td><td>2.71</td></tr>
</table>

	Great Wall Department		and quartzite					
	Turn the group into a group	Hd	Angled schist and crystallized limestone	45	2.54-2.75	2.64	Fourth layers 2.65	
Archaean	Single tower subgroup	Dn	Breccia, gneiss and amphibolite	443	2.42-3.00	2.64		
	Qianxi group	Qn	Gneiss, breccia and amphibolite	311	2.36-3.11	2.68		

Table 3. A list of density of magmatic rocks

Rock category	Number of blocks	times	Intrusive rock			Eruption rock		
			Rock name	Range of change 103kg/m3	average value 103kg/m3	Rock name	Range of change 103kg/m3	average value 103kg/m3
alkalinity	20	The Paleozoic Era	Nepheline syenite	2.41-2.59	2.54			
Acidic	751	The Paleozoic Era	Granite	2.33-2.68	2.56	Rhyolite	2.17-2.63	2.44
	81	The Paleozoic Era	Granite	2.51-2.65	2.57			
	13	Archaean	Granite	2.53-2.65	2.58			
	59	mesozoic	Granodiorite	2.52-2.68	2.60			
neutral	10	mesozoic	Syenite	2.45-2.63	2.54			
	10	The Paleozoic Era	Syenite	2.48-2.70	2.62			
	20	The Paleozoic Era	Diorite	2.52-2.97	2.77	Andesite	2.46-2.59	2.53
Basic	20		Diabase and gabbro	2.67-3.14	2.83	basalt	1.97-2.97	2.62
Ultrabasic	28		Pyroxenolite	2.80-3.49	3.21			

The intrusive rock mass is widely distributed in the area, the scale of the rock mass is different and the lithology is complex. When a certain scale of intrusive rocks contact with the surrounding rock to form an obvious density interface, they can form different gravity anomalies, mainly in the following three situations [8].

Anthem density of a, ultrabasic, basic rock and neutral diorite is higher than all the strata. When this kind of rock mass has a certain scale, it can produce a more regular gravity anomaly.

b. The density of a, ultrabasic, basic rock and neutral diorite is higher than all the strata. When this kind of rock mass has a certain scale, it can produce a more regular gravity anomaly.

c. Acidic and alkaline rocks of Archean, Proterozoic and lower density and higher density of Paleozoic, Mesozoic and Cenozoic strata density. When they have a certain scale and intruded into the Archean, Proterozoic and Paleozoic strata, can produce low gravity anomalies; when they have a certain scale and intruded in Mesozoic and Cenozoic strata, can produce high gravity anomalies.

2.2 Magnetic Characteristics of Stratigraphic and Magmatic Rocks

The magnetic properties of the strata can be roughly divided into three types: sedimentary rocks, volcanic rocks and metamorphic rocks. The magnetic susceptibility kappa value is the largest metamorphic rock, the volcanic clastic rock is the second, and the sedimentary rocks are basically nonmagnetic. The Jr value of residual magnetization is the largest in volcanic clastic rocks and second in metamorphic rocks. From the late Proterozoic to Cenozoic sedimentary rocks of the rock forming minerals are mainly felsic carbonate rocks, magnetic properties are very low, and most of them are diamagnetic. Therefore, the sedimentary rocks are basically a set of non-magnetic strata [9].

The general trend of the change of the magnetic properties of igneous rocks is from the ultrabasic basic rock, which is from large too small. The same kind of rocks than plutonic eruptive rock with strong magnetism. The intrusive rocks are mainly magnetic, and the ejecting rock is dominated by eminence. This is mainly related to the structure and conditions of their formation.

3. Regional Gravity Survey Method

3.1 Regional Gravimetry

Class I and II gravity base net used in the regional gravity survey, Hebei Bureau of geological exploration geophysical exploration Institute in conjunction 1980 - 1982 years. The precision of the first class net (the weakest mean square error) is + 0.056 x 10-5m/s2. The precision of the second class network (the most weak mean square error) is + 0.053 x 10-5m/s2. The gravity base point network is based on the national basic point of Beijing (Bostan system). All the maps compiled in this research work have been revised, and the national basic point of Beijing has been calculated at the same time (belonging to the 85 gravity system). The Persian system and the 85 gravity system, including the -13.056 x 10-5m/s2 reference error and the approximately 0.2 per thousand scale error). During the field investigation in the construction of regional gravity, due to some point damage and easy to use[10], some places from class I and II on the basis of expenditure support, at least two gravimeter by support base point measurement, and each edge of at least four qualified independent increments, the accuracy (the weakest side) + 0.036 * 10-5m/s2.

3.2 Topographic Correction

(1) 0 - 2km topographic correction

0 - 2Km topographic correction is divided into two parts. 0 - 500 meters are used to read the height data of the node in the air, and the radius is 0 - 50 - 100 - 200 - 350 - 500 meters, five rings and eight directions. From 500 to 2000 meters, we use the 1:5 10000 map, the average height of the sector, and the specific ring radius is 500 - 700 - 1000 - 1500 - 2000 meters, which is divided into sixteen directions. The terrain correction calculation, the first ring 0 - 50 meters with the cone formula, the second after the fan-shaped formula, the density value of 2.67103 kg /m3

(2) 2 - 20km and 20 - 166.7km topographic correction.

The 2 - 20km terrain correction value is calculated with the common point method with the height of 1km x 1km node. The 20 - 166.7km topographic correction is calculated by using geographic coordinates 5 'x 5' node elevation data. The gravity database of 2 - 20km and 20 - 166.7km is used to calculate the gravity database of the gravity center of the original mine.

3.3 Data Processing Technique

The purpose of data processing is to separate or highlight the fields of some objects based on eliminating all kinds of errors, and make information easier to identify and explain quantitatively. The method of data processing should be determined according to the geology of the working area, the characteristics of the geophysical field and the purpose of interpretation. According to the development of fault structure, the widespread distribution of magmatic rocks and the need for comprehensive interpretation of targets in this study area, different methods and software were used to do repeated comparison experiments. The following data processing methods were selected in this research[11].

4. Comprehensive Application of Regional Gravity Data

4.1 Application of Regional Gravity Survey in Inferential Fissure Structure

(1) Characteristics of gravity and magnetic anomalies in fractured structures

Whatever faults in Bouguer gravity anomaly map display after data processing or in other types of gravity map in varying degrees, so using gravity data inference and fault research is effective.

(2) Inference of depth and occurrence of fracture cutting

The inference of the depth of cutting

A.Deducing the cutting depth of fracture according to the gravity field

Fault depth mainly based on Bouguer gravity anomaly cascade extension zone with different levels and different height level extension of a derivative of local anomaly and vertical axis two derivative zero line judge fracture relative depth, the gravity inversion profile fitting quantitative calculation of the depth.

B.Judging the cutting depth of fracture according to the geological phenomenon

It is characterized by large TECTONIC ZONING boundary, basic intermediate, ultrabasic and multi-stage large-scale intermediate acid magmatic belt, reflecting deep cutting. There are ultrabasic magmatic rocks that are cut to Moho; it is cut to conk's surface with intermediate acid magmatic rocks; it is cut to basement without magmatic rocks[12].

Inference of fracture occurrence

A.According to the Bouguer gravity anomaly gradient zone center is determined according to the location of fracture, offset on the extension of Bouguer gravity anomaly with different height of the cascade center position, understand the tendency of fracture surface approximation.

B. The horizontal direction by extending the different height of the first derivative of local abnormal axis symmetry, tendency of wings discriminant of fault plane, such as contour symmetry derivative extremum wings showed that fracture occurrence is asymmetric when erect, two wings in the fault dip direction, the gradient is slow, sparse contour.

(3) Division of fracture structure level

The classification of fault structure is mainly based on the downward extension of the gravity field source (cutting depth), combined with the geological division. According to the cutting depth, the fault structures in the area can be divided into three levels, namely, deep faults, large faults and general faults.

(4)Inferential interpretation of fracture structure

According to the sign of gravity and magnetic field fracture, combined with geological and remote sensing data and fault structures of the region (a certain scale) for inference and interpretation, a total of 68 inferred faults (deep 8 faults, big 7 faults, generally 53 faults, which inferred three NW faults (Lancaster sub - Longmen, Zhangbei - Shahe fault fracture of F11 F47, Yulin - south ditch water) is the fracture area in North West to biggest faults, they have a certain control effect on the formation and the distribution of magmatic rocks in this area, which is of great significance to the mineralization in this area.

4.2 Application of Regional Gravity Survey in Inference and Interpretation of Intrusive Rock Mass

(1) Qualitative interpretation of rock mass

A, with a certain scale, in acidic and neutral acid rock (including granite, granodiorite, syenite porphyry, quartz diorite) to carbonate rocks (including Proterozoic, Paleozoic dolomite, limestone strata) for surrounding rock, the general performance of high magnetic gravity low anomaly and the corresponding exception.

B, a medium scale acid, acid and partial neutral rock (including granodiorite, granite, syenite porphyry and quartz diorite).

(2) The distribution characteristics of magmatic rocks in the northwest of Hebei Province

In the whole geological evolution history of Northwest Hebei, magmatic activity is very frequent, showing obvious multi period. The magmatic activity in Yanshan period is the most widely distributed and the most intense, forming the main body of magmatic activity in this area. The magmatic activity in this area is obviously directional, which shows that its distribution is strictly controlled by fracture structure, and forms a spatial pattern of group and zone distribution. In general, it can be divided into a magmatic zone, that is, four east-west, and two North East.

(3) Gravity anomaly analysis of typical intrusive rock mass

Three Sichuan Road is long porphyry is located in Chicheng county and Fengning county at the junction of Qingyang ditch River fault of the North East, exposed on the surface discontinuities in the rock mass on the Bouguer gravity anomaly for obvious equiaxed low gravity anomalies and the lowest values of gravity anomalies is -136 * 10-5m/s2, abnormal contour center relatively wide slow. On the plane map of residual gravity anomaly, it is an obvious and equiaxed low gravity anomaly, which is larger than the exposed area of the rock mass.

According to the characteristics of gravity and magnetic field, combined with geological data, it is considered that there is a large area of the syenite porphyry in the lower part of the anomaly center. It is quantitatively calculated that the undergrowth of the syenite is larger than that of the long spot, which is exposed on the surface. The depth is about 4800 meters.

5. Summary

Based on the regional gravity survey data, combined with the distribution characteristics of the main minerals and the new understanding of the spatial distribution characteristics of the structures and magmatic rocks in the area, we can make a metallogenic prediction study on the investigation area, summarize the metallogenic regularities of the area, and set up the prospecting criteria. In the study area, 2 gold metallogenic belts, 3 prospective areas, and 3 polymetallic metallogenic belts, which provide a basis for finding new mineral deposits in the future.

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