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General requirements for mineral exploration
固体矿产地质勘查规范总则

(English Translation)

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Foreword

SAC/TC 93 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with the rules given in the GB/T 1.1-2009.

This standard replaces the GB/T 13908-2002 *General requirements for mineral exploration* in whole. The following technical deviations have been made with respect to the GB/T 13908-2002 (the previous edition).

- The sequence of chapters and items was adjusted;
- The basic principles for exploration were added (see Clause 3);
- The stage of reconnaissance was canceled, and the connotation of each stage of exploration were modified in accordance with the GB/T 17766 (see Clause 4, or 2002, 4.3);
- The exploration research level and control level were combined into exploration stage (see Clause 6, or 2002, 4.1, 4.2);
- "Reasonably determining the exploration engineering spacing and deploy the exploration" and "effectively verify the continuity of the orebody" was supplemented as purpose to determine the exploration type (see 6.1.1.1);
- The standards for the main orebody determination (see 6.1.1.2), conditions for determination of the exploration type (see 6.1.1.3) and requirements (see 6.1.1.5), and "the principle of three exploration lines" (see 6.1.1.6) for determination of the exploration type were added;
- The connotation of basic exploration engineering spacing was added (see 6.1.2.1);
- The exploration depth (see 6.1.4) and requirements for the degree of comprehensive exploration and comprehensive evaluation (see 6.1.5.2) were added;
- The requirements for the test and research on ore processing and metallurgical properties were revised (see 5.4, 6.2.5, 6.3.4, 6.4.4, 8.8, or 2002, 4.1.4);
- The principles for the determination of proportion of mineral resources, and the reference requirements for the proportions of mineral resources defined in each exploration stage of the metallic and nonmetallic deposits were added (see 6.3.6、6.4.6 and Annex A);
- The exploration stage requirements of complex and small scale deposits for mine construction design were added (see 6.5);
- The requirements for green exploration were added (see Clause 7);
- The requirements for the conditional use of air reverse circulation drilling technology were added (see 8.5.3.5);
- The requirements for rock and mineral identification sampling, sample preparation and identification (see 8.6) and the analysis of harmful components of rocks (see 8.7.2.8) were added;
- The spectral total analysis was revised to qualitative and semi-quantitative total analysis (see 8.7.2.1, or 2002, 4.4.6);

- The requirements for chemical analysis, internal check, and external check (see 8.7.1,8.7.2) and requirements for analytical quality check (see 8.7.4) were supplemented;
- The requirements for raw data preservation were added (see 8.10);
- The requirements for feasibility assessment were revised (see Clause 9, or 2002, Clause 5);
- The requirements of specific condition for the classification of mineral resources were added (see Clause 10);
- The requirements for the use of computer application technology (see 11.2.2), the extrapolation principle of the orebody (see 11.2.6), the measured resources and indicated resources delineation (see 11.2.7), and capping (see 11.2.8) and multi-mineral orebody delineation were added (see 11.2.10);
- The basic requirements for mineral reserves estimation were added (see 11.2);
- The Annex A in the edition 2002 was modified, and the "Classification of Mineral Resources/ Mineral Reserves" was revised to "Classifications of Mineral Resources and Mineral Reserves and the Conversion Relationships" (see Annex B, or 2002, Annex A) ; The Annex B and Annex C in edition 2002 were deleted, while the "Mineral Resources Estimated in Each Exploration Stage of the Metallic and Nonmetallic Deposits and the Reference Requirements for the Proportions" was added (see Annex A, or 2002,Annex B and Annex C);

This standard was proposed by the Ministry of Natural Resources of the People's Republic of China.

This standard was prepared by SAC/TC 93 (National Technical Committee 93 on Land and Resources of Standardization Administration of China).

The previous edition of this standard is as follow:

- GB/T 13908 - 2002

General requirements for mineral exploration

1 Scope

This standard specifies requirements for solid mineral exploration (hereinafter referred to as exploration), including the basic principles, purposes and stages, research contents, exploration level, green exploration, work content and quality, feasibility assessment, classifications for mineral resources and mineral reserves, as well as estimates and other aspects.

This standard is applicable to the overall deployment for all exploration stages, and is also applicable to guide the preparation of mineral type (group) exploration specifications, technical requirements, related specifications and regulations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 17766 *Classifications for mineral resources and mineral reserves*

3 Basic principles

3.1 Explore in accordance with corresponding laws and regulations, green exploration, comprehensive exploration, reasonably utilize and protect the mineral resource.

3.2 Be technically feasible, economically viable, and environmentally acceptable.

3.3 Based on the occurrence of mineral resources, exploration is carried out under the criterion of meeting the needs of varied work degrees and exploration purpose, properly balancing the means and the purpose, the local and the global, the need and the possibility.

3.4 Follow the rules of geological prospecting and proceed step by step.

3.5 Carry out exploration in parallel with relevant research, design and optimization.

4 Purposes and stages of exploration

4.1 Purposes of exploration

The purposes of exploration are to discover and evaluate mineral deposits (ore bodies) that are possible for further exploration or mining, provide relevant geological information supporting exploration or development decision, thus ultimately provide necessary geological data for mine construction design, so as to reduce investment risks in exploration and development of deposits, and obtain reasonable economic benefits.

4.2 Stages of mineral exploration

4.2.1 Division of mineral exploration stages

According to the GB/T 17766, exploration is divided into three stages: general exploration, detailed exploration and advanced exploration, which should be carried out in order of stages. When submitting the results of exploration altogether or across stages, it should also be implemented by steps with reference to the requirements of corresponding exploration stage.

4.2.2 Purposes and tasks for each stage

4.2.2.1 General exploration

The tasks for general exploration are, on the basis of regional geological survey and research, to search, check, verify and trace the mineralization clues using appropriate exploration techniques, and then discover an (mineralized) orebody. Meanwhile, through limited sampling and test work, as well as test and research, preliminarily identify the geological characteristics of the orebody(deposit)and the metallurgical properties of the ores, and have a preliminary understanding of the mining technical conditions. At this stage, it is necessary to conduct a scoping study to estimate the inferred resources, and evaluate whether it is necessary to upgrade to a detailed exploration, if thus, outline the target zones for detailed exploration.

4.2.2.2 Detailed exploration

On the basis of general exploration, the tasks of detailed exploration are, with appropriate exploration techniques and systematic sampling control and test work, as well as test and research, to identify primarily the geological characteristics of a deposit, the performance of ore processing metallurgical properties, and the mining technical conditions, which is adopted as the geological basis for planning of the property area (mine field) and advanced exploration scope identification. At this stage, it is necessary to conduct a scoping study and estimate the inferred resources and indicated resources, determine whether it is necessary to upgrade to advanced exploration, if thus, outline the target zones for advanced exploration. A pre-feasibility study and/or feasibility study may also be conducted to estimate probable mineral reserves.

4.2.2.3 Advanced exploration

On the basis of detailed exploration, the tasks for advanced exploration are, by appropriate exploration techniques, infilled sampling, and comprehensive test work, to identify in detail geological characteristics of a deposit, the performance of ore processing metallurgical properties, and the mining technical conditions, which provide necessary geological data for mine area planning with production capacity, product scheme, mining method, development scheme, ore processing and metallurgical technology, and the overall layout. At this stage, it is necessary to conduct a scoping study and estimate the inferred, indicated, and measured resources. A pre-feasibility study and/or feasibility study may also be conducted to estimate probable and proved mineral reserves.

5 Exploration research contents

5.1 Metallogenic geological conditions

5.1.1 The basic requirements for exploration research are to collect and study the results of previous regional geology and mineral research. Based on the knowledge of regional geological conditions and geological research on the exploration area, it is necessary to study continuously the metallogenic geological conditions of ore minerals, summarize the prospecting signs of known deposits and analyze the genesis of the deposits.

5.1.2 As for the conditions of the strata, it is necessary to carry out the research on the lithological characteristics (including color, composition, texture, structure, rock type, etc., the same below), thickness, orientation and distribution of the strata in the exploration area, and divide the stratigraphic sequences, lithological composites, lithofacies zone and marker layers, study the material composition, and the physical and chemical properties of rocks and lithofacies, and investigate their relationship with mineralization, consequently providing a basis for the study of ore-bearing horizons. For sedimentary minerals, the relationship between sedimentary background and mineralization should also be studied.

5.1.3 As for the conditions of the structure, it is necessary to study the geological structural characteristics of the exploration area, including the scale, shape, orientation, nature, spatial distribution range and development order of the main structures, as well as the development degree of small structures, the relationship with metallogenic zones, and the effects on ore bodies.

5.1.4 As for the conditions of the magmatic rock, it is necessary to study the scale, shape, orientation, lithological characteristics, lithofacies, geochemical characteristics, emplacement mode, intrusion stage, intrusion age, and contact relationship between rock mass and wall rock etc. for the deposits associated with magmatic intrusions; for the deposits related to volcanic activities, to study the lithological characteristics, lithofacies, geochemical characteristics of volcanic rocks related to mineralization, tectonic characteristics related to volcanic

activities, types of volcanic mechanism, eruption modes, eruption cycles, eruption rhythms, eruption ages, together with their relationship with mineralization.

5.1.5 As for the conditions of the metamorphic rock, it is necessary to study the lithological characteristics, metamorphic mineral composites, metamorphic facies and distribution characteristics of facies belts, the property, intensity, and influencing factors of metamorphism, as well as the influence of metamorphism on the formation or transformation of deposits.

5.1.6 As for the conditions of the wall rock alteration, it is necessary to study the types, mineral composition, intensity, distribution range and zoning characteristics, as well as the relationship between alteration and mineralization.

5.2 Orebody characteristics

5.2.1 To study the effect and influence of post-mineralization structures and magmatic rocks on the orebody, and find out the contrasting signs of orebody.

5.2.2 To study the quantity, scale, shape and internal texture, orientation, spatial location, thickness and variation of ore bodies, as well as contents of main useful components and associated changes, contrasting signs, continuity of ore bodies, and the overall distribution of orebody within the exploration area, etc.

5.2.3 To study the type, scale, lithology, thickness and distribution of internal waste, characteristics of non-ore area, lithology and distribution of roof and floor of ore bodies, etc.

5.2.4 To study the development degree, scope, mineral compositions and distribution of the oxidized zone, transitional zone and primary zone (referred to as "three zones") of the deposit, as well as the secondary enrichment phenomenon and enrichment rules of the deposit.

5.3 Ore characteristics

5.3.1 To study the type, content, coexisting combination of ore minerals and gangue minerals, as well as the ore texture and structure, and the embedded characteristics of the ore minerals (intergranular, fractured, interstitial, encapsulated, etc.) and so on.

5.3.2 To study the chemical composition of ores, type, content, occurrence state of useful, beneficial and harmful components (isolated minerals, isomorphism, adsorption condition, dispersion condition, etc.), as well as the change and distribution of main useful components and so on.

5.3.3 To study and classify the natural and industrial type of ores. The classes of ore shall be divided necessary.

5.3.4 For coal, to study the coal quality characteristics such as coal petrography, physical properties, chemical properties, technological performance, category and so on.

5.4 Technical property of ore processing beneficiation, and metallurgy

5.4.1 Based on the test purpose, requirements, extent and the reliability of the results in practice, ore processing and metallurgical tests are divided into five categories as amenability test, laboratory process test, laboratory expanded continuous test, pilot plant test, and industrial test; the physical and chemical property test work of non-metallic minerals is divided into three categories as preliminary test work, basic test work and detailed test work based on the research level.

5.4.2 Research on ore processing and metallurgical properties generally includes mineralogy research of ore, processing and metallurgical test work of metallic ores and some non-metallic ores, assay on physical and chemical properties of some non-metallic ores, study on processing, metallurgical ore products and tailings properties and so on.

5.4.3 Research on the ore mineralogy mainly focuses on the mineral composition, chemical composition, texture and structure, technological particle size and embedded characteristics of ore minerals, physical and chemical properties of ore, content, occurrence, distribution ratio of useful, beneficial and harmful components, and the distribution of ore, the oxidation status of the ore, etc. in the process of processing and metallurgy.

5.4.4 Test work and research on processing and metallurgical properties mainly include the amenability of ore, the availability of major useful components, the comprehensive recovery of associated useful components and the possibility of removing harmful components, the process and conditions, together with experimental indicators during ore processing and metallurgy.

5.4.5 Assay on physicochemical properties include physical and chemical property tests on some ore or non-metallic minerals, including the study of the physical and chemical properties of minerals or ores that are closely related to the technological performance of mineral products.

5.4.6 Research on processing and metallurgical refinery ore products and tailings properties is through analyzing the quality of concentrates and metallurgical products, the mineral composition, grade, particle size composition of tailings and their utilization methods or application trends, as well as sedimentation characteristics and indicators, toxic leaching, and purification as well as treatment of processing wastewater.

5.5 Mining technical conditions

5.5.1 Hydrogeological conditions

The main research contents of hydrogeological conditions are as follows:

a) Regional hydrogeological conditions, characteristics of the hydrogeological unit in which the exploration area (mine area) is located, recharge, runoff, and discharge conditions of groundwater.

b) The lithology, thickness, orientation, distribution and burial conditions of aquifer and aquifuge, water bearing and permeability of aquifers, hydraulic connection between aquifers, the level, quantity, quality, temperature of groundwater and dynamics variation, stability and water barrier properties of aquifuge.
c) Development degree, distribution, water bearing and conductivity of fault fracture zones, joints, weathered fracture zones and karst caves, distribution of surface water as well as the means and extent of hydraulic connection with the main aquifers of the deposit, etc.
d) Distribution, depth, water accumulation and subsidence of goafs.
e) The complexity of the hydrogeological conditions of the deposit.
f) Normal and ultimate groundwater yield of mine, and rainfall catchment in open pit mines.
g) Water supply source (direction), water quantity, water quality, etc.

5.5.2 Engineering geological conditions

The main contents of the research on engineering geological conditions are as follows:
a) The physical and mechanical properties of the orebody and the rock on the roof and floor, such as density, hardness, moisture, lumpiness, compressive strength, shear strength, loosening coefficient, angle of repose, joint density, rock quality designation (RQD) value, etc.
b) The influence of structure, weathered zone, weak interlayer, etc. on the mining of the deposit.
c) The lithology, thickness and distribution of Quaternary strata.
d) Slope stability of the open pit.
e) The complexity and the type of engineering geological conditions of the deposit.
f) The main engineering geological problems that may arise during the mining of the deposit.

5.5.3 Environmental geological conditions

The main research contents of environmental geological conditions are as follows:

a) Relevant environmental geological phenomena (rockslides, landslides, debris flows, land subsidence, ground fissures, karst, ground temperature, etc.), the quality of surface water and groundwater, the content and distribution of radioactive elements and other harmful substances in the exploration area (mine area).

b) Seismic geological conditions such as earthquakes and neotectonics' activities and the stability of the mine area.

c) The quality of the geological environment before the mining of the deposit, and the possible damage together with impact on the environment and ecology of the mining area during and after the mining of the deposit.

d) For coal, the coalbed gas, ground temperature, ground pressure, spontaneous combustion potential, and coal dust explosion, etc. should be studied as well.

6 Level of exploration

6.1 Basic requirements for exploration control

6.1.1 Exploration types

6.1.1.1 The exploration types shall be reasonably determined for precisely selection of the exploration method and techniques, reasonably determine the exploration engineering spacing and effectively control the deposit, and verify the continuity of the orebody as well.

6.1.1.2 The exploration types shall be determined according to the characteristics of the main orebody, namely, one or more ore bodies that will be the main mining targets. At the exploration stage, the main ore bodies are generally determined according to the scale of the mineral resources of the ore bodies, and the mineral resources (generally the main minerals, if necessary, the paragenetic commercial minerals shall also be considered) of one or more ore bodies which occupy over 60% of the total mineral resources of the deposit shall be selected as the main ore bodies (listed from bigger to smaller in mineral resources), which is specified in the specifications for different types of minerals (groups) in the light of their own characteristics.

At the general exploration stage, it is difficult to determine the exploration type since the basic characteristics of the ore body are not identified. However, if comparable, the exploration type can be preliminarily determined by comparison with the similar deposits. At the detailed exploration stage, the exploration type shall be determined according to the related main geological factors. At the advanced exploration stage, the exploration type shall be verified in the light of changes in the main geological factors affecting the exploration type, and the exploration type shall be adjusted if it is verified to be unreasonable.

The exploration types are generally classified into three types as simple (type I), medium (type II), and complex (type III) according to the scale of the orebody, the shape and complexity of the internal texture, the degree of thickness stability, the division of distribution uniformity of the useful components , and the complexity of the structure, together with other major geological factors. In view of the complexity of geological factors, transitional exploration types such as simple-medium type (type I-II) and medium-complex type (type II-III) also could be defined. The specification for different mineral type (group) shall, in accordance with the characteristics of the different mineral type (groups), reasonably determine the main geological factors affecting the division of the type of exploration, as well as reasonably divide the type of exploration and determine the conditions of different type

6.1.1.3 At the general exploration stage, it is difficult to determine the exploration type since the basic characteristics of the ore are not identified. However, if comparable, the exploration type can be preliminarily determined by comparison with the similar deposits. At the detailed exploration stage, the exploration type shall be determined according to the related main geological factors. At the advanced exploration stage, the exploration type shall be verified in the light of changes in the main geological factors affecting the exploration type ,and the exploration type shall be adjusted if it is verified to be unreasonable.

6.1.1.4 When determining the exploration type of deposit, the overall scale of the orebody shall be considered, the exploration type of each orebody shall be determined according to the geological characteristics, and exploration type of deposit shall be determined according to the characteristics and spatial relationship of the main ore bodies. When exploration type of the main ore bodies varies, the characteristics of the main ore bodies and the requirements of the research level of the overall control factors of the deposits should be comprehensively considered, and the exploration types of the deposits shall be reasonably defined. For large-scale deposits (orebody) with significant differences related to the exploration difficulty of different sections, the exploration type can be defined by sections (or portions).

6.1.1.5 In principle, when a certain orebody is defined to be a certain exploration type (except Type III), it shall be possible to be continuously controlled by minimum three exploration lines at the basic exploration engineering spacing of the corresponding exploration type, and orebody shall be intersected in no less than two consecutive engineering works per line.

6.1.2 exploration engineering spacing

6.1.2.1 The exploration engineering spacing should be reasonably determined according to the exploration types. For deposits of different types of minerals and different exploration types, the exploration engineering spacing for delineation of indicated resources is defined as the basic exploration engineering spacing. The reference values are specified by the specifications of different mineral type (group).

6.1.2.2 Generally, the exploration engineering spacing of measured resources is narrowed down 50% against the basic exploration engineering spacing and that of inferred resources is two times of the basic exploration engineering spacing, but not limit as these, to meet the requirements of the corresponding exploration research degree. During practical exploration process, methods such as comparison, geostatistical analysis, engineering verification, etc. shall be applied for the detailed exploration and advanced exploration stages to demonstrate the rationality of the exploration engineering spacing, and shall be adjusted as needed.

6.1.2.3 When the variations of orebody along the strike or dip are inconsistent, the exploration engineering spacing should be adapted to the variations. When the orebody is exposed to the surface, the spacing of surface exploration should be appropriately increased, so as to further study the metallogenic regularity and ore-control regularity, as guidance for deep exploration.

6.1.3 Exploration planning

6.1.3.1 On the basis of reasonably determining the exploration type and exploration engineering spacing, considering the geological characteristics of the orebody and the needs of mine construction, the conditions of topography, geophysical survey, and geochemical survey, and requirements for ecological and environmental protection, exploration methods and techniques which are appropriate, effective, and have less impact on the ecological environment shall be selected. Meanwhile, the exploration shall be deployed according to the exploration type and the corresponding exploration engineering spacing, controlling the deposit in general. It is necessary to adjust local exploration engineering spacing by specific conditions, so as to strengthen the understanding of local ore bodies (such as areas of great variety in ore bodies) and secondary ore bodies.

6.1.3.2 In general, trenching, soil stripping, shallow shaft, surface boring, small round shafting and other green and effective alternative exploration methods are mainly adopted on the surface, supplemented by shallow-hole drilling, combined with effective geophysical and geochemical surveys. And core drilling is mostly conducted in depth. When the shape of the orebody is complex, in the shape of a tube, and the composition of the ore material varies greatly, resulting in difficulty to achieve the exploration purpose by drilling, tunneling should be adopted as the main method supported by drilling, or through tunneling for verification. When the geological results obtained are similar to the results of tunneling verification, further tunneling are not required. When the terrain is favorable, tunneling shall be primarily considered. When it is necessary to collect bulk samples of mineral processing, tunneling can also be adopted. During the exploration, general operations such as geological mapping, geophysical survey, geochemical survey, remote sensing, and heavy-mineral survey should be carried out first, in order to guide and optimize the layout and construction of exploration work.

6.1.3.3 In general, limited sampling is carried out for study in general exploration stage, and systematic sampling control (according to a certain and regular exploration engineering spacing) is carried out in detailed exploration stage. The sampling density in advanced exploration stage is reasonably increased on the basis of detailed exploration.

6.1.3.4 During the exploration, attention should be paid to study the overall distribution range and mutual relationship of ore bodies within the exploration scope. As for the boundary of the outcropped orebody, the orientation and scale of the larger undulating basement, non-ore area, structure, vein, karst, salt solution,

mud ridge, mud column, collapse column and goaf that damage the orebody and affect extraction, as well as boundary of the mining area (mine field), there should be engineering controls. The small orebody that can be mined simultaneously with the main orebody should be properly controlled. For the ore deposit to be mined underground, the main orebody should be controlled specially at the two ends, the upper and lower boundaries and the extension of the ore deposit. For the open pit mine, the boundary around the orebody and the boundary of the orebody at the bottom of the pit should be systematically controlled. For the main blind orebody, the top boundary should be controlled.

6.1.4 Exploration depth

6.1.4.1 The exploration depth should be determined scientifically and reasonably. When there is certain mineralization potential at depth, the common practice for exploration shall be carried out to the depths of the corresponding minerals generally required. The exploration depth shall be increased properly if the internal and external conditions of deposit are favorable, or in the edge or deep part of mine with long history, while the specific requirements shall be stipulated by the mineral type (group) according to the actual mining conditions.

6.1.4.2 Comparison is recommended to determine the exploration depth if conditions permit, otherwise, the exploration depth shall be determined through demonstration. Study on mining technical conditions shall be strengthened properly for the deep orebody exploration.

6.1.5 Comprehensive exploration and comprehensive evaluation

6.1.5.1 The comprehensive exploration and comprehensive evaluation for the deposit shall be carried out at each stage of exploration. The specific requirements shall be implemented in accordance with the relevant specifications of the comprehensive exploration and comprehensive evaluation and the different ore mineral type (group).

6.1.5.2 At the stages of detailed exploration and advanced exploration, the multi-mineral orebody or paragenetic commercial minerals in different orebody with a resource scale of medium or above shall be overall considered together with the main minerals, and the evaluation shall be conducted according to the requirements for the corresponding paragenetic commercial minerals exploration. As for the exploration level, the detailed exploration is generally required to reach the stipulated corresponding requirements by exploration specifications, and the degree of advanced exploration shall depend on the specific situations. For the paragenetic commercial minerals with a small-scale mineral resources, the infill control shall be carried out depending on the situation and requirements of the engineering that control the main minerals, and the evaluation shall be carried out according to the requirements for the corresponding paragenetic commercial minerals exploration.

6.1.5.3 Associated minerals are usually controlled by the engineering that controls the main minerals. A comprehensive recovery plan shall be studied and proposed for the associated minerals which have reached the comprehensive evaluation reference index and can be recycled under the current technical and economic conditions. For the associated minerals that do not meet the comprehensive evaluation reference index or are not included in the comprehensive evaluation reference index, but can be produced separately in the ore processing and metallurgy, or can be enriched in a product to meet the valuation standard, research should be carried out to propose comprehensive recycling and utilization pathways, and evaluation should be carried out accordingly.

6.1.6 Radioactive inspection

Radioactive inspection should be conducted on the radiative minerals at all the stages of exploration in accordance with the general requirements for exploration, and strengthen the evaluation of the radioactive impact on human health and environment. Radioactive inspection shall be carried out for non-radioactive minerals exploration and the samples shall be collected and tested as required when the assay results report anomaly values. Further work shall not be conducted if the radionuclide content in orebody or wall rock exceeds an allowable limited value and cannot be recovered, meanwhile the human health and environmental protection may be affected and there are no effective prevention and treatment measures.

6.1.7 Data collection and utilization

Regional geological data should be comprehensively collected at each stage of exploration, particularly for the geology, minerals, geophysical and geochemical surveys, remote sensing, heavy mineral survey, exploration engineering, sampling test, test and research data, and the latest research results in and around the exploration area. All the data are fully studied and utilized.

6.2 Requirements for general exploration

6.2.1 On the basis of fundamental geological research, by carrying out geological mapping (generally a simple geological survey map), remote sensing interpretation and outcrops inspection in the exploration area at a scale ranged from 1:25,000 to 1:5,000, and combined with exploration engineering, it is necessary to study mineralized geological rules, compare to known deposits, discuss the genesis of mineral deposit, summarize the mineralization markers and preliminarily identify the metallogenic geological conditions as well as the characteristics of the mineralized bodies in the exploration area. For sedimentary minerals such as coal, detailed classification of coal bearing strata should be carried out, with focus on the research of sedimentary environment and facies, metallogenic regularity and ore-control regularity, and preliminarily identifying the structure.

6.2.2 The mineralization anomalies shall be verified, checked, traced and evaluated one by one through the ore (mineral) occurrence inspection, 1:10,000 or larger scale geophysical and geochemical surveys profile measurement (or a comprehensive profile of geology, geophysical and geochemical surveys) or area measurement, and necessary sampling, etc.

6.2.3 The discovered orebody, especially the major ones, shall be controlled by sparse sampling on the surface, especially for the main orebodies, with the deep verification by engineering, while systematic engineering control is not required, however, the reasonable connection with the subsequent exploration engineering layout should be considered as much as possible. Geological mapping (simple or normal geological survey map) shall be carried for the deposit outcropped on the surface as required at a scale ranged from 1:5,000 to 1:1,000. The continuity of the orebody is reasonably interpreted through research on the control, to preliminary identify the geological characteristics of the main orebody and the overall distribution in the exploration area.

6.2.4 By means of mineral identification (identification of rock and mineral, the same below), testing, analyzing and comparing to a known deposit with a similar geological characteristic by sparse sampling engineering, it is necessary to preliminarily identify the ore features such as material composition, texture and structure, embedded characteristics of ore minerals, contents and occurrence of useful, beneficial and harmful components, as well as the natural types of ore, etc.

6.2.5 On the basis of the ore processing mineralogy and mineral processing technology, the comparative research on the easy processing ore should be carried out. Generally, comparative research on the medium difficult processing ore is carried out, and the amenability test shall be carried out if necessary. For the new types of ore and difficult processing ore, the amenability test is generally adopted, and the laboratory process test shall be conducted if necessary. The preliminary testing research on physical and chemical properties for some non-metallic minerals is carried out, and the basically testing research shall be carried out if necessary. The technical performance of ore processing and metallurgy in the exploration area is preliminarily investigated.

6.2.6 The information related to the hydrogeology, engineering geological and environmental geology of the region and the exploration area shall be collected and investigated by comparison with mines which have similar mining technical conditions. For deposits with highly complex mining technical conditions, the hydrogeological and engineering geological work shall be assigned properly to preliminarily investigate the hydrogeological, engineering geological, environment geological conditions of the exploration area. The types of hydrogeological and geological engineering exploration are preliminarily classified.

6.2.7 When one orebody is discovered, and under the premise of complying with geological rules, the inferred resources can be estimated according to the

exploration type preliminarily determined or Type Ⅱ (in case with no such analogy conditions) and the corresponding exploration engineering spacing.

6.3 Requirements for detailed exploration

6.3.1 On the basis of general exploration, the metallogenic geological conditions and the characteristics of mineralized orebodies in the exploration area are basically identified through the geological mapping prepared for the mining area at scale of 1:25,000 – 1:5,000 (normal geological survey map) and geological mapping for the deposit at scale of 1:5,000 – 1:500 (normal geological survey map), combined with engineering control and exposure, to elucidate the geological conditions, characteristics, metallogenesis and metallogenic regularity of a deposit.

6.3.2 Once the exploration type is determined, through using reasonable exploration engineering spacing, effective exploration techniques and methods, and systematic sampling engineering, the deposit is controlled. The characteristics of ore bodies are basically ascertained. The work is to primarily identify the number of main ore bodies, basically control the scale, shape, orientation, spatial location and the overall distribution of ore bodies in the exploration area, and basically determine the continuity of the main orebodies. Further work should be done on the structures affecting the mining area (field) division, as well as large structures and magmatic rocks that control, damage and affect the orebody.

6.3.3 Sampling, testing and analyzing in systematic engineering works are conducted to basically identify the ore features such as material composition, texture and structure, ore particle size and embedded characteristics of ore minerals, content of useful, beneficial and harmful components, occurrence and variation, nature and industrial types, etc.

6.3.4 On the basis of ore mineralogical research and mineral processing technology, the comparative research and amenability test are carried out for easy processing ore depending on the circumstances, and laboratory process test shall be conducted if necessary. The amenability test and laboratory process test are carried out for the medium difficult processing ore according to the circumstances. The laboratory process test is carried out for new types of ore and difficult processing ore, and laboratory expanded continuous test shall be conducted if necessary. The preliminary testing research on physical and chemical properties for some non-metallic minerals is carried out, and the detailed testing research shall be carried out if necessary. The technical performance of ore processing and metallurgy in exploration area is basically identified.

6.3.5 Investigation of hydrogeology, engineering geology and environmental geology shall be carried out for the area that may be affected by the mining operation (include the extent of affected mine requiring drainage, destructive area by ground deformation, waste dump and possible contaminated area). Necessary pumping and drainage experiment shall be carried out to basically identify the hydrogeological, engineering geological and environment geological conditions , and classify the

types of hydrogeological and engineering exploration. Investigate the deposit water filling factors, the engineering geological characteristics, the roof and floor of ore bodies, wall rock of the adits and shafts, stripping materials and slope engineering characteristics of open pit, etc. The major issues that affect deposit mining from the hydrogeological, engineering geological and environment geological aspects are predicted.

6.3.6 Indicated resources and inferred resources are generally estimated with reasonable proportion of distribution for the area that above the determined exploration depth. Indicated resources shall be concentrated in the section that may be mined primarily or at early stage. While for the area below the determined exploration depth, further work is usually not required, but evaluation on the metallogenic prospect shall be carried out. The proportion of mineral resources for metal and non-metallic mineral deposits at the detailed exploration stage can be referred to the requirements of Annex A. The mineral resources proportion in line with the actual ore mineral type is determined for each type of ore minerals (group) according to the related characteristics, and the corresponding regulation shall be implemented.

6.4 Requirements for advanced exploration

6.4.1 On the basis of detailed exploration, it is necessary to revise the geological map of the exploration area and the geological map of the mine (should be prepared as normal geological survey map) as needed or carry out a large-scale geological mapping (normal geological survey map), combining with the engineering of infill control and exposure. The metallogenic geological conditions and characteristics of mineralized geological bodies, the mineralization and metallogenic genesis and regularity should be identified in detail.

6.4.2 On the basis of systematic engineering control of detailed exploration, the necessary infill drilling shall be carried out through effective exploration methods to control the orebody as well as the large structures and magmatic rocks which may control, damage and affect the orebody. The mineral characteristics of the main orebody such as scale, shape, orientation, spatial location, continuity and the overall distribution are identified in detail.

6.4.3 On the basis of infill engineering and through sampling, testing and assaying, it is necessary to identify the characteristics of ore such as material composition, texture and structure, ore particle size and embedded characteristics of the mineral, as well as the types of useful, beneficial and harmful components, occurrence and content of useful components and the variation, ore nature and industrial types, so as to meet the basic requirements of mine construction design in terms of characteristics research on the ore quality.

6.4.4 On the basis of detailed study on ore processing and mineralogical research, for easy processing ore, laboratory process test shall be conducted; for medium difficult processing ore, laboratory process test shall be conducted, and laboratory

expanded continuous test shall be carried out if necessary. For difficult processing ore, the laboratory process test and laboratory expanded continuous test are conducted, and pilot plant test and industrial test shall be conducted if necessary. A detailed testing research on physical and chemical performance for some non-metallic minerals shall be carried out. The technical performance of ore metallurgy and processing is preliminarily investigated to provide a reasonable ore processing and metallurgical flowsheet for the mine construction and design.

6.4.5 The hydrogeological conditions of the exploration area and water filling factors of the deposit shall be investigated in detail. The calculating parameters are obtained to estimate the groundwater yield of mine in the initial mining area (first mining level), and the comprehensive utilization for underground water resources is evaluated to provide suggestions for water prevention and treatment in mine, and point out the direction of water supply sources (direction). The engineering geological conditions are identified in detail to evaluate the engineering geological characteristics of orebody and the roof and floor, quality and rock mass stability of the wall rock and open pit, analyze and evaluate the main engineering geological hazards that may occur under the mining conditions, and propose suggestions for prevention and treatment. The quality of geological environment in the mining area is investigated and evaluated to predict the main environment geological issues that may be caused by the development of the deposit, proposing suggestions for prevention and treatment.

6.4.6 Measured resources, indicated resources and inferred resources are generally estimated for the area above the proposed exploration depth, and a reasonable proportion is also required. The stage of advanced exploration shall focus on the initial mining area with consideration of the whole mining area. The measured resources and indicated resources shall be fundamental within the initial mining area (early mining section for coal). While for the area below the determined exploration depth, further work is generally not required, but evaluation on the metallogenic prospect shall be carried out. Generally, according to the principle of "Ensure that principal and interest are repaid in the initial mining area, and mine construction risks are controllable", the proportion for each resource category shall be reasonably determined after demonstration. The proportion requirements of mineral resources for metallic and non-metallic mineral deposits at the advanced exploration stage can be referred to Annex A. The mineral resources proportion in line with the actual ore mineral type is determined for each type of ore minerals (group) according to the related characteristics and the corresponding regulation shall be followed.

6.5 Exploration level requirements of complex and small scale deposits for mine construction design

6.5.1 Metallic and non-metallic complex deposits refer to the deposit which is difficult to estimate the measured resources with infill sampling on basic spacing

of exploration work, or difficult to estimate the indicated resources with basic spacing of exploration work in Type III. For complex large and medium-scale deposits which are difficult to estimate the measured resources with infill sampling based on basic spacing of exploration work, the indicated resources shall be estimated, and the final detailed exploration report shall be submitted as the basis for the mine construction design. For the complex small scale deposit which is difficult to estimate the indicated resources with basic spacing of exploration work, the inferred resources shall be estimated, and the final general exploration report shall be submitted as the basis for being explored while mining during the mine production stage.

6.5.2 The level of final detailed exploration requires that the characteristics of orebody and ore quality research for exploration control of small deposit for mine construction design shall generally reach the level of detailed exploration. The level of final general exploration requires characteristics of orebody and ore quality research and control for exploration shall generally reach the level of general exploration. Moreover, the research level of exploration control on the other aspects shall meet the requirements of advanced exploration. The requirements of mineral resources proportion are referred to Annex A.

6.5.3 The geological risks should be fully considered when the final detailed exploration report and final general exploration report are used as the geological basis for the mine design, which is not suitable for the construction of large, and medium-scale mines.

7 The requirements for green exploration

7.1 General requirements

7.1.1 The requirements for green development and ecological environment protection shall be applied throughout the whole process of exploration design, construction, check and acceptance, and delivery, to minimize the impact on the environment in the whole process of exploration.

7.1.2 By relying on technology and management innovation, the disturbance, pollution, and damage to the ecological environment caused by exploration activities are maximumly avoided or reduced. The exploration technique that provides an effective alternative to trenching and costeaning is recommended, and the exploration technique with less land occupation such as “one platform with multiple drillholes, one drillhole with multiple purposes” is encouraged.

7.1.3 Environmental protection knowledge and skills training should be provided to the workers to enhance the awareness of environmental protection, and the requirements of green exploration shall be implemented effectively.

7.2 Exploration design

7.2.1 The requirements of green mineral exploration shall be fully reflected and clearly proposed in the exploration design.

7.2.2 On-site survey shall be carried out prior to the exploration design to predict the potential impact and degree on ecological environment by the exploration activities.

7.2.3 The relationship between the exploration purposes and tasks and the protection of ecological environment shall be coordinated during the process of exploration design. Appropriate exploration methods, technological means, equipment, technology and new materials shall be adopted to reasonably deploy the exploration engineering. Operational and technical arrangement for green exploration in all aspects of the exploration activities shall be deployed, such as site selection, road routing, stockpiling, waste disposal, various engineering construction, environmental rehabilitation and governance. The measures for prevention and control, as well as for the organizational management shall be proposed.

7.3 Exploration activities

7.3.1 The activities of mineral exploration shall be carried out in strict compliance with the requirements of the exploration design. The green exploration requirements shall be fully considered for the optimization of exploration design.

7.3.2 Effectively management and control shall be conducted against the damage of soil and vegetation caused by vehicles, personnel passage, and land occupation, the waste gas pollution from mechanical operation, light and noise disturbance from equipment operation, damage caused by digging and burying detectors and excitation and blasting, and collapse and slope type mudflow caused by excavation of soil and rocks, and the mud (waste water, waste residue, waste oil, etc.), domestic garbage, and waste, etc.

7.4 Environmental rehabilitation, governance,check and acceptance

7.4.1 When the exploration or stage work is completed, the environmental rehabilitation and governance work shall be carried out in time against the environmental impact of exploration activities in accordance with national laws and regulations, mandatory standard and requirements of rehabilitation and governance design to minimize the negative impact of the exploration activities on the ecological environment.

7.4.2 The implementation of green exploration requirements shall be used as important criteria for check and acceptance of the project.

8 Content and quality of exploration

8.1 Survey