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Specifications for rock gold mineral exploration

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(*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 GB/T 1.1-2009 *Directives for standardization - Part 1: Structure and drafting of standards*.

This standard replaces the DZ/T 0205-2002 Specifications for rock gold mineral exploration in whole. In addition to a number of editorial changes, the following technical modifications have been made with respect to the DZ/T 0205-2002 (the previous edition):

- The scope of application of the standard was modified.
- The classifications and categories of mineral resources and mineral reserves were redefined; the classification of stages for mineral exploration was revised to three stages: general exploration, detailed exploration and advanced exploration; the purposes of the mineral exploration and the tasks of each mineral exploration stage were modified.
- The sequence of chapters on control level, the mineral exploration, and quality requirements was adjusted.
- The requirements for the research level of oxidized, transitional and primary zones were further clarified.
- The requirements for the experimental research on ore metallurgical properties were revised.
- The general requirements for the proportion of resources in each mineral exploration stage were added: in the detailed exploration stage, the indicated resources are generally not less than 50%; in the advanced exploration stage, the sum of the measured and indicated resources is greater than 50%, of which the measured resources shall meet the needs of capital repayment with interest for mine construction.
- The requirements for the advanced exploration and research level of small-scale deposit were added.
- The “final general exploration” and “final detailed exploration” were included in the advanced exploration stage as special cases.
- The requirements for "control level of the initial mining area", "control level of the boundary", "control level of the structure" and "control level of the small orebody", "control level of the deep and peripheral areas of old mine", "control level of the complex deposit" and "the densest exploration grid for rock gold mine" were added to the advanced exploration stage.
- The control level of coexisting and associated minerals and the general requirements for reasonable mineral exploration depth of rock gold deposit were added.

- The determination of the exploration type, the selection of mineral exploration methods, and the determination of the mineral exploration engineering spacing in each stage were revised.
- The basic mineral exploration engineering spacing corresponding to each exploration type was revised.
- The content and quality requirements of mineral exploration were enriched.
- The green mineral exploration requirements were added.
- The general requirements for sampling and sample processing procedures were revised.
- The processing flowsheet of coarse-grained and giant-grained gold ores was revised.
- The general technical parameters and variables for ore deposit of rock gold ore were revised.
- The relevant requirements for orebody delineation and capping of outliers were revised.

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 China Standardisation Committee for Natural Resources and Land and Space Planning.

The previous edition of this standard is as follow:

- DZ/T 0205-2002。

Specifications for rock gold mineral exploration

1 Scope

This standard specifies the purposes of rock gold mineral exploration, mineral exploration stage, research level, control level, exploration and quality requirements, feasibility evaluation, and estimation for mineral resources and mineral reserves.

This standard is applicable to the rock gold mineral exploration and the evaluation of the results.

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 12719 Exploration specification of hydrogeology and engineering geology in mining areas

GB/T 13908 General requirements for mineral exploration

GB/T 17766 Classifications for mineral resources and mineral reserves

GB/T 18314 Specifications for global positioning system (GPS) surveys

GB/T 18341 Specifications of survey for geological and mineral resources exploration

GB/T 25283 Specification for comprehensive exploration and evaluation of mineral resources

DZ/T 0033 Specifications for compilation of geological reports on mineral exploration

DZ/T 0078 Procedures for original geological record of solid mineral exploration

DZ/T 0079 Technical requirements for recording and research of geological data of solid mineral exploration

DZ/T 0130 The specification of testing quality management for geological laboratories (in whole)

DZ 0141 Regulations for tunneling of mineral exploration

DZ/T 0227 Geological core drilling regulations

DZ/T 0275 Specification identification of rock and mineral (in whole)

DZ/T 0336 Specifications for scoping study of mineral exploration

DZ/T 0338 Regulations of mineral resources estimation (in whole)

DZ/T 0339 Requirements for technical parameters and variables for ore deposit

DZ/T 0340 Requirements for mineral processing test research level in mineral exploration

3 Purposes and stages of mineral exploration

3.1 Purposes of mineral exploration

The purposes of mineral exploration are to discover and evaluate mineral resources, estimate mineral resources and mineral reserves, and provide basis for investment decision-making and mine construction design.

3.2 Stages of mineral exploration

3.2.1 Classification of mineral exploration stages

The rock gold mineral exploration is divided into three stages: general exploration, detailed exploration, and advanced exploration according to GB/T 17766 and GB/T 13908. In the course of implementation, the mineral exploration stages may be adjusted as the circumstances may require: the three stages may be carried out in order, or combined, or completed at one time across the stages.

3.2.2 General exploration

The task is, by simple geological mapping, geophysical and geochemical surveys, and sparse sampling, to seek mineralization clues, discover an orebody (or deposit), primarily identify the characteristics of the deposit, the quality properties of the ore, the metallurgical properties of the ore, and prelimiarily learn the mining technical conditions for the deposit, to conduct a scoping study and estimate inferred resources to determine whether the project shows potential for economic development and provide a basis for whether further work is worthwhile, and to outline targets for detailed exploration.

3.2.3 Detailed exploration

The task is, by large-scale geological mapping, appropriate exploration techniques and methods, and systematic engineering works and sampling, to identify primarily the characteristics of the deposit, the quality properties of the ore, the metallurgical properties of the ore, and the mining technical conditions for the deposit, as the basis for general mine planning and advanced exploration. A scoping study is conducted to estimate inferred and indicated resources. A pre-feasibility study and/or feasibility study may also be conducted to estimate probable mineral reserves and determine whether the project has the industrial value.

3.2.4 Advanced exploration

The task is, by increasing sampling density, to clearly identify the characteristics of strata, structure, magmatic rocks, mineralization and alteration of wall rock in the advanced exploration area, the characteristics of the deposit, the quality properties of the ore, the metallurgical properties of the ore, and the mining technical conditions for the deposit, providing the necessary geological data for mine construction design to determine the scale of mine production, product scheme, mining method, development scheme, ore processing and metallurgical process and general layout of the mine. A scoping study is conducted to estimate inferred, indicated, and measured resources. A pre-feasibility study and/or feasibility study may also be conducted to estimate probable and proved mineral reserves.

4 Research level

4.1 Geological research

4.1.1 General exploration

4.1.1.1 Through conventional geological mapping at a scale of 1:10,000 to 1:2,000, effective geophysical and geochemical surveys, remote sensing, heavy mineral method, and limited sampling, the geological characteristics, such as strata, structures, magmatic rocks, and mineralization alteration, preliminarily identify the metallogenic geological conditions.

4.1.1.2 Through the inspection of ore (mineral) occurrences, screening of anomalies by geophysical and geochemical surveys, and Levels I-II verification, the reasons for the anomalies are studied and explained to discover an orebody.

4.1.1.3 The main ore bodies are preliminarily controlled. The surface is controlled by sparse sampling, with the depth verified by engineering works, and no systematic exploration grid is required. The continuity of the orebody, the quantity, scale, geometric shape, orientation, distribution, and thickness and grade characteristics of the main orebody, and the development degree and distribution scope of the oxidized zone are preliminarily identified.

4.1.1.4 Inferred resources are usually estimated using general technical parameters and variables for ore deposit.

4.1.2 Detailed exploration

4.1.2.1 Through geological surveys at a scale of 1:5,000 to 1:1,000, systematic sampling, effective geophysical and geochemical surveys, identify primarily the geological characteristics such as strata, structures, magmatic rocks, mineralization alteration, and metallogenic geological conditions.

4.1.2.2 The type, nature, spatial location, quantity, scale, orientation, and complexity of the main ore-controlling structures in the property area (deposit), as well as the controlling and destructive effects on the ore deposit (orebody) are primarily identified. A certain amount of engineering works shall be conducted to control the faults which are more destructive to the orebody.

4.1.2.3 The rock type, lithofacies distribution and contact relationship with the wall rock of the magmatic rocks related to metallogenesis and the spatial location, geometric shape, orientation, scale, and intrusion (extrusion) age of rock mass and the relationship with metallogenesis are primarily identified. A certain amount of dedicated exploration shall be conducted to control the rock mass and vein rock which are more destructive to the orebody.

4.1.2.4 The lithology, age, and facies distribution of metamorphic rocks related to metallogenesis and their relationship with metallogenesis are primarily identified.

4.1.2.5 The type, intensity, scale, combination of wall rock alteration, and the relationship with gold mineralization are primarily identified. The industrial type of the deposit is primarily determined (see Annex A).

4.1.2.6 The quantity, scale, shape, orientation, spatial location, internal texture of the orebody are primarily identified, the thickness, grade and their variation characteristics of the orebody are primarily identified. And its continuity is primarily determined.

4.1.2.7 The lithology, scale, shape, orientation, distribution, and ore-bearing potential of the internal waste, as well as the lithology and ore-bearing potential of the wall rocks on the roof and floor, are primarily identified.

4.1.2.8 Based on the oxidation characteristics and oxidation rates of featured minerals, the development degree and oxidation characteristics of the oxidized zone are primarily identified. The oxidized zone, the transitional zone and the primary zone are primarily determined. When there is an impact on processing and metallurgy, the oxidized zone, transitional zone, and primary zone shall be delineated respectively.

4.1.2.9 The technical parameters and variables for ore deposit determined by demonstration are adopted to delineate the orebody and estimate the inferred and indicated resources.

4.1.3 Advanced exploration

4.1.3.1 Based on the primary identification of the strata, structures, magmatic rocks, metamorphic rocks, alteration of wall rocks and metallogenetic patterns of the property area (deposit) during the detailed exploration, further exploration and geological study are carried out to upgrade the level to detailed exploration.

4.1.3.2 The quantity, scale, shape, orientation, spatial location, and internal texture of the main ore bodies, as well as the thickness, grade, and their variation rules, are identified in detail to determine the continuity of the ore bodies.

4.1.3.3 The lithology, distribution, scale, orientation, shape, and ore-bearing potential of the internal waste, as well as the lithology and ore-bearing potential of the wall rocks of the roof and floor, are identified in detail.

4.1.3.4 Based on the oxidation characteristics and oxidation proportion of featured minerals, the development degree and oxidation characteristics of the oxidized zone are identified in detail, and the boundaries between the oxidized zone, the transitional zone, and the primary zone are accurately determined. When there is an impact on processing and metallurgy, the oxidized zone, transitional zone, and primary zone shall be delineated in detail.

4.1.3.5 The technical parameters and variables for ore deposit determined by optimization demonstration are adopted to delineate the orebody and estimate the inferred, indicated, and measured resources.

4.1.3.6 For small deposits (Standards for scale divisions of deposit, see Annex B), the level of exploration and research shall be reasonably determined according to the actual needs.

4.1.3.7 For complex deposits, the final results of the detailed exploration shall be submitted when the exploration grid of (20 m - 40 m) × (20 m - 40 m)[1] can only estimate the indicated resources at most; the final results of the general exploration shall be submitted when the exploration grid of (20 m - 40 m) × (20 m - 40 m) can only estimate the inferred resources at most. The final detailed exploration and the general exploration, as special cases of the advanced exploration stage, shall meet the requirements of mine construction design in terms of ore quality, the metallurgical properties of the ore, and the mining technical conditions for the deposit.

4.2 Research on ore characteristics

4.2.1 General exploration

4.2.1.1 Ore minerals, gangue mineral composition, chemical composition, and ore grade are preliminarily identified.

4.2.1.2 The ore texture and structure, the gold occurrence state, and the embedded characteristics of the gold minerals are preliminarily identified. The ore types are preliminarily classified.

4.2.1.3 The content and relationship of valuable components, and beneficial and harmful components for coexisting and associated minerals are preliminarily identified.

1) The engineering grid refers to the size of the grid composed of two adjacent engineering works arranged at a certain spacing in two different directions, and is generally expressed as the “side length × side length” of the grid. The engineering grid of (20 m - 40 m) × (20 m - 40 m) basically corresponds to the specifications of a single stope/pit or mining block. Engineering spacing refers to the distance between two engineering works in a single direction.

4.2.2 Detailed exploration

4.2.2.1 The type, content, and coexisting combination of ore minerals and gangue minerals, as well as the chemical composition, grade, and their variation characteristics of the ore, are primarily identified.

4.2.2.2 The texture and structure of the ore, as well as the natural type, industrial type, and distribution characteristics of the ore, are primarily identified.

4.2.2.3 The type, content, and proportion of the main gold-bearing minerals in the ore and the relation between the gold-bearing minerals and gold mineral are primarily identified.

4.2.2.4 The occurrence state and embedded characteristics of gold, the particle size, shape and relative purity of gold minerals, and the physical and chemical characteristics of gold-bearing minerals shall be primarily identified. The respective proportions of fractured gold, intergranular gold, interstitial gold, and encapsulated gold, the proportions of coarse-grained, medium-grained, and fine-grained gold, and the proportions of various shapes of gold minerals are counted. See Annex C for rock gold minerals, and Annex D for classifications of particle size and shape of gold minerals.

4.2.2.5 The content and relationship of coexisting and associated valuable components,and beneficial and harmful components are primarily identified.

4.2.3 Advanced exploration

4.2.3.1 The type, content, and coexisting combination of ore minerals and gangue minerals, as well as the chemical composition, grade, and variation characteristics of the ore, are identified in detail.

4.2.3.2 The texture and structure of the ore, as well as the natural type, industrial type, and distribution characteristics of the ore, are identified in detail.

4.2.3.3 The type, content, and proportion of the main gold-bearing minerals in the ore and the generic connection between the gold-bearing minerals and gold are identified in detail.

4.2.3.4 The occurrence state and embedded characteristics of gold, the particle size, shape and relative purity of gold minerals, and the physical and chemical characteristics of gold-bearing minerals shall be identified in detail. The respective proportions of fractured gold, intergranular gold, interstitial gold, and encapsulated gold, the proportions of coarse-grained, medium-grained, and fine-grained gold, and the proportions of various shapes of gold minerals are counted.

4.2.3.5 The type, content, and distribution should be detailed for sliming minerals such as chlorite and kaolinite, which influence the processing and metallurgical process.

4.2.3.6 The content and relationship should be detailed in terms of valuable, beneficial and harmful components, coexisting, and associated components.

4.3 Research on ore processing and metallurgical properties

4.3.1 Basic requirements

4.3.1.1 The experimental research level requirement on ore metallurgical properties depends on different exploration stages, the complexity of ore processing and metallurgy, and the scale of mineral resources, which shall be determined on a case-by-case basis. The implementation is specified in accordance with DZ/T 0340.

4.3.1.2 The experimental research on ore metallurgical properties for newly discovered orebody in the deep area and surrounding area of the production mine may be determined according to a comparison of the mineralogical research results of ore with relevant information from the production mine, depending on the following:

a) If the ore properties are generally consistent, and the existing processing and metallurgical facilities can be used to process the ore, analogy research may be conducted in the general exploration stage or for small-scale deposits; for large and medium-scale deposits, the current processing and metallurgical flowsheet of the mine shall be employed for verification tests, and the experimental research on amenability shall be carried out if necessary.
b) If the ore properties are inconsistent, corresponding experimental research shall be conducted according to the requirements of different mineral exploration stages.

4.3.2 General exploration

On the basis of the process mineralogical research of the ore, the ore metallurgical properties are preliminarily identified. For easy and medium difficult processing ores, evaluation can be carried out by analogy; for difficult processing ores and new types of ores, amenbility test shall be carried out, and laboratory process test shall be conducted if necessary.

4.3.3 Detailed exploration

On the basis of the process mineralogical research of the ore, the ore metallurgical properties are primarily identified. For easy and medium difficult processing ores, amenbility test shall be carried out, and laboratory process test shall be conducted if necessary; for difficult processing ores or ores with complex properties, many associated components, and harmful components that have a great impact on the environment, laboratory process test shall be carried out, and laboratory expanded continuous test shall be conducted if necessary.

4.3.4 Advanced exploration

On the basis of a detailed process mineralogical research of the ore, representative samples shall be collected for different ore types, and the test on ore metallurgical properties shall be carried out to identify the detailed technical characteristics. For easy and medium difficult processing ores, laboratory process test shall be conducted, and laboratory expanded continuous test shall be carried out if necessary; for difficult processing ores and new types of ores, laboratory expanded continuous test shall be conducted, and pilot plant test or industrial test shall be carried out if necessary.

4.4 Research on the mining technical conditions for the deposit

4.4.1 General exploration

4.4.1.1 While conducting geological survey or geological mapping, hydrogeological, engineering geological and environmental geological information of the region and the exploration area shall be collected, and information on various protected areas, residential areas and important infrastructure in the exploration area shall be investigated, to have a preliminary understanding of the mining technical conditions for the deposit. The hydrogeological, engineering geological and environmental geological sketch maps at corresponding scale shall be prepared if necessary.

4.4.1.2 For deposits with simple mining conditions, comparisons may be made with mines of the same type; for deposits with moderately or highly complex hydrogeological conditions, hydrogeological work shall be carried out if necessary to learn the depth of groundwater, water quality and quantity; for areas where geological hazards are common, information on natural geological hazards such as collapses, landslides, and mudslides shall be collected with attention.

4.4.2 Detailed exploration

4.4.2.1 The distribution range of surface water bodies in the mineral exploration area and the water level, flow velocity, flow rate, water quality, water yield, elevation of the highest flood level and the inundation range in wet period, mean-flow period, and dry period, as well as the hydrogeological characteristics, development degree and distribution of aquifer (aquiclude), structural fracture zones and weathered zones, are primarily identified, and the development degree, distribution and water abundance of karst are studied. The distribution and water accumulation of goaf are investigated to propose recommendations for further work.

4.4.2.2 The groundwater recharge, runoff and discharge conditions in the mineral exploration area and the hydraulic connection between surface water and groundwater, as well as the main water filling factors of the deposit, are primarily identified, and the water yield of mine is estimated. The type of hydrogeological exploration is primarily determined, and the complexity of hydrogeological conditions is evaluated. The water quantity, quality and utilization conditions of available water supply sources are investigated and studied to trace the direction of water supply sources.

4.4.2.3 According to the type of wall rock and ore characteristics of the orebody, the engineering geological rock groups of the deposit are classified, and the physical and mechanical properties of the main rocks and ores are sampled and tested. The development degree and distribution of faults, fracture zones, joints and fissures in the mineral exploration area are primarily identified, and the stability of the orebody and the wall rocks of the roof and floor is evaluated. The weathering and alteration degree of wall rock, the distribution of soft rock and weak interlayers, and the influence on mining are primarily identified. The type of engineering geological exploration is primarily determined, and the complexity of engineering geological conditions is evaluated.

4.4.2.4 The slope stability for the proposed open pit is primarily evaluated.

4.4.2.5 The composition, content and harmful level of elements, radionuclides and other harmful gases in rocks, ores and groundwater that are harmful to human health and the ecological environment, as well as the development of geological hazards such as earthquakes, collapses, landslides, and debris flows in the mineral exploration area and adjacent areas, are investigated. The possible impacts of the extraction of the deposit on the geological environment of the area are analyzed and evaluated.

4.4.3 Advanced exploration

4.4.3.1 The groundwater recharge, runoff, and discharge conditions in the mineral exploration area, as well as the lithology, thickness, orientation, distribution, and burial conditions of aquifer and aquiclude of the deposit, are identified in detail. The water abundance, water conductivity, and permeability coefficient of the aquifer in the area, the hydraulic connection between the aquifers, and the water level, water temperature, water volume, hydro-chemical characteristics and dynamic changes of groundwater are identified in detail.

4.4.3.2 The location, scale, orientation, filling and cementation degree, water abundance, water conductivity and their changes in faults, fractured zones, joints, and weathered fissure zones are identified in detail, and the sections where structural fracture zones may cause water inrush are analyzed, to further study the water abundance and water conductivity of the karst. The distribution and water accumulation of goaf are investigated, and the water accumulation is roughly estimated, to propose recommendations for water prevention and control.

4.4.3.3 The catchment area, distribution range, water level, flow rate, and flow velocity of surface water, as well as the elevation of the highest flood level and the inundation range in history that has an impact on the extraction of the deposit are identified in detail, and the impact of surface water on the extraction of the deposit is analyzed and demonstrated, to propose water prevention and control measures.

4.4.3.4 For underground mining deposits, the usual water yield of mine and ultimate water yield of mine in the initial mining area are estimated. For mines requiring drainage, the groundwater storage volume within the scope of corresponding falling funnel of drawing water shall also be estimated when draining to the elevation of each level. For open pit, in addition to estimating the usual yield of mine and ultimate water yield of mine water inflow of groundwater in the open pit, the normal rainfall and maximum stormwater that flow into the pit from the surrounding areas shall also be estimated according to the specified frequency standard of heavy rain. The type of hydrogeological exploration is determined, and the complexity of hydrogeological conditions is evaluated.

4.4.3.5 The possibility and plan of mine water utilization are evaluated. The water quantity, quality, and utilization conditions of the available water supply sources are investigated in detail to indicate the water supply sources.

4.4.3.6 The compressive strength, shear strength, angle of repose, density of joint fissure, and stability of the orebody and the wall rock of the roof and floor are analyzed by sampling and testing. The influence of structural weathered zones and weak interlayers on the extraction of the deposit, as well as the lithology, thickness, and distribution of the Quaternary, are identified in detail. The slope stability of the open pit is evaluated. The distribution and subsidence of the goaf are investigated. The type of engineering geological exploration is determined, and the complexity of engineering geological conditions are evaluated. The main engineering geological problems that may occur during the extraction of the deposit are predicted to propose prevention and control measures.

4.4.3.7 The development of geological hazards such as earthquake, collapse, landslide, debris flow in the mineral exploration area, as well as the radiological anomalies, are investigated in detail to evaluate the impact on production safety and environment.

4.4.3.8 The impact of regional water level decline due to underground tunnel drainage, as well as dry-up wells and springs on local water use, are investigated in detail. The wastewater and waste gas discharge during mining, processing, and metallurgy process, the stockpiles of waste rocks and tailings, and other possible impacts on environment are assessed, and the possibility and hazard of initiating or exacerbating geological hazards are evaluated, to propose prevention and control measures. The quality category of geological environment is determined.

4.4.3.9 The work of hydrogeology, engineering geology, environmental geology and their quality requirements shall be implemented with reference to GB/T 12719.

4.5 Comprehensive exploration and assessment

4.5.1 Basic requirements

In each stage of mineral exploration for gold deposit, according to the geological characteristics of the deposit, comprehensive exploration and comprehensive assessment shall be carried out on the coexisting and associated minerals with economic value. The implementation is specified in accordance with GB/T 25283.

4.5.2 General exploration

The material composition, occurrence and recovery methods of coexisting and associated minerals are roughly comprehended to make a preliminary assessment on the possibility of comprehensive development and utilization of coexisting and associated minerals.

4.5.3 Detailed exploration

The coexisting minerals are primarily identified, the geological characteristics, ore quality, material composition, and occurrence of associated minerals are primarily identified, the ore types of coexisting minerals are classified, and the experimental research on ore metallurgical properties is conducted, to assess the comprehensive development and utilization of coexisting and associated minerals.

4.5.4 Advanced exploration

The coexisting minerals are detailedly or primarily identified, the geological characteristics of associated minerals are primarily identified, in-depth experimental researches on ore material composition, occurrence, ore type, ore quality, and ore metallurgical properties are conducted, comprehensive development and utilization of coexisting and associated minerals are assessed in detail to meet the needs of mine construction design.

5 Control level

5.1 Exploration types

5.1.1 Basis for classification of the exploration types

The exploration types are classified according to the dimension of the orebody, the scope of shape change, the degree of thickness stability, the degree to which the orebody is influenced by structure and vein rock, and the division of distribution uniformity of main valuable components. See Annex E for factors used for the classifications of the exploration types.

5.1.2 Classification of the exploration types

5.1.2.1 The rock gold deposits are classified into three exploration types: Type I (simple), Type II (medium), Type III (complex) according to five factors: the dimension of the orebody, the scope of shape change, the degree of thickness stability, the degree to which the orebody is influenced by structure and vein rock, and the division of distribution uniformity of main valuable components. See Annex E for details.

5.1.2.2 Five factors are generally used as the basis for the classification of the exploration types, but the main influencing factors shall be identified. When a geological factor leads to the difficulty of exploration, this factor shall be used as the main basis for the classification of the exploration types.

5.1.2.3 When classifying the exploration types, the primary and secondary orebodies and their spatial relationship shall be distinguished. When the primary and secondary orebodies are spatially distributed in parallel and overlappingly with small intervals can use same exploration system, the primary orebody shall prevail. When the orebodies are far apart, or distributed in different sections, with different engineering systems required for exploration, the exploration types of mineral deposits shall be determined separately.

5.1.2.4 When the characteristics of the orebody vary considerably in different parts or directions, the exploration types may be determined in sections or in different directions.

5.1.2.5 The exploration type shall be adjusted in time with the progress of exploration process and geological understanding.

5.2 Exploration engineering spacing

5.2.1 Principles for determining the exploration engineering spacing

5.2.1.1 The exploration engineering spacing in different exploration stages shall be reasonably determined according to the purposes and tasks.

5.2.1.2 When the complexity of different orebodies and same orebody in different sections and different directions (e.g. along the strike and dip of the orebody) is inconsistent, the exploration engineering spacing shall adapt to their changes.

5.2.2 Determining the exploration engineering spacing

5.2.2.1 General exploration stage: focusing on ore prospecting. According to the principle that the exploration engineering spacing is determined without requiring a systematic engineering grid if there are sparse sampling for surface control and engineering verification in the depth, and that the engineering in this stage can be used for the work in the next stage.

5.2.2.2 Detailed exploration stage: systematic sampling is required, focusing on evaluating the industrial significance of the deposit. In the primary stage of detailed exploration, the exploration engineering spacing may be determined by comparing similar deposits, or by 2 to 4 times of the basic engineering spacing of Type II (engineering spacing of indicated resources) to form a systematic engineering grid; in the later stage of the detailed exploration, and various methods (e.g. comparison analysis on increasing and decreasing exploration density, geostatistics method, SD method, etc.) shall be used to analyze and study the characteristics of the deposit, and to demonstrate and determine the exploration type and the reasonable exploration engineering spacing. Refer to Annex F for the exploration engineering spacing corresponding to different exploration types.

5.2.2.3 Advanced exploration stage: it is required to infill the control engineering based on the systematic sampling engineering. According to the exploration type determined in the later stage of the detailed exploration, a reasonable exploration engineering spacing may be selected. During the exploration process, the exploration type shall be optimized and the engineering spacing shall be adjusted according to the verification results of infill engineering in some sections.

5.3 Exploration methods, execution principles, and control level

5.3.1 Exploration methods

5.3.1.1 The exploration shall adopt reasonable and effective technical methods and means, consider the needs, possibilities, benefits, and other aspects, focus on green exploration, protect the ecological environment, and encourage the use of new technologies and methods. Generally, the surface exploration is dominated by geological mapping, trenching, soil stripping, shallow shaft, and shallow-hole drilling, together with effective geophysical and geochemical surveys; at depth, drilling is the primary method with tunneling for verification, and in special circumstances, tunneling is the main method.

5.3.1.2 Trenching, soil stripping, shallow shaft, shallow-hole drilling are mainly used to understand and study the thickness of the Quaternary overburden and the lithology of the underlying bedrock, to expose the near-surface mineralization, alteration zone, major fault characteristic, and main geological boundary, to control the orebody outcrop and change in shape, orientation and ore quality of orebody, to verify the geophysical and geochemical surveys and heavy mineral anomalies, and to provide geological basis for the layout of engineering at depth.

5.3.1.3 When the thickness of the overburden is less than 3 m, trenching and soil stripping are applicable; when it is greater than 3 m, shallow shaft and shallow-hole drilling are applicable.

5.3.1.4 Drilling is mainly used to verify the anomalies of geophysical and geochemical surveys; to control the changes in the shape, orientation, thickness, and valuable components of ore (mineralized) body in the deep; and to study the interrelationship between the ore (mineralized) bodies at depth, and between the ore (mineralized) body and the strata, structure, and magmatic rocks.

5.3.1.5 Tunneling is mainly used for complex types of deposits or for verification drilling of Type I and Type II deposits, and may also be adopted to take samples for special purposes.

5.3.1.6 Geophysical and geochemical surveys are generally applicable to the general exploration stage to delineate anomalies and predict metallogenic areas;

in the detailed and advanced exploration stages, the geophysical and geochemical surveys in boreholes may provide a basis for finding blind orebody.

5.3.1.7 In practice, according to different situations, comprehensive exploration methods and means shall be adopted to achieve the ore prospecting target and reasonably control the orebody. Specific requirements are as follows:

a) The general exploration stage is dominated by mapping, geophysical and geochemical surveys, and exploration engineering, with a small amount of drilling verification in the deep; the detailed and advanced exploration stages are dominated by drilling, with tunneling as supplementation.
b) For Types I and Type II deposits, drilling is generally the main method, with tunneling for verification.
c) For Type III deposit, tunneling shall generally be the main method, supplemented by drilling. For complex deposit with very complex shape such as tube shape, dendritic shape, and cystic shape, or with extremely unstable thickness, or with extremely uneven mineral composition, it can only be explored while mining during the production stage.
d) For those requiring tunneling verification, when the results of tunneling verification are similar to the geological results obtained by drilling, the tunneling engineering may be reduced, and drilling is the main method in conjunction with tunneling; when the tunneling engineering cannot be carried out due to various factors, infill drilling may be adopted instead.
e) Exploration engineering such as trenching and shallow shafting are required for the near-surface, but if the execution cannot be carried out for various reasons, shallow-hole drilling may be adopted instead.

5.3.2 Execution principles

Exploration shall follow the principles of known to unknown, surface to underground, shallow to deep,and sparse to dense. Mapping, geophysical and geochemical surveys, remote sensing, and heavy-mineral survey shall be carried out first; the geophysical and geochemical survey verification exploration shall be conducted first along the main profile of the strike or dip; the exploration layout of each stage shall consider the connection between the subsequent exploration and development work; the existing exploration and mining achievements shall be comprehensively collected and utilized to avoid repeated execution.

5.3.3 Control level

5.3.3.1 General requirements: the exploration engineering shall be deployed based on the purposes and tasks of the exploration to reasonably determine the control level. Comprehensive exploration shall be carried out to focus on controlling the overall distribution of orebodies and their interrelationship, and local areas shall be controlled according to specific circumstances (e.g.

the significant difference between local and overall variations in orebodies, and whether small orebodies can be mined along with the main orebodies, etc.).

5.3.3.2 General exploration stage: there are sparse sampling on the surface and a small amount of engineering verification in the deep, focusing on the discovery of deposits and the control of deposit scale. The inferred resources are estimated.

5.3.3.3 Detailed exploration stage: systematic sampling engineering is conducted, generally with at least two engineering controls per cross section along the dip at depth, to primarily determine the continuity of the orebody, focusing on the evaluation of the industrial value of the deposit. The indicated and inferred resources are estimated, of which the indicated resource shall generally be no less than 50% of the total mineral resources.

5.3.3.4 Advanced exploration stage: based on the systematic sampling engineering in the detailed exploration stage, combined with the general planning of the mine, suitable sections shall be selected for infill engineering with a focus, to control the orebody in detail and determine the continuity of the orebody. The measured, indicated, and inferred resources are estimated, of which the sum of measured and indicated resources shall generally account for more than 50% of the total mineral resources, and the measured resources shall meet the needs of capital repayment with interest for mine construction. Relevant requirements of control level are as follows:

a) Control level of the initial mining area: the initial mining area is a test area for mining, processing and metallurgical methods, processes, and flowsheets in the early stage of mining. The control level shall meet the requirements of mine construction design and ensure that the mining method, development system and ore processing and metallurgical process cannot change significantly. Therefore, the initial mining area shall be controlled by infill engineering system to identify the orebody, ore characteristics and the mining technical conditions in detail, and to determine the continuity of the orebody. The measured resources are estimated primarily.
b) Control level of the boundary: for the boundary of the orebody exposed on the surface, the outcrop of the orebody shall be fully studied, and the infill exploration control may be adopted if necessary; the top boundary of the blind orebody shall be controlled; for the deposit to be mined underground, the two ends, upper and lower interfaces and extension of the main orebody shall be mainly controlled; for the deposit to be mined by open pit, attention shall be paid to the systematic control of the boundary around the orebody and the boundary of the orebody at the bottom of the open pit.
c) Control level of structure: faults, fracture zones, vein rocks, etc. that damage the orebody and affect the development and extraction of workings shall be controlled in terms of the orientation and dimension

with no less than three exploration engineering to determine related impact on the integrity of the orebody and the degree of damage.

d) Control level of small orebody: small orebody is not applicable for exploration according to the exploration type and engineering grid. The control level shall be determined on a case-by-case basis, focusing on controlling the spatial location and dimension. Generally, there shall be no less than six exploration engineering works for independent small orebody that can be included in the formal mining design target (minimum three exploration lines, with no less than two exploration engineering per line); for small orebody that cannot be included as a formal mining design target, but can be mined incidentally around the main orebody, a small amount of engineering control may be added, or explored while mining ; for isolated small orebody that cannot be mined incidentally, further engineering works may not be added.

e) The control level of the deep and peripheral areas of old mine: in the deep and peripheral areas of old mine, the occurrence rules of orebodies, ore characteristics, ore processing and metallurgical properties, hydrogeology, engineering geology, environmental geology, etc. have been verified by practice. The main purpose of the exploration is to increase mineral resources and mineral reserves and extend the life of mine. The focus shall be on controlling the extension of the orebody and estimating the indicated or inferred resources. More detailed exploration may be carried out during the mine production stage.

f) Control level of complex deposit: complex deposit which is difficult to be identified in detail in the mineral exploration stage, and can only be mined while exploring in the production stage.

g) The densest exploration grid[2)] for rock gold deposit is generally (20 m－40 m) × (20 m－40 m). When an exploration engineering grid of (20 m－40 m) × (20 m－40 m) can only estimate the indicated resources, the final report of detailed exploration shall be submitted with the proportion of indicated resources greater than or equal to 50%; when an exploration grid of (20 m－40 m) × (20 m－40 m) can only estimate the inferred resources, the final report of general exploration shall be submitted.

5.3.3.5 Control level of coexisting and associated minerals: comprehensive exploration and evaluation of coexisting and associated minerals shall be carried out in all exploration stages. For coexisting mineral in the multi-mineral orebody or coexisting mineral in different orebody with a resource scale of medium or above, they shall be considered together with the main minerals: the

2) The degree of identification that can be achieved in the mineral exploration stage is limited, and some problems can only be solved in the development stage. It is neither economical nor reasonable to try to identify complex and extremely complex deposits with an overly dense exploration grid in the stage of mineral exploration.

detailed exploration stage shall generally meet the requirements of the detailed exploration level stipulated in the corresponding mineral exploration specifications; in the advanced exploration stage, for the coexisting minerals that cannot be explored by areas, the gold ore shall be the primary focus, the gold exploration engineering works shall be fully utilized, and infill engineering works shall be carried out if necessary. For coexisting minerals that can be explored by areas, the corresponding exploration level requirements for the mineral types shall be achieved based on the needs and requirements. For the coexisting minerals with small-scale mineral resources, each stage is subject to the principle of gold-ore-based exploration. For associated minerals, the exploration engineering works of gold ores shall be fully utilized to conduct corresponding evaluation. The implementation is specified in accordance with GB/T 25283.

5.3.3.6 Reasonable exploration depth: In general, the common exploration depth is 1,000 m; if the internal and external conditions are good, it is generally not deeper than 1,200 m; the deep and peripheral areas of old mine are generally not deeper than 1,500 m. When the orebody is occurred or extended deeply, the exploration depth shall be reasonably determined according to the characteristics of the deposit, combined with technical parameters and variables for deposit or pre-feasibility study and feasibility study.

6 Content and quality requirements of exploration

6.1 Survey

The national coordinate system and national elevation system shall be adopted for topographic survey and exploration survey. Large-scale topographic map, geological map, profile of exploration line, tunnel plan and various engineering points shall be surveyed.

The implementation of survey accuracy and requirements is specified in accordance with GB/T 18341, and the implementation of global positioning system (GPS) survey is specified in accordance with GB/T 18314.

6.2 Geological mapping

Before mapping, a geological profile or a comprehensive profile of geology, geophysical and geochemical surveys shall be prepared to fully observe and study various geological phenomena related to mineralization with unified rock names, and mapping units, contents, requirements and methods shall be determined.

During large-scale geological mapping in the exploration area, the geological boundary of the orebody in the covered area shall be explored by trenching, costeaning, shallow-hole drilling or other effective works. The geophysical and geochemical surveys and remote sensing data shall be fully used to extract as much geological information as possible and improve the mapping quality. When the scale is 1:2,000 or greater, all geological observation points shall adopt the total station method to determine the accurate position; when the scale is less than 1:2,000, in addition to engineering points, special geological points or orebody marks, other geological points may be measured by a handheld GPS receiver for meter level positioning.

The accuracy and quality requirements for geological mapping are implemented in accordance with the specifications for geological survey at the same scale.

6.3 Geophysical and geochemical surveys

According to the actual needs of each stage of mineral exploration and research, effective geophysical and geochemical surveys on surface and in tunneling are selected in conjunction with topographic, geological and geophysical, and geochemical characteristics, with a view to obtaining information related to the orebody, various geological bodies and geological structures to guide further exploration.

Radioactive inspection shall be carried out for the ore and rock exposed by engineering works.

Geothermal survey shall be carried out for deposits with a vertical burial depth greater than 500 m.

The quality of geophysical and geochemical surveys at various scales shall meet the requirements of the corresponding specifications, with accurate and reliable test data.

6.4 Hydrogeology, engineering geology, environmental geology

Hydrogeological, engineering geological surveys and environmental geological survey at various scales shall meet the requirements of the corresponding scale specifications and the requirements of hydrogeological, engineering geological and environmental geological work in corresponding exploration stages. Hydrogeological, engineering geological, and environmental geological work and the quality shall be implemented in accordance with GB/T 12719.

6.5 Exploration engineering

6.5.1 Trenching, costeaning and shallow-hole drilling

They are mainly used to systematically explore for surface orebodies, structures, important geological boundaries and geophysical and geochemical anomalies. The trenching, costeaning and shallow-hole drilling that control the orebody shall be arranged vertically to the strike of the orebody as far as possible, and intersected with the orebody roof and floor.

6.5.2 Void survey

Focus on investigating the distributions of voids, old mining drives. According to the actual situation, they shall be cleaned, logged, and sampled, with their spatial position being determined, as far as possible.

6.5.3 Tunneling

Tunneling shall generally be arranged in the main orebody and the initial mining area, and may replace some drillholes for exploration at depth when conditions are applicable. The tunnel of strike drift shall be excavated within the vein as much as possible. When the thickness of the orebody is greater than 2m, or when the orientation of the orebody changes and the tunnel of strike drift does not penetrate the roof and floor of the orebody, the cross cut shall be adopted to control the orebody. The project quality shall be implemented in accordance with DZ 0141.

6.5.4 Drilling

Drilling is the most important approach to control orebodies, verify anomalies of geophysical and geochemical surveys and estimate mineral resources. The core recovery rates of the orebody and within 3–5 m above and below the orebody boundary shall be 80% or greater . The core diameter shall be generally not less than 48 mm (underground drilling shall be determined according to the situation). Vertex angle, azimuth angle and hole depth shall be surveyed every certain depth, as well as at the top and bottom boundary lines of the orebody. The quality of other engineering works shall be in accordance with DZ/T 0227.

6.6 Identification of rock and mineral

Representative rock and mineral identification samples shall be taken according to the orebody, the ore type and grade, and the rock type of the wall rock near the ore and partings to identify the rock and mineral composition, texture, structure and also type of rock or ore. The number of samples shall meet the needs of the study. Sample preparation and identification shall be carried out in accordance with DZ/T 0275.

6.7 Sample collection, preparation and assay for chemical analysis

6.7.1 Sample collection

6.7.1.1 Basic analysis samples: samples shall be continuously taken according to the orebody (ore type), mineralized zone and internal waste in each exploration work. The roof and floor of the orebody or the wall rocks on both sides shall be controlled by at least one basic analysis sample. The length of a sample shall be determined by the represented true thickness, which should in principle match the minimum mineable thickness of the orebody or the minimum thickness of separable internal waste. The sampling method and sample specification shall fully consider the occurrence, particle size and uniformity of gold to ensure samples' representativeness.

Channeling method is usually used for sampling in trenching, costeaning and tunneling. The cross-section of the sampling channel is generally a rectangle of (10 cm–5 cm) × (5 cm–3 cm), or a triangle according to the sampler, but the cross-sectional area shall be not less than 15 cm^2. In the case of uneven mineralization, both walls of the whole deposit shall be sampled, with the average thickness and grade calculated in combination, and the partial two-wall sampling method shall not be selectively adopted. The cross-cut is generally sampled continuously at the waistline of one wall, while the strike spacing of the samples in tunnels of strike drift shall be determined according to the variation of mineralization, which is generally 4 m－6 m, and can be increased to 8 m－10 m when the variation is not large.

Gold deposits of thin-vein type (true thickness of less than 0.3 m) shall be sampled by layer stripping method. Sample specifications:

length (true thickness direction of the orebody) × width (dip direction of the orebody) × depth (strike direction of the orebody) = true thickness (m) × (0.5 m －1 m) × 5 cm.

To ensure the quality of sampling, the surface of rock and ore at the sampling point shall be palleted before sampling. The surrounding cloth shall be hung, and the cloth liner shall be smooth and easy to clean, preventing sample splashing or mixing of substances outside the sample channel. The difference between actual weight[3] and theoretical weight of the sample shall not exceed 10%.

Rock and ore cores shall be sampled by 1/2 core cutting (sawing) method. The cutting (sawing) apparatus shall be used to cut (saw) along the long axis of the rock and ore cores. In the case of small diameter (less than or equal to 30 mm) of rock and ore cores, the whole core shall be sampled. For rock and ore cores of different runs, samples shall be taken separately in the case of greatly different hole diameters and recovery rates.

6.7.1.2 Qualitative and semi-quantitative determine for total elements analysis samples: samples shall be taken from different parts of the orebody and different ore types (including wall rock and alteration zone), by individual sampling or utilizing the duplicate samples for basic analysis. The results can be used as the basis for determining the items of total elements analysis, basic analysis and composite analysis.

6.7.1.3 Total elements analysis samples: representative samples shall be taken according to major orebodies and ore types, based on qualitative and semi-quantitative total analysis. Generally, one or two samples shall be taken for each ore type. The results can be used as the basis for determining the items of basic analysis and composite analysis.

6.7.1.4 Composite analysis samples: samples shall consist of several subsamples extracted from the duplicate samples for basic analysis from one or several adjacent exploration engineering work(s) according to the orebody or block as well as ore types (or grades), and the corresponding weight of the subsample

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3) In people's production, life and trade, mass is customarily referred to as weight.

shall be in accordance with the proportion of true thickness represented by the sample. The weight of each composite sample shall generally be no less than 200g. The analysis items shall be determined according to the results of total qualitative and semi-quantitative analysis, total elements analysis and identification of rock and mineral. The main purpose of composite analysis is to identify the associated valuable components, and the contents and distributions of beneficial and harmful components in the ore. The analysis results can be used as the basis for the estimation of associated mineral resources.

6.7.1.5 Phase analysis samples: in order to study the natural zoning of gold orebody and determine the natural ore type, samples shall be taken from the surface to the deep at a certain distance of a certain number of exploration engineering works, or from the duplicate samples for basic analysis of adjacent positions. The analysis items focus on the primary and oxidation contents of index minerals. Sampling and analysis shall be prompt and timely to avoid sample oxidation.

6.7.2 Sample preparation

6.7.2.1 For sample preparation of gold ore, different processes shall be formulated according to the occurrence and the distribution of particle size of gold in the samples, and different sampling quantities for analysis shall be balanced. The key process is to determine the particle size of the test sample during the first reduction, which shall be determined through assays if necessary.

6.7.2.2 In the case of micro- and fine-grained gold in ore, the sample can be prepared by general sample preparation process of rock and ore, and reduced according to the Qeqott formula.

$$Q = Kd^2 \qquad \text{............ (1)}$$

where:

Q——the minimum reliable mass of sample, in kilograms (kg);

K——the reduction coefficient determined according to the characteristics of rock and ore samples. The K value of micro- and fine-grained gold ore generally takes 0.8.

d——the maximum particle diameter after sample reduction, in millimeters (mm);

6.7.2.3 In the case of coarse- and giant-grained gold in ore, the Run of Mine (RoM) sample shall be directly crushed to the particle size required for the analysis (−200 mesh generally), without sample reduction or screening during the whole preparation process.

6.7.2.4 The preparation apparatus should be cleaned before sample preparation to avoid errors caused by improper operation. The loss rate of sample preparation shall be no more than 5%.

6.7.3 Sample assay

6.7.3.1 Sample assay (basic analysis) shall, in principle, be undertaken by the organization with metrology accreditation.

6.7.3.2 The results of basic analysis, composite analysis and phase analysis shall be subject to internal check for accidental errors in batches. Internal check samples shall be taken by the original sample delivery institute from the duplicate samples for basic analysis according to 10% of the total number of the original analysis samples. Each batch shall not be less than 30 samples, which shall be coded and sent to the original analysis laboratory for re-testing. In the case of small total number of basic analysis samples, the sampling ratio of internal check samples should be appropriately increased. In the case of large (more than 2,000 pieces) total number of basic analysis samples, the sampling ratio of internal check samples can be reduced to no less than 5%.

6.7.3.3 External check samples shall be taken by the original sample delivery institute from the basic analysis samples that have passed the internal check according to 5% of the total number of the analysis samples, and at least 30 samples shall be coded and sent to the organization with metrology accreditation for testing. In the case of small total number of basic analysis samples, the sampling ratio of external check samples should be appropriately increased. In the case of large (more than 2,000 pieces) total number of basic analysis samples, the sampling ratio of external check samples can be reduced to no less than 3%.

6.7.3.4 The quality and error handling method of chemical analysis shall be implemented according to DZ/T 0130.

6.8 Test on ore metallurgical properties

Sampling shall consider the representativeness of ore type, grade, and spatial distribution, and the wall rock and internal waste required for ore blending at the same time. When there are coexisting and associated minerals in the ore, the representativeness of sampling shall be considered together, in order to determine a reasonable recovery process through tests. The content of the major components of the sample shall be lower than the average grade of the ore type represented. If selective mining and processing are required, samples shall be collected by ore type. If bulk mining and processing are feasible, samples shall be collected according to the proportion of different ore types.

Each link of the test on ore metallurgical properties shall meet the requirements of corresponding specifications and regulations.

6.9 Test on rock and ore physical and technical properties

6.9.1 General samples

During the exploration, the physical and mechanics parameters of the ore and the wall rock of the roof and floor shall be collected and tested. Testing items generally include: ore volumetric weight[4], moisture, lumpiness, porosity, coefficient of volumetric expansion, hardness, angle of repose, as well as compressive, shear and tensile strengths, elastic modulus, cohesion, Poisson's ratio, etc. The sampling method, quantity and quality shall meet the requirements of relevant specifications and regulations.

6.9.2 Density samples

Samples shall be taken separately according to ore type, and the distribution and quantity of samples shall be representative. Generally, specific density samples shall be collected for dense massive ore with no less than 30 samples for each ore type, while bulk density samples for loose and porous (fractured) ore shall be collected at least 3 pieces (generally not less than 0.125 m^3 in volume) for correction of specific density values. In the case of directly using the bulk density value for resource estimation, the bulk density samples of each ore type shall not be less than 5 pieces.

The specific density samples shall be sealed with wax on site.

Moisture, porosity (oxidized ore) and the content of major elements that affect the density value must be measured along with the determination of ore density.

6.10 Original logging, comprehensive reviewing and report preparation

6.10.1 Original logging and comprehensive reviewing

The original logging shall be completed on site in a timely manner to record first-hand geological data objectively, accurately and comprehensively. All the original logging data shall be checked for quality acceptance and comprehensively reviewed in a timely manner. The original and comprehensive data shall be submitted in a timely manner after the completion of each work program, with clear drawings, and concise and consistent text. The work quality shall be executed according to DZ/T 0078 and DZ/T 0079.

6.10.2 Report preparation

The report shall be prepared according to DZ/T 0033.

4) Also known as volume mass

7 Feasibility assessment

7.1 Basic requirements

7.1.1 At each stage of general exploration, detailed exploration and advanced exploration, feasibility assessment shall be carried out simultaneously with the exploration progress and deepened dynamically, to closely link the mineral exploration with the next stage exploration or mine construction, reduce the investment risks, and improve the economic and social benefits of mineral exploration and mine development.

7.1.2 According to the research degree from general to detailed, feasibility assessment is divided into three stages of scoping study, pre-feasibility study and feasibility study. The scoping study can be undertaken by the exploration unit, while the pre-feasibility study and the feasibility study shall be carried out by organizations with corresponding capabilities.

7.1.3 Based on the needs of research degree, feasibility assessment shall comprehensively consider geological, mining, processing, metallurgical, infrastructure, economic, market, legal, environment, community and government policy factors, analyze and study the possibility and feasibility of mine construction (investment opportunities), and make conclusions on whether it is appropriate to transfer from a lower exploration stage to a higher one and whether mine development is feasible.

7.2 Scoping study

7.2.1 A scoping study is a brief study assessing the technical and financial feasibility of the project by understanding and analyzing geological, mining, processing, metallurgical, infrastructure, economic, market, legal, environment, community and government policy factors, which shall conclude whether the development of the deposit is possible and whether the next stage exploration shall be conducted.

7.2.2 The scoping study can be carried out based on all exploration stages, and the specific implementation shall be in accordance with DZ/T 0336.

7.3 Pre-feasibility study

7.3.1 A pre-feasibility study is a preliminary study assessing the technical and financial feasibility of the project by analyzing geological, mining, processing, metallurgical, infrastructure, economic, market, legal, environment, community and government policy factors, which shall conduct a basic assessment on the feasibility of the mine construction, to provide a decision-making basis for mine construction.

7.3.2 The pre-feasibility study shall be conducted on the basis of detailed and above exploration level.

7.4 Feasibility study

7.4.1 A feasibility study is a detailed study assessing the technical and financial feasibility of the project by analyzing geological, mining, processing, metallurgical, infrastructure, economic, market, legal, environment, community and government policy factors, which shall conduct a detailed assessment on the feasibility of the project to provide a basis for the decision-making of mine construction investment, the determination of project construction plan, and the preparation of preliminary mine design.

7.4.2 The feasibility study shall generally be carried out on the basis of advanced exploration.

8 Estimation of mineral resources and mineral reserves

8.1 Technical parameters and variables for deposit

8.1.1 Determination of technical parameters and variables for deposit

Technical parameters and variables for ore deposit are the standards and basis for evaluating ore deposits, delineating orebodies, and estimating mineral resources and mineral reserves. General technical parameters and variables for deposit (see Annex G) are usually adopted in the general exploration stage, and technical parameters and variables for ore deposit formulated by demonstration shall be adopted in the detailed exploration and advanced exploration stages, and comprehensive industrial criteria can be formulated for deposits with coexisting minerals and associated minerals. The determination of technical parameters and variables for ore deposit formulated by demonstration shall be carried out in accordance with DZ/T 0339.

8.1.2 Main content of technical parameters and variables for ore deposit

The main contents of the technical parameters and variables for ore deposit are as follows:

a) Cut-off grade in grams per tonne (g/t).
b) Minimum mining grade in grams per tonne (g/t).
c) Minimum mining thickness (true thickness) in meters (m).
d) Value of meter·gram per tonne (m·g/t).
e) Minimum thickness of separable internal waste (true thickness) in meters (m); and
f) Minimum non-ore area rejected length in meters (m).

8.2 Mineral resource estimation methods and general principles

8.2.1 Estimation methods

The appropriate method shall be selected according to the geological characteristics of the deposit, the shape and orientation of the orebody, the number and layout of the exploration engineering work. Commonly used estimation methods include geometry method(such as section method, geological ore block method, nearest neighboring area method, etc.), geostatistical method, inverse distance weight method, SD method, etc. The specific implementation shall be conducted in accordance with DZ/T 0338.

The use of new technological methods such as computer is advocated and encouraged to establish databases and three-dimensional geological models to estimate mineral resources.

8.2.2 General principles

8.2.2.1 The quality of exploration engineering, and the qualities of sampling, processing, testing and analysis of various samples involved in mineral resource estimation shall comply with the requirements of relevant specifications, procedures and regulations.

8.2.2.2 According to the classifications for mineral resources and mineral reserves, ore quantity and metal content of each orebody and the whole property area shall be estimated respectively according to orebody, resource type and ore type (selective mining and separation).

8.2.2.3 The standards for the estimation of the coexisting mineral resources are the same as that for the main minerals. The metal content of the associated minerals shall be estimated according to the ore quantity of the block or orebody and the average grade of the associated minerals.

8.3 Geometry methods

8.3.1 Block division

8.3.1.1 In the case of using geometry methods (such as section method, geological ore block method, nearest neighboring area method, etc.) for mineral resource estimation, ore blocks shall be reasonably divided according to the structural characteristics, control level, ore type, variation characteristics of thickness and grade of orebody, as well as the requirements for mining design.

8.3.1.2 Block division shall fully consider the weight of each engineering work. In the case of using geological ore block method for mineral resource estimation, in principle, the area controlled by four nearest neighboring engineering works shall be divided into one block, and generally each engineering work could be used for four times at most.

8.3.1.3 Measured and indicated resources shall be delineated by the connection of ore-intersected engineering work. Inferred resources can be delineated by the connection of limited engineering works, or also be delineated in a certain range based on geological, geophysical and geochemical anomalies beyond the connection of limited engineering works. Generally, along the strike and dip of orebodies, besides the measured and indicated resources block delineated along the engineering connections, the inferred resources can be estimated by extrapolating 1/4 of the inferred resources engineering spacing.

8.3.2 Determination of resource estimation parameters

8.3.2.1 Area: the area measurement can be directly accessed from the resource estimation drawings by computer software, and the scale of the drawings is generally 1:2,000 - 1:1,000.

8.3.2.2 Average grade: it includes the average grade of a single exploration engineering work, the average grade of a block, and the average grade of an orebody or a deposit. The calculation method and notes are as follows:

a) Average grade of a single exploration engineering work: it is usually obtained by weighting the true thickness corresponding to the sample length. If there is an outlier in the sample, it shall be capped first, and then the average grade of the single engineering work (or the sample interval) shall be calculated.

b) Average grade of a block: in the case of using the geological ore block method to estimate mineral resources, the average grade of a block is usually obtained by weighting the orebody thickness of each exploration engineering work. In the case of using the vertical section method and the horizontal section method, the average grade of the profile or section shall be obtained first by weighting the orebody thickness of each engineering work, which is then used together with the area of the profile or section to obtain the average grade of the block by weighted average method.

   When the upper part of the block is exposed by tunneling and the lower part is controlled by boreholes, the upper and lower parts of the block shall be processed first according to the principle of equal engineering quantity, which is then used to obtain the average grade of the block by weighted average method.

   When the locations of the tunnel and the borehole are neighboring, and the grades are inconsistent, the grade shall be weighted first to be then used to obtain the average grade of the block.

   When the grades of tunnel and the borehole are inconsistent at the same sampling location, the tunnel shall prevail.

c) Average grade of an orebody or a deposit: it is generally obtained by dividing the amount of metal in the orebody or deposit by the volume of ore.

8.3.2.3 Average thickness of blocks: it is generally obtained by arithmetic average method. In the case of uneven distribution of engineering, the average thickness can be calculated by weighting the influence length or area.

There are three types of average thickness of blocks, namely, average horizontal thickness, average vertical thickness and average true thickness. When estimating the amount of block resources, the average thickness depends on the direction of the blockprojection area: when the longitudinal projection area is used, the average horizontal thickness shall be adopted; when the horizontal projection area is used, the average vertical thickness shall be adopted; when the oblique area is used, the average true thickness shall be adopted.

8.3.2.4 Density: the density of ore involved in resource estimation shall be based on the actual measured value. In the case of estimating mineral resources by ore type, the density of ore is generally calculated by the arithmetic average method according to the ore type. In the case of estimating mineral resources regardless of ore type, the number of density samples of each type shall be determined according to the proportion of different types of ore, and then the average density of the orebody is calculated. When the density is closely related to a certain component in the ore, the linear regression method shall be used to obtain the corresponding average density of the ore of different types and blocks (ore lumps).

For loose or porous ores with multiple fractures (such as oxidized ores), the specific density value shall be corrected by the bulk density value.

In the case of high ore moisture (greater than 3%), the density value shall be corrected for moisture.

8.3.3 Capping of outliers

Usually, samples with grade 6－8 times higher than the average grade of orebody (weighted by all samples) is identified as outliers. The outliers shall be determined according to the grade variation coefficient of the orebody. In the case of large grade variation coefficient of the orebody, the upper limit value shall be taken, while in the case of small one, the lower limit value shall be taken. The capping method is to replace the sample grade with the average grade of the block composed of the engineering work containing outliers and adjacent engineering work. If the outliers are regularly distributed and the high-grade zones can be delineated, they shall not be treated as outliers and the high-grade zones can be delineated separately to estimate the mineral resources.

8.3.4 Delineation of orebody

8.3.4.1 Delineation of orebody with a single exploration

8.3.4.1.1 The delineation of orebody with a single exploration is mainly based on comprehensive considerations, such as cut-off grade, minimum thickness of separable internal waste, minimum mining thickness, or m·g/t value. When multiple sample blocks conforming to technical parameters and variables for ore deposit are delineated in the same engineering work, the orebody shall be delineated according to the structural characteristics, ore-controlling factors, changes in orientation and the corresponding relationship of sample blocks between adjacent engineering works. In the case of insufficient basis, it is generally inappropriate to treat them as branching and composite relations.

8.3.4.1.2 When the thickness of the orebody is less than the minimum mineable thickness, the orebody shall be delineated according to the m・g/t value.

8.3.4.2 Interpretation of orebodies on profile

8.3.4.2.1 The primary rules for interpretation of orebodies shall be interpret the geological boundaries first, and then interpret the orebodies according to the main ore-controlling geological characteristics. Generally, straight lines are used to interpret orebodies, and natural trend curves can also be used under the condition of fully understanding the geological rules. The thickness of the orebody between two engineering works shall not be greater than the actual thickness controlled by the two engineering works, whether it is interpreted by a straight line or a curve.

8.3.4.2.2 For orebodies with complex shape, some sections may fail to meet the requirements of technical parameters and variables for ore deposit, and rapidly pinch out and reappear along the strike and the dip, in the shape of lentils or beads, with sharp expansion and contraction in thickness or with branching and composite phenomena. When the volume of the non-ore area is too small to be rejected by mining, it can be interpreted as a continuous orebody.

8.3.4.2.3 As for two adjacent engineering works, if the ore is only discovered in one engineering work, it is generally considered as 1/2 pinch-out.

8.3.4.2.4 Thick and large contiguous orebody with low grade shall be delineated separately.

8.3.4.3 Delineation of internal waste

8.3.4.3.1 It shall be determined according to the indexes of cut-off grade and minimum thickness of separable internal waste. When the internal waste thickness is greater than or equal to the minimum thickness of separable internal waste, it shall be rejected; otherwise, it can be delineated into the orebody.

8.3.4.3.2 The interpretation of internal waste on profile shall follow the principle of “diagonal pinching out”, namely, when internal waste is seen in one engineering work and not in the other, the engineering work without internal waste shall be taken as the pinch-out point, and a straight line shall be extended from the engineering work with internal waste to the one without parting for interpretation according to the trend to ensure that the estimated thickness of the orebody between two engineering works is less than the actual thickness controlled by the two engineering works.

8.3.4.4 Delineation of non-ore area

When the orebody is explored and controlled by the tunnel of strike drift, the index of "minimum non-ore area rejected length" shall be accurately used to delineate the range of non-ore area. When the average grades of multiple consecutive sampling points are lower than the cut-off grade, and the strike and dip lengths are longer than the "minimum non-ore area rejected length", the non-ore area shall be delineated individually according to the corresponding adjacent tunnels stipulated by the technical parameters and variables for ore deposit.

8.3.4.5 Principles of orebody extrapolation

8.3.4.5.1 Extrapolated distance: it refers to the actual distance in the extension direction of the orebody, rather than the plane projection distance on the horizontal projection or vertical projection.

8.3.4.5.2 Finite extrapolation:

a) When ore is only discovered in one engineering work, and is not discovered in the other engineering work, and the spacing between the two engineering works is greater than or equal to the "theoretical engineering spacing[5)]", it can be 1/2 pinch-out or 1/4 parallelly extrapolated according to the "theoretical engineering spacing"; when the spacing between the two engineering works is less than the "theoretical engineering spacing", it shall be 1/2 pinch-out or 1/4 parallelly extrapolated according to the actual spacing between the two engineering works.

b) When ore is only discovered in one engineering work, and is not discovered in the other engineering work, and if the orebody is cut by fault or vein rock and staggered, instead of mineralization, the orebody boundary can be extrapolated to the fault or vein rock boundary according to the trend.

8.3.4.5.3 Infinite extrapolation:

a) Infinite extrapolation shall be comprehensively considered in combination with the characteristics of the orebody. When the extension of orebody has certain rules after analysis and research, it can be extrapolated according to the geological rules; when there are no obvious rules, generally, it can be 1/2 pinch-out or 1/4 parallelly extrapolated according to the engineering spacing of inferred resources corresponding to relevant exploration type.

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5) Theoretical engineering spacing refers to the exploration engineering spacing corresponding to a certain exploration type and its resource category.

b) When the value of m·g/t is adopted for the marginal engineering work of the orebody, it can be interpreted as an orebody internally, but shall not be extrapolated externally.

c) The top and uppermost layer of tunnel of the blind orebody can be extrapolated upward by adopting the principle of 8.3.4.5.3a). In the case of denudation boundary at the top, it can be extrapolated to the denudation boundary at most.

8.4 Geostatistical method and other methods

When geostatistical method, inverse distance weight method, SD method, etc. are used to estimate mineral resources, the block modelling, the determination of estimate parameters, and the capping of outliers shall be conducted in accordance with DZ/T 0338.

8.5 Classification of mineral resources and mineral reserves

Mineral resources are classified on the basis of geological confidence, whereas mineral reserves are classified by the confidence of modifying factors with consideration of geological confidence. The classification of mineral resources and mineral reserves shall be conducted in accordance with GB/T 17766 and GB/T 13908.

8.6 Estimation results of mineral resources and mineral reserves

The estimation results of mineral resources and mineral reserves shall be summarized in a table,supporting by comprehensive and accurate description. The summary table of estimation results of mineral resources and mineral reserves shall generally list the cumulatively identified, exploited and retained mineral resources and mineral reserves by orebodies, the main minerals and coexisting and associated minerals, and the ore volume, metal content, and average grade of different ore industrial types and different mineral resource and mineral reserve types.

8.7 Measurement units and numerical rounding requirements

The unit of measurement and the rounding requirements for numerical values are as follows:

a) Ore volume: 10,000 tonnes (10^4t).
b) Metal content: kilogram (kg).
c) Orebody thickness: meter (m).
d) Density of ore: tonne per cubic meter (t/m^3).
e) Ore grade: grams per tonne (g/t).
f) The value of ore volume shall be rounded to one decimal place, while the value of metal content shall be rounded to an integer, and the rest shall be rounded to two decimal places.

g) The unit of measurement and the rounding requirements for coexisting and associated mineral resources and mineral reserves shall be implemented in accordance with relevant specifications.

Annex A
(informative)
Industrial types of rock gold deposits

For industrial types of rock gold deposits, see Table A.1.

Table A.1 Brief list of industrial types of rock gold deposits

Industrial types of rock gold deposits		Metallogenic geological characteristics	Coexisting mineral associations		Wall rock alteration	Orebody shape	Scale and grade	Coexisting and associated minerals	Deposit examples
			Metal minerals	Gangue Minerals					
Fracture zone altered rock type (Jiaojia type)		it is formed in the metamorphic basement uplift area, and dominated by intermediate-acid magmatic rocks, migmatites and metamorphic rocks. Controlled by the contact zone between the regenerated granitic rock mass and the Jiaodong Group, the mineralization is developed in breccia, cataclasite, and cataclastic granite in the footwall of the main fault zone	mainly pyrite, followed by chalcopyrite, galena, sphalerite, and pyrrhotite, with a small amount of electrum, native gold, native silver, marcasite, bornite, chalcocite, tetrahedrite, orthopyroxenite bismuth ore, zircon, and siderite	quartz, sericite, feldspar, with a small amount of chlorite, dolomite, epidote, and garnet	potassization, silicification, beresitization	veined	small to extra-large scale	Ag	Jiaojia, Xincheng, Sanshandao
Gold-bearing	Quartz single-vein type	it is represented by the Wulong Gold Mine, which occurs in the biotite-granite-gneiss development area of the Luliang period. The gold-bearing quartz	pyrite, scheelite, arsenopyrite, pyrrhotite, bismuthinite, native gold, chalcopyrite,	quartz, potassium feldspar, fluorite, calcite	silicification and sericitization, followed by chloritization	vein, lentil, and fine-vein	small to extra-large scale with average gold grade		Wulong

quartz vein type		veins are closely related to the structure and located at the compound area of two groups of structures	sphalerite, colloidal pyrite		and pyritization	shaped	of 10.14g/t		
	Quartz network vein and complex vein type	the complex vein type is represented by the Jinchangyu Gold Mine, which occurs in the Archean Zunhua Group. The host rock is the altered phyllonite formed by ductile shearing of the amphibole	pyrite, with a small amount of chalcopyrite, harrisite, sphalerite, pyrrhotite, magnetite, molybdenite, bismuthinite, argentite, etc., as well as limonite, malachite, covellite	quartz, calcite, dolomite, albite, and muscovite, with a small amount of sericite, chlorite, apatite, rutile, sphene, and zircon	sericitization, pyritization, silicification, chloritization, carbonation	veined, irregularly veined and lenticular shaped	small to large scale with gold grade of 1g/t to 21.4g/t	Mo	Jinchangyu
	Quartz silicification and potassic altered rock type (Dongping type)	it occurs in medium and high-grade metamorphic rock areas, with the lithology of amphibolite, gneiss, granulite, and leptynite. The distribution of ore-bearing geological bodies is controlled by regional deep faults and derived secondary faults. The orebodies occur in alkaline complex and its outer contact zone, which consist of quartz veins and silicified and potassic altered rocks	pyrite, followed by galena, magnetite, chalcopyrite, with a small amount of sphalerite, altaite and limonite, hematite, bornite, chalcocite, covellite, sardinianite oxidation minerals	Quartz, feldspar, kaolinite, sericite, with a small amount of epidote, muscovite, garnet, chlorite	potassium modification, silicification, sodium modification, pyritization, sericitization, kaolinization, limonitization, carbonatization	veined and lenticular shaped	medium to extra-large scale with average gold grade of 7.25g/t	Sb	Dongping, Hadamen, Hougou

Continued Table A.1 Brief list of industrial types of rock gold deposits

Industrial types of rock gold deposits	Metallogenic geological characteristics	Coexisting mineral associations		Wall rock alteration	Orebody shape	Scale and grade	Coexisting and associated minerals	Deposit examples
		Metal minerals	Gangue Minerals					
Porphyry type (Tuanjiegou type)	it is associated with intermediate-acid, acid and alkaline subvolcanic rocks. Gold orebodies occur at the top of granodiorite-porphyry bodies and near the contact zone	pyrite, marcasite, stibnite, native gold, chalcopyrite, cinnabar, realgar, orpiment	chalcedonic quartz, calcite, iceland spar, ankerite, opal, feldspar, kaolinite	silicification, pyritization and/or marcasite modification, carbonatization	stratiform, veined, lentiform	large to extra-large scale with gold grade of 2g/t to 10g/t	Ag, Cu, S	Tuanjiegou
Skarn type	it occurs at the contact zone between small intermediate-acid intrusions and limestone and volcanic tuff. The wall rock is mostly garnet, hedenbergite, epidote skarn	magnetite, chalcopyrite, pyrite, hematite, bornite, electrum	essonite, diopside, epidote, quartz, calcite	mainly skarnization, followed by potassium modification, siliconization, chloritization and sericitization	lenticular, stratiform-like, nested, beaded	medium to large scale with gold grade of 2g/t to 200g/t, and copper grade of 1% to 4%	Fe, Cu, Pb, Zn, Bi	Huatong, Yinan, Jiguanzui, Laozuoshan
Breccia type	breccia bodies mainly occur in the Archean and Proterozoic metamorphic rocks, and the protolith is intermediate-basic volcanic rock. The rock mass is distributed in groups and zones and controlled by structure. The lithology is multiferroic silico-alumina	pyrite, followed by chalcopyrite, galena, native gold, with a small amount of sphalerite, bismuthinite, covellite, bornite,	quartz, chlorite, epidote, followed by calcite, potassium feldspar, sericite, albite, with a	silicification, chloritization, epidotization and sericitization	stratiform-like, lenticular	medium to large scale with gold grade of 1g/t to 45.85g/t	Ag, Cu, S	Qiyugou, Shuangwang

	rock. Gold mineralization is distributed around the breccias and the fracture development area in the rock mass, and closely related to the cements	molybdenite	small amount of biotite, plagioclase, ouralite, actinolite, fluorite					
Formation of gold-bearing iron in siliceous rock (Dongfengshan type)	it is located at the marginal depression area of the platform uplift. Mineralized geologic bodies occur in banded iron-siliceous rock formations from Archean to Proterozoic	magnetite, pyrrhotite, pyrite, arsenopyrite, ilmenite, with a small amount of native gold, cobaltite, chalcopyrite, galena, sphalerite	grunerite, quartz, cummingtonite, carbonate minerals	silicification, sericitization, carbonatization, pyritization,	stratiform-like, lentiform	small to medium scale with gold grade of 5g/t to 20g/t up to 160g/t	Co, As	Dongfengshan
Gold-bearing volcanic type	it mainly occurs in the Meso-Cenozoic volcanic belt and volcanic basin. The orebody is composed of gold-bearing calcite quartz veins, filled in the annular radial fissures near the crater, or in the volcanic pipelines, and crater facies extrusive rock	pyrite, chalcopyrite, tetrahedrite, sphalerite, argentite, electrum, kustelite, gold tellurite	chalcedony, opal, feldspar, quartz, carbonate minerals	silicification, albitization, kaolinization, pyritization, carbonatization, sericitization and decolorization	vein shaped	small scale with gold grade of 5.54g/t to 7.73g/t		Ciweigou
Fin-grained disseminated type	it is distributed in the Phanerozoic quasi-platform and geosynclinal area. The strata are from the Upper Paleozoic to the Mesozoic, and the main gold-bearing formation is the Middle Triassic series, a sedimentary rock series	pyrite, marcasite, arsenopyrite, arsenian pyrite, stibnite, native gold, realgar	hydromica, barite, fluorite, gypsum	silicification, kaolinization, carbonatization, marcasite modification, arsenopyrite modification	stratiform, stratiform-like, lenticular	medium scale	Sb, Hg	Yata, Banqi

	composed of clastic rocks. Gold and sulfide are disseminated among them							

Annex B
(informative)
Standards for classifications of rock gold deposits by scale

For the standards for classifications of rock gold deposits by scale, see Table B.1.

Table B.1 Standards for classifications of rock gold deposits by scale

Deposit scale	Resource volume (gold metal content, t)
Large	＞20
Medium	5 - 20
small	＜5

Annex C
(informative)
Rock gold minerals

For rock gold minerals, see Table C.1.

Table C.1 Rock gold minerals

Minerals	Chemical formula	Mass fraction of gold %	Remark
I. Natural elements, natural alloys and metal sulfides			
1. Gold	Au	＞80	it is often alloyed with silver, platinum, palladium, rhodium, copper, bismuth, etc
2. Electrum	(Au, Ag)	80 - 50	
3. Maldonite	Au_2Bi	65.3	
4. Auricupride	Cu_3Au	50.6	
5. Weishanite	$(Au, Ag)_3Hg_2$	56.91	it was officially recognized by the International Mineralogical Association in April 1983
II. Sulfides			
6. Uytenbogaardtite	Ag_3AuS_2	32.6	
III. Tellurides			
7. Calaverite	$AuTe_2$	44.03	sometimes containing small amounts of silver
8. Krennerite	$AuTe_2$	43.5	
9. Montlbrayite	$(Au, Sb)_2Te_3$	50.6	
10. Petzite	Ag_3AuTe_2	25.4	
11. Muthmannite	(Ag, Au) Te	22.9 - 35.2	
12. Sylvanite	$(Au, Ag)\ Te_4$	24.1	
13. Kostovite	$CuAuTe_4$	25.5	
14. Nagyagite	$Pb_5Au\ (Te, Sb)_4S_{5-8}$	7.41 - 10.16	composition is uncertain
15. Bessmertnovite	$Au_4Cu\ (Te, Pb)$	68.0 - 75.0	
16. Bogdanovite	$Au_5(Cu, Fe)_3(Te, Pb)_2$	57.6 - 63.6	
17. Bilibinskite	$Au_3Cu_2PbTe_2$	40.7 - 50.5	
IV. Antimonide			
18. Aurostibite	$AuSb_2$	44.7	
V. Selenides			
19. Fischesserite	Ag_2AuSe_2	29.0	

Annex D
(informative)
Gold minerals particle sizes and shapes classifications

For the classification of gold minerals by particle size and shape, see Table D.1 and Table D.2.

Table D.1 Gold minerals particle sizes classifications

Particle size	Giant-grained gold	Coarse-grained gold	Medium-grained gold	Fine-grained gold	Micro-grained gold
Particle diameter (mm)	＞0.295	0.295 to ＞ 0.074	0.074 to ＞ 0.037	0.037 to ＞ 0.0l	≤0.01
Note: The particle size of gold shall largely determine the grinding fineness and processing method. According to the influence on the processing technology, the particle sizes are divided into five grades. In the process of ore crushing, almost all giant-grained and coarse-grained gold can be separated into monomers, which is beneficial to the recovery by gravity separation method, but the flotation and leaching effects are not good. In the process of grinding, most of the medium-grained gold can achieve monomer dissociation, with a few exposed as coenobium or wrapped by sulfide. Fine-grained gold and micro-grained gold present good flotation and cyanidation effects. The monomer gold minerals are easily adsorbed by mercury regardless of size.					

Table D.2 Gold minerals shapes classifications

Elongation	Shape		
	Smooth boundary	Flat and angular boundary	Uneven boundary with sharp point and branch
1 - 1.5	Perfectly round granular	Kernel shaped	Pointed angulargrained
1.5 - 3	Angular granular	Long-angular granular	Branched shape
3 - 5	Foliaceous	Plate-like	
＞5	Needlelike		
Note: Native golds of different shapes present distinctive effects in different processing methods. For example, granular gold is easy to recover by gravity separation method, gold with large surface area dissolves faster in solvent, and flake gold is easy to recover by flotation.			

Annex E
(informative)
Classifications of the rock gold deposits by exploration type

E.1 Classification factors of the exploration types

For the classification factors of the exploration types, see Table E.1 to Table E.5.

Table E.1 Dimensions of orebodies

Scale	Strike length of orebody (m)	Dipping extension (or width) of orebody (m)
Large	＞500	＞500
Medium	200 – 500	200 – 500
Small	＜200	＜200

Table E.2 Degree of orebody shape variation

Complexity of orebody shape	Characteristics of orebody shape variation
Simple	it is stratiform—stratiform-like and plate—plate-like large vein body and large lenticular body, with regular or relatively regular geometric shape, continuous orebody and simple variation in orientation
Medium	it is irregular large lenticular body or large vein body, with ore pillars and ore chambers. The orebodies are basically continuous with branching and composite phenomena and moderate variation in orientation
Complex	it is irregular lenticular body and small lenticular body, vein body and small vein body with small ore pillar, small ore chambers, intermittent orebodies and complex variation in orientation

Table E.3 Degree of thickness stability

Degree of thickness stability	Variation coefficient of orebody thickness (%)
Stable	＜80
Relatively stable	80 – 130
Unstable	＞130

Table E.4 Influence degree of structure and vein rock

Influence degree	Main characteristics
Small	the orebody is basically free of fault dislocation or vein rock interspersed, and the structure has little or no influence on the orebody
Medium	the orebody is dislocated by fault or interspersed by vein rock, and the structure and vein rock have obvious influence on the geometric shape of the orebody, but the damage is not great

Influence degree	Main characteristics
Large	the orebody is dislocated by fault and interspersed by relatively many or even numerous vein rocks with relatively large dislocation distance, which seriously affects the geometric shape of the orebody and causes great damage

Table E.5　　Degree of distribution uniformity of valuable components

Degree of distribution uniformity	Variation coefficient of orebody grade (%)
Uniform	＜100
Relatively uniform	100 - 160
Nonuniform	＞160

E.2 Classifications of the exploration types

E.2.1 Type I (simple type). The orebody of this type is large in dimension, simple in geometric shape, stable in thickness, and small in influence of structure and vein rock, which is mainly stratiform—stratiform-like and plate—plate-like large vein body and large lenticular body with uniform distribution of valuable components. Deposits belonging to this type include the Orebody #1 of the Jiaojia Gold Deposit in Shandong Province, the Xincheng Gold Deposit in Shandong Province, and the Orebody KT8 of the Shuangwang Gold Deposit in Shaanxi Province.

E.2.2 Type II (medium type). The orebody of this type is medium in dimension, moderate in orientation variation, relatively stable in thickness, and moderately affected by structure and vein rock with little damage, which is mainly the vein body, lenticular body, ore pillar and ore chamber with relatively uniform distribution of valuable components. The deposits belonging to this type include the Vein Group #II-5 of the Jinchangyu Gold Deposit in Hebei Province and the Wenyu Gold Deposit in Henan Province.

E.2.3 Type III (complex type). The ore body is small in dimension, complex in geometric shape, unstable in thickness, and greatly affected by structure and vein rock, which is mainly the vein body, small vein body, small ore pillar and small ore chamber with uneven distribution of valuable components. The deposits belonging to this type include the Vein #II-2 of the Jinchangyu Gold Deposit in Hebei Province, the Vein #4 of the Jiuqu Gold Deposit in Shandong Province, and the Zhilong Vein #1 of the Gupao Gold Deposit in Guangxi Province.

Annex F

(informative)

Exploration engineering spacing of rock gold deposits

For the exploration engineering spacing corresponding to different types of rock gold deposit exploration , see Table F.1.

Table F.1 Exploration engineering spacing

Exploration type	Exploration engineering spacing of indicated resource (m)			
	Tunneling		Drilling	
	Transverse drift	Ore drift	Strike	Dip
I	80－160	80－160	80－160	80－160
II	40－80	40－80	40－80	40－80
III	20－40	20－40	20－40	20－40

Note 1: Exploration engineering spacing refers to the actual spacing along the strike and dip of the orebody.

Note 2: The engineering spacing corresponding to each type shall be used as a reference, which can be appropriately adjusted according to the actual situation of the deposit in practical work.

Note 3: The engineering spacing for exploring measured resource can be reduced to 1/2 of that for indicated resource, and it can be enlarged to 2－3 times the engineering spacing of indicated resource in the case of estimating inferred resource.

Note 4: For complex ore deposits, in the case of impossible to explore the mineral resource required by the corresponding control level by using the engineering spacing in above table, it can only be explored while mining.

Note 5: When the orebody changes to various degrees in different sections or directions, the engineering spacing shall be adjusted accordingly.

Annex G
(informative)
General technical parameters and variables for rock gold deposits and reference index for comprehensive evaluation of its associated minerals

For the general technical parameters and variables for ore deposit of rock gold ore and the reference index for the comprehensive evaluation of associated minerals, see Table G.1 and Table G.2.

Table G.1 General technical parameters and variables for rock gold deposits

Item	Index		
	Primary ore		Oxidized ore
	Underground mining	Open-pit mining	
Cut-off grade (g/t)	0.8－1.0		0.5
Minimum mining grade (g/t)	2.2－3.5	1.6－2.8	1.0
Minimum mineable thickness (m)	0.8－1.5; steeply inclined orebody shall take the lower limit, while gentle inclined to horizontal shall take the upper limit		
Thickness of separable internal waste (m)	2.0－4.0; underground mining orebody shall take the lower limit, and open-pit mining orebody shall take the upper limit		
Non-ore area rejected length (m)	it shall be 10－15 when the adjacent tunnels correspond, and 20－30 when not correspond		
Note 1: For cut-off grade and the minimum mining grade, in the case of good ore occurrence, simple mineral composition, and good external construction condition, it shall take the lower limit; otherwise, it shall take the upper limit. Note 2: When the thickness of the orebody is less than the minimum mineable thickness, the product value of thickness and grade — m·g/t shall be used.			

Table G.2 Reference index for comprehensive evaluation of associated minerals of rock gold ore

Composition	Copper (Cu)	lead (Pb)	Zinc (Zn)	Tungsten trioxide (WO_3)	Antimony (Sb)	Molybdenum (Mo)
Content	0.1%	0.2%	0.2%	0.05%	0.3%	0.01%
Composition	Arsenic (As)	Sulphur (S)	Cobalt (Co)	Silver (Ag)		
Content	0.2%	2%	0.01%	2g/t		

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