Exploration and Development Phases and Corresponding Supporting Standards, Codes and Guidelines in China

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Exploration Phases and
the corresponding Standards, Codes, regulations and guidelines

The final goal of exploration is to provide necessary mineral resource and reserve data and relative technical and economic information so that the mineral project would avoid investment risk and make reasonable interests.

<table>
<thead>
<tr>
<th>Reconnaissance</th>
<th>Prospecting</th>
<th>General Exploration</th>
<th>Detailed Exploration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Looking for prospecting targets.</td>
<td>Preliminary evaluation for the prospecting mineralization area; defining the area for general exploration, if such prospecting is successful.</td>
<td>Systematic sampling, providing data for pre-feasibility study; defining the area for detailed exploration, if such general exploration is successful.</td>
<td>Use various and effective methods for dense sampling, providing data for feasibility study to determine mineral commodities, production rate, mining method, ore processing method, and metallurgical method.</td>
</tr>
</tbody>
</table>
## Requirements for exploration phases

<table>
<thead>
<tr>
<th>Geological Study and sampling</th>
<th>Reconnaissance</th>
<th>Prospecting</th>
<th>General Exploration</th>
<th>Detailed Exploration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovering mineralization, analogy with known deposits, testing geophysical and geochemical anomalies by drilling or other exploration workings.</td>
<td>Preliminary study of geological characteristics, preliminary control of the mineralization, testing geophysical and geochemical anomalies</td>
<td>Global control of ore body; describe the deposit model, testing geophysical and geochemical anomalies</td>
<td>Detailed control of ore body; establish the deposit model.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample space</th>
<th>Limited samples</th>
<th>Systematic sampling</th>
<th>Systematic dense sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very few samples</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Continuity</th>
<th>Inferred</th>
<th>Basic</th>
<th>Confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geological Confidence</th>
<th>Predicted Resource (334?)</th>
<th>Inferred Resource (333)</th>
<th>Indicated Resource (332)</th>
<th>Measured resource (331)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogy, separability test</td>
<td>Laboratory processing test, enlarge test, semi-commercial test, if necessary.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metallurgical test</th>
<th>Preliminary Study</th>
<th>Preliminary Study is required, the estimate mineral resources is used for pre-feasibility study.</th>
<th>Preliminary study is required, the estimate mineral resources is used for feasibility study.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

## The Existing Mineral Resource/Reserve Classification System of China

<table>
<thead>
<tr>
<th>Discovered</th>
<th>Undiscovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured</td>
<td>Inferred</td>
</tr>
<tr>
<td>Reserved</td>
<td>Basic Reserve</td>
</tr>
<tr>
<td>111</td>
<td>111b</td>
</tr>
<tr>
<td>2M1</td>
<td>2M21</td>
</tr>
<tr>
<td>2S11</td>
<td>2S21</td>
</tr>
<tr>
<td>331</td>
<td>332</td>
</tr>
</tbody>
</table>

Feas: feasibility study  Pre: pre-feasibility study
There are three levels of studies corresponding to the three major exploration phases:

1. Preliminary study: a investment opportunity study, based on geographic location, characteristics of the mineralization, market situation and other factors.
2. Pre-feasibility study: in general, carried out by mine design institutions based on guideline developed by the institutions.
3. Feasibility study: in general, carried out by mine design institutions based on guideline developed by the institutions.
The changes of exploration phases

1. **Before 1987**
   - Preliminary Prospecting
   - Detailed Prospecting
   - Preliminary Exploration
   - Detailed Exploration

2. **1987-1999**
   - Prospecting,
   - General Exploration
   - Detailed Exploration

3. **1999-**
   - Reconnaissance
   - Prospecting
   - General Exploration
   - Detailed Exploration
Since early 50's of the 20 century, China began to develop standards for mineral exploration by referring to the Soviet Union’s standards. The efforts to make China standards were from 1959 by the State Commission of Mineral Reserves (SCMR). After 1983, SCMR issued standards concerning mineral resource and reserve classification, principals of mineral exploration, exploration codes of individual minerals. In the last ten years, the committee of standardization of the ministry was authorized to approve such standards. The state standards shall be issued by General Administration of Quality Supervision, Inspection and Quarantine. The trade standards shall be issued by the ministry. So far, the series of standards were revised five times. The China Geological Survey issued some standards.
Series of Mineral resource and Reserve classification

Solid Mineral Resource/Reserve classification  
GB/T17766-1999

Petroleum Resource/Reserve Classification  
GB/T19492-2004

Coal Bed Gas  
Mineral Resource/Reserve Classification  
DZ/T0216-2002

Principals of Codes of Solid Mineral Exploration  
GB/T13908-2002

Classification Standards for underground Water  
GB 15218-94

Principals of Codes of Solid Mineral Exploration includes the following contents:

Scope  
Reference to standards  
The goal of mineral exploration project:
reconnaissance, prospecting, general exploration, detailed exploration.

The exploration work:
the contents of exploration, control requirements, requirements for exploration phases, requirements for exploration quality.

Feasibility studies:
Preliminary study, pre-feasibility study, feasibility study.

Mineral Resource/Reserve Classification:
factors, conditions and criteria of classification.

Mineral Resource/Reserve estimation:
cut off, general principals of estimation, selection of estimation methods.

For each exploration codes of individual minerals, includes requirements for exploration phases.
Exploration and Development Phases and Supporting Standards Codes and Guidelines in China

Series of Codes for Field Work

- Code for geological logging of mineral exploration
- Code for exploration data and information documentation
- Code for survey
- Code for drilling
- Code for tunnelling
- Code for core management
- Code for exploration of hydrogeology and engineering geology of mineral deposit
- Code for sampling
- Guidelines for selecting cut-off of thickness, grade and other quality parameters of ore deposits
- Code for geophysical and geochemical survey

The existing exploration codes for individual or group minerals

- Coal, peat coal (DZ/T0215-2002)
- Uranium (DZ/T0199-2002)
- Iron, manganese, chromium (DZ/T0200-2002)
- Copper, lead, zinc, silver, nickel, molybdenum (DZ/T0214-2002)
- Tungsten, tin, mercury, antimony (DZ/T0201-2002)
- Rock gold (DZ/T0201-2002)
- Bauxite, magnesite (DZ/T0202-2002)
- Pyrite (DZ/T0210-2002)
- Phosphate (DZ/T0209-2002)
- Placer (metal) (DZ/T0208-2002)
• Rare Earth (DZ/T0204-2002)
• Rare Metal (DZ/T0203-2002)
• barite, witherite, fluorspar, boron (DZ/T0211-2002)
• metallurgical and chemical limestone (DZ/T0213-2002)
• kaolin, bentonite, refractory clay (DZ/T0206-2002)
• salts and lake salts (DZ/T0212-2002)
• silicon material for glass, decorative stone, gipsy (DZ/T0207-2002)
• gypsum, chrysotile, wollastonite, talc, graphite (DZ/T0207-2002)
• Code of resource/reserve reporting for mine shut
• Regulations for ore processing test

In 80-90’s of 20 century, The series of codes for mineral reserve classification issued by the State Committee of Mineral Reserves include deposit types, case studies which are useful and helpful for exploration geologists to conduct their exploration work.

Case studies include deposit type, mineralization characteristics, ore processing nature, cut off of grade, drill hole distribution, conclusion. A case study provides geological map, section map, comparison between exploration and mining reserves.
Evaluation for Mineral Resource/Reserve Report

Since 1950’s of the lat century, The State Committee of Mineral Reserves was responsible for evaluating and supervising mineral reserve reports. There was a branch of the central committee In each province, responsible for evaluating and supervising mineral reserve reports in the province. This reserve evaluation and supervision system took a role to guarantee the quality of mineral reserve reports.

With the ever bettering of market economy in China, the governmental controlled reserve evaluation and supervision system is not suitable for exploration and mining practice. A new consulting evaluation system replaced the old system. Now there are about 20 reserve evaluation centers through out China. Any evaluation of Mineral resource or reserve report should follow the evaluation procedures and regulations. If a report passed by evaluation, it is permitted to provide this report for governmental, technical or commercial use.
Mine development

The procedure of mine development in China includes four stages:

- Earlier stage of construction
  - preparation
  - in the process of construction, completion
  - check and accept.

If a mineral resource or reserve report is qualified by evaluation, then it can be submitted, with relevant materials to mineral resources administration for applying mining license.

If some significant changes of mineral resources or reserves arise during the mine development or production, the resource or reserves should be re-estimated and submit the report for evaluation.

If a mine is going to shut down, the remaining resource or reserves should be estimated and submit the report for evaluation.
Technical Requirements and Guidelines for Feasibility study and Mine Design

Codes, regulations, guidelines handbooks for feasibility study and mine design are developed by mine design institutes. Taking nonferrous metal industry as an example, a set of standards can be listed as follows:

- Outline of report compilation for preliminary feasibility study
- The principal regulations in contents and depth of feasibility study for nonferrous metal enterprises
- The principal regulations in contents and depth of feasibility study report compilation for nonferrous metal enterprises
- The principal regulations in contents and depth of preliminary mine design for nonferrous metal enterprises
- Handbook for mining engineers

Thank you!