United Nations ECE/ENERGY/GE.3/2020/9

Economic and Social Council

Distr.: General
28 February 2020

Original: English

Economic Commission for Europe

Committee on Sustainable Energy

Expert Group on Resource Management

Eleventh session
Geneva, 20-24 April 2020
Item 9 of the provisional agenda
Development, maintenance and implementation of the United Nations Framework Classification for Resources and the United Nations Resource Management System

Case Studies on Bridging from the National Standard of the People's Republic of China Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999) to the United Nations Framework Classification for Resources

Prepared by the Mineral Resources and Reserves Evaluation Center of the Ministry of Natural Resources of the People's Republic of China, in cooperation with the Technical Advisory Group of the Expert Group on Resource Management

Summary

The case studies in this document serve as guidance and reference to demonstrate the application of the Bridging Document Between the Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999) and the United Nations Framework Classification for Resources (UNFC). The four case studies presented cover two gold mines, a coal mine, and an iron ore mine. The case studies indicate that correspondence of classification codes of mineral resources/reserves between GB/T 17766-1999 and UNFC can be achieved through application of the Bridging Document.

GE.20-03137(E)
2003137

Contents

Figures *Page*

I. Foreword

1. The case studies described in this document were carried out by the Mineral Resources and Reserves Evaluation Center of the Ministry of Natural Resources of the People's Republic of China, in cooperation with the Technical Advisory Group of the United Nations Economic Commission for Europe (ECE) Expert Group on Resource Management. The case studies were prepared by Li Jian, Yang Qiang, Liu Yongqiang, Li Shengxiang, Feng Tao, Xu Yongzhong, Li Linwei, Du Gang, Qiu Xianhai, Wang Yunpeng, Wang Haijun, Wen Qifu, and Yang Hua, and reviewed by Andrew Barrett, Roger Dixon and Brad Van Gosen.

2. The four case studies cover two gold mines, a coal mine, and an iron ore mine. The Protection and Supervision Department of Mineral Resources of the Ministry of Natural Resources of the People's Republic of China and ECE are acknowledged for the guidance and support they provided. China National Gold Group Co., Ltd., Coalfield Geological Bureau of Inner Mongolia Autonomous Region, the Fourth Geological Brigade of Henan Province Non-ferrous Metals Geological Mineral Resources Bureau, and Wuyang Mining Co., Ltd of Henan Angang Group are acknowledged for the help and support they provided.

3. The case studies serve as guidance and reference to demonstrate the application of the Bridging Document Between the Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999) and the United Nations Framework Classification for Resources (UNFC)[1] (hereinafter referred to as the Bridging Document).

II. Key highlights of the Bridging Document

4. The Bridging Document explains the mapping between the National Standard of the People's Republic of China Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999) and UNFC.

5. The correspondence of Classes and Categories is shown in Figure I (refer to Figure 5 in the Bridging Document).

Figure I
Mapping of GB/T 17766-1999 to UNFC Classes and Categories

<table>
<tr><th colspan="2">GB/T 17766-1999 Classes</th><th colspan="4">GB/T 17766-1999 Categories</th><th>UNFC Classes</th><th colspan="3">UNFC "minimum" Categories</th></tr>
<tr><td rowspan="4">Economic</td><td rowspan="2">Reserves</td><td>(111)</td><td></td><td></td><td></td><td rowspan="2">Commercial Projects</td><td rowspan="2">E1</td><td rowspan="2">F1</td><td rowspan="2">G1, G2</td></tr>
<tr><td>(121)</td><td>(122)</td><td></td><td></td></tr>
<tr><td rowspan="3">Basic Reserves</td><td>(111b)</td><td></td><td></td><td></td><td colspan="4" rowspan="2">Not defined in UNFC</td></tr>
<tr><td>(121b)</td><td>(122b)</td><td></td><td></td></tr>
<tr><td>Marginal Economic</td><td>(2M11)</td><td></td><td></td><td></td><td rowspan="5">Potentially Commercial Projects</td><td rowspan="5">E2</td><td rowspan="5">F2</td><td rowspan="5">G1, G2, G3</td></tr>
<tr><td></td><td>(2M21)</td><td>(2M22)</td><td></td><td></td></tr>
<tr><td>Sub-Marginal Economic</td><td rowspan="3">Mineral Resources</td><td>(2S11)</td><td></td><td></td><td></td></tr>
<tr><td></td><td>(2S21)</td><td>(2S22)</td><td></td><td></td></tr>
<tr><td>Intrinsic Economic</td><td>(331)</td><td>(332)</td><td>(333)</td><td></td></tr>
<tr><td>Economic-Interest Undefined</td><td>Undiscovered Resources</td><td></td><td></td><td></td><td>(334)?</td><td>Exploration Projects</td><td>E3</td><td>F3</td><td>G4</td></tr>
</table>

[1] The Bridging Document Between the Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999) and UNFC was endorsed by the ECE Committee on Sustainable Energy at its twenty-seventh session, September 2018 (ECE/ENERGY/119, para 54).

6. The correspondence of E and F Axes is shown in Figure II (refer to figure 6 in the Bridging Document).

Figure II
Mapping of GB/T 17766-1999 to UNFC by E and F Axes

	F1.1	*F1.2*	*F1.3*	*F2.1*	*F2.2*	*F2.3*	*F3*	*F4*
E1.1	1	2	3	4				
E1.2	1	2	3					
E2			4	4	5			
E3.1	10	10	10	10	10	10		
E3.2			6	6	6		9	
E3.3			7	7	7	7		8

			UNFC Sub-classes
Economic	Reserves	1	On production
		2	Approved for Development
		3	Justified for Development
	Basic Reserves	Not defined in UNFC	
Marginal Economic	Basic Reserves	4	Development Pending
		5	Development On hold
Sub-Marginal Economic	Mineral Resources	4	Development Pending
		5	Development On hold
Intrinsic Economic	Mineral Resources	4	Development Pending
		5	Development On hold
Not defined in GB/T 17766-1999		6	Development Unclarified
		7	Development Not Viable
		8	Additional Quantities in Place
Economic-Interest Undefined	Undiscovered Resources	9	Exploration Project
Not defined in GB/T 17766-1999		10	Quantities forecast to be extracted but not for sale
Less Common Mappings			

III. Case study of Gold Mine A

A. Introduction

7. Data sources: Mineral Resources/Reserves Verification Report of Gold Mine A, Plan for Development and Utilization of Mineral Resources in Gold Mine A (hereinafter referred to as Gold Mine Development and Utilization Plan).

8. Main references: Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999), Specifications for Hard-rock Gold Exploration (DZ/T0205-2002), UNFC, and the Bridging Document Between the National Standard of the People's Republic of China Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999) and UNFC. An official English version of the Specifications for Hard-rock Gold Exploration (DZ/T0205-2002) is not yet available, however key terms used in these case studies are defined in the Annex "Related Instructions".

9. W Gold Company holds the mining rights of Gold Mine A with the internal and external conditions that allow it to operate and produce.

10. After several periods of reconstruction and expansion, the gold mine has a processing capacity of 3,000t of ore per day and produces 1.5t gold per annum. The mine is being developed by joint systems of adits and shafts; and applies the mining methods of short-hole shrinkage stoping and room and pillar. The ore is processed by whole ore cyanidation – carbon in pulp. The product of the mine is gold dore with a gold content of 94%, a silver content of 5%, as well as minor amounts of copper and other metals.

B. Classification of mineral resources/reserves in line with GB/T 17766-1999

11. Mineral resources/reserves are estimated according to the Recommendations and Opinions on Industrial Indexes of Gold Mine A prepared by Changchun Gold Design Institute Co. Ltd. and approved by W Gold Company:

(a) Cut-off grade: 1.0g/t;

(b) Minimum industrial cut-off grade: 1.8g/t;

(c) Average grade of the deposit: 2.5g/t;

(d) Minimum mining thickness: 1.0 m;

(e) Minimum thickness of separable waste rock within orebody: 2.0 m;

(f) Centimetre*gram/tonne cut-off: ≥180cm*g/t.

12. In accordance with Specifications for Hard-rock Gold Exploration, 17 orebodies in Gold Mine A are classified as three exploration types on the basis of the scale, level of morphological variation, thickness continuity, complexity of structure and dykes, as well as the distribution uniformity of the main recoverable elements. With regard to type I, measured mineral resources are delineated by sampling on a grid pattern at 40m height of adit levels and 50m spacing of transverse drifts; indicated mineral resources are delineated by drilling at 160m×160m (strike × incline) spacing or gridding at 120m height of adit levels and 100m spacing of transverse drifts; and inferred mineral resources are delineated by drilling at 320m×320m. With regard to type Ⅱ, measured mineral resources are delineated by sampling on a grid pattern at the 40m height of adit levels and 15m to 25m spacing of transverse drifts; indicated mineral resources are delineated by a sampling grid of 40m to 60m height of adit levels and 25m spacing of transverse drifts; and inferred mineral resources are based on a drilling pattern of 100m×160m. With regard to type Ⅲ, indicated mineral resources are delineated by a sampling grid of the 40m height adit levels and 25m spacing of transverse drifts, and inferred mineral resources are on the basis of drilling at a pattern of 80m×80m.

13. Production results at Gold Mine A have proven the economic viability demonstrated by the feasibility study. According to GB/T 17766-1999, the gold mine development and utilization plan has converted the measured intrinsic economic mineral resources (331) and indicated intrinsic economic mineral resources (332) to measured economic basic reserves (111b) and indicated economic basic reserves (122b) respectively, and taking into consideration mine design as well as production practices, further upgraded as reserves (111) and reserves (122).

C. Alignment of classification axes and classification codes

14. Alignment of E axis. As regulated in GB/T 17766-1999, mineral resources/reserves in Gold Mine A can be categorized as the economic category "1" and the intrinsic economic category "3" in terms of degree of economic viability (E axis of GB/T 17766-1999); the economic category covers measured and indicated mineral resources, and the intrinsic economic category covers inferred mineral resources. In accordance with the Bridging Document, the economic category "1" in GB/T 17766-1999 corresponds to E1.1 in UNFC. The inferred mineral resources are used in the Plan for Development and Utilization of Mineral Resources to estimate the life of the mine; they correspond to E2 in UNFC.

15. Alignment of F axis. Gold Mine A is on production. Based on the feasibility study, a Plan for Development and Utilization of Mineral Resources focusing on a comprehensive technical and economic study was completed to demonstrate a further detailed basis for a final decision on the development of the project. As regulated in GB/T 17766-1999, measured mineral resources are based upon the feasibility study converted to reserves (111), indicated mineral resources are based upon the pre-feasibility study converted to reserves (122), however the inferred mineral resources are based upon the scoping study which cannot be converted to reserves. Feasibility study, prefeasibility study and scoping study correspond respectively to category "1", category "2", and category "3" in terms of feasibility assessment (F axis of UNFC). In accordance with the Bridging Document, the feasibility study category "1" and prefeasibility study category "2" in GB/T 17766-1999 correspond to F1.1 in UNFC because the Gold Mine A development project is classified as a commercial project that is on production. Since the deposit is on production and assuming that inferred intrinsic economic mineral resources (333) can be mined after infill drilling, the Mine Development and Utilization Plan used 45% of inferred intrinsic economic mineral resources (333) to estimate the mine life. Therefore, the feasibility categories "3" in GB/T 17766-1999 correspond to F2.1 in UNFC.

16. Alignment of G axis. According to GB/T 17766-1999, the mineral resources of Gold Mine A are categorized as measured, indicated, and inferred in terms of geological assurance, which correspond to G1, G2, and G3 in UNFC respectively.

17. The correspondence of classification codes between GB/T 1776-1999 and UNFC is shown in Table 1.

Table 1
Correspondence of classification codes of mineral resources/reserves of Gold Mine A between GB/T 17766-1999 and UNFC

GB/T 17766-1999 Classes		*GB/T 17766-1999 Categories*				*UNFC Classes and Sub-classes*		*UNFC Minimum Categories*
Economic	Reserves	(111)	1233.6 kt	3.19 g/t	127 koz	Commercial Projects	On Production	E1.1 F1.1 G1
		(122)	5147.3 kt	2.80 g/t	463 koz			E1.1 F1.1 G2
	Basic Reserves	(111b)	1370.6 kt	3.51 g/t	154 koz	Not defined in UNFC		
		(122b)	5719.2 kt	3.07 g/t	565 koz			
Intrinsic Economic	Mineral Resources	(333)	12049.2 kt	3.38 g/t	1311 koz	Potentially Commercial Projects	Development Pending	E2 F2.1 G3

Notes:
1. koz is for contained gold metal, kt is kilo tonnes for ore tonnage, and g/t is for gram/tonne.
2. (111b) and (122b) of GB/T 17766-1999 are inclusive of (111) and (122).
3. The effective date of mineral resources and reserves was 20 December 2019.
4. The reference point of mineral reserves was the portal point.
5. Assumed gold (Au) price was 1,400 US$/oz.

IV. Case study of Gold Mine B

A. Introduction

18. Sources of data: detailed exploration report of Gold Mine B, certificate for reviewing and registration of detailed exploration report of Gold Mine B.

19. Main references: Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T17766-1999), Specifications for Hard-rock Gold Exploration (DZ/T0205-2002), UNFC, and the Bridging Document.

20. X Company holds the exploration right of Gold Mine B with excellent road access, water and power supply, and source of labour.

21. Mineral processing and metallurgical tests reveal the ore is free-milling. Hydrogeological, geotechnical, and environmental conditions that may affect the development of mineral resources have been well understood through detailed exploration and studies.

22. The feasibility study has not been completed. Only a scoping study has been done.

B. Classification of mineral resources/reserves in line with GB/T 17766-1999

23. Industrial indexes for estimation of mineral resources/reserves are recommended in the Recommendation of Industrial Indexes for General Exploration of Gold Mine B developed by G Engineering Design and Research Co., Ltd., and reviewed by the Mineral Resources/Reserves Review Office of K Province. The industrial indexes are as follows:

(a) Cut-off grade: 1.00g/t;

(b) Minimum industrial cut-off grade: 2.20g/t;

(c) Average grade of the deposit: 3.40g/t;

(d) Minimum mining thickness: 1.2 m;

(e) Minimum thickness of separable waste rock within orebody: 3.0 m;

(f) Centimetre* gram/tonne cut-off: 264 cm*g/t.

24. A total of 80 orebodies have been delineated within the exploration area and classified as three exploration types. The feasibility study of the project has not been completed, only the scoping study has been done. Mineral resources in the area should be categorized as the intrinsic economic category in terms of economic viability. With regard to type I, the measured intrinsic economic mineral resources (331) were delineated by a drilling spacing of 40m to 76m×34m to 95m (strike × incline); the indicated intrinsic economic mineral resources (332) were delineated by a drilling spacing of 76m to 150m×78m to 147m; and the remaining resources were classified as the inferred intrinsic economic mineral resources (333). With regard to type II, the inferred intrinsic economic mineral resources (333) was delineated by a drilling pattern of 80m to 262m × 83m to 246m. With regard to type III, the resources were classified as (333).

C. Alignment of axes and classification codes

25. Alignment of the E axis. According to GB/T 17766-1999, mineral resources of Gold Mine B are categorized as the intrinsic economic category "3" in terms of the degree of economic viability (E axis). As suggested in the Bridging Document, the project is a potentially commercial project with reasonable prospects for economic extraction and sale in the foreseeable future corresponds to E2 in UNFC.

26. Alignment of the F axis. As suggested in the bridging document, because the feasibility study has not been completed and only the scoping study has been done, the level of feasibility assessment of the project is categorized as the scoping study "3" in GB/T 17766-1999, which corresponds to F2.1 in UNFC in terms of field project status and feasibility.

27. Alignment of the G axis. In accordance with GB/T 17766-1999, measured, indicated, and inferred have been categorized for the Gold Mine B in terms of the degree of geological assurance, which correspond to G1, G2, and G3 in sequence as suggested in the Bridging Document.

28. The correspondence of classification codes between GB/T 17766-1999 and UNFC is shown in Table 2.

Table 2
Correspondence of classification codes of mineral resources of Gold Mine B between GB/T 17766-1999 and UNFC

GB/T 17766-1999 Classes		*GB/T 17766-1999 Categories*				*UNFC Classes and Sub-classes*		*UNFC Categories*
Intrinsic Economic	Mineral Resources	(331)	5408.2 kt	4.07 g/t	708 koz	Potentially Commercial Projects	Development Pending	E2 F2.1 G1
		(332)	23833.4 kt	3.36 g/t	2575 koz			E2 F2.1 G2
		(333)	20781.8kt	2.93 g/t	1958 koz			E2 F2.1 G3

Notes:
1. koz is for contained gold metal, kt is kilo tonnes for ore tonnage, and g/t is for gram/tonne.
2. The effective date of mineral resources was 20 December 2019.
3. Assumed gold (Au) price was 1,450 US$/oz.

V. Case study of Coal Mine C

A. Introduction

29. Sources of data: (1) Report of prospecting of Coal Resources in Exploration Area C (hereinafter referred to as the Coal Prospecting Report), (2) Report of Detailed Exploration of Coal Resources in C Minefield (hereinafter referred to as the Detailed Coal Exploration Report), (3) Report of Feasibility study of Coal Mine C and Coal Processing Plants, Design for Modification of Coal Mine C and Coal Processing Plants, and (4) Report of Coal Resources/Reserves Verification of Coal Mine C (hereinafter referred to as the Coal Verification Report).

30. Main references: Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T17766-1999), Geological Exploration Standard for Coal and Peat (DZ/0215-2002), Code for Design of Mine of Coal Industry (GB 50215-2015), UNFC, and the Bridging Document.

31. Coal Mine C is located in North China. Exploration and mining rights have been acquired by Y Company. The internal and external construction conditions satisfy the ability for production and operation.

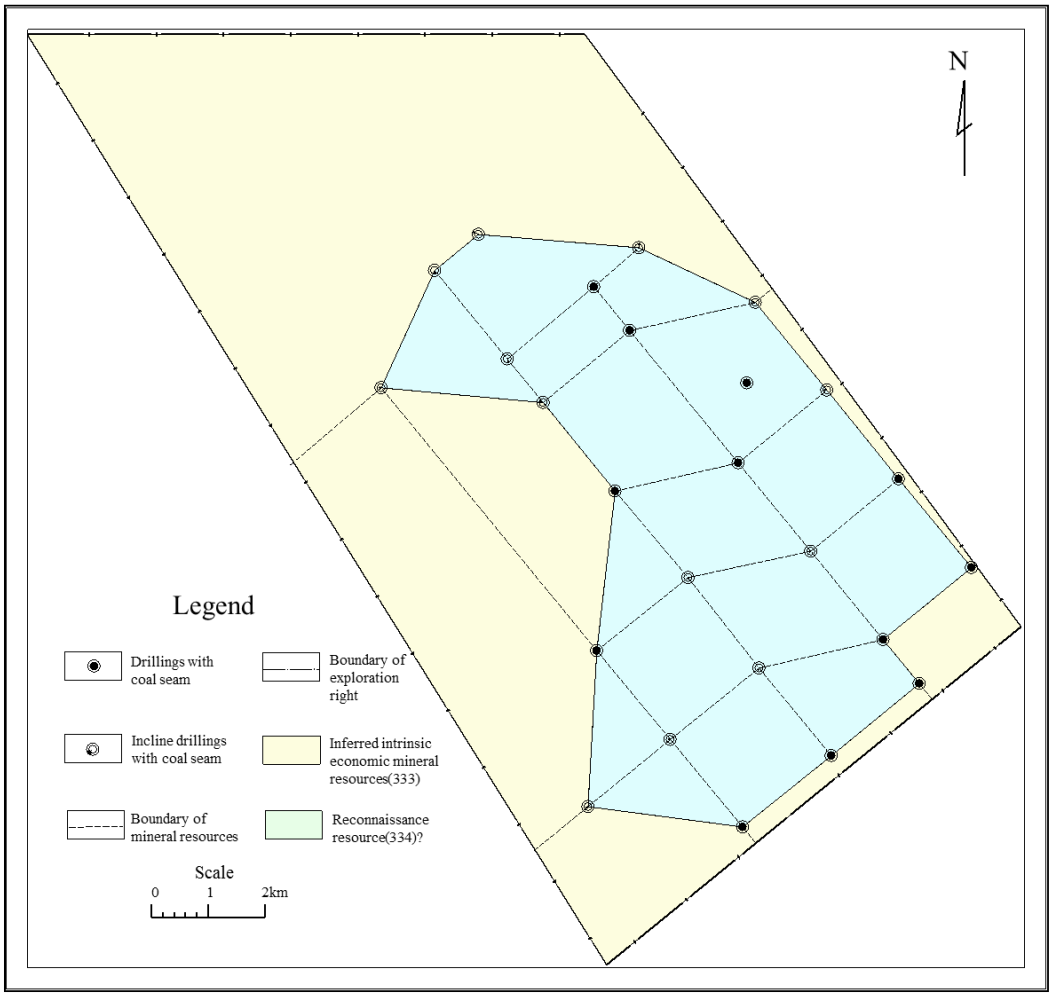
32. The production capacity of Coal Mine C is designed to produce 15 million tonnes per year and the life of mine is over 100 years. The mine has vertical shafts and three adits. The construction of the mine started on 1 April 2013 and is presently in the pilot production stage. A processing plant has been built up with processing capacity of 15 million tonnes per year. The products include washed coal and coal middlings.

33. With regard to the project status, Coal Mine C has gone through three stages: prospecting stage, detailed exploration stage, and construction and production stage. A case study for each stage is outlined in the following paragraphs.

B. Classification of coal resources/reserves of the coal mine in line with GB/T17766-1999

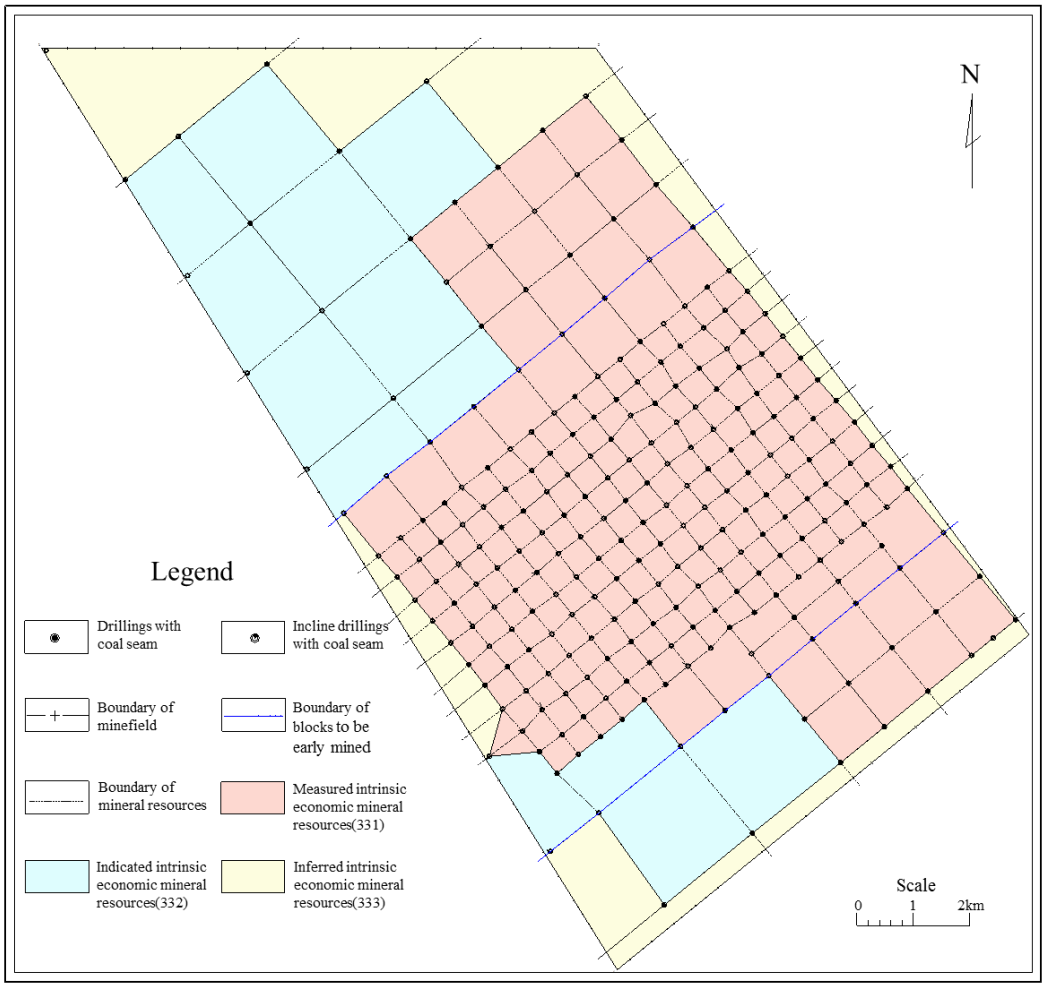
34. Classification of coal resources/reserves of the coalfield in the prospecting stage in line with GB/T17766-1999 was as follows. As indicated by the Coal Prospecting Report (25 drill holes), the prospecting area has geological features with simple structures and stable mineable coal seams near several production mines. According to DZ/0215-2002, coal resources were categorized as the inferred category using 25 drill holes on a grid of 2,000m×2,000m (strike × incline), and the remaining portion was categorized as the reconnaissance category based on a grid of 2,000m to 4,000m×2,000m to 4,000m. The scoping study was done in terms of feasibility assessment of the coal prospecting project with the result that the project was worthy of further development. The inferred resources (333) were estimated to be 965.27 million tonnes and the reconnaissance resources (334)? were estimated to be 2,027.19 million tonnes. The distribution and classification of coal resources is shown in Figure III.

Figure III
Distribution and classification of coal resources in GB/T 17766-1999 of the coal prospecting stage



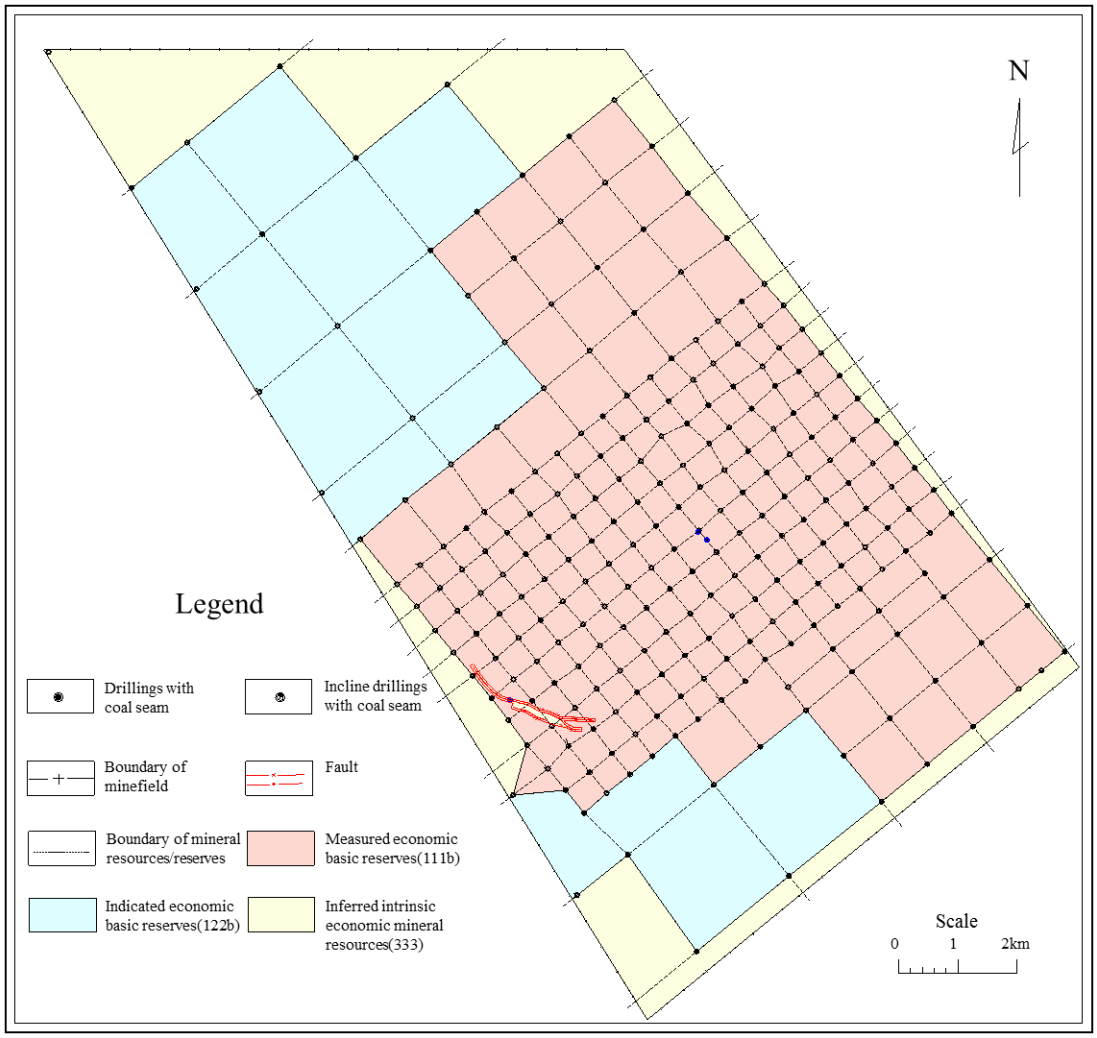
35. Classification of coal resources/reserves of the detailed exploration project in line with GB/T17766-1999 is as follows. As indicated in the Detailed Coal Exploration Report, large folds and igneous rocks have not yet been found in the area, but five faults with displacement of no more than 8 m have been interpreted from three-dimensional seismic data. It suggests that the structure of the minefield is simple. For stable coal seams, measured resources are delineated at a drilling spacing of 1,000m×1,000m (strike × incline); indicated resources at drilling spacing of 2,000m×2,000m; and the rest of the resources in the inferred category. For coal seams, which are nearly stable, measured resources, are delineated at intervals of 500m× 500m drilling; indicated mineral resources defined by drill spacing of 1,000m×1,000m; and the remaining resources are classified in the inferred category. For unstable coal seams, only inferred resources are estimated. Only a scoping study has been conducted during the detailed exploration stage with the conclusion that it is worth conducting a feasibility study for this project. The total identified coal resources are 3,219.42 million tonnes, which includes measured resources (331) of 1,012.50 million tonnes, indicated resources (332) of 723.54 million tonnes, and inferred resources (333) of 1,483.38 million tonnes. The distribution and classification of coal resources is shown in Figure IV.

Figure IV
Distribution and classification of coal resources in GB/T 17766-1999 in the detailed exploration stage



36. Classification of coal resources/reserves of the coal mine in the construction and production stage in line with GB/T17766-1999 is as follows. To apply for the mining permit, the exploration license owner submitted the coal verification report based on the same exploration data and information as the Detailed Coal Exploration Report. These two reports have the same classification of the exploration type. On the basis of the Detailed Coal Exploration Report, a programme of work has been conducted, including feasibility study, mine design, mine construction, and pilot production. The coal verification report was presented to the Mineral Resources and Reserves Evaluation Center for review. The amount of retained coal resources/reserves was 3,213.78 million tonnes, including measured economic basic reserves (111b) of 1,001.10 million tonnes, indicated economic basic reserves (122b) of 7,23.54 million tonnes, and inferred resources (333) of 1,489.14 million tonnes. The distribution and classification of coal resources and reserves are shown in Figure V. As indicated in the feasibility study, the (331) and (332) coal resources of the coal seams (upper 3-1, 3-1, 4-1, 4-2, and 6-1) are converted to (111b) and (122b), respectively, and their reserves have been estimated and categorized as (111) and (122). The majority of (331) and (332) mineral resources of coal seams (5-1, 5-2, 6-2, 6-4), have been categorized as (2M11) and (2M22) respectively, a minority of them are converted to (2S11) and (2S22) as isolated blocks respectively.

Figure V
Distribution and classification of mineral resources/reserves in 4-1 coal seam in GB/T 17766-1999 in the construction and production stage



C. Alignment of axes and classification codes

37. The scoping study had been done in terms of feasibility assessment in the prospecting stage with the result that the project was deemed worthy of further development. For the intrinsic economic mineral resources (333) of the project, there are reasonable prospects for economic extraction and sale in the foreseeable future. According to the Bridging Document, the category (333) corresponds to the E2F2.1G3 categories in UNFC, and the category (334)? of GB/T 17766-1999 corresponds to the categories E3.2F3G4 under UNFC.

38. The economic variability of the detailed exploration stage that is categorized as the intrinsic economic category “3” in GB/T 17766-1999 corresponds to E2 in UNFC as suggested in the Bridging Document. Only a scoping study has been conducted in this stage. The category in terms of feasibility assessment in this stage is “3” in GB/T 17766-1999, which corresponds to F2.1 in UNFC as indicated in the Bridging Document. In accordance with GB/T 17766-1999, measured, indicated and inferred resources have been categorized for the project in terms of degree of geological assurance, which correspond to G1, G2, and G3 in sequence as suggested in the Bridging Document.

39. A feasibility study has been conducted in the construction and production stage. The project is currently on pilot production. The feasibility study converted parts of the (331) and (332) mineral resources to (111b) and (122b) respectively, and estimated reserves are categorized as (111) and (122); parts of the (331) and (332) mineral resources have moved

upward to (2M11) and (2M22), and some are now assigned to (2S11) and (2S22) as mentioned in the previous text; the resources of category (333) are not adjusted. Mineral resources/reserves at this stage have been categorized as categories "1", "2M", 2S", and "3" in terms of degree of economic viability (E axis), and as categories "1", "2", and "3" in terms of feasibility assessment (F axis) in line with GB/T 17766-1999. According to the Bridging Document, the category "1" of the E axis in GB/T 17766-1999 corresponds to "E1.1" in UNFC, and the categories "2M", "2S", and "3" of the E axis correspond to E2 in UNFC. The categories "1" and "2" of the F axis within (111) and (122) in GB/T 17766-1999 correspond to F1.1 in UNFC. The categories "1", "2", and "3" of the F axis within (2M11), (2M22), and (333) correspond to F2.1 in UNFC. The categories "1", "2" of the F axis within (2S11) and (2S22) correspond to F2.2 in UNFC. In accordance with GB/T 17766-1999, measured, indicated and inferred have been categorized for the project in terms of degree of geological assurance, which correspond to G1, G2, and G3 in sequence as suggested in the Bridging Document.

40. The correspondence of classification codes of mineral resources at the prospecting stage between GB/T 17766-1999 and UNFC is shown in Table 3.

Table 3.
Correspondence of classification codes of mineral resources of the prospecting stage between GB/T 17766-1999 and UNFC

GB/T 17766-1999 Classes		*GB/T 17766-1999 Categories*		*UNFC Classes and Sub-classes*		*UNFC Categories*
Intrinsic Economic	Mineral Resources	(333)	965270 kt	Potentially Commercial Projects	Development Pending	E2F2.1G3
Economic-interest Undefined	Undiscovered Resources	(334)?	2027190 kt	Exploration Projects		E3.2F3G4

Notes:
1. kt is kilo tonnes for raw coal tonnage.
2. The raw coal dry-ash content ranges from 3.5% to 33.65%, its sulphur content ranges from 0.18% to 1.24%, its calorific value ranges from 5,509 to 7,739 kcal/kg.
3. The Effective Date of the coal resources estimation was 31 May 2007.
4. Assumed raw coal price was 40 US$/tonne.

41. The correspondence of classification codes of mineral resources of the coal exploration project between GB/T 17766-1999 and UNFC is shown in Table 4.

Table 4
Correspondence of classification codes of mineral resources of the detailed exploration stage between GB/T 17766-1999 and UNFC

GB/T 17766-1999 Classes		*GB/T 17766-1999 Categories*		*UNFC Classes and Sub-classes*		*UNFC Categories*
Intrinsic	Mineral Resources	(331)	1012500 kt	Potentially Commercial Projects	Development Pending	E2F2.1G1
		(332)	723540 kt			E2F2.1G2
		(333)	1483380 kt			E2F2.1G3

Notes:
1. kt is kilo tonnes for raw coal tonnage.
2. The raw coal dry-ash content ranges from 2.6% to 36.8%, its sulphur content ranges from 0.13% to 1.29%, its calorific value ranges from 5320 to 7662 kcal/kg.
3. The Effective Date of the coal resources estimation was 30 September 2007.
4. Assumed raw coal price was 40 US$/tonne.

42. The correspondence of classification codes of mineral resources of the coal mine construction and production project between GB/T 17766-1999 and UNFC is shown in Table 5.

Table 5
Correspondence of classification codes of mineral resources of the coal mine construction and production stage between GB/T 17766-1999 and UNFC

GB/T 17766-1999 Classes		*GB/T 17766-1999 Categories*		*UNFC Classes and Sub-classes*		*UNFC Categories*
Economic	Reserves	(111)	691698kt	Commercial Projects	On Production	E1.1F1.1G1
		(122)	466181 kt			E1.1F1.1G2
	Basic Reserves	(111b)	1001100 kt	Not defined in UNFC		
		(122b)	723540 kt			
Marginal Economic		(2M11)	73120 kt	Potentially Commercial Projects	Development Pending	E2F2.1G1
		(2M22)	79530 kt			E2F2.1G2
Sub-marginal Economic	Mineral Resources	(2S11)	3610 kt		Development On Hold	E2F2.2G1
		(2S22)	1800 kt			E2F2.2G2
Intrinsic Economic		(333)	1489140 kt		Development Pending	E2F2.1G3

Notes:
1. kt is kilo tonnes for raw coal tonnage.
2. (111b) and (122b) of GB/T 17766-1999 are inclusive of (111) and (122).
3. The Effective Date of the mineral resources and reserves estimation was 20 December 2019.
4. The reference point of reserves was the portal point.
5. Assumed raw coal price was 45 US$/tonne.
6. The raw coal dry-ash content ranges from 1.9% to 37.5%, its sulphur content ranges.

from 0.12% to 1.57%, its calorific value ranges from 5,435 to 7,658 kcal/kg.

VI. Case study of Iron Ore Mine D

A. Introduction

43. Sources of data: Resources/Reserves Verification Report of Iron Ore Mine D (hereinafter referred to as “Iron Mine Verification Report”) and Development and Utilization Plan for Mineral Resources in D mining area (hereinafter referred to as “Mine Development and Utilization Plan”).

44. Main references: Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T17766-1999), specification for iron, manganese and chromium mineral exploration (DZ/T 0200-2002), Code for design of metal mine (GB 50830-2013), UNFC, and the Bridging Document.

45. Iron Ore Mine D has the internal and external conditions that satisfy the production and operation of an iron mine. Z Company holds the mining right. The project to be developed by Iron Ore Mine D is recognized as the sedimentary metamorphic type. 91 diamond holes at a total of 37,954 m have been drilled. Nine iron orebodies have been delineated. Ores are classified as magnetite, maghemite, and hematite in accordance with processing methods.

46. The iron ore deposit was discovered in 1956, and subsequently was exploited with a conventional processing method approved by local authority in 1958. The mine was built formally in 1970 and put into production in 1989 using the open-pit mining method. Currently, the mine mainly applies an underground mining method and magnetic processing. According to the design, it has a life of mine of 60 years, and there are 36.7 years left. It is expected to produce 2.15 million tonnes per year as designed and now produces approximately 2.0 million tonnes per year. As suggested in the iron mine development and utilization plan and production practices, magnetite is the main

exploitation target at present and in the future; the development of maghemite is halted due to high costs; and hematite is excluded from production targets because they are refractory ore with complex features such as fine grain sizes, complex embedding, and different processing requirements than the magnetite ores and high processing costs. The product is iron concentrate with an average grade of 66.5% iron (Fe). Through the site investigation, it was found that the processing plant of hematite has been demolished.

47. With regard to the project status, the D iron deposit is divided into three projects which are magnetite, maghemite, and hematite projects on the basis of the industrial ore types as well as design and production practices.

B. Classification of mineral resources/reserves of the iron ore mine in line with GB/T17766-1999

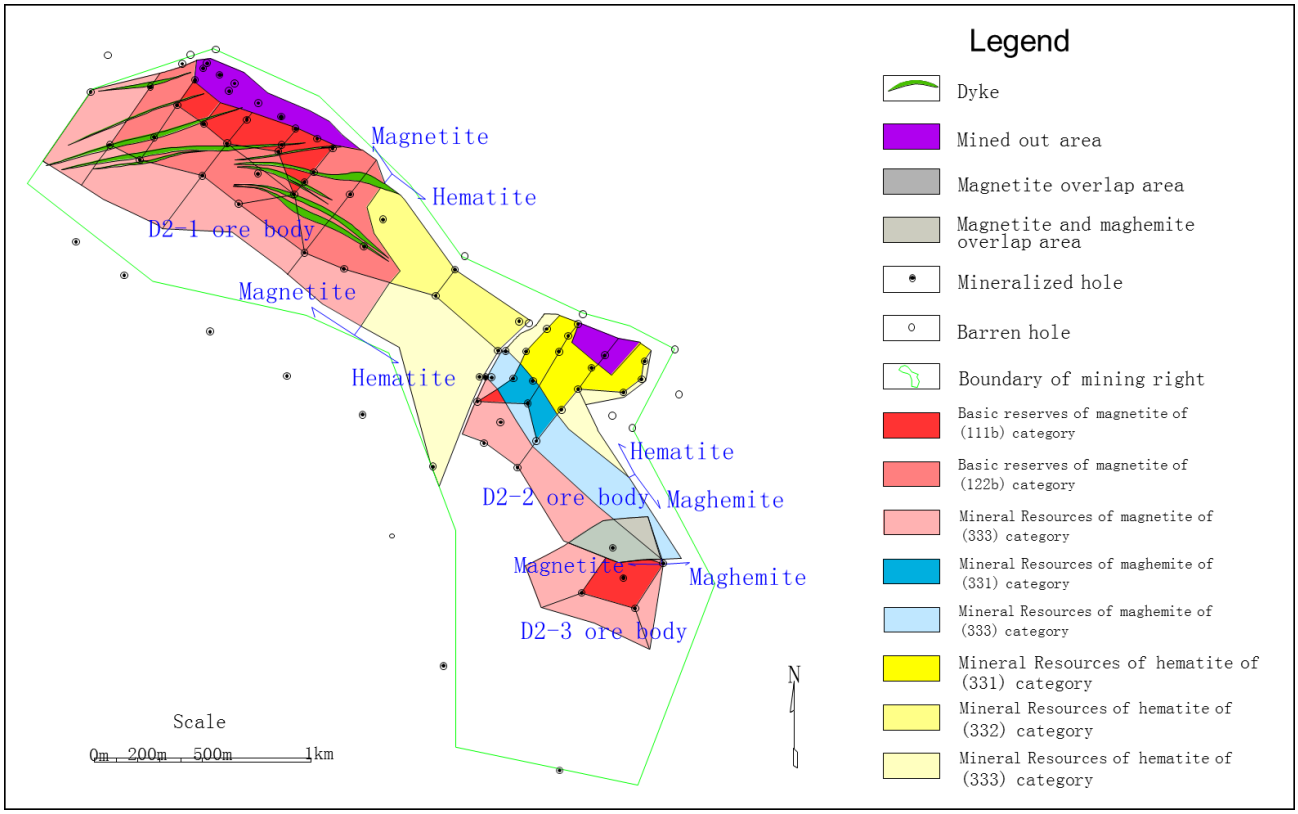
48. According to the iron mine verification report and development and utilization plan, the main ore bodies are large-scale with simple geometry and geological structures; the thickness, occurrence, and ore quality are stable; there is no obvious impact on ore bodies caused by magmatic veins or dykes. The exploration types of the main ore bodies are defined as type I. With regard to type I, measured resources are delineated based on a drilling grid of 200m×200m (strike × incline), indicated resources are based on a drilling grid of 200m to 400m×200m to 400m, and inferred resources are based on a drilling grid of 400m to 800m×400m to 800m or the extrapolated part of the measured resources or indicated resources. The magnetite resources/reserves are categorized as (111b), (122b), and (333), and relevant reserves (111) and (122) have been estimated in the development and utilization plan. The maghemite and hematite resources are categorized as (331), (332), and (333). The distribution and classification of mineral resources and reserves is shown in Figure VI.

C. Alignment of axes and classification codes

49. The categorizing of the project associated with magnetite resources is described here. The Mine Development and Utilization Plan of iron ore demonstrates that mining magnetite is economically viable. The economic category “1” in GB/T17766-1999 corresponds to E1.1 in UNFC. Categories “1” and “2” related to the feasibility assessment in GB/T 17766-1999 correspond to F1.1 in UNFC. Considering that the deposit is under production and inferred intrinsic economic mineral resources (333) can be mined after infill drilling, the Mine Development and Utilization Plan used 51% of inferred intrinsic economic mineral resources (333) to estimate mine life. Therefore, the feasibility categories “3” in GB/T 17766-1999 correspond to F2.1 in UNFC. Geological assurance is categorized as measured, indicated and inferred in GB/T 17766-1999, which correspond to G1, G2, and G3 in UNFC, respectively.

50. The categorizing of the project associated with maghemite resources is described here. As indicated in the Mine Development and Utilization Plan of iron ore, the development of maghemite is on hold, and is expected to restart in the foreseeable future. Its economic category “3” in GB/T 17766-1999 corresponds to E2 in UNFC; its feasibility category “3” in GB/T 17766-1999 corresponds to F2.2 in UNFC; its geological assurance is categorized as measured, indicated and inferred in GB/T 17766-1999 which correspond to G1, G2, and G3 in UNFC, respectively.

Figure VI.
Distribution and classification of mineral resources and reserves in GB/T 17766-1999



51. The categorizing of the project associated with hematite resources is described here. The hematite ores were determined as intrinsic economic mineral resources at the time of preparation of the Iron Ore Mine Verification Report but have been excluded from mineable resources in the Mine Development and Utilization Plan. As the processing plant for hematite has been demolished, with no plans to build a new facility, it is evident that there are not reasonable prospects for economic extraction of hematite in the foreseeable future. Therefore, the intrinsic economic category "3" defined in the Iron Ore Mine Verification Report corresponds to E3.3 in UNFC; the scoping study category "3" corresponds to F3 in UNFC; and geological assurance is classified as measured, indicated, and inferred according to GB/T 17766-1999, which correspond to G1, G2, and G3 in UNFC, respectively.

52. Correspondence of classification codes of mineral resources/reserves of magnetite, maghemite, and hematite projects between GB/T 17766-1999 and UNFC is shown in Table 6.

Table 6
Correspondence of classification codes of mineral resources/reserves of magnetite, maghemite, and hematite projects between GB/T 17766-1999 and UNFC

Industrial types of ores	*GB/T 17766-1999 Classes*			*UNFC Classes*		*UNFC Categories*
	Categories	*Quantity of ore (kt)*	*TFe (%)*			*Categories*
Magnetite	(111)	21346.1	27.39	Commercial Project	On Production	E1.1F1.1G1
	(122)	25047.2	26.78			E1.1F1.1G2
	(111b)	26642.2	28.18	Not defined in UNFC		
	(122b)	31321.5	27.56			
	(333)	89193.0	28.40	Potentially Commercial Project	Development Pending	E2F2.1G3
Maghemite	(331)	4725.2	28.70		Development On Hold	E2F2.2G1
	(333)	20965.2	28.52			E2F2.2G3
Hematite	(331)	17173.6	29.73	Non-Commercial Projects	Development Not Viable	E3.3F2.3G1
	(332)	2939.2	29.61			E3.3F2.3G2
	(333)	43173.2	30.55			E3.3F2.3G3

Notes:
1. kt is kilo tonnes for iron ore tonnage.
2. (111b) and (122b) of GB/T 17766-1999 are inclusive of (111) and (122).
3. The Effective Date of mineral resources and reserves estimation was 20 December 2019.
4. The Reference Point for the reserves was the portal point.
5. Assumed iron concentrate price was 95 US$/tonne.

VII. Conclusions

53. The case studies indicate that correspondence of classification codes of mineral resources/reserves between GB/T 17766-1999 and UNFC can be achieved through application of the Bridging Document.

54. As demonstrated by a large quantity of comparative research between mineral exploration and production, it is effective to apply GB/T 17766-1999 and its supporting technical standards in mineral exploration and evaluation. The case studies also indicate that UNFC can satisfy the requirements of mineral exploration, exploitation and related evaluation as it has the key principle of application of project status and feasibility to classify mineral resources/reserves.

55. When reserves in GB/T 17766-1999 correspond to the “Commercial Projects” class in UNFC, a feasibility study or an equivalent study should be completed to support the estimation of design loss and mining loss, and from this study economic basic reserves may be converted to reserves.

56. Mining dilution is not considered in the estimation of reserves in GB/T 17766-1999, so at the time of bridging the reserves in GB/T 17766-1999 to the “Commercial Projects” class in UNFC, reserves values reported in GB/T 17766-1999 should be adjusted according to the dilution parameters addressed in the feasibility study.

57. When the economic viability of a project has been demonstrated by a feasibility study, for the project in the construction or production stage, its reserves category (122) (indicated reserves) in GB/T 17766-1999 should correspond to E1F1G2 of a commercial project in UNFC.

58. A comparison with direct classification to UNFC, with supporting evidence, has not yet been conducted. This would be helpful to enable validation of the bridging.

Annex

Related Instructions

Cut-off Grade: The minimum content of a target element/commodity used to discriminate mineralization and waste. It is the key parameter to delineate the orebodies for mineral resource estimation. To some extent, it is similar to the cut-off that geologists use to interpret the domains for mineral resources estimation.

Minimum industrial cut-off grade: The minimum content of a target element/commodity calculated to achieve the break-even point, with reasonable consideration of technology and economic assumptions.

Centimetre* gram/tonne cut-off: For the high-grade intercepts narrower than the minimum mining thickness, this cut-off may be applied to delineate orebodies for resources estimation. However, the wireframe or boundary is not allowed to extrapolate when such a value is applied.

Orebody: When used in the context of mineral resources and mineral reserves estimation, it refers to the wireframe interpreted or solid modeled by systematic consideration of geological factors, cut-off grade, thickness etc. In this case, to some extent, it is similar to the mineralization domain used by geologists in mineral resources and mineral reserves estimation.

Measured: One of the definitions of geological assurance defined in the National Standard of the People's Republic of China Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999). It indicates that the geological features of the deposits, the ore body's shape, occurrence, size, ore quality, grade, the hydrological, geotechnical and environmental conditions for the mining, and the continuity of the ore body have been established in detail as per the requirement of detailed exploration. The estimation of quantities of solid fuels and mineral resources of this category is based on a comprehensive range of detailed data, with a high level of confidence.

Indicated: One of the definitions of geological assurance defined in the National Standard of the People's Republic of China Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999). This indicates that the main geological features of the deposit, the ore body's shape, occurrence, size, ore quality, grade, the hydrological, geotechnical and environmental conditions for the mining, and the continuity of the ore body have been primarily established within a certain range in the exploration area, as per the requirement of general exploration. The estimation of quantities of solid fuels and mineral resources of this category is based on relatively detailed data, with a relatively high level of confidence.

Inferred: One of the definitions of geological assurance defined in the National Standard of the People's Republic of China Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999). It indicates that the geological features of minerals and the distribution, grade, quality of the ore body (site) have been roughly established for the prospecting areas as per the requirement for prospecting, as well as the parts extrapolated from basic reserve or resource with relatively high geological assurance. However, due to limited information and a number of uncertainties, the continuity of ore bodies is extrapolated. The estimation of resources of this category is based on limited data, with a relatively low level of confidence.

Stability of coal seam: Used to define the continuous status of a specific coal seam in the Specification for Coal and Peat Exploration (DZ/T 0215-2002), one of the Chinese standards for geology and mineral industry. According to the variability of thickness and quality of the specific coal seam, and the quantity of seam partings, the stability of coal seam is classified as four types: stable, nearly stable, unstable, and very unstable.

Specification for Coal and Peat exploration (DZ/T 0215-2002): One of the Chinese standards for geology and mineral industry published by the former Ministry of Land and Resources of the People's Republic of China in 2002. This standard specifies the objectives

and tasks, exploration stage division, work level requirements for every exploration stage, principles of exploration methods of coal and peat geological exploration, classification conditions and estimation principles of coal and peat resources/reserves. This standard is applicable to geological exploration and resource/reserve estimation for coal and peat, as well as acceptance and review of coal and peat resource/reserve reports.

Specification for Hard-rock Gold Exploration (DZ/T 0205-2002): A professional standard published by the former Ministry of Land and Resources of the People's Republic of China in 2002. This standard specifies the objectives and tasks, and the requirements for study level, exploration programme quality, exploration work level, feasibility study of development of rock gold resource, and estimation and classification of mineral resources/reserves for rock gold deposits. This standard is applicable to geological exploration and resource/reserve estimation of rock gold deposits, as well as acceptance and review of resource/reserve reports of rock gold deposit.

Specification for Iron, Manganese and Chromium Mineral Exploration (DZ/T 0200-2002): A professional standard published by the former Ministry of Land and Resources of the People's Republic of China in 2002. This standard specifies the objectives and tasks, the requirements for exploration work level, quality control, feasibility study for geological exploration of iron, manganese and chromium deposits, and classification conditions and estimation principles of mineral resources/reserves for the deposits. It is applicable to the geological exploration and the estimation of mineral resources/reserves for iron, manganese and chromium deposits, as well as the acceptance and review of resources/reserves reports of iron, manganese and chromium deposits.

Verification report: A type of technical report submitted to the relevant Chinese Government department or disclosed to the capital market to update the mineral resources and mineral reserves estimate. It is commonly subjected to a production project or a development project when the technical and economic circumstance changed. The verification report is usually prepared in the absence of new sampling information and mainly based on the previous sampling programme for mineral resources/reserves update. A coal verification report is a verification report involving a coal resources/reserves update.

Code for Design of Mine of Coal Industry (GB 50215-2015): The national standard of the People's Republic of China, jointly issued by the former Ministry of Housing and Urban-Rural Development of the People's Republic of China and the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China in 2015. The Code is applicable to the preliminary feasibility study, feasibility study and design of new construction etc.

Code for Design of metal mine (GB 50830-2013): The national standard of the People's Republic of China, jointly issued by the former Ministry of Housing and Urban-Rural Development of the People's Republic of China and the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China in 2013. It was translated as the "Code for design of metal mine". The code is applicable to the preliminary feasibility study, feasibility study and the mining design of new construction, reconstruction and expansion of metal mines.

Internal and external construction conditions: These include the internal construction conditions and the external construction conditions. The internal construction conditions refer to the shape, thickness, grade, content, depth, processing and metallurgy, hydrological, geotechnical conditions of orebody. The external conditions refer to transportation, water supply, electricity, fuels, marketing and labor force etc.

Exploration Type: In order to select appropriate exploration methods and programmes, to determine reasonable exploration grids, and to effectively control and delineate the orebodies, an orebody or a deposit can be classified to one of the three Exploration Types based on their major geological features. The three types are: simple type (Type I), moderate type (Type II), and complex type (Type III). Due to the complexity of geological factors transitional types are also allowed, for example Type I-II or Type II-III. The above mentioned major geological features include but are not limited to the size of the orebody, geometrical complexity, textural complexity, homogeneity of the distribution of economical elements, structural complexity and other key features of the orebody or deposit.

For a coal project, it is a requirement to analyze the structural complexity and stability of the coal seams of a coal field or a specific exploration area to determine its exploration type and select reasonable exploration grids.

The exploration grids for reference, which correspond to indicated mineral resources in gold, iron and coal deposits with different exploration type, are shown in Tables 1, 2 and 3. In practice, the estimator needs to choose a rational drilling spacing in accordance with the feature of the given deposit. Generally, the drilling spacing for measured mineral resources is half of that used for indicated mineral resources. The drilling spacing for inferred mineral resources is 2 to 3 times that used for indicated mineral resources, as well as the parts extrapolated from measured or indicated mineral resources.

Table 1
Exploration Grids to Outline Indicated Mineral Resources for a Rock Gold Deposit

Exploration Type	*Tunneling*		*Drilling*	
	Levels	*Cross-cut (m)*	*Strike (m)*	*Incline (m)*
Type I	2	40~80	80~160	80~160
Type II	1~2	20~40	40~80	40~80
Type III			20~40	20~40

Table 2
Exploration Grids to Outline Indicated Mineral Resources for an Iron Ore Deposit

Exploration Type	*Strike (m)*	*Incline (m)*
Type I	400	200~400
Type II	200	100~200
Type III	100	50~100

Table 3
Exploration Grids to Outline Indicated Mineral Resources for a Coal Deposit

Exploration Type	*Strike (m) or Incline (m)*
Type I	1000~2000
Type II	500~1000
Type III	250~500
Type Ⅳ	For extremely complex types, it is only suitable to conduct exploration in parallel with mining activities, there is no specific stipulation for the spacing.