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RECORD 1992/44 - COMPARISON OF THE MINERAL RESOURCE CLASSIFICATION SCHEMES OF CHINA AND AUSTRALIA BY M.B. HULEATT & OFFICIALS OF THE CHINESE INSTITUTE OF GEOLOGICAL SCIENCES, BEIJING, CHINA

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Comparison of the Mineral Resource Classification Schemes of China and Australia

by

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Geological and Mineral Resources Information

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Preface to the Australian Report

This report is the end product of a cooperative research project between the Australian Bureau of Mineral Resources (BMR) and the Ministry of Geology and Mineral Resources of China. A Chinese language version of the report will be prepared and published in China by the Ministry of Geology and Mineral Resources.

During two Australian missions to China and two return Chinese missions to Australia many people provided considerable assistance and input into the deliberations. Thanks are due to Dr Li Yuwei and Mr Wang Jiashu and their colleagues, Mr Zhang Chuan and Mr Chen Gang, at the Chinese Institute for Geological and Mineral Resources Information in Beijing for making the two Australia missions to China successful and for their hospitality. Particular thanks are also due to Mr Huang Dehua for his efforts as interpreter and guide during the Australian visits to China and the first Chinese mission to Australia and to Mr Zhang Qiuming who provided excellent interpretation during the second Chinese mission.

Officers of the Queensland Department of Resource Industries participated in both Australian missions. Mr Jim Sawers was a member of the 1989 mission and Dr Cec Murray the 1991 mission. Mr Andrew Bailey from BHP was a member of the 1991 mission. The efforts of all three were invaluable and the support of their organisations is gratefully acknowledged. Thanks is also due to Mr Paul Shelley, formerly of BMR, who was a member of the first mission.

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Finally I would like to thank my colleagues in the Identified Resources Project, Minerals Resource Assessment Program for their input into the discussions and assistance with the organisation of the two Chinese missions. Particular thanks to Roger Pratt for escorting both missions on interstate visits to mines and other organisations. Also thanks are due to David Newham, of BMR, for his handling of arrangements for all missions associated with this project.

M.B. Huleatt

Comparisons of the Mineral Resource Classification Schemes of China and Australia

ABSTRACT

Major mineral producing countries throughout the world have formulated mineral resource classification systems suited to their own conditions. As yet, there is no single classification in common use. The differences between exploration standards, methodology and economic systems make direct comparison of mineral resources between countries difficult. The Sino-Australian cooperative research program attempts to establish a correlation between the mineral resource classifications of the two countries and to compare the mineral resource classification systems of both with the USA and the former USSR.

Following consultations and study by geoscientists from China and Australia, a preliminary correlation between the mineral resource classifications used by the Chinese Institute of Geology and Mineral Resources Information (CIGMI) and the Australian Bureau of Mineral Resources, Geology and Geophysics (BMR) was established. As well, the Australian AusIMM(*)/AMIC(**) industry classification for minerals and the Australia Coal Code are included in the correlation. The proposed correlation will be useful, not only for analysis and assessment of the mineral resources in China and Australia but also for the comparison of the resources of other countries, especially between planned economy countries and market economy countries.

SUMMARY

It is possible to compare, approximately, on the basis of geoscientific and engineering studies the categories of demonstrated reserves of China with the categories of BMR's demonstrated resources. Category A and B in the General Principle (see text for explanation) is correlated with BMR's Measured Resource. Category C reserves correlate with BMR's Indicated Resource and Category D reserves correlate with BMR's Inferred Resources.

In the mineral reserve classification scheme proposed by CIGMI, based on "economic" feasibility, "Usable (within Reserve Balance-sheet) Reserves" of the General Principle are divided into three categories: (1) Using Reserve, (2) Usable Reserves for Planning and Programming and (3) Temporarily Unusable Reserves. Using Reserves plus Usable Reserves for Planning and Programming are correlated with BMR's Economic Demonstrated Resources and the Temporarily Unusable Reserves with BMR's Sub-Economic Resources.

It is difficult to directly compare the reserve classification system of China with the AusIMM/AMIC Minerals Code and the Australian Coal Code. The principal difficulty is that the AusIMM/AMIC Minerals Code and the Australian Coal Code aim to report reserves in specific deposits rather than national aggregates as is the case with the CIGMI system. While it is possible to correlate much of the Australian industry codes approximately with the CIGMI system by means of their correlation with the BMR system problems still remain to be solved. The CIGMI system, for example, has no equivalent categories for recoverable and marketable reserves that are included in the Australian Coal Code.

(*) Australasian Institute of Mining and Metallurgy
(**) Australian Mining Industry Council

INTRODUCTION

Formulation of mineral resource classification systems is influenced by the political and economic systems, the level of industrial development and the nature of the mineral resources in the country. The classification proposed in China in 1954 was derived from that of the Soviet Union and was refined later in the light of experience and conditions in China. In general terms, the classification system now used in China is similar to those adopted in other planned economy countries. Australia has based its national mineral resource classification scheme on that used by the United States Bureau of Mines. BMR adopted its original system in 1975 and refined it in 1984 when the system now in use was adopted.

In November 1983 a Memorandum of Understanding (MOU) covering geoscientific and technological cooperation between the Australian Department of Primary Industries and Energy and the Ministry of Geology and Mineral Resources of China was signed. Signatories to the Memorandum were Professor RWR Rutland, Executive Director of the Australian Bureau of Mineral Resources, Geology and Geophysics and Mr Yang Zhilin, Chief of the Department of Foreign Affairs of the Ministry of Geology and Mineral Resources. Included in the Memorandum was provision for cooperation in the fields of mineral resource assessment and administration of mineral resources. It was subsequently agreed that exchange delegations would study mineral resource assessment, mineral resource related databases, and administration of mineral resources in both countries.

In September 1989 an Australian delegation led by Mr M.Huleatt, Principal Resource Geologist, BMR, visited China to study mineral resource assessment and the administration of mineral resources. During that visit discussions were held to examine the possibility of cooperative research into the correlation of the mineral resource classification schemes of both countries, the exchange of mineral resource information and joint research programs into various aspects of mineral resources.

In December of the same year a Chinese "Investigation Group for Australian Mineral Resources" headed by Mr Wang Jiashu, Deputy Director, CIGMI, paid a return visit to Australia. This delegation studied mineral resource assessment and analysis, including classification systems and economic analysis, in Australia. Following detailed discussions it was agreed to recommend to the managements of BMR and CIGMI that a research program based on a comparative study of the mineral resource classification systems of the two countries be implemented. The objective of the program was to be the correlation of the classification systems of China and Australia to facilitate future comparisons of the mineral resources of these countries. It was also agreed that, if possible, the classification systems of other countries should be included.

At the invitation of Professor Rutland a delegation led by Mr Wang Xionglin, Director of the Department of International Cooperation, MGMR, visited Australia in August 1990. A renewal of the MOU was agreed to which included provision for the resource classification correlation program.

Subsequently, in May 1991, Mr M.Huleatt led an Australian delegation to China. Discussions were held with geoscientists from CIGMI at which the BMR national code, the Australian industry codes for mineral and coal resource classification and the Chinese classification systems were studied in detail. A preliminary correlation of the classification schemes was determined.

In October 1991 a Chinese delegation led by Mr Zhang Chuan, Deputy Chief of the Science and Technology Division of CIGMI, visited Australia to finalise the correlation of the systems and to prepare a report on the research program.

MINERAL RESOURCE CLASSIFICATION SYSTEMS IN AUSTRALIA

Mineral resource classification systems are used at two levels in Australia. The first is at the industry level and is aimed at classifying the resources of individual deposits and the second is used by BMR for national resource assessment. Two separate sets of guidelines are used at the industry level in Australia; one for minerals and another for coal.

INDUSTRY LEVEL CLASSIFICATION SYSTEMS

For minerals the guidelines for resource classification were established by a joint committee of the AusIMM and AMIC. The guidelines are known as the "Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves" and were adopted for general use by the mining industry in 1988 and explanatory guidelines for the Code were released in May 1990.

The "Australian Code for Reporting Identified Coal Resources and Reserves" was developed to meet the needs of both government and industry. The code was drafted by officers from the New South Wales Department of Mineral Resources and the then Queensland Department of Mines and was ratified for use in Australia in 1986.

Both codes provide general guidelines only. It is the responsibility of the individual mining company reporting resources or reserves to ensure that sufficient exploration has been done to ensure that the report accurately reflects the resources present in a deposit. Unlike the situation in China, Australia does not use detailed exploration standards for minerals or energy exploration. The exploration company has total responsibility for ensuring that the exploration it has done is adequate to delineate the resources or reserves in a deposit -- governments are not generally involved in this aspect of mineral resource assessment.

Australian Code for Reporting Identified Coal Resources and Reserves

This code is based entirely on geoscientific and technical parameters. There is no consideration given to economic, financial or commercial factors. Consequently "reserves" defined under the Coal Code are not directly comparable to "reserves" defined under the Minerals Code.

The Coal Code is general in its definitions of various resource categories. While it does specify the maximum distance between points of observation (for example, drill holes) for each category the actual spacing used is determined by the exploration company on the basis of its knowledge of the deposit. Although there is provision for reporting marketable reserves it is rare for companies to make use of that category. The resource and reserve categories defined in the Coal Code are reproduced below:

Coal resources are all of the potentially usable coal in a defined area and are based on points of observation and extrapolations from those points.

Potentially usable coal is defined as coal which has, or could be, beneficiated to give a quality acceptable for commercial usage in the foreseeable future and excludes minor coal occurrences. The estimator should state both the quality and thickness limits used to define potentially usable coal in any resource evaluation.

Coal reserves are those parts of the coal resources for which sufficient information is available to enable detailed or conceptual mine planning and for which such planning has been undertaken.

Measured Resources are those for which the density and quality of points of observation are sufficient to allow for a reliable estimate of the coal thickness, quality, depth and in situ tonnage.

Points of observation should provide a level of confidence sufficient to allow detailed planning, costing of extraction and specification of a marketable product.

The points of observation generally should not be more than 1 km apart. Where geological conditions are favourable it may be possible to extrapolate known trends a maximum distance of 0.5 km from points of observation.

Indicated Resources are those for which the density of observation and quality of points of observation are sufficient to allow for a realistic estimate of the coal thickness, quality, depth, and in-situ tonnage and for which there is reasonable expectation that the estimate of resources will not vary significantly with more detailed exploration.

Points of observation should provide a level of confidence sufficient to enable conceptual planning of extraction and to determine the likely quality of the product coal.

Points of observation generally should not be more than 2 km apart. Where geological conditions are favourable, it may be possible to extrapolate known trends a maximum distance of 1 km from points of observation.

Inferred Resources are those for which the points of observation are widely spaced and, as a result, assessment of this type of resource may be unreliable.

Points of observation should allow the presence of coal to be unambiguously determined.

Inferred Resources Class 1 are those resources for which the points of observation allow an estimate of the coal thickness and general coal quality to be made, and the geological conditions indicate continuity of seams between the points of observation.

Points of observation generally should be not more than 4 km apart. Extrapolations of trends should extend not more than 2 km from points of observation.

Inferred Resources Class 2 are those for which there is limited information and as a result the assessment of this type of resource may be unreliable.

Provided the coal thickness can be determined, the order of magnitude of Inferred Resources Class 2 may be expressed within the following ranges:

1-10 million tonnes
10-100 million tonnes
100-500 million
500-1000 million tonnes
greater than 1000 million tonnes

If a more specific quantitative estimate is made to determine exploration priorities, etc., it should not be quoted in public reports or in any prospectus.

Mineable In-situ Reserves are the tonnages of in-situ coal contained in seams or sections of seams for which sufficient information is available to enable detailed or conceptual mine planning and for which such planning has been undertaken.

Mineable In-situ Reserves may be calculated only from Measured and Indicated Resources. Measured Resources are required for detailed mine planning and are the preferred basis for Mineable In-situ Reserves. Indicated Resources may be used for conceptual mine planning. In general, further exploration will be required prior to the commencement of mining operations.

Mineable In-situ Reserves should be quoted separately for surface and underground mines and an outline of the proposed mining method(s) should be provided.

Recoverable Reserves are the tonnages of Mineable In-situ Reserves that are expected to be recovered; i.e., that proportion of the seam(s) which will be extracted. If dilution is added to the recoverable reserves tonnage, the total equates to the 'run-of-mine' tonnage. If allowance is made for dilution it should be stated.

In calculating Recoverable Reserves a mining recovery factor must be applied to the Mineable In-situ Reserves. This factor will depend on the mining method to be used. Unless a specific factor has been determined for conceptual studies, the historically proven mining recovery factor should be used. If such information is not available, a mining recovery factor of 50% for underground reserves and 90% for surface reserves may be applied. An outline of the proposed mining method should accompany any statement of Recoverable Reserves.

Marketable Reserves are the tonnages of coal that will be available for sale. If the coal is to be marketed raw, the Marketable Reserves will be the same as the Recoverable Reserves plus dilution; i.e., the "run-of-mine" tonnage. If the coal is to be beneficiated Marketable Reserves are calculated by applying the predicted yield to the Recoverable Reserves. The basis of the predicted yield should be stated; e.g., 200mm cores, slim cores, pretreated cores.

Australasian Code for Reporting Identified Mineral Resources and Ore Reserves

The AusIMM/AMIC Minerals Code, similar to the Coal Code, uses general terms to define the various categories of reserves and resources. The responsibility to ensure that the available data is sufficient to justify inclusion of a resource or reserve in any category rests solely with the exploration or mining company undertaking the work.

In contrast to the Coal Code the AusIMM/AMIC Minerals Code does make provision for consideration of economic factors. Before a resource can be upgraded to one of the reserve categories several technical and economic requirements must be satisfied. Consequently, if study of a resource shows that it would not be economic to mine it cannot be upgraded to reserve status. If an exploration or mining company using this Code reports a deposit as having reserves it is implied that it is, or will, be economic to mine.

The various categories of resources and reserves defined by the AusIMM/AMIC Minerals Code are described below:

The term Resource is defined as an identified, in situ mineral occurrence, which excludes "Pre-Resource" mineralisation, from which valuable or useful minerals may be recovered. A resource may be reported as:

- an Inferred Resource;
- an Indicated Resource; or
- a Measured Resource.

In defining a resource, a competent person will only take into consideration geoscientific data. It must be appreciated, however, that in reporting a resource, there is an implication that there are reasonable prospects for eventual economic exploitation.

The term Inferred Resource is an estimate, inferred from geoscientific evidence, drill holes, underground openings, or other sampling procedures and before testing and sampling information is sufficient to allow a more reliable and systematic estimation.

The term Indicated Resource means a resource sampled by drill holes, underground openings, or other sampling procedures at locations too widely spaced to ensure continuity but close enough to give a reasonable indication of continuity and where geoscientific data are known with a reasonable level of reliability.

The term Measured Resource means a resource intersected and tested by drill holes, underground openings, or other sampling procedures at locations which are spaced closely enough to confirm continuity and where geoscientific data are reliably known.

The term Ore Reserve means that part of a Measured or Indicated Resource, which could be mined, including dilution and from which valuable or useful minerals could be recovered economically under conditions realistically assumed at the time of reporting. Ore Reserves should be reported as:

- Probable Ore Reserves or
- Proved Ore Reserves.

The term Probable Ore Reserves means Ore Reserves stated in terms of mineable tonnes/volumes and grades where the conditions are such that ore will probably be confirmed but where the in situ identified resource has been categorised as "Indicated" and has not been defined with the precision necessary for the "Measured" category. Probable Ore Reserves includes ore that has been sampled on a pattern too widely spaced to ensure continuity.

The term Proved Ore Reserves means Ore Reserves stated in terms of mineable tonnes/volumes and grades in which the identified in situ resource has been defined in three dimensions by excavation or drilling, and should include additional minor extensions beyond actual openings and drill holes, where the geological factors that limit the ore body are known with sufficient confidence, that it is categorised as a "Measured Resource".

The choice of the appropriate category of Ore Reserve depends upon the quantity and quality of data available and the level of confidence that is attached to those data.

NATIONAL RESOURCE ASSESSMENT IN AUSTRALIA

National resource assessment in Australia is done by BMR and is based to a large degree on data published by mining and exploration companies according to the AusIMM/AMIC Minerals Code and the Coal Code. In 1975 BMR adopted, for use in Australia, a slightly modified version of the McKelvey resource classification system used by the US Bureau of Mines and the US Geological Survey. Subsequently, in 1984, following a thorough review of the system, BMR again modified the system. The system revised in 1984 is still in use and is outlined below.

BMR classifies known mineral resources according to two parameters: degree of geological assurance of occurrence and the degree of economic feasibility of exploitation. The former takes account of data on tonnage and grade and the latter takes account of changing economic factors such as price and operating costs.

The various categories used in the BMR system are described below and the system is illustrated in Figure 1:

Resource - A concentration of naturally-occurring solid, liquid, or gaseous materials in or on the earth's crust and in such form that its economic extraction is presently or potentially (within a 20-25 year timeframe) feasible (see guideline i).

Categories of resources based on degree of assurance of occurrence:

	IDENTIFIED			UNDISCOVERED	
	DEMONSTRATED		INFERRED	HYPOTHETICAL	SPECULATIVE
	MEASURED	INDICATED			
ECONOMIC					
PARAMARGINAL					
SUB-ECONOMIC					
SUBMARGINAL					

Figure 1: BMR's resource classification system used for national resource assessment in Australia

Identified Resources - Specific bodies of mineral-bearing material whose location, quantity, and quality are known from specific measurements or estimated from geological evidence. Identified Resources include economic and sub-economic components. To reflect degrees of geological assurance, Identified Resources can be subdivided into the following categories:

Measured - resources for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drill holes, and for which the grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely, and the geological character is so well defined that size, shape, and mineral content are well established.

Indicated - resources for which tonnage and grade are computed from information similar to that used for measured resource, but the sites for inspection, sampling and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for resources in the measured category, is high enough to assume continuity between points of observation.

Demonstrated - a collective term for the sum of Measured and Indicated Resources.

Inferred - resources for which quantitative estimates are based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity, or repetition, of which there is geological evidence. This evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geological evidence of their presence. Estimates of Inferred Resources should be stated separately and not combined in a single total with Measured or Indicated Resources (see guideline ii).

Undiscovered Resources - unspecified bodies of mineral-bearing material surmised to exist on the basis of broad geological knowledge and theory.

Undiscovered resources include the following categories:

Hypothetical - resources which may reasonably be expected to exist in a known mining district or mineral province under known geological conditions. As exploration confirms their existence and reveals information about tonnage and grade, such resources would be reclassified in the appropriate subdivision of Identified Resources.

Speculative - resources which may occur either in known types of deposits in a favourable geological setting where no discoveries have previously been made, or in as yet unknown types of deposits which remain to be recognised. As exploration confirms their existence and reveals information about tonnage and grade, such resources would be reclassified in the appropriate subdivision of Identified Resources.

Categories of resources based on economic considerations:

Economic - this term implies that, at the time of determination, profitable extraction or production under defined investment assumptions has been established, analytically demonstrated or assumed with reasonable certainty (see guideline iii).

Sub-economic - this term refers to those resources which do not meet the criteria of economic; sub-economic resources include paramarginal and submarginal categories.

Paramarginal - that part of the Sub-economic Resources which, at the time of determination, almost satisfies the criteria for economic. The main

characteristics of this category are economic uncertainty and/or failure (albeit just) to meet the criteria which define economic. Included are resources which would be producible given postulated changes in economic or technologic factors.

Submarginal - that part of Sub-economic Resources that would require a substantially higher commodity price or some major cost-reducing advance in technology, to render them economic.

BMR guidelines for classifying mineral resources:

(i) Use of the term 'resources' is restricted to material, the extraction of which is generally judged to be potentially economically viable in an arbitrary time frame of about 20 to 25 years. The term includes, where appropriate, material such as tailings and slags. The definition does not intend to imply that exploitation of any such material will take place in that time span, but only that its possibility might reasonably be considered. This guideline attempts to establish a lower limit to what is worth assessing. It should be applied on a commodity by commodity basis to take account of prevailing and prospective technologies. Material falling outside the category of resources should be referred to as "occurrences". Unless otherwise stated, the classification system refers to in-situ resources. However, as is the case with the United Nations' system, it is possible and in fact desirable to also show recoverable quantities of resources in each category.

(ii) By definition, Inferred Resources are classified as such for want of adequate knowledge and therefore it may not be feasible to differentiate between economic and subeconomic inferred resources. Where inferred resources are shown as "undifferentiated", the amount known or judged to be economic may be indicated. Such judgements must take careful account of the commodity being assessed and its mode of occurrence as these factors will have a bearing on the reliability of estimates made. Specifically, grade estimates can be more reliably made for concordant sedimentary and biological deposits than for discordant epigenetic deposits.

(iii) The definition of "economic" is based on the important assumption that markets exist for the commodity concerned. All deposits which are judged to be exploitable economically at the time of assessment, whether or not exploitation is commercially practical, are included in the economic resource category. It is also assumed that producers will operate at optimum rates of output, and will receive the "going market price" for their production. The classification is therefore based on the concept of what is judged to be economic rather than what is considered to be commercial at any particular time.

The information required to make detailed assessments of economic viability of a particular deposit is commercially sensitive (e.g. a company's costs and required internal rate of return), and these data may not be available to organisations such as BMR. Furthermore, as corporate strategies are likely to be different, individual companies will have different criteria for what is considered to be "economic". Thus to standardise the approach for national or regional resource assessments, the following mineral deposits/situations are accepted by BMR as a general guide, to be economic:

(a) the resources (published or unpublished) of operating enterprises, whether or not such operations are sustained by long or short term, direct or indirect, government subsidies;

(b) resources in a deposit which is being developed for production (i.e. where there is a corporate commitment to production);

(c) undeveloped resources which are judged to be economic on the basis of a financial analysis using actual, estimated or assumed variables, viz: the tax rate, capital and operating costs, discount rate (such as reflects the long term bond rate), commodity prices, and depreciation schedules; the values for economic variables used in an assessment must be realistic for the circumstances prevailing at the time of the assessment;

(d) resources at mines on care-and-maintenance meeting the criteria in (c) above.

(iv) The term "recoverable" is considered to make allowances for mining as well as processing losses. Where a finer distinction needs to be made, mineable is used to take account of mining losses and metallurgically recoverable (saleable for coal) is used to take account of processing losses.

(v) Some minerals derive their economic viability from their co-product or by-product relationships with other minerals. Such relationships and assumptions must be clearly explained in footnotes or in accompanying text;

(vi) National aggregates of resource estimates should be rounded to the appropriate last significant digit so as not to create false impressions of accuracy.

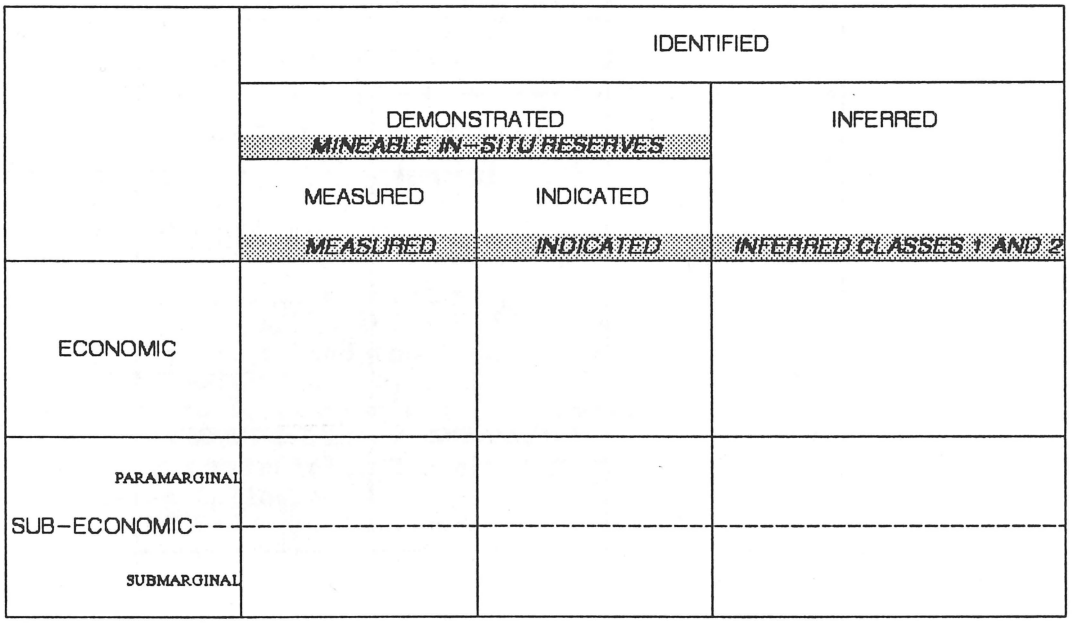
CORRELATION OF THE INDUSTRIAL CODES WITH BMR'S SYSTEM

Australian Coal Code

Direct correlation of the geological categories of the BMR system with the categories of the Australian Coal Code is possible. The Coal Code's Measured Resources and Indicated Resources correlate with BMR's Measured and Indicated Resources respectively. The Coal Code divides Inferred Resources into two separate classes based on the possibility of determining a specific tonnage figure or the need to specify a possible tonnage range for the deposit. BMR's system does not provide for any equivalent subdivision of the Inferred Resource category. Consequently the Inferred Class 1 and Inferred Class 2 categories of the Coal Code are correlated with the Inferred category of the BMR scheme.

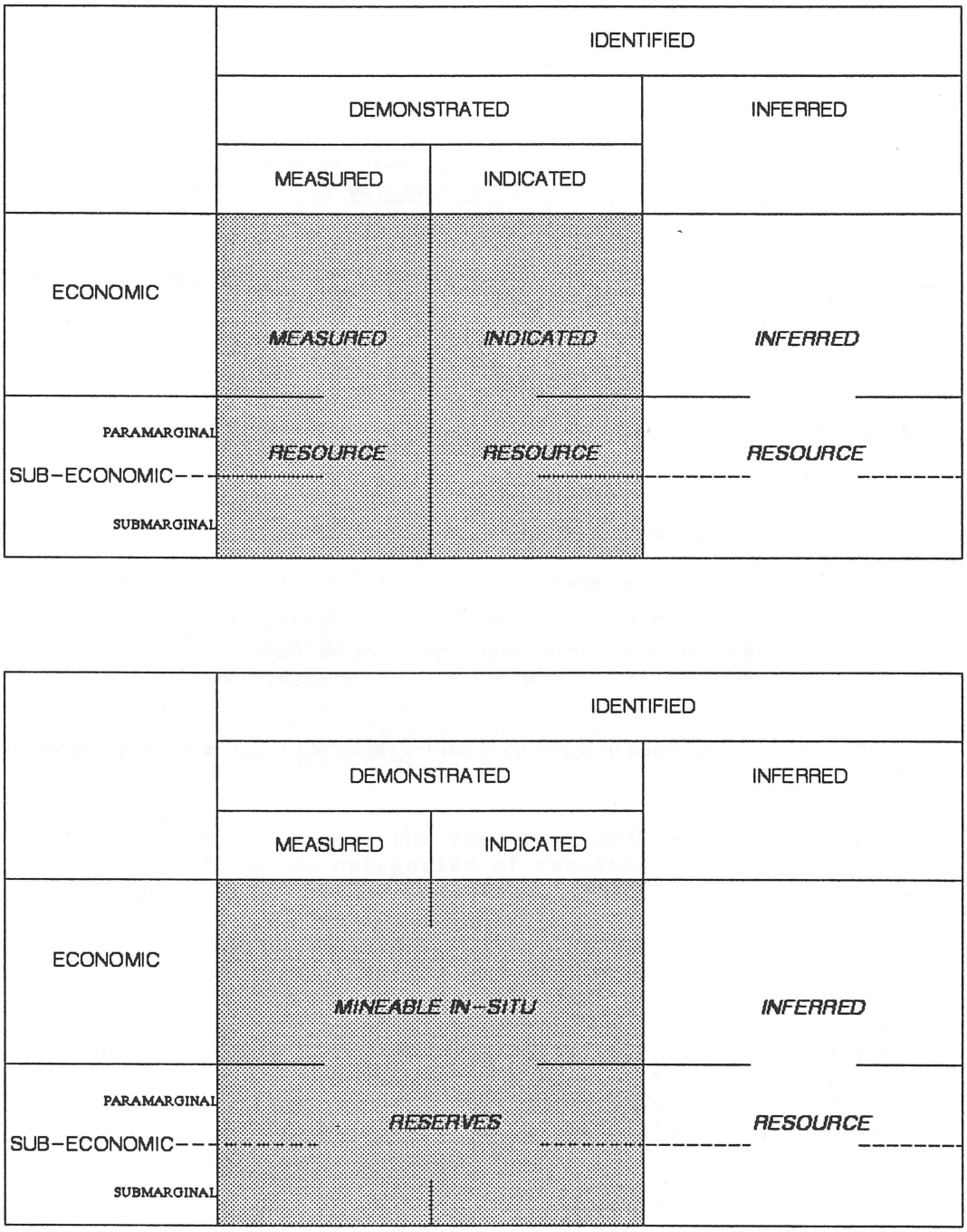
Because the Coal Code is used to assess the resources and reserves of individual deposits there are three categories of reserves defined - Mineable In-situ, Recoverable and Marketable. The BMR system, which is aimed at national resource assessment, does not provide for any categories of reserves. Mineable In-situ Reserves are derived from Measured and Indicated Resources and the transistion to the reserve category involves the development of an actual or conceptual mine plan but no additional geological knowledge is required. Therefore in terms of the degree of geological assurance the Mineable In-situ Reserve is equivalent to BMR's Measured and Indicated Resources. It may not be known which resource category the reserve is derived from and consequently the correlation of Mineable In-situ Reserve with the BMR system is with the Demonstrated Resource category which is made up of the Measured plus Indicated Resources. This correlation is illustrated in Figure 2.

The absence of economic parameters in the Coal Code prevents a direct correlation with the economic categories of the BMR system. Consequently the economic classification of a coal resource within the BMR system is based on an interpretation of the economic viability of the resource. The possible correlation of the Coal Code's categories with the BMR categories are shown in Figure 3. The Coal Code's Measured Resource may, for example, correlate with either BMR's Economic Measured Resource or Sub-economic Resource. Mineable In-situ Reserves would correlate with either BMR's Economic Demonstrated Resource or Sub-economic Demonstrated Resource.



BMR categories are shown in block capitals eg MEASURED
Australian Coal code categories are shown in italicised capitals eg INDICATED

Figure 2: Correlation of the BMR identified resource categories with categories from the Australian Coal Code



BMR categories are shown in block capitals eg MEASURED
Australian Coal Code categories are shown in italicised capitals eg INDICATED

Figure 3: Interpreted correlation of the BMR identified resource categories with categories from the Australian Coal Code

AusIMM/AMIC Minerals Code

In contrast to the Coal Code, the AusIMM/AMIC Minerals Code does provide for economic assessment of resources. Although the resource categories are independent of economic parameters, economic viability must be shown before a resource can be upgraded to a reserve category. The correlation of resource categories of the AusIMM/AMIC Minerals Code and the BMR system based on the degree of geological assurance is relatively simple. The BMR categories of Measured, Indicated and Inferred Resources correlate directly with the AusIMM/AMIC Minerals Code categories of the same name (Figure 4). For correlation of the economic categories the provision of economic parameters in the definition of reserves allows direct correlation of the AusIMM/AMIC Proved and Probable Reserves with the BMR's Economic Measured and Economic Indicated Resources (Figure 5). Similar to the Coal Code, the correlation of the AusIMM/AMIC Measured and Indicated Resources with BMR's economic categories are subject to interpretation. The possible correlations are shown in Figure 5.

MINERAL RESOURCE CLASSIFICATION SYSTEMS OF CHINA

DEMONSTRATED RESERVES

The mineral reserves classification system in operation in China is the "General Principle of the Metallic and Non-metallic Ore Deposits Geological Exploration Code" (hereafter called the "General Principle"), issued by the National Committee on Mineral Reserves in 1977. Though other Ministries, such as those concerned with coal, uranium ore, oil and gas, and hydrogeology for water supply, have formulated their own classification systems they are all comparable to the General Principle. The classification and criteria of the General principle are as follows:

1. In the light of the present technical and economic conditions in China and to meet the requirements of long-range development, mineral reserves are classified into two types:
   (1) Usable (Within Reserve Balance-sheet) -- refers to reserves that can be mined with current production technology and under present economic conditions.
   (2) Temporarily Useless (Out of Reserve Balance-sheet) -- Reserves which cannot satisfy current economic conditions or production technology as a result of low grade, low content of other useful minerals or components, small tonnage, thickness of the orebody, complex mining or hydrogeological conditions and uncertain processing technology. These reserves may be used in the future.

2. On the basis of ore district-wide exploration and according to the degree of control on the different parts of the orebody, reserves are divided into four categories: A, B, C and D.
   Category A -- Reserves which can be used as the basis for formulating a mining plan and which are calculated by mine production departments. The criteria used to define this category are as follows:
   (i) The shape, occurrence and spatial position of orebodies have been accurately defined;
   (ii) Faults, folds and fracture zones that influence exploitation have been accurately controlled and the lithologies, occurrence and distribution of interbeds and igneous rocks that disrupt the orebodies have been clearly defined;
   (iii) The industrial types(*) and sorts(**) of ore and their ratios and distribution have been clearly established, particularly if selective exploitation is required and geological conditions permit.

(*) The industrial type is a classification of ore based on the different processing techniques used to treat it.
(**) Classified according to end use e.g. direct metallurgical use, chemical industry use etc.

	IDENTIFIED		
	DEMONSTRATED		INFERRED
	MEASURED	INDICATED	
	MEASURED	*INDICATED*	*INFERRED*
ECONOMIC			
PARAMARGINAL			
SUB-ECONOMIC			
SUBMARGINAL			

BMR categories are shown in block capitals eg MEASURED
AusIMM/AMIC categories are shown in italicised capitals eg INDICATED

Figure 4: Correlation of the BMR identified resource categories with categories from the AusIMM / AMIC Code

	IDENTIFIED		
	DEMONSTRATED		INFERRED
	MEASURED	INDICATED	
ECONOMIC	*PROVED RESERVE*	*PROBABLE RESERVE*	
PARAMARGINAL			
SUB-ECONOMIC			
SUBMARGINAL			

	IDENTIFIED		
	DEMONSTRATED		INFERRED
	MEASURED	INDICATED	
ECONOMIC	*MEASURED*	*INDICATED*	*INFERRED*
PARAMARGINAL	*RESOURCE*	*RESOURCE*	*RESOURCE*
SUB-ECONOMIC			
SUBMARGINAL			

BMR categories are shown in block capitals eg MEASURED
AusIMM/AMIC categories are shown in italicised capitals eg INDICATED

Figure 5: Interpreted correlation of the BMR identified resource categories with categories from the AusIMM/AMIC Code

Category B --Reserves which can be used as the basis for mine planning and also the highest rank of reserve that can be defined during geological exploration. The criteria for Category B reserves are as follows:

(i) The shape, occurrence and spatial distribution of orebodies have been defined in detail;
(ii) Faults, folds and fracture zones that influence and disrupt the orebodies have been delineated in detail and the lithologies, occurrence and distribution of interbeds and igneous rocks that disrupt the main orebodies have been defined in detail;
(iii) The industrial types and sorts of ore and their ratios and distribution have been established in detail, particularly if selective exploitation is required and geological conditions permit.

Category C -- Reserves which will be used for mine planning. The criteria for Category C reserves are as follows:

(i) The shape, occurrence and spatial position of orebodies have been basically controlled;
(ii) The nature and occurrence of major faults, folds and fracture zones that disrupt and influence the main orebodies have been basically controlled. The lithologies, occurrence and distribution of interbeds and major igneous rocks that disrupt the main orebodies are approximately known.
(iii) The industrial types and sorts of ore and their ratios and distribution of various ores have been basically determined.

Category D -- Reserves which have three separate applications: (1) As a basis for planning further exploration and establishing the potential for mine development; (2) A certain proportion of Category D reserves may be included, as a basis for mine design, in those Category C reserves which occur in complex orebodies where tonnage is difficult to calculate; (3) A part of Category D reserves may be used in planning and mine design in non-complex deposits. The criteria for Category D are as follows:

(i) The shape, occurrence and distribution of the orebodies have been approximately determined;
(ii) The nature of the geological structures that disrupt the orebodies are approximately known;
(iii) The types and varieties of ores have been approximately determined.

Category D reserves are, therefore, those that (1) are controlled by sparse exploration data; (2) are controlled by detailed exploration data but which fail to meet the criteria for Category C because of the complexity of the orebodies or for any other reasons; (3) are estimated only by testing of geophysical and geochemical anomalies and (4) are estimated by extrapolation, with minor controls, from a reserve block above the level of Category C.

The classification system of China is summarised in Figure 6.

PREDICTED RESOURCES

Estimation of unknown resources in China only commenced relatively recently. In 1983, the Department of Mineral Resources Supervision and the Department of Geological Data (the present Department of Mineral Resources Supervision) of the Ministry of Geology and Mineral Resources formulated the "Trial Basic Requirements for Prediction of Mineral Resources Totals" ("the Requirement") which is used within MGMR and is recognised by other Ministries. The criteria for each category of resources stipulated by the Requirement are as follows:

Category E -- Predicted reserves which do not include Category A, B or C reserves in known deposits. They should be an extension of Category D reserves or the quantity possibly existing in newly discovered orebodies in those deposits which have been or are being explored.

Category F -- Refers to the amount of mineral resources in predicted deposits in known mineral fields.

Category G -- Refers to all predicted mineral resources in areas in which conditions are favourable for ore formation but where no deposits have been found or where the potential for discovery is uncertain.

USABILITY CATEGORY	GEOLOGICAL CATEGORY			
	A	B	C	D
USABLE (WITHIN RESERVE BALANCE–SHEET) RESERVES				
TEMPORARILY USELESS (OUT OF RESERVE BALANCE–SHEET) RESERVES				

Figure 6: The mineral resources classification system of China

The complete mineral resource classification of China, therefore, is composed of two parts, i.e. demonstrated reserves and predicted resources and is illustrated in Figure 7.

CIGMI Reserves Classification Scheme

After adoption of the USSR "Solid Mineral Reserves Classification Code" by China's National Committee on Mineral reserves in 1954, reserves in all geological classification and gradation systems were divided into Usable (Within Reserve Balance-sheet) and Temporarily Useless (Out of Reserve Balance-sheet) Reserves. However, until 1987, a considerable proportion of the reserves of various minerals which were included in the Usable (Within Reserve Balance- sheet) Reserves should have been included in the Temporarily Useless Reserves. For example one-third of China's iron ore, one-fourth of its manganese ore and one-third of its copper should have been classified as Temporarily Useless Reserves. In general, the users of the General Principle failed to objectively reflect the degree of usability of the reserves.

Since 1987 the situation regarding the degree of assurance of some 80 major minerals has been assessed for national economic and development purposes and to assure the supply base for development in China. This assessment was achieved by 300 relevant specialists from the Ministry of Geology and Mineral Resources, the National Committee on Planning, the National Committee on Science and the former National Committee on the Economy as well as other industrial departments including: Ministry of Oil Industry, Ministry of Coal Industry, Ministry of Nuclear Industry, Ministry of Metallurgical Industry, China Non-ferrous Metals Corporation, Ministry of Chemical Industry, State Bureau of Building Materials, Ministry of Light Industry, State General Bureau of Gold (formerly called the Gold Corporation) and related sectors of the administrations at the provincial, municipal and autonomous region levels. Included in the degree of assurance of demand for mineral products is an assurance of the ability to supply that product.

During the assessment, reserves in Categories A, B, C, and D (i.e. Demonstrated Reserves Within the Reserve Balance-sheet) of the classification system of the General Principle were divided into Using, Usable for Planning and Programming for Exploitation in the near Future, Usable for Planning and Application within the century and Temporarily Unusable Ore Occurrences and the Reserves they Occupy. The main results of this extensive demonstration of the degree of assurance of mineral resources for the whole of China have been recognised by the relevant departments of the State Council, as well as the industrial Ministries.

As a major participant in the assessment work CIGMI established, based on the results of the assessment, a reserve classification of the Demonstrated Reserves (A+B+C+D) on the basis of economic feasibility (Figure 8).

The CIGMI Reserves Classification Scheme is outlined below:

1. Using Reserves -- This term refers to the sum of reserves in all occurrences which (1) are presently being mined; (2) have experienced development or regular exploitation, but the construction and exploitation are currently stopped; and (3) are under construction.

2. Usable Reserves for Planning and Programming -- The term refers to reserves in all occurrences, which are recommended for mining in the near future or included in the short term exploitation plan because geological exploration has satisfied the requirements for mine design. It may also include the sum of reserves which are recommended for use or planned to be used before the end of the century because both internal and external conditions are favourable, although the geological exploration work failed to meet the requirements for mine designing.

USABILITY CATEGORY	GEOLOGICAL CATEGORY				PREDICTED RESOURCES		
	A	B	C	D	E	F	
USABLE (WITHIN RESERVE BALANCE–SHEET) RESERVES							
TEMPORARILY USELESS (OUT OF RESERVE BALANCE–SHEET) RESERVES							

Figure 7: The total mineral resources classification system of China

USABILITY CATEGORY	GEOLOGICAL CATEGORY			
	A	B	C	D
USING				
USABLE FOR PLANNING AND PROGRAMMING				
TEMPORARILY UNUSABLE				

Figure 8: The CIGMI classification system and the gradation of the General Principle

3. Temporarily Unusable Reserves -- Includes the sum of all reserves in all occurrences which cannot be mined before the year 2000 because the ore grade is low, mining and processing difficulties remain unresolved, hydrogeological conditions are complex, transport is difficult because of the remote location or the depth of overburden is so large that economic exploitation is not possible. For example, China possess 50 billion tonnes of iron ore reserves of which the Using Reserve is 16.2 billion tonnes; the Usable Reserve for Planning and Programming which is for regular industrial use (i.e. in iron making) is 7.6 billion tonnes and that for local and medium sized enterprises is 9.3 billion tonnes; the Temporarily Unusable Reserve is more than 16 billion tonnes. This classification more objectively reflects the real situation of iron ore in China at present and for some time into the future than does the General Principle Classification.

COMPARISON OF MINERAL RESOURCE CLASSIFICATION SYSTEMS

CORRELATION OF CIGMI AND BMR MINERAL RESOURCE CLASSIFICATION SYSTEMS

This report compares the CIGMI system, rather than that of the General Principle formulated by the National Committee on Mineral Reserves in 1987, with the BMR mineral resources classification system.

In the reserve classification system in operation in China Category A reserves are those that have been accurately delineated by exploration and for which there are sufficient data to allow the preparation of mining plans. Category B contains reserves that have been delineated in detail and can be considered as a basis for mine construction design work. Category C contains reserves that have been basically delineated and can be considered as a basis for mine planning. Category A plus B plus C are also called Industrial Reserves because they are the reserves that are or will be utilised by China's minerals industry before the end of the century. Category D reserves have been only approximately delineated and can be used as a basis for planning further exploration work and for planning possible mine construction and sometimes for planning actual mine construction. Category D reserves are also referred to as future reserves.

In summary the Category A, B and C reserves are delineated by the geological sector for use by China's industrial sector as a basis for mine construction. In comparison mine development in Australia would usually be based on resources that would, in terms of the degree of geological assurance, be in BMR's Measured or Indicated categories. BMR's Measured Resources are very well delineated by exploration and on that basis are correlated to the General Principle's Categories A and B. BMR's Indicated Resources are less well delineated but are still well known and are, therefore, correlated with China's Category C reserves. In general BMR's Inferred Resources may be correlated with the General Principle's Category D reserves, however, it may be the case that the degree of assurance of some Category D reserves may be a little better than for Inferred Resources.

A direct economic feasibility correlation between the resource classification systems of China and BMR is not possible. While correlation based on the degree of geological assurance can be made with a reasonable degree of certainty the major difficulty occurs with the economic classification. The basis of uncertainty in economic correlation is in the different economic systems in place in Australia and China.

China's planned economy contrasts sharply with the Australian market economy. In China the main factor in determining whether a deposit (except for small ones) will be mined is the requirement of the national plan for the minerals in the deposit. In essence, if the mineral requirement of the plan requires production from a deposit to meet the planned demand then it will be mined, providing it is technically feasible to mine and process the ore. In

Australia's market economy the cost-price relationship is the principal factor in determining whether a deposit is able to be mined to help satisfy demand.

This brief discussion outlines the basis of the dilemma in attempting to correlate the economic classifications of the mineral resource classifications of Australia and China. In China the basic determinant of viability is tonnage demanded by the national economic plan while in Australia it is the ability to produce the mineral profitably.

While remembering the limitations caused by these differences it is possible to correlate in general terms the economic classifications of the two systems. That approximate correlation is as follows:

BMR	CIGMI
Economic Resource	Using + Usable for Planning and Programing
Sub-economic Resource	Temporarily Unusable

It is not possible to correlate the BMR subeconomic categories of paramarginal and submarginal with any specific category of the Chinese system. Consequently the correlation is restricted to the combined paramarginal plus submarginal classification of sub-economic.

A similar problem is encountered when attempting to correlate the resource classification systems of any planned economy country with those of a market country. Generally, however, an approximate correlation similar to that outlined above may be used. While this tentative correlation can be made it must always be remembered that ore in the Chinese Using + Usable for Planning and Programing categories may not be able to be mined economically in the Australian situation.

The proposed correlation of the BMR and CIGMI mineral resource classification systems is outlined in Figure 9.

COMPARISON BETWEEN THE CIGMI AND AusIMM/AMIC CLASSIFICATIONS

The Proved and Probable Reserves of the AusIMM/AMIC Minerals Code are Measured and Indicated Resources respectively that have successfully been subjected to the necessary economic, mining, metallurgical and other tests. They are reserves that can be economically mined under existing economic and technical conditions. As has been discussed earlier the AusIMM/AMIC Proved and Probable Reserves correlate with the BMR's Economic Measured and Economic Indicated Resources. Further the AusIMM/AMIC Measured and Indicated Resource categories correlate directly with the BMR Measured and Indicated Resources but not with a BMR economic category -- that correlation must be based on an assessment made by BMR. On this basis, therefore, and remembering the constraints caused by the different economic systems in the two countries, it is proposed that the following correlations be made between the CIGMI and AusIMM/AMIC systems:

CIGMI	AusIMM/AMIC
Category A+B	Measured Resource
Category C	Indicated Resource
Category D	Inferred Resource
Using (Part A+B) Usable for Planning and Programming (Part A+B)	Proved Reserve
Using (Part C) Usable for Planning and Programming (Part C)	Probable Reserve

	IDENTIFIED		
	DEMONSTRATED		INFERRED
	MEASURED	INDICATED	
ECONOMIC	'A'+'B' * USING * USABLE FOR PLANNING AND PROGRAMMING	'C' * USING * USABLE FOR PLANNING AND PROGRAMMING	'D' * USING * USABLE FOR PLANNING AND PROGRAMMING
PARAMARGINAL SUB-ECONOMIC--- SUBMARGINAL	'A'+'B' TEMPORARILY UNUSABLE	'C' TEMPORARILY UNUSABLE	'D' TEMPORARILY UNUSABLE

Figure 9: Correlation of the CIGMI and BMR mineral resource classification systems

COMPARISON OF THE COAL CODES OF CHINA AND AUSTRALIA

In the Coal Code (1980) in operation in China, reserves defined by geological exploration are divided into four categories: A, B, C and D. The first three categories are the industrial reserve while Category D is the future reserve. By stipulation, reserves of Category D are those which are main reserves of the 1:50 000 -- 1:25 000 scale exploration and are approximately equal to the sum of reserves for the General Principle's Category E and part of D that have been controlled by sparse exploration and testing of geophysical and geochemical anomalies. This correlation is shown in Figure 10.

Compared with the categories established in the General Principle, those in the Coal Code of China are one rank lower. Category C in the Coal Code of China corresponds to part of Category D of the General Principle. Category D in the Coal Code of China covers part of the reserves for Category D and the predicted resources for Category E in the General Principle. The exploration grid for coal in China is outlined in Figure 11. On the basis of this grid it is possible to correlate the categories of the Coal Code of China with the categories of the Australia Coal Code.

The correlation of the categories of the Coal Code of China and the Australian Coal Code, based on the degree of geological assurance which is shown by the grid spacing of points of observation e.g. drill holes, is a little different to the correlation of the AusIMM/AMIC Minerals Code with the CIGMI system. On the basis of the degree of assurance given by observation spacings as outlined in the foregoing descriptions of the two coal codes the following correlation is proposed:

CHINA	AUSTRALIA
Category A	Measured Resource
Category B	Indicated Resource
Category C	Inferred Resource Class 1
Category D	Inferred Resource Class 2

Mineable Reserves in the Australian Coal Code may be considered equivalent to reserves for Category A plus B in the Coal Code of China. Similarly the Australian category of recoverable reserves may equal the reserves less mining losses of the Coal Code of China.

In the Coal Code of China there is no equivalent to the Australian Coal Code's Marketable Reserve. The category of marketable reserve refers to that part of the recoverable reserve that can be sold in the market after washing or to the recoverable coal that can be sold without washing.

COMPARISONS OF THE CLASSIFICATIONS OF CHINA, AUSTRALIA, USA AND USSR

The classifications of China and the former USSR are similar. Those of Australia and the USA are similar but have a different basis to the Chinese and Soviet systems. The fundamental difference between the two types of systems is that the Chinese and Soviet systems are based on the requirements of a planned economy while the Australian and US systems are based on the requirements of a market economy. Therefore, the classification system under a planned economy takes greater account of the technical and economic conditions of individual deposits as they relate to the requirements of the economic plan. In the market economies the classification system considers whether the deposit can be economically mined. However, while it is difficult to correlate between the economic categories of the systems a good correlation is possible according to the degree of geological assurance.

The "Classification of Solid Mineral Reserves and Predicted Resources" (in which Predicted Resources are estimated by the Ministry of Geology) formulated

<table>
<tr><td rowspan="2">GENERAL PRINCIPLE (1977)</td><td colspan="6">Demonstrated Reserves</td><td colspan="3">Predicted Reserves</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td colspan="4">D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td></td><td></td><td></td><td></td><td>C extrapo–lation</td><td>C Reducing Rank</td><td>Sparse Data</td><td>Anomalous Testing</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Coal Code (1980)</td><td rowspan="2"></td><td colspan="2">High Rank Reserves</td><td rowspan="2" colspan="3">C</td><td colspan="2">Future Reserves</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>A</td><td>B</td><td colspan="2">D</td></tr>
</table>

Figure 10: Correlation of China's coal code categories with categories of the General Principle

TYPE	SEAM CONDITIONS	CATEGORY		
		A (m)	B(m)	C(m)
I	Stable. Thickness changes only slightly. Structure is simple. All coal is mineable	750--1000	1500--2000	3000--4000
II	Relatively stable. Thickness variation is evident. Structure is simple to complex. All or most coal is mineable, and within areas of mineable coal no evident changes occur.	375--500	750--1000	1500--2000
III (1)	Unstable. Thickness is changes greatly but the change is not evident and may be sudden. Structure is complex. All or most coal is mineable.	250	500	1000
III (2)	Unstable, braided and anastomising structure, locally mineable. Amount of coal mineable is limited		250	250--500

Figure 11: Exploration guidelines for coal in China

by the National Committee on Mineral Reserves of USSR in 1981 classified reserves into two types, i.e. Reserves Within Reserve Balance-Sheet and Reserves Out of Reserve Balance-Sheet, presently based on the natural technical and economic conditions of individual deposits. This is the same as the General Principle in China.

However, because of the difficulties associated with the comparison of the economic categories of the various systems discussed above the current comparison will be restricted to the geological categories. The comparison is outlined in Figure 12. It should be noted, however, that the resources of Category E of China and P1 of the USSR have some reserves extrapolated from lower categories and some reduced to the lower grade from Categories D and C respectively. Categories E and P1 are only used in the geological sector they are not significant in the industrial sector.

	INDUSTRIAL RESERVES			FUTURE RESERVES	PREDICTED RESOURCES		
China	A	B	C	D	E	F	G
USSR	A	B	C1	C2	P1	P2	P3
	DEMONSTRATED			INFERRED	UNDISCOVERED		
Australia	Measured		Indicated	Inferred	Hypothetical		Speculative
USA	Measured		Indicated	Inferred	Hypothetical		Speculative

Figure 12: A comparison of the geological categories of Australia, China, USSR and USA