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PRACTICAL APPLICATION OF THE UNITED NATIONS FRAMEWORK CLASSIFICATION FOR RESERVES/RESOURCES

(Submitted by the Government of Germany) */

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It is also true of other mineral deposits involving little or no financial risk that are exploited by small scale mining ventures consisting of small groups of artisanal miners, sometimes producing relatively valuable commodities such as gold, diamonds, precious stones, tin, and even copper. It is true as well for coal which in some countries is mined by individuals using rather simple underground extraction methods. In the People´s Republic of China some 600 million tons of coal were produced in this way in 1997, representing some 45 % of the total production.

This type of deposits requiring both low investment to bring them into operation and low cost to extract them are referred to in this paper as “low-investment mineral deposits”.

UNFC AND LOW-INVESTMENT MINERAL DEPOSITS

The United Nations International Framework Classification for Reserves/Resources (UNFC) was originally designed for assessing coal deposits and was then expanded to include mineral deposits in general such as chromium, iron, copper and diamonds. These mineral resources are not necessarily all metalliferous, but all relatively high-value resources. Such resources, in view of the high financial risk especially when mined on a large scale, require careful geological, mining and economic assessment before reliable reserves and resources figures can be obtained. Moreover, in the UNFC, reserves can be only assessed as economic if a feasibility study or at least a prefeasibility study has been carried out in which it is demonstrated that these particular reserves can be exploited at a profit under the current economic and political conditions and using state-of-the-art technology (economic viability category 1).

If a feasibility or prefeasibility study shows that the reserves are not mineable at the present time but might become so in the (near) future, then they are called potentially economic resources (economic viability category 2). If neither a feasibility nor a prefeasibility study has been carried out and only geological work, then the deposit will be classified in the UNFC, on an international level, as "economic to potentially economic (intrinsically economic)" and is given an economic viability category of "1–2". It has already been suggested by others and is further emphasised here that an economic viability category of "1–2" is not practicable and should be replaced by a "3".

Thus, on an international level in the UNFC, the low-investment mineral deposits mentioned above, i.e. the low-value industrial minerals and rocks and many small-scale deposits of high-value minerals, will mostly be classified in the bottom category (Geological Study) of the matrix, and will of necessity be placed in economic viability category 3. This means that the codes would be

331, 332, 333, or 334, depending on the amount of geological work that has been done. Therefore, as an example, the few hundred tonnes of ore of a small copper mine worked by four men in the Andes Mts. would have a code of 334 and would probably never be mentioned in international mineral statistics, although they might have considerable significance for the country itself, in this case say Peru. It is the same for most of the resources of low-investment ventures mentioned above: internationally normally ignored, but nationally often very significant.

EXTENSION OF THE GEOLOGICAL STUDY CATEGORY

In view of the national (but not international) significance of low-investment mineral deposits, it is suggested that the bottom category (Geological Study) of the UNFC diagram could be amended to accommodate the low-investment mineral deposits, for national purposes only, to make it more flexible and increase its "resolution". In a national system, therefore, the Geological Study category could be amended by adding two extra economic viability classes (1 = economic and 2 = potentially economic) if the country wished to do so (Figure 1).

Class 1 (economic): The reserves of any mine, pit or quarry for minerals or rocks of low investment that has been working for a reasonably long period should be classified as economic. In this case the fact that the mine is being worked regularly is sufficient proof of its viability, and normally a Feasibility or Prefeasibility Study is not needed. This class would equally apply to reserves of a possible future mining enterprise whose viability is anticipated by an experienced geologist by analogy with comparable operating mining ventures in the region. These reserves would have codes 131, 132, 133 or 134 in order of decreasing geological assurance, and would be known as 131-reserves, 132-reserves, 133-reserves or 134-reserves.

Under **Class 2 (potentially economic)** would fall all those resources which in a Geological Study, for example in analogy with existing mining ventures in the region, cannot be classed as economic at the time, but may become so in the (near) future if certain economic, environmental, legal and other conditions change favourably and/or technological advances are made. In analogy to class 1, these would be known as 231-resources, 232-resources, 233-resources and 234-resources, in order of decreasing geological assurance.

Class 3 (intrinsically economic) embraces all mineral resources as defined in this class in the international UNFC. These would be known as 331-, 332-, 333- or 334-resources, depending on the thoroughness of the geological investigation. Normally it applies to high-value resources for which neither a feasibility study nor a prefeasibility study has been carried out. In the case of the low-investment deposits this class will usually apply

to those which have an uncertain viability. In practice, class 331 and probably class 332 too, will usually not be realised when dealing with low-investment mineral deposits, because it is highly improbable that at the end of a detailed exploration campaign (last digit of the code = 1) or a general exploration (last digit = 2) no clear statement as to the economic viability should be possible (as indicated by the first digit = 3).

EXAMPLES FOR THE APPLICATION OF THE UNFC

Seven examples of industrial minerals and rocks from German Technical Cooperation Projects are given below. The reserves/resources are assessed on the basis of the UN International Framework Classification for Reserves/Resources as modified for use on the national level. The international UNFC code and classification (or denomination) is given for comparison at the end of each example.

Example 1	**Quarries mining trass (volcanic ash) for local construction industry**
General data	company names not known, Cibeber, west of Bandung, Java, Indonesia; Sheet Bandung 4522-III
Deposit/mine	several quarries mining trass to produce lime-bonded bricks for the local construction industry
Reserve/Resource situation	1989: short visit to trass deposits in the Cibeber area; estimate of reserves by experienced geologist: several (5-10) million tonnes
Assessment	ECONOMIC ASSESSMENT: existing profitable operation; therefore, first digit of code = **1** FEASIBILITY ASSESSMENT: no feasibility assessment, no cost estimation; short visit to deposit, short site inspection by experienced geologist; therefore, second digit of code = **3** GEOLOGICAL ASSESSMENT: reconnaissance stage only; therefore, third digit of code = **4**
Reserve classification	**code = 134** **National classification = >5 million tonnes of 134-*reserves* (as of 1989)** (According to the International UNFC the code would be 334 and the classification would be “reconnaissance mineral *resources*”.)

Example 2	**Small brickyard producing for local needs**
General data	Mineral Holding Trust, Kanye, Botswana; pit operated between 1981 and 1985
Deposit/mine	brickearth pit, Moshaneng, QDS 2425C3, Southern District
Reserve/Resource situation	alluvial floodplain sediments overlying granite; clayey, silty sand, clay fraction 25-30 wt.-%; between 1500 and 3000 bricks of standard size were produced daily
Assessment	ECONOMIC ASSESSMENT: profitable operation; therefore, first digit of code is **1** FEASIBILITY ASSESSMENT: no feasibility assessment, no cost estimates; determination of firing properties of raw material; in 1985 estimation of reserves (>5000 tonnes) and assessment of viability by experienced geologist; thus, second digit of code is **3** GEOLOGICAL ASSESSMENT: only reconnaissance carried out; therefore third digit of code is **4**
Reserve/ resource classification	**code = 134** **National classification = >5 000 tonnes of 134-*reserves* (as of 1985)** (According to the International UNFC the code would be 334 and the classification would be „reconnaissance mineral *resources*“.)

Example 3	**Lime kiln producing for local construction industry**
General data	Mineral Holding Trust/Southern Rural Development Association, Kanye, Botswana; has been operating since 1983
Deposit/mine	limestone dump of former asbestos mine, Moshaneng, QDS 2425C3, Southern District
Reserve/Resource situation	hydrothermally altered carbonates have been used for quicklime burning and manufacture of pozzuolana-lime-cement; several thousand tonnes of already crushed carbonates are available; daily production between 1.5 and 2.0 tonnes quicklime; reserves deduced in 1983 as several thousand t (>5 000 tonnes)
Assessment	ECONOMIC ASSESSMENT : existing profitable operation; therefore first digit of code = **1** FEASIBILITY ASSESSMENT: no feasibility assessment, no cost estimates; only limeburning tests carried out; no geological work, except for estimation of reserves by experienced geologist in 1983; thus, second digit of code = **3** GEOLOGICAL ASSESSMENT: equivalent to prospecting stage; thus third digit of code = **3**
Reserve classification	**code: 133** **National classification = >5 000 tonnes of 133-*reserves* (as of 1983)** (According to the International UNFC the code would be 333 and the classification would be “inferred mineral *resources*”.)

Example 4	**Dolerite quarry producing high-quality aggregate**
General data	Mineral Holding Trust, Kanye, Botswana; quarry operated intermittently 1981 - 1985
Deposit/mine	Dolerite quarry, Moshaneng, QDS 2425C3, Southern District
Reserve/Resource situation	Dolerite sill about 310 m thick intruding Precambrian dolomites; the minimum in-situ reserves of dolerite deduced by an experienced geologist are more than 1 million tonnes; no drilling programme. The dolerite has been used successfully as aggregate for surfacing tarmac roads and as concrete aggregate.
Assessment	ECONOMIC ASSESSMENT: profitable quarry operation existed up to 1985; therefore, first digit in code is **1** (see Fig. 1) FEASIBILITY ASSESSMENT: no feasibility assessment, no cost estimates; no testing of mechanical properties; in 1985 geological mapping and estimates of reserves and quality carried out by experienced geologist; therefore, second digit of code = **3** GEOLOGICAL ASSESSMENT: prospecting (no drilling programme); thus third digit = **3**
Reserve/resource classification	**code = 133** **National classification = >1 million tonnes of 133-*reserves* (as of 1985)** (According to the International UNFC the code would be 333 and the classification would be "inferred mineral *resources*".)

Example 5	**Small pits mining white kaolinitic clay for local ceramic industry**
General data	company name not known, Río San Juan, Dominican Republic
Deposit/mine	Chirivico, some 15 km south of Río San Juan, sheet 6174-I Río San Juan, 7; ceramic clays mined since 1988
Reserve/Resource situation	reddish-brown and white kaolinitic clays derived from deeply weathered basic rocks, kaolinitic material transported by rivers and deposited in favourable environment, probably mangrove swamps; some drilling and pitting in 1987; estimate of reserves: >60000 t; chemical and mineralogical investigations; extensive ceramic tests;
Assessment	ECONOMIC ASSESSMENT: existing profitable operation; therefore, first digit of code = **1** FEASIBILITY ASSESSMENT: no feasibility assessment, no cost estimates; relatively thorough geological study; therefore, second digit of code = **3** GEOLOGICAL ASSESSMENT: general exploration; therefore, third digit of code = **2**
Reserve classification	**code = 132** **National classification = >60 000 tonnes of 132-*reserves* (as of 1987)** (According to the International UNFC the code would be 332 and the classification would be "indicated mineral *resources*".)

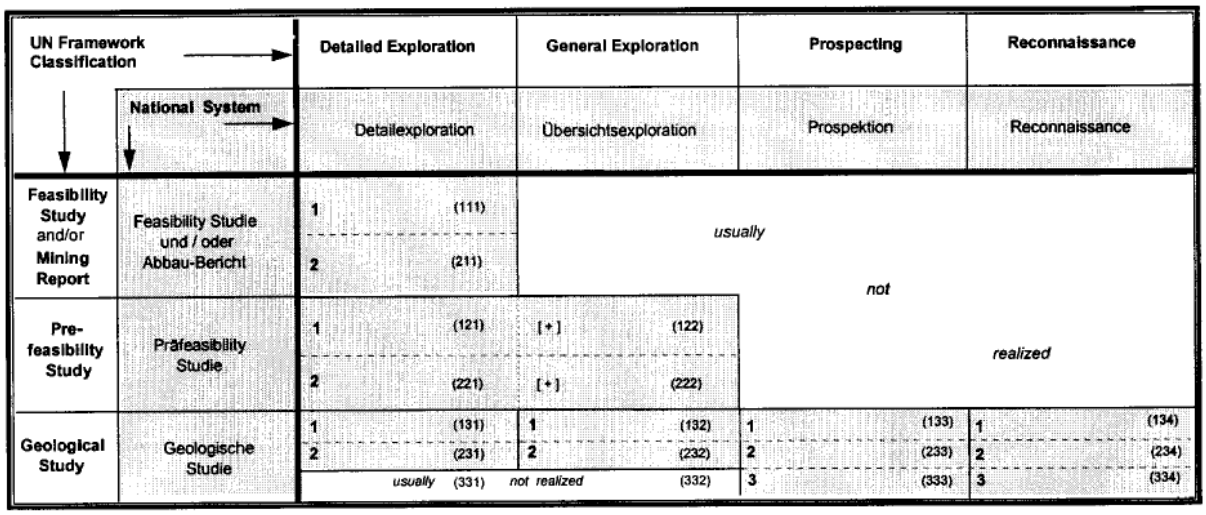
Example 6	**Brickyard producing high-quality bricks for local consumption**
General data	company name not known, Lobatse/Woodhall, Botswana; operates since 1992
Deposit/mine	Woodhall brickearth deposit, Lobatse, QDS 2525B, Southeast District
Reserve/Resource situation	red-brownish, clayey material (weathered Precambrian shales); pitting and drilling on a 100 m grid; mineralogical and chemical investigations of several dozens of samples; extensive testing of physical properties of the raw material; reserve calculation in 1985: >1.3 mio m^3 (= >2.6 mio t), large potential reserves to the north; all these investigations carried out by Geological Survey Department together with foreign experts; additional investi-gations (prefeasibility category) carried out by consultants
Assessment	ECONOMIC ASSESSMENT: existing profitable operation, as also predicted in prefeasibility study; therefore, first digit of code = **1** FEASIBILITY ASSESSMENT: prefeasibility study carried out; therefore, second digit of code = **2** GEOLOGICAL ASSESSMENT: general exploration; therefore, third digit of code = **2**
Reserve classification	**code: 122** **National classification: >2.6 million tonnes of probable mineral reserves (as of 1985)** (According to the International UNFC, code and classification would be the same: 122, and “probable mineral reserves”.)

Example 7	**Brickyard producing high-quality bricks for local consumption and export**
General data	company name not known, Makoro, Botswana; has been operating since 1986
Deposit/mine	Makoro mudstone deposit, 10 km south of Palapye, QDS 2227C, Central District
Reserve/Resource situation	>20 m of grey, yellowish pink and buff mudstones, Middle Ecca, Karoo System; geological mapping, electrical resistivity traversing, pitting on a 200 m grid, drilling on a 100 m grid in most promising parts of the deposit; mineralogical and chemical investigations on hundreds of samples; extensive testing of mechanical properties of the raw material; detailed reserve calculation for northeastern part of deposit in 1985: >1.1 million m^3 (approx. 2.2 million tonnes) of kaolinitic mudstone, enough to produce a total of 770 million bricks of standard size; all these investigations carried out by Geological Survey Department together with foreign experts additional investigations (prefeasibility level) carried out by consultant
Assessment	ECONOMIC ASSESSMENT: existing profitable operation, as also predicted in prefeasibility study; therefore first digit of code = **1** FEASIBILITY ASSESSMENT: prefeasibility study carried out; therefore second digit of code = **2** GEOLOGICAL ASSESSMENT: detailed exploration; therefore third digit of code = **1**
Reserve classification	**code = 121** **National classification = 2.2 million tonnes of probable mineral reserves (as of 1985)** (According to the International UNFC, code and classification would be the same: 121 and “probable mineral reserves”.)

Note on the definitions of Prefeasibility Study and Geological Study in the International UNFC

It is considered desirable that the difference between a Prefeasibility Study and a Geological Study be enhanced. It is suggested that the definition of a Prefeasibility Study be amended by addition of the following sentence: "In general, a Prefeasibility Study is prepared by a number of experts in various fields (e.g. engineer, geologist, economist, and legal expert), but at least by a mining geologist/engineer." Accordingly, when defining the term Geological Study, the following sentence should be added: "In general, a Geological Study is prepared by an experienced geologist with no experts in other fields being involved." This is intended to provide a clearer distinction between these two economic feasibility categories, and thus between reserves and resources.

Fig. 1: Extended UNFC-diagram for low-investment mineral deposits adapted for use in a national classification system (shaded area corresponds to national UNFC-system).



Categories of mineability: **1** = economic **2** = potentially economic **3** = intrinsically economic (economic to potentially economic)

(123): Code