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

Private Enterprise and National System of Mineral Resources

(Submitted by the Government of Hungary) */ **/

*/ Prepared by the Hungarian National Geological Survey, Budapest

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1. Government regulations (acts and decrees) concerning mining of mineral resources

This section is a comprehensive summary of the major acts, government directives, decrees, etc., which significantly impact mining investments in Hungary

1.1. The XVI/1991. Concession Act

The Concession Act concerns the following activities of the mining sector:

- mineral exploration
- mineral deposit development and exploitation
- pipeline transport and underground storage of petroleum and natural gas

These activities can be carried out by 1) Hungarian companies in which the State has majority ownership or 2) by other companies and unofficial persons who have obtained a concession contract.

The important parts of the Concession Act that concern mining specify that:

- The general duration of a concession agreement is 35 years. Related laws may increase this time by 50 %.
- Concessions can be granted only through publicly announced tenders.
- Anyone who is awarded a concession and who does not already have a registered mining company has 90 days in which to establish a Hungarian company to perform the activities of the concession.

1.2. The VI/1988. Company Act

The Company Act recognizes two forms of corporate legal entities:

- Limited Liability Company (Korlátolt Felelősségű Társaság, KFT)
- Stock Company (Részvénytársaság, RT)

The liability of both corporate forms extend only to the limits of their subscription. Other corporate forms are also acknowledged (partnership, trust, etc.) but these are not protected legal entities, i.e. the liability of owners is unconditional and unlimited .

The minimum equity capital required of a KFT is 3,000,000 HUF (Hungarian Forint).
(1 USD = 227 HUF in 1999 /February 23./)

The RT-type company is owned by shareholders whose liability extend only to their individual investment in subscribed shares. The minimum primary equity capital required of an RT is 10,000,000 HUF. Forigners may acquire only registered shares in RT companies.

1.3. The XXIV/1988. Foreign Investment Act

This Act guarantees non-discrimination and protection for foreign investors. The Act and the associated executive decree jointly provide the general legal framework for mining investments by foreign nationals:

- Investments of foreigners enjoy full protection in Hungary.
- Any equipment or other assets, representing in - kind contributions of the foreign partner, are free of customs duty.
- Companies with foreign participation may freely use the equity that has been paid in hard currency and deposits that have been made to hard - currency accounts.
- Monies produced by the business activities of the company, or funds from the sale of company shares owned by foreign investors, may be freely transferred abroad in hard currency.
- Off-shore companies, including banks, may also be established.
- Legal disputes can be resolved by either Hungarian or foreign arbitration, as decided by the concerned parties in the Articles of Association.

1.4. The Mining Act (XLVIII/1993)

The new Mining Act came into force 12 June 1993.
The Act and the decree jointly provide the general legal framework for mining activities:

- solid and fluid mineral exploration, development and exploitation;
- mine closures and subsequent reclamation;
- building and cleaning-up waste dumps;
- maintenance, utilisation and abandonment;
- construction and operation of petroleum, gas, and product pipelines;
- the construction and utilisation of underground hydrocarbon storage facilities;
- exploration and production of geothermal energy.

The right of the state and its transfer through concession

Mineral resources and geothermal energy are owned by the State as they occur in nature. After extraction, the minerals and geothermal energy becomes the property of the mining company.

This general rule applies to all types of mining activities under the Concession Act. It is the discretion of the Minister of Economic (referred to subsequently in this paper as „Minister") to enable the exploration and production of certain mineral resources by means of the concession process.

The Mining Bureau of Hungary (MBH) has defined the „closed areas„ as those areas which are only available by concession. In addition to these „closed areas" the following activities are exclusively governed by the concession procedures.

- exploration, development and production of hydrocarbon and carbon dioxide resources in the closed areas;
- exploration, development and production of sand, gravel, limestone, dolomite and basalt resources in the closed areas;
- construction and operation of hydrocarbon pipelines, and underground storage facilities in the closed areas;
- exploration and utilisation of gethermal energy (No area may be designated for a concession for the purpose of exploration of geothermal energy connected with the exploration of underground waters and their utilisation for energetic purpose).

Reconnaissance investigations

Reconnaissance investigations, that will result in identifying hypothetical and speculative resources do not need prior licensing nor do they require a concession contract. Results of these investigations are not to be reported to the mine supervision division.

Surface pre-prospecting investigations

Pre-prospecting on „open areas", that will not result in the surface degredation, may be performed on the basis of an agreement with the landowner. The agreement will accompany a preliminary report to mining supervision announcing the date the investigation will begin. An example of allowed activity is electro-magnetic prospecting where no surface damage occurs. Drill holes and trenches are examples of activities that may not be conducted as pre-prospecting activities.

Prospecting and Exploitation that requires a license

Mine Supervision shall license the following activities in „open areas":

- prospecting for mineral raw materials by drilling, trenching, boring, etc.
- exploration and, following the designation of the mining site, development of the mine and exploitation of the reserve.
- recovery of waste stockpiles.

Concession tenders and contracts

The first step of the concession bidding process is a preliminary announcement by the Minister. Based on the available geological data and the requests of entrepreneurs, areas will be announced for tender which, following complex preliminary investigations of environmental, economic and social impacts may prove suitable for the conduct of exploration and mining activities. The content of the tender document is regulated by the

law (definition of the area, working program, reclamation, proposal for payment of excess royalty, etc). The concession will be granted to the applicant submitting the most favourable proposal.

No concession fees will be required for a concession to explore, develop and produce mineral resources. In the proposal the applicant must make an offer for the proposed royalty to be paid to the State when the resource is produced. The concession agreement will be based on the proposed royalty percentage and will be calculated by multiplying the extracted quantity (for example in tonnes) by the value of the product (in tonnes per HUF).

Mining Right

The Mining Right is granted by the District Mine Office. The Mining Right may be applied for by the holder of the Exploration Licence or a Concession Contract, after completion of the exploration. The Mining Right confers exclusive right to develop and extract the mineral resources. The right-to-mine is transferable. Exploration for mineral raw materials or geothermal energy may take place on the surface or underground in the area defined for that purpose (mine site).

Technological Operation Plan

Mining activities shall be performed on the basis of an approved Technological Operation Plan.

The Technological Operation Plan should include all activities related to:

- exploration under the Exploration Licence,
- development and exploitation under the Mining Right,
- mine closures, abandonment of oil/gas fields,
- long-term suspensions of production.

The Mining Royalty

After production the minerals and geothermal energy become the property of the mining entrepreneur. At that time the mining royalty is to be paid to the state. The mining royalties required, as a percentage of the value of the quantity of mineral raw material produced, are:

⇒ 12 % for crude oil, natural gas and CO_2
⇒ 5 % for non-metallic hard minerals from surface mines (with the exception of energy hard minerals)
⇒ 2 % for other hard minerals (including energy hard minerals) and geothermal energy.

Mining concession contracts may require higher royalty percentages than the minimum the law requires. The Minister (with the agreement of the Finance Minister) may also lower the mining royalty for purposes of mineral management or for other reasons of public interest.

According to ***the XII/1997. Act*** , which was a modification and supplement to the **XLVIII/1993** mining act, 10 percent of the annual mining royalty income goes to the Central

Environment Protection Fund and this can be the source of funding for land reclamation projects that can not be paid for by private industry.

Land reclamation

The Mining Act contains regulations concerning the land reclamation subsequent to mining. Technological Operation Plans should contain plans for land reclamation.

Surface rights - compensation

The surface property owner must provide access to the property by the mine entrepreneur for the purpose of conducting the work of the concession and to bring elecrtricity, gas, water, etc, onto the property, over or under the surface. Easement may be established for the mine enterpreneur to carry out his activities. These activities may not significantly affect the use of the property by the owner, unless appropriately compensated by the mine entrepreneur.

Geological Information Supply and Handling

Geological and geophysical prospecting tasks, as well as the tasks related to management of mineral resources of the State shall be performed by the Hungarian Geological Survey, as an independent institution supported by the Hungarian Government.

The mining enterpreneur shall send any geological information on the quantity, quality and location of the mineral raw materials gained in the course of mining activities, to the Hungarian Geological Survey. The mining entrepreneur shall send an account of any changes in the mineral resources and reserves annually, and of the mineral resources and reserves left behind on closure of the mine, and/or on abandoning the field, to the Hungarian Geological Survey.

The information provided by the beneficiary of the concession shall be handled as business secret during the period of the concession.

The entrepreneur is responsible for authenticity of the information and the Hungarian Geological Survey has authority to check these data **(XII/1997. Act).**

1.5. Governmental Decree No. 132/1993 about the Hungarian Geological Survey

The Hungarian Geological Survey provides the geological and geophysical investigation capabilities of the State. Moreover, the Survey has specfic authority relating to the management of mineral resources.

The parts of the Decree referring to the mineral resource management responsibilities of the Survey are:

- geological exploration, involving great economic risk, in order to increase the mineral resource potential of the country;

- summarizing the Nation's mineral resources, systematic (annual) balance-like recording and preliminary economic estimation;
- estimation of tne Nations mineral reserves, determination of environmental and other risks of exploitation;
- geological and geophysical data acquisition and recommendation for mineral exploration, aimed at the selection of areas suitable for concessions;
- source of geological data packages for concession tenders; providing other geological, hydrogeologic, geotechnical, environment-protection and mining information to be included in outline of tender conditions;
- investigations to find new techniques to utilize the geological resources of the country, including geothermal energy.

1.6. Accounting, taxation, depreciation, and amortization

As of January 1, 1992, the Accounting Act (XVIII/1991) has governed the accounting obligations of entrepreneurs, the basic principles to be followed in preparing the reports, as well as the rules based on them. All of these principals have been correlated with international practice.

The final activity of the company shall be covered by reports to be prepared according to fiscal years.

Taxes and contributions payable by the mining companies

For the central (National) budget:

- corporate tax,
- general value added tax
- personal income tax,
- royalty

For the local town or village government:

- building tax,
- property tax,
- community tax,
- local trading tax,
- motor vehicle tax

For other National government funds:

- social security contribution,
- contribution for technical development,
- contribution for technical education

The company is obliged to pay tax if it has a positive cash flow. The definition of a profit is covered by the accountancy law.

For instance:

- The companies consider taxes paid to be a business expense. The net result on the balance sheet is calculated after tax have been paid and dividends have been paid to the owners.
- Corporate tax is 18 percent of the taxable income.
- The dividend tax is 20-27 percent of the dividend amount.
- The local tax is 1.2 percent of the net revenue.

Tax preferences may be given in order to stimulate investments in foreign capital.

Depreciation and amortization

The Accounting Act provides choices for the method a mining company uses to depreciate its assets. Thus the tax returns contain different figures for depreciation.
The calculation of amortization (amortization proportional to the depletion of mineral reserves) may be handled differently in case of mine buildings, mining areas, equipment used exclusively for the purpose of mining.
The part of the amoritization that is not proortional to the depletion of mineral reserves is strictly time propotional (e.g. machines and equipment: 14,5 percent/year; motor vehicles: 20 percent/year).

2. Calculation of solid mineral resources/reserves

The process for the calculation and the technological and economic evaluation of the solid mineral resources/reserves is outlined in Fig. 1.

In Fig. 1. $(\text{cut-off})_1$ is the total geological resource, $(\text{cut-off})_2$ is the geological resource for a planned mine. These are defined during the geological studies and may be carried forward and used in the stages of the pre-feasibility study, feasibility study and mining report.

The basic unit of the resource/reserve calculation, the evaluation of the extractable resource /reserve and the economic assessment is the so-called mining block. The mining block, in view of the geological assessment, feasibility assessment and viability, is relative homogenous (considering the natural parameters, value, mining technology, mining costs, etc.).

The unit of the annual inventory and material balance is also the mining block. The larger unit of calculation and evaluation is the mining area/deposit, which summarizes and averages the mining blocks.

SOLID MINERAL RESOURCE/RESERVE (HUNGARY)

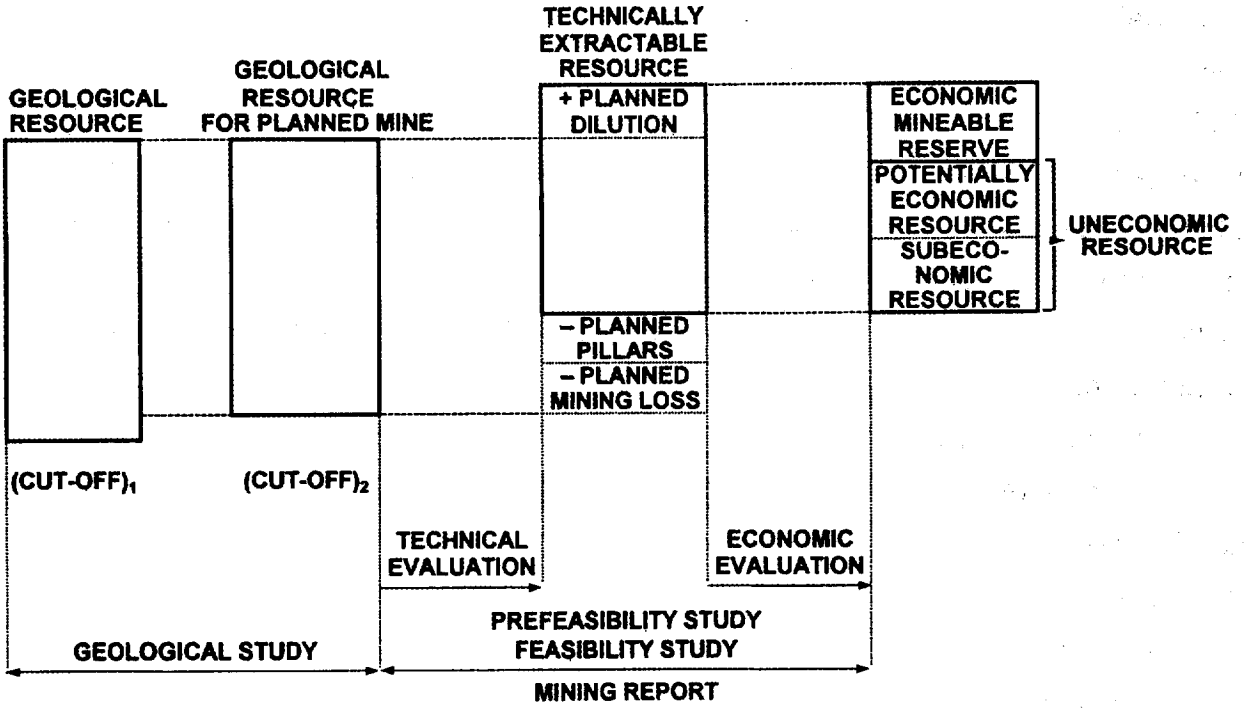


Fig. 1.

2.1. The geological resource

The geological resource is a part of the raw material beds, which satisfies some cut-offs. The geological resource also includes, in part, the inseparable barren material associated with the deposit (the average grade of the geological resource contains a contribuition from the grade of barren material), but it does not contain the intercalations that

can be economically separated from the raw material by selective mining. The selective mining conditions depend on the mining technology to be used (e.g. in the case of sublevel caving method, longwall face technology, or room and pillar system).

The input data for the resource calculations are the coordinates of drill holes, chemical analyses of drilling intervals, bulk density, areas and categories of mining blocks, cut-offs, etc.

2.1.1. Cut-offs- (limits of physical and/or chemical properties)

In former times the Hungarian state stipulated the cut-offs of the mineral resources. **These cut-offs are not obligatory for use at present.**

Raw material	Thickness (meter)	Grade	Other
Hard coal	0,4	12,6 MJ/kg	
Brown coal	0,8-1,0	6,3-8,4 MJ/kg	
Lignite	1,0	4,2 MJ/kg	
Petroleum	-	-	resource greater than 10 kton
Natural gas	-	-	resource greater than 100 Mm^3
Carbon dioxide gas	-	90 % CO_2	resource greater than 500 Mm^3
Uranium ore	0,7	0,03 U %	
Bauxite	1,0	40% Al_2O_3; 2,6 modulus*	barren would mine selective: 2m
Manganese ore			
-oxide	1,0	8,0 % Mn	
-carbonate	1,0	10,0 % Mn	
Lead-Zinc ore	0,8	1,3 Pb equivalent % **	
Copper ore			
-enargite	0,8	2,1 Cu equivalent % ***	
-calcopirite	2,0	0,4 Cu %	
Iron ore	1,0	15,0 Fe+Mn %	

Remark

* $\text{modulus} = \frac{Al_2O_3\ \%}{Si\ O_2\ \%}$

** Pb equivalent %: = $\sum$ Pb% equivalent; where:
1% Pb = 1% Pb equivalent
1% Zn = 1,18% Pb equivalent
1% Cd = 2,43 % Pb equivalent
1% Fe = 0,01 % Pb equivalent
1g/t Au = 0,71 % Pb equivalent
1g/t Ag = 0,07 % Pb equivalent

*** Cu equivalent % = $\sum$ Cu% equivalent; where:
1% Cu = 1 % Cu equivalent
1g/t Au = 8,5 % Cu equivalent
1g/t Ag = 0,18 % Cu equivalent

The optimal — economically flexible — cut-offs

The reserve is considered optimal when the nominal net profit or the net present value will be maximum. An optimal cut-off belongs to the optimal reserve in the "fund" type reserves. Figure 2. shows schematically the concept of the fund and flow types resources/reserves. The term "fund" relates to a mineral deposit in which variations in average grade of the

mineral will inversely affect the quantity of raw material in the deposit (e.g. uranium, copper, gold, silver, bauxite). The "flow" resource/reserve indicates a deposit of a highly uniform distribution of the mineral grade, so that changes in the grade do not affect the quantity of raw mineral (e.g. oil fields, most of coal beds, sand and gravel). [3]

A simplified outline of the optimal cut-off model (in the case of the „fund" resource/reserve) for a single drill hole is shown in Figure 3. In this case the grade of the upper and lower parts of the raw material beds is low. The calculated thickness (in meters, t_1; t_2; t_3; t_4) grade; (g_1; g_2; g_3; g_4) and specif price of the mineral/mining product (in USD/ton, p_1; p_2; p_3; p_4) of the resource/reserve are functions of the cut-offs.

With an increase in cut-off grade, the thickness, the geological and extractable reserves decrease; the grade and the price of the mining product increase: and the expenditure or mining cost increases because the mine development investment increases. The profit at first shows an increase and with further cut-offs shows a decrease. The profit-curve has a maximum, which is the position of the optimal economically mineable reserve. If the different cut-off grades are considered and different tonnages computed, it is then very easy to obtain a grade-tonnage curve for various cut-offs.

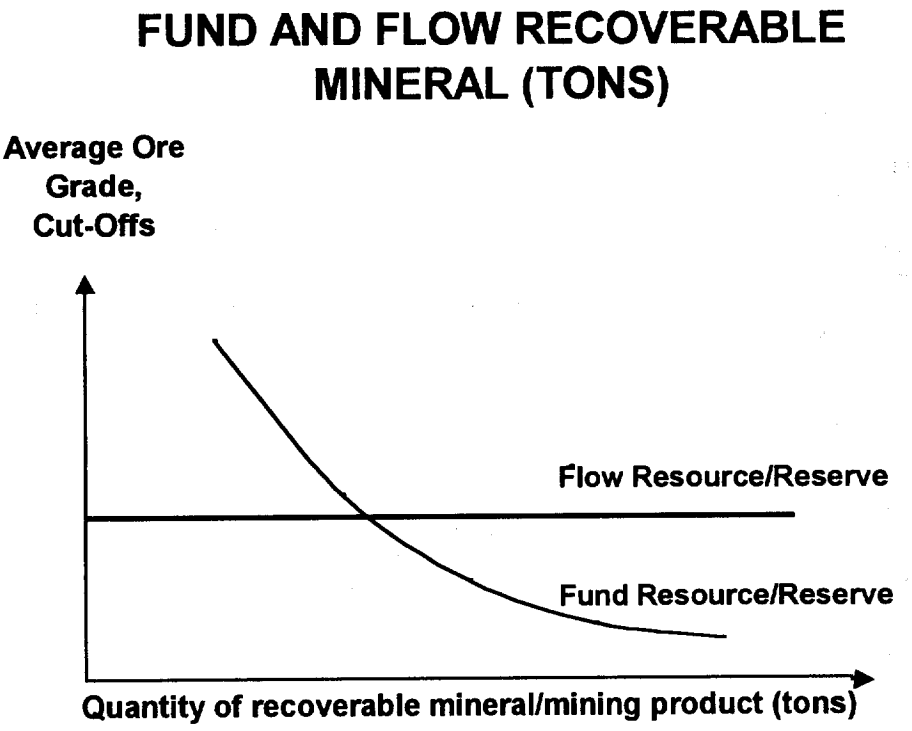


Fig. 2.

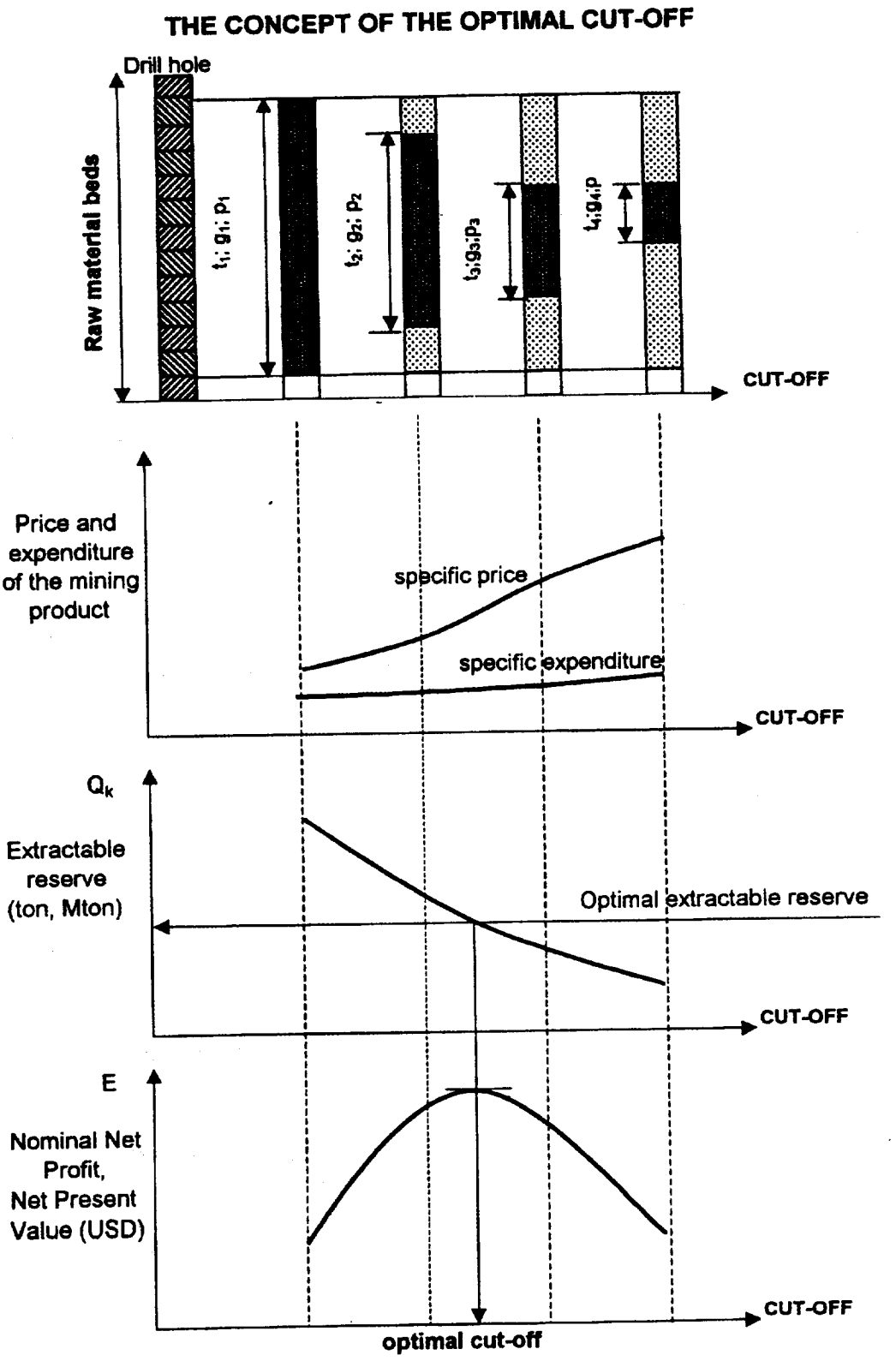

THE CONCEPT OF THE OPTIMAL CUT-OFF
Drill hole
Raw material beds
$t_1; g_1; p_1$
$t_2; g_2; p_2$
$t_3; g_3; p_3$
$t_4; g_4; p$
CUT-OFF
Price and expenditure of the mining product
specific price
specific expenditure
CUT-OFF
Q_k
Extractable reserve (ton, Mton)
Optimal extractable reserve
CUT-OFF
E
Nominal Net Profit, Net Present Value (USD)
CUT-OFF
optimal cut-off

Fig. 3.

2.1.2. The complex model of maximum economic results

This model may be used in the making of a mining report, a feasibility study, or a prefeasibility study for a mine/deposit.

In the model, the dependent variable is the economic result (million USD). The independent variables are the production capacity (million tons/year), and the reserve, which is a function of cut-off limits used in the study. This functional relationship is plotted on the Fig. 4.
The grade is a function of cut-off and therefore the price of the mining product is also a function of the cut-off. The total expenditure is a function of the economic reserve and the mining capacity.

THE COMPLEX MODEL OF THE MAXIMUM ECONOMIC RESULT

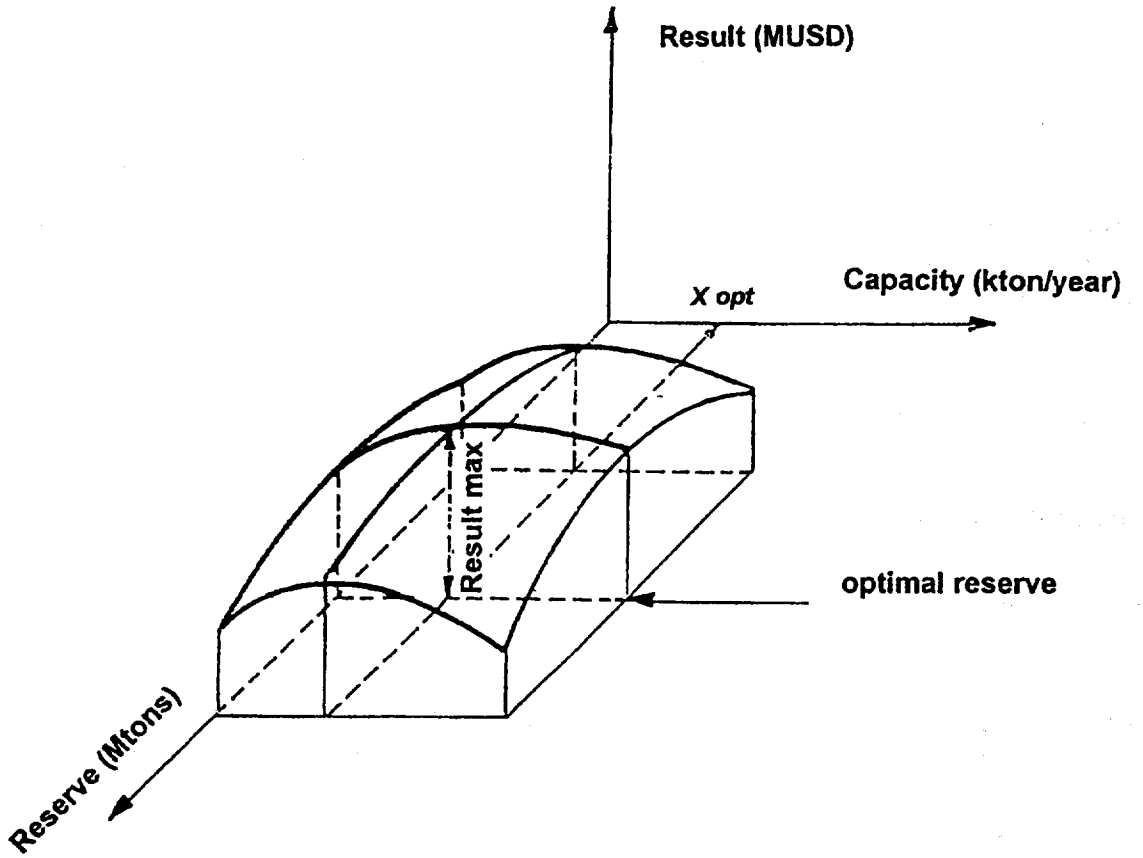


Fig. 4.

2.2. Calculation of technically extractable resource

The planned technically extractable resource (tons) is:

- The geological resource (tons)
- *minus* planned pillars (tons), an unrecoverable quantity
- *minus* planned mining loss (tons), an unrecoverable quantity
- *plus* mining dilution (tons)

The volume of pillars depends on the mine development (location of structures on the surface that require protection, shafts, development openings, main drifts, etc.)

The volume of mining loss and dilution is related to the mining technology applied, the geological and rock mechanical conditions and the technological efficiency. The percentage of the planned/effective mining loss (ml%) and dilution (d%) is calculated in comparison with the geological resource (Rg) to be effected by mining production:

$$ml\% = \frac{ml}{p+ml-d} \cdot 100$$

$$d\% = \frac{d}{p+ml-d} \cdot 100$$

where ml = the tonnage of mining loss,
d = the tonnage of mining dilution,
p = the tonnage of mining production,
Rg = p+ml–d = the tonnage of the geological resource to be effected by mining

When the mining loss and dilution are optimal the economic result is at the maximum. The economic mineable reserve, the price and the expenditures of the mining product all depend on the mining loss and dilution.

3. Economic evaluation

3.1. Preliminary economic evaluation

In this case the following formula of **Nominal Net Profit** is used

$$\mathbf{NNP = Q\,(p-c)}$$

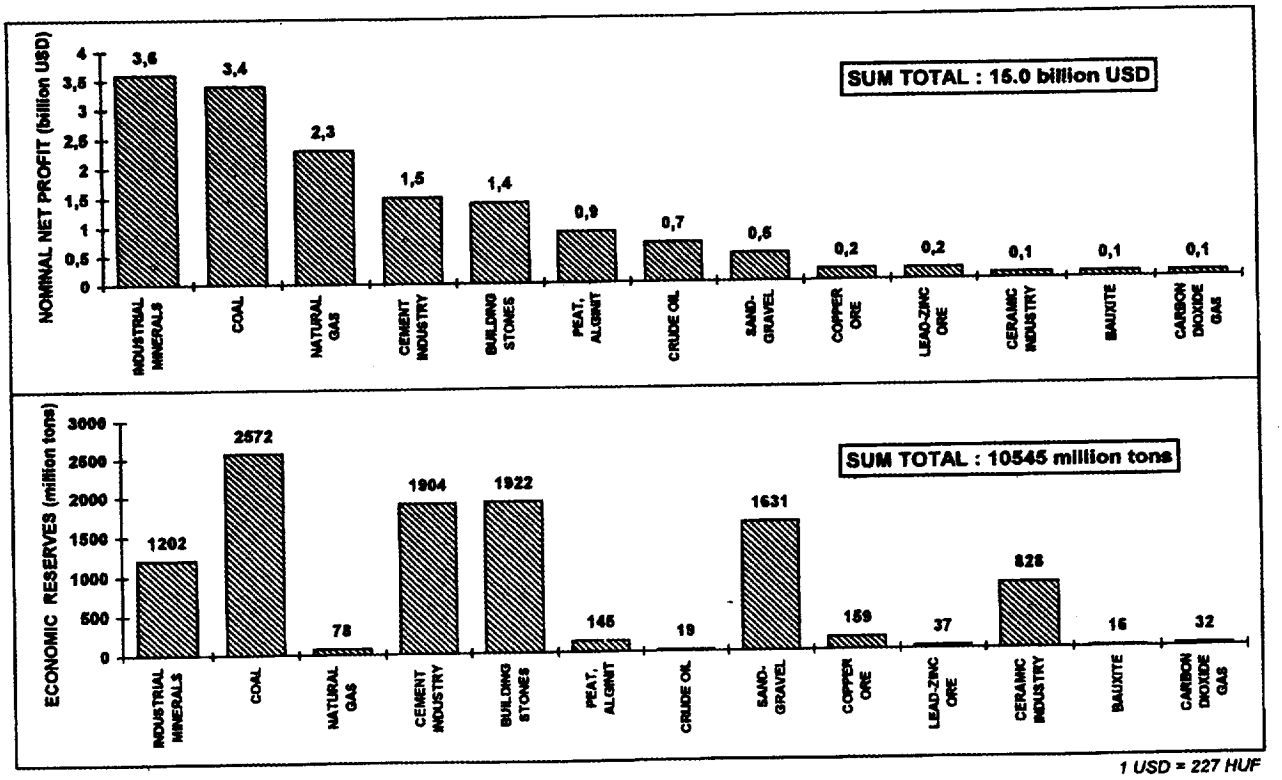
where NNP = Nominal Net Profit (USD)
Q = extractable reserve (ton); at the annual NNP, Q is the yearly mining product (ton)
p = price of mining product (USD/ton)
c = mining cost (USD/ton)

The NNP is equivalent to the sum of the annual nominal (net) cash-flow at a planned/operating mine. This method is used at the early stages of investigations

(opportunity studies and geological studies) and utilizes estimates of cost and prices. Estimations are made not only for the quantity of resource, but for the basic natural and economic parameters (depth, thickness, ground water, gas accumulation, components of quality of resource, prices, ... etc.) These estimates are made, in part, on the bases of geological and mining analogy. Based on these analogies, and utilizing simulations (e.g. we use cost and price functions of natural parameters) preliminary economic evaluations can be made at the opportunity study, and at all levels of geological study.
In the National Mineral Resource/Reserve Inventory the Hungarian Geological Survey calculates and records the NNP, and not the Net Present Value (NPV), because the inventory contains all (approx. 2700) deposits and mines (from the prospecting exploration phase to the operating mines).

Figure 5. shows the Nominal Net Profit and the economic mineable reserves of Hungary, according to the mineral-reserve groups.

ECONOMIC MINERAL RESERVES OF HUNGARY (January 01, 1998)



1 USD = 227 HUF
Reserves are shown in metric tons

Fig. 5.

3.2. Detailed economic evaluation

In Hungary the detailed economical evaluation is done by the mining entrepreneur or occasionally the Hungarian Geological Survey using the Net Cash Flow, Net Present Value, and Internal Rate of Return, and these are done in prefeasibility studies, feasibility studies and mining reports.

3.2.1. Net Present Value (NPV)

The NPV method is probably the most common evaluation technique in use. It requires a predetermined interest rate, representing the firm's capital cost, and a number of other factors. Expected Net Cash-Flows throughout the life of the project, either negative or positive, are discounted at this predetermined rate for a given period (usually starting at the present, or year 0) and summed up.
Whenever the NPV is positive, the project is attractive (profitable).

$$NPV = \sum_{i=0}^{n} A_i (1+r)^{-i} - \sum_{i=0}^{n} I_i (1+r)^{-i}$$

where: A_i = net income after tax in the i-th year
I_i = investment outlays in the i-th year
i = time periods (i=0; 1; 2; ... n year)
r = rate of discount = $\frac{\text{discount factor \%}}{100}$

Figure 6. shows the NPV configuration of the investment at "0" year. Summing the upper and lower areas, we can get the total NPV. The cumulative Cash-Flow is shown in Figure 7.

The Pay Out Time shows, how long will it take to fully recover all of the initial investment outlay. The Financial Exposure is the minimum of cumulative cash flow curve. This is the maximum outlay that can be lost if the enterprise is not successful.

The NPV means the **business value of a mine/deposit**.

The NPV is equivalent to the sum of the discounted annual Cash-Flow.
At an operating mine the i= 0-th year is the current year (Fig. 8.). The configuration of NPV in the exploration-development-production-reclamation process is shown in Figure 8.

where E_i = annual exploration cost,
I_i = annual development cost,
R_i = annual reclamation cost.

THE NPV CONFIGURATION OF THE INVESTMENT AT "0" YEAR

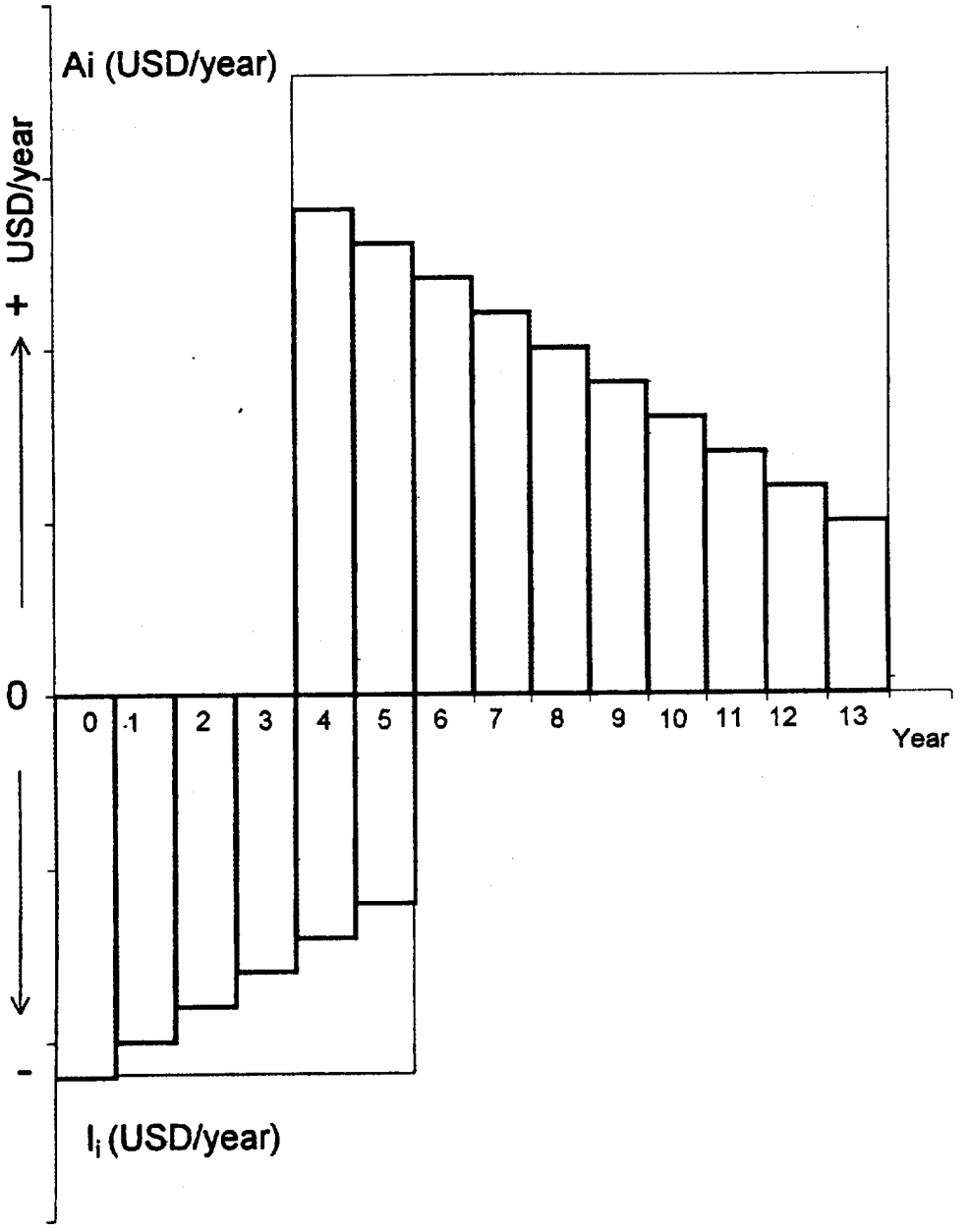


Fig. 6.

CUMULATIVE CASH FLOW

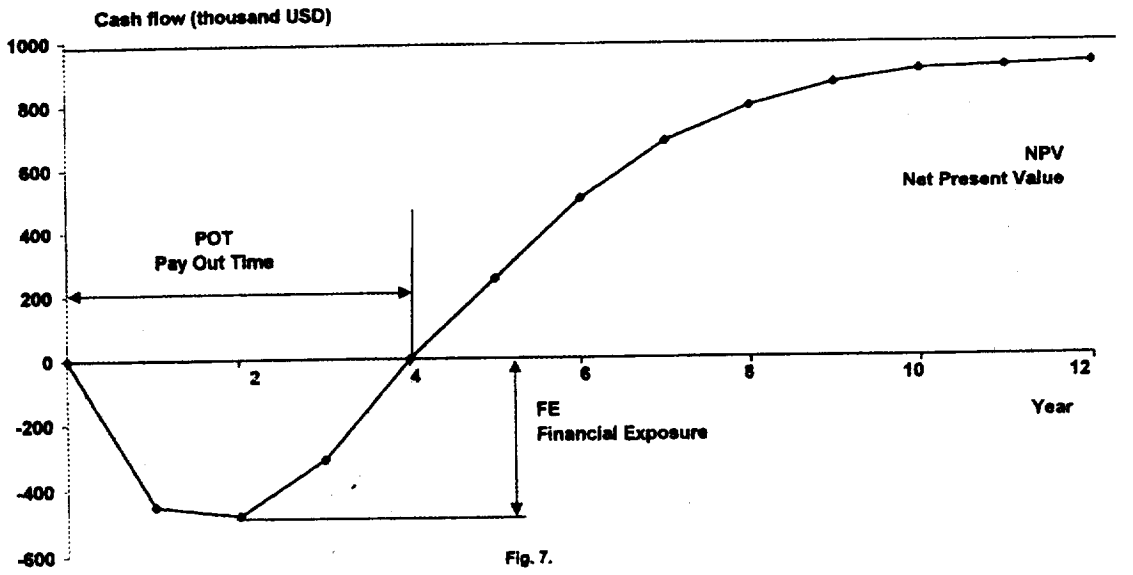


Fig. 7.

EXPLORATION-DEVELOPMENT-PRODUCTION RECLAMATION PROCESS

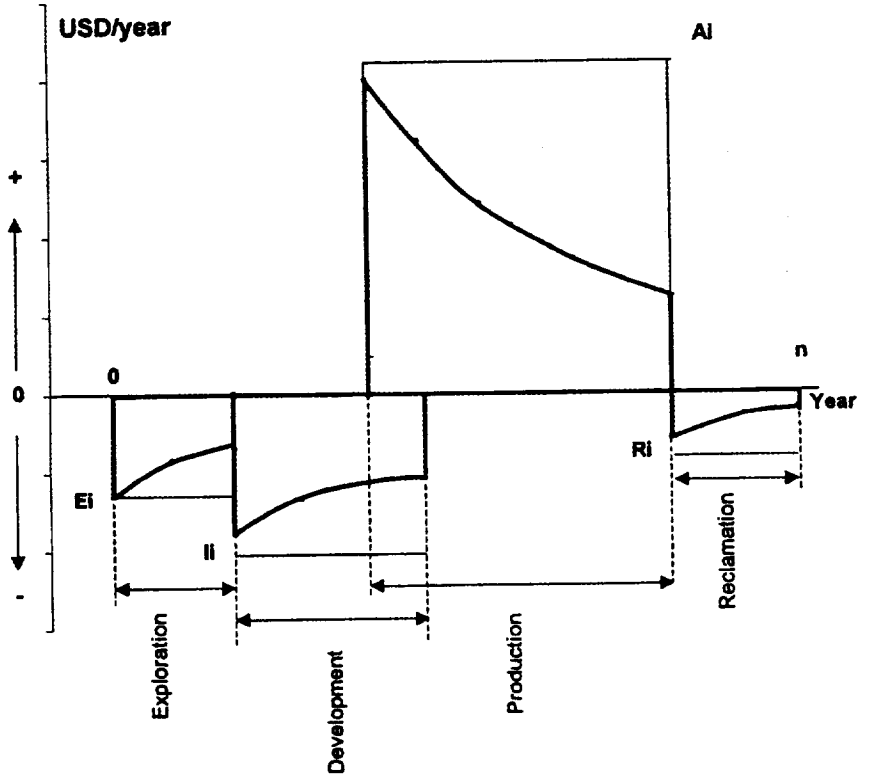


Fig. 8.

3.2.2. Internal Rate of Return (IRR)

The IRR method assumes total NPV to be zero and looks for that interest rate **r** that will satisfy the following condition:

$$NPV = 0 = \sum_{i=0}^{n} A_i (1+r)^{-i} - \sum_{i=0}^{n} I_i (1+r)^{-i}$$

The IRR can be approached by multiple iteration.

Using different discount rates, different NPV-s can be calculated. The IRR is placed between the last negative and the first positive NPV. There is a close connection between the IRR and NPV. Figure 9. shows that if the interest rate of banks is less than IRR then the NPV is positive. The larger the difference between the IRR and the bank interest rate, the greater the NPV.

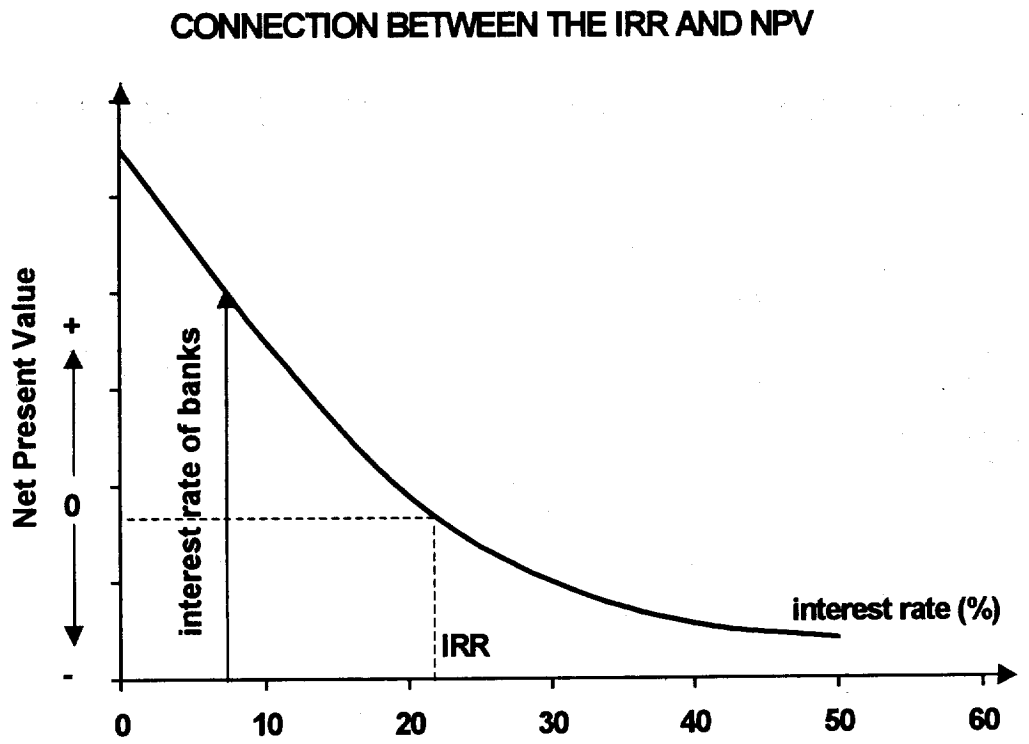


Fig. 9.

3.2.3. Cash-Flow analysis

The sequence to be followed in doing an economic evaluation is presented in Figure 10. (after Rudawsky).
In Figure 10. the Non -Cash charges are:

- Depreciation and amortization
- Depletion allowance

Operating costs are:

- Labor
- Energy
- Supplies
- Parts
- Maintenance and service
- Selling expenditures
- Royalty payments
- Interest payments

LIST OF SEQUENCES FOR ECONOMIC EVALUATION

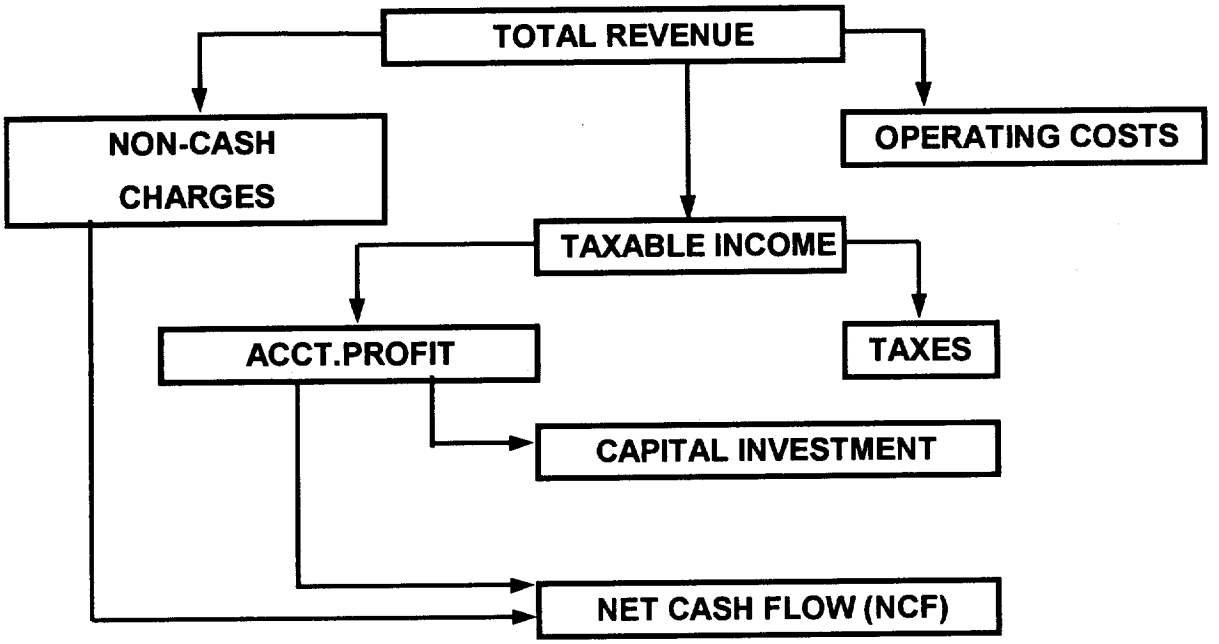


Fig. 10.

Derivation of Annual Cash-Flow (USD; MUSD)

Years
Total Revenue
Operating Costs:
Materials Energy Labor Amortization Reclamation Royalty Repayment of Interest to bondholders and creditors Others (local tax, selling expenditures, rent and compensation to landowner,etc.)
Operating Costs summarized
Taxable Income
Corporation Tax
Result After Tax (Accounting Profit)
Amortization and Depreciation
Credit Granted
Capital Investment
Replaced Investment
Reimbursementof the Loan
Annual Net Cash-Flow
Discounted Annual Net Cash-Flow
Cummulative Discounted Annual Net Cash-Flow

NPV = ...

4. National Inventory of Mineral Resources in Hungary

In Hungary, regular (annual) mineral resources/reserves inventories and balances have been made since 1953. The Hungarian State introduced the annual economic assessment of mineral resources/reserves in 1970.

A requirement under the 132/1993, Governmental Decree is that the Mineral Management Division of the Geological Survey is " to provide for the nation, a summary of mineral resources, uniform listing in a balance-sheet format, and a preliminary economical assessment."

The Mineral Management Division of the Hungarian Geological Survey is where the National Mineral Resources Inventory is updated each year and the annual balance sheet of mineral resources and reserves is prepared. The inventory includes data on the raw material reserves of more than 2,700 known occurrences and mines, as of January 1 of the subject year, and is subdivided into sites of occurence or mining blocks with resources and

reserves calculated. This results in 34,000 data base records a year, and more than 1,500,000 numerical values. That is more than 25 Mbytes of information. The preparation of annual balance sheets involves more than just deducting the annual mining production from the reserve as of January 1. It is a very complex process - and varies by raw material types - during which the change of mineral resources is calculated first for each unit of registration (block), then for the particular site of occurrence, and finally for the various levels of aggregation, broken down into categories by geological assurance, economic feasibility and causes for change.
The balance sheet does not only indicate annual production and mining loss, but also considers the result of surface and mining exploration, and the reassessment of resources/reserves. The movement of mineral reserves and resources between categories of geological assurance or between classes of profitability can be traced, and even the reserve re-groupings taking place when occurrences are split or combined, can be followed.

Data related to changes during the year are provided by the mining entrepreneurs. These data are fed into the computer at the Mineral Management Division. Data input, checking results of balance sheet programs, and checking and evaluating final results takes months of continuous work. The final results are summarized in about 50 different publications (some may be in digital form on discs), several hundred copies of which are prepared by the Mineral Management Division, totalling tens of thousand of pages. These are then sent to the partners who supplied the data or are forwarded to government agencies and institutes.

It can be understood that a requirement for annual feasibility studies, or even for prefeasibility studies, for all the registered 2,700 occurences would be unreasonable. Therefore approximation methods are applied, using the data bases in the records and the data and information supplied by mining entrepreneurs. In this case, a rapid estimate about the value of a mineral resource or the economic value of an occurrence is obtained by running computer programs. Specific costs and sales price are calculated for each reserve calculation block using figures of actual expenditures and sales income of the mine if it is an operating mine or, if it is an occurrence currently under exploration or one that has been explored, experimental natural-parameter-functions are used. We revise and update those functions from time to time. The economic reserve of an occurrence is the sum of the extractable reserves of those blocks where the value is equal to or greater than that costs. That is, potential sales income exceeds the amount of expected expenditures.

Producing the annual reassessment of resources and reserves

The reassessment contains the actual original and calculated data on of blocks, groups of blocks, and mining areas. It comprises the most important of the following factors:

- natural parameters: e.g. extent, thickness of the deposit, dip, rock mechanics, depth of deposit, production of water and gas in the mine, etc. ;
- resource data: the tonnage and the grade of the geological resource and the exploitable resource:
- technical parameters,:e.g. haulage and freight distance of the mining product, mining system and technology, operating thickness, etc.;
- data referring to the production: e.g. the tonnage and the grade of the material produced, mining loss and dilution, etc.;

- economic data: e.g. the required cost of exploration and mining investment, the freight cost, the income fom the sale of water, the price received for the mining product, the operating cost, the rentability index, etc.

Some of the abovementioned data are primary input data, e.g. the natural and technical parameters, the production, the tonnage and the grade of the geological resource, etc. The others are calculated data, e.g. the tonnage and the grade of the exploitable reserve, the planned mining loss and dilution, the optimum mining capacity, the rentability index, the "NPV" etc.

During the processing repeated iterations are used. For example, natural parameters in the mining cost-functions must be weight-averaged over the exploitable reserves of the blocks that are the basis for the operating rentability index

$$\frac{\text{sales price}}{\text{mine operating cost + block extraction cost}} \geq 1{,}0$$

In the beginning of the process only the geological resource is known. At first we weight using the geological resource and the final result will be achieved only by repeated iterations (with extractable resource). The result of the processing is the **new state (annual reassessment)** of information at the level of blocks, groups of blocks and mining areas. The data base for blocks contains much detailed information.
The processing is carried out at several levels of aggregation, e.g. per groups of blocks, per mining areas, per enterprises, etc. Figure 11. shows a summarized inventory of a deposit/mine. The table contains the most important data concerning the tonnage, grade and economic factors, summarized by categories and economic groups.

The changes in the resources and reserves (balance) during one year

The annual balance sheets are produced in the following categories: groups of blocks, mining enterprises, and total. The result of the analyses, done by computer processing, is illustrated in Figure 12. Columns 6 and 9 contain the fluctuations between the categories and those are combined with the fluctuations within the rentability (profitability index) groups. Columns 7 and 10 list the rentability fluctuations within the categories in those cases where there has been of the exploration on the surface and in the mine.

If there are several causes of changes, the computer performs the economic assessment after every change, therefore the balance sheet contains the rentability fluctuations of each cause of change.

THE DISTRIBUTION OF MINERAL RESOURCE/RESERVE ON THE BASIS OF QUANTITY, QUALITY AND RENTABILITY

Name of Deposit/Mine = ...

Category	Intervals of rentability index	DATA OF RESOURCE/RESERVE QUANTITY					DATA OF RESOURCE/RESERVE QUALITY		ECONOMIC DATA		
		Geological resource/ reserve	Final pillars	Planned mining loss	Planned mining dilution	Extractable resource/ reserve	Geological	Extractable	Price	Costs	Rentability index
1	2	3	4	5	6	7	8	9	10	11	12
		Thousand t.	Thousand t.	Thousand t.	Thousand t.	Thousand t.			HUF/ton	HUF/ton	HUF/HUF
A	<0,8 0,8-1,0 >=1,0 Sum										
Etc. B C_1 C_2 Sum											

Nominal Net Profit = ...

Remarks:
A+B categories = Measured
C_1 category = Indicated
C_2 category = Inferred
D_1+D_2 categories = Hypothetical
D_3 category = Speculative

Quality: e. g.:
- caloric value, ash content, sulphur content,
- Al_2O_3 %; SiO_2 %,
- Cu %; Zn %; Pb %
- Au g/t; Ag g/t,
- etc.

1 USD = 227 HUF (1999/February)

Fig. 11.

CHANGES OF MINERAL RESOURCE/RESERVE DURING ..... YEAR IN A BALANCE

Name of Deposit/Mine = ...

Category	Intervals of rentability resource/ reserve	Initial geological resource/ reserve	CHANGES DURING THE YEAR												Closing geological resource/ reserve
			Total	Prospection and exploration					Extraction			Changes of economic conditions	Recalculation		
				On the ground			In the mine								
				New resource/ reserve	Changes		New resource/ reserve	Changes		Production	Loss	Dilution			
					In category	In rentability		In category	In rentability						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		THOUSAND TONS													
A	<0,8 0,8-1,0 >=1,0 Sum														
Etc. B C_1 C_2 Sum															

Fig. 12.

5. Resource/reserve classification in Hungary

Hungary uses a National system for resource/reserve classification (A, B, C_1, C_2, D_1, D_2 categories, and the mineability-economic system: economic, potentially economic, sub-economic).

This system is comparable to both the United Nations International Classification Framework and U.S. Geological Survey and the former U.S. Bureau of Mines systems.

The correlation between the U.N., U.S. and Hungarian classification systemsis shown below.

U.N. Classification	U.S. Geological Survey and U.S. Bureau of Mines	National System in Hungary
detailed exploration	= "Measured" =	A, B
general exploration	= "Indicated" =	C_1
prospection	= "Inferred" =	C_2
reconnaissance	= "Hypothetical" =	D_1, D_2
	= "Speculative" =	D_3

The economic classification

$$\text{economic} = \frac{p}{c} \geq 1{,}0$$

$$\text{potentially economic} = 1{,}0 > \frac{p}{c} \geq 0{,}8$$

$$\text{subeconomic} = 0{,}8 > \frac{p}{c}$$

Where

p = price of mining product (USD/ton)
c = mining cost (USD/ton)

The **reserve** is an economically extractable part of the resource.

The "in situ" geological **resource** and the non-economic part of technically extractable resource are not reserves.
The correlation between the U.N. International Framework of Reserves/Resources Classification and the Hungarian classification system is illustrated in Figure 13.

This classification system is concerned with both the geological and extractable resource/reserve.

The application of the Economic Viability Categories in the Hungarian Practice (with the indicating of the U.N. System Codes)

	Detailed Exploration	General Exploration	Prospecting	Recconnaissance	
	Identified			Undiscovered	
	Measured (A, B)	Indicated (C1)	Inferred (C2)	Hypothetical (D1, D2)	Speculative D3
Feasibility Study or Mining Report	1. Measured RESERVE (111) 2. Measured-Potentially Economic Resource (211) 3. Measured Subec. Resource	usually			
Prefeasibility Study	1. Measured RESERVE (121) 2. Measured-Potentially Economic Resource (221) 3. Measured Subec. Resource	1. Indicated RESERVE (122) 2. Indicated Potentially Economic Resource (222) 3. Indicated Subec. Resource	not	relevant	
Opportunity Study or Geological Study	1. Measured RESERVE (331) 2. Measured-Potentially Economic Resource 3. Measured Subec. Resource	1. Indicated RESERVE (332) 2. Indicated Potentially Economic Resource 3. Indicated Subec. Resource	1. Inferred RESERVE (333) 2. Inferred Potentially Economic Resource 3. Inferred Subec. Resource	1-2. Reconnaissance Intrinsically Economic Resource (334) 3. Reconnaissance Subeconomic Resource	

HUNGARIAN SYSTEM: **Economic Viability Categories:**

1= economic
2= potentially economic
3= subeconomic

1-2 = economic to potentially economic

Hungarian Geological Survey
Division of Mineral Management

U.N. Code: (1 2 1)

Fig. 13.

This figure (the UN Framework classification) provides information as to the stage of Geological Assessment, the stage of Feasibility Assessment, and the degree of Economic Viability.

6. The effect of exploration and mining on nature and the enviroment.

Protection of the environment is becoming of increasing concern with respect to industrial projects in Hungary. This is also happening in the mining industry, where the concern for the environment begins with licensing and ends with the restoration of the original environment. Rules concerning environmental protection are described in Decree 8/1992 of the Council of Ministers.
The agencies supervising environmental protection are the National Park Directorate and the local councils. About six percent of the land in Hungary is in protected areas. There are three categories of protection:

- **Natural reserve**

  Area designed to protect a specific type of natural treasure, either of national or local importance.

- **Landscape reserve**

  Area for protection of certain assemblages of natural treasures (landscape, flora,

fauna).

- **National Park**

  Highly protected area to preserve the flora, fauna, landscape.

The Mining Act classified some areas as "special" areas. The mining sites (which have mining rights) are not "special" areas. If however, a national treasure of great importance is discovered during mining, and it can not be protected in any other manner, the discrict mine office may modify the mining site. However, this modification may not cause a disadvantage to the mine entrepreneur.

The Mining Act deals with major aspects of environmental problems of mining. (The supervising agency is the District Mine Authority.)

The following are the main points:

- agreement with land owner for reconnaissance
- access and easement rights to surface lands for exploration and development purposes, and the compensation for possible damages
- obligations related to Concession Contracts, Exploration Licences, and Mining Rights
- environmental issues in theTechnical Operation Plan

The regulations for air quality are found in the Decree 21/1986 of the Council of Ministers. The supervision of air quality is by the Inspectorate for Environmental Protection. In case of dangerous air contamination or noise, the Inspectorate for Environmental Protection may order a stoppage of operations.

The regulations concerning the protection of **natural water** are contained in the Act VI./1964. The supervising agency is the District Water Authority.

Mining companies are obliged to provide pumped water that is of drinking water quality to the water authority. Mining companies are responsible for water quality but not for water quantity. In order to protect water producing areas, the authority may require mines to protect areas by leaving pillars. For the protection of **fertile lands**, the respective regulations are contained in the Act I/1987. The relevant authorities are the District Land Registries and local councils.

The use of hazardous materials for landfills is prohibited. The regulations concerning **environmental impact studies** are described in the 86/1993 Govermental Decree.

The following mining activities require an environmental study:

- open pit,
- underground mine,
- mineral processing,
- waste dumps (greater than 100,000 cu. m volume),
- ore processing plant,
- coal washing and briquetting plant,
- petroleum and gas processing plant,
- underground gas storage

- economic data: e.g. the required cost of exploration and mining investment, the freight cost, the income fom the sale of water, the price received for the mining product, the operating cost, the rentability index, etc.

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REFERENCES

[1] Gy. Bárdossy, G. Faller, B. Fodor et al. (1993).
Mineral Opportunities in Hungary. Mining Journal Research Services, London

[2] U.S. Bureau of Mines and the U.S. Geological Survey (1980)
Principles of a Resource/Reserve Classification For Minerals. Geological Survey Circular 831.
U.S. Geological Survey Bulletin 1450-A.

[3] Rudawsky, Oded. (1986).
Mineral Economics. Elsevier, Amsterdam-Oxford-New York-Tokyo

[4] United Nations, Economic Commission for Europe: (1994; 1995).
Workshop on Reassessment of Coal and Mineral Deposits under Market Economy Conditions. Proceedings. Berlin, 1994; Hannover, 1995.

[5] United Nations, Economic Commission for Europe: U.N. International Classification for Reserves/Resources – Solid Fuels and Mineral Commodities –ENERGY/WP. 1.R. 77 Geneva, September 1997.