

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

THE ERDENET MINE  
MONGOLIA

REPORT  
ON  
STUDY OF THE ERDENET MINE  
MODERNIZATION AND  
DEVELOPMENT PROGRAM

VOLUME II  
RECOMMENDATION ON ASSET VALUATION METHOD

December, 1993

MITSUI MINERAL DEVELOPMENT ENGINEERING CO., LTD.,  
TOKYO  
(MINDECO)

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MITSUMI MINERAL DEVELOPMENT ENGINEERING CO., LTD.,  
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国際協力事業団

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## Volume II

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## 1. Foreword to the Volume II

Recommendations for an asset valuation method for the Erdenet mine are made in this volume. The Mongolian explanation of the mine's asset valuation is as follows.

“As the original investment in the mine was in Russian Roubles and Mongolian Tugriks, asset valuation was also performed in these currencies. However, since the dollar exchange rate for the currencies has changed considerably, asset valuations in Ruble and Tugrik do not permit a grasp of the fundamental situation. Consequently an evaluation of the mine in dollars is necessary and we would like to ask for your advice on this matter in the current modernization study.”

In response, the study group confirmed the opinions of those concerned with asset valuation in the second field study and, in the third field study, they introduced methods of asset valuation commonly used in the West and explained the DCF method as the most suitable valuation method for the Erdenet mine to those concerned.

A general understanding of such technical terms as “Net Present Value” and “Cash Flows” is an indispensable prerequisite for the understanding of the DCF method. At the time of the field study, these terms, together with details of the method, were explained and, after question-and-answer and discussion sessions, the Mongolian group had gained a good grasp of the method.

This edition gives a summary of the content of these discussions and the appendices contain the explanatory materials used in the discussion.

## 2. The Importance of Asset Valuation

Generally, the valuation of the assets of an enterprise takes place at the time of disposal or acquisition of that enterprise for the purpose of establishing one criterion for the transaction price for the enterprise. This is why asset valuation has become an important factor in Mergers and Acquisition (M&A). In this context "Asset Valuation" could also be described as "Company Price Calculation."

On the other hand, in the Mongolian case the problem of asset valuation has arisen for the privatization of state-owned enterprises with which the government is contemplating.

In the past, privatizations in Mongolia have been carried out using the so-called "Coupon Method," which is not a sale as the enterprise is transferred to private ownership free of charge. However, whatever the case may be, an asset valuation must be carried out prior to the transfer. Until now, companies have been valued at Tugrik-denominated book value but, because of inflation and exchange-rate movements associated with the economic reforms, this does not necessarily reflect the actual value of the company. In reality, the acquisition prices of previously-purchased machinery and equipment at the Erdenet mine, have become excessively cheap as a result of inflation and this will cause problems with covering depreciation cost at the time of replacement purchase.

To cope with this problem, Japan and various Western countries have adopted the method of revaluing assets in line with inflation. However, in Mongolia it is not simply a question of inflation but, now that the shift to a market economy has been made, previous investments, i.e. past costs, must be



calculated on a completely different basis (dollar denominated) and this is an extremely troublesome problem.

Notwithstanding, to continue privatizations in the future, asset valuation is unavoidable and, in particular, to start the privatization of a succession of large-scale enterprises, a definite rule must be decided upon.

In this way, asset valuation for the Erdenet mine is examined, reflecting the increased importance of the valuation.

### 3. Asset Valuation Methods

There is no standard, internationally-used asset valuation method. There are several theoretical methods which are used in parallel. Here three representative methods are introduced.

However, it should be noted that, whichever valuation method is adopted, usually in Western countries the value of a company is decided by the price of its stock on the stock market. In other words, the company's price is decided by agreement between its buyers and sellers, the amount thus arrived at is the company's value decided by the market.

Put another way, under a market economy the value of an enterprise is not decided by prior calculation but by the market. Accordingly the calculated figures are merely one yardstick and there is no guarantee that the enterprise can be sold at the calculated price.

The calculated result differs with the method used. Usually, calculations are made using several different methods and all the results are used for reference. So, in one sense, it is difficult to get an idea of the value in advance but since, whatever the case, the value is decided by agreement between buyers and

sellers it is necessary for the sellers (the Mongolian Government) to understand the purchase price the buyers (investors) deem appropriate, and the valuation method they usually use.

### 3-1 Net Asset Method

The net asset method uses the net asset value of a company at the time of valuation as the value of the company. More specifically, the total liabilities are subtracted from the total assets of the company to calculate the balance, namely net assets.

$$\begin{aligned}\text{Company Value} &= \text{Net Assets} \\ &= \text{Total Assets} - \text{Total Liabilities}\end{aligned}$$

Balance sheet figures can be used as a basis for Total Assets and Total Liabilities but the following adjustments must be made.

[Example of adjustment of assets and liabilities]

– Outdated machinery:

Since the market value is close to zero, asset value should be adjusted downwards.

– Assets with prices affected by inflation:

Should be adjusted upwards to present value.

– Doubtful assets: Uncollectables etc. should not be valued.

– Invisible assets:

Goodwill, technical skills, knowhow etc. should be valued as an asset although they have no book value.

Foreign currency denominated loans:

Should be adjusted according to exchange-rate movements.

This method has the following advantages and disadvantages:

[Advantages]

1. Easy to understand.
2. Useful for estimating a company's liquidation value.

When investigating the liquidation of a company, it is important to know the price its assets will fetch so this method best reflects the situation.

[Disadvantages]

1. Some assets are difficult to value.

Assets are basically valued at market value but, some machinery manufactured in former Eastern Bloc countries does not exist in Western markets and its value is difficult to calculate.

Furthermore, intangible assets such as goodwill, technical skill and management quality are subjective and difficult to value.

2. The company's future possibilities cannot be accounted for.

According to this method the value of the company is decided by the value of its currently-owned assets. Future takings and profits, i.e. the company's future possibilities, are not considered.

### 3-2 Price-Earnings Multiple Method (PE Method)

Under this method, the value of the company is calculated from the sales price of the company and the net earnings multiple (Price-Earnings Ratio or PE Ratio) based on the previous sales cases. This means taking the sale of another

company of the same type of business for reference, the PE Ratio is calculated, and applying that ratio to the latest net annual earnings of the company whose sale is under consideration to calculate the estimated sales price.

$$\text{PE Ratio} = \frac{\text{Sales Price of the Company}}{\text{Net Annual Earnings of the Company}}$$

Company Value = Net Annual Earnings × PE Ratio of another company  
in the same type of business

There are quite a few examples of acquisitions of companies like this. This method is unique to the United States, where it is easy to obtain data on acquisition prices, stock prices, book values and so on. The advantages and disadvantages of this method are as follows.

[Advantages]

1. Easy to understand.
2. More objective than Net Asset Method.

[Disadvantages]

1. Cannot be used when there is no similar company in the same industry sold as an example.
2. Large errors can arise because of differences in the state of business and operations even for companies in the same industry.

### 3-3 Discounted Cash Flows Method (DCF Method)

Under this method, the total cash-based net profits, to be produced by the company in the future, are calculated and the total amount is discounted at a specified rate to obtain the present value. The present value is deemed as the asset value of the company.

The cash-based net profits mentioned above refer to the amount calculated by subtracting cash-based expenses and investment in facilities from the income for the year. It is also called cash flow, in the sense that it remains with the company in the form of cash each year. The reason for discounting the total amount at a specified rate lies in the calculation of future earnings. Future earnings must be less than the current return, because of interest rates.

This is the Discounted Cash Flow (DCF). The total value of the DCF is also known as the Net Present Value (NPV) of the company. The details of the overall method will be explained separately.

$$\begin{aligned}\text{Company Value} &= \text{Total of Future DCF} \\ &= \text{NPV}\end{aligned}$$

The advantages and disadvantages of this method are as follows.

[Advantages]

1. Future earnings are taken into consideration.

This method values the company as a "Going Concern" in contrast to the Net Asset Method which attaches importance to the liquidation value.

2. This method is normally used by Western investors.

3. It is a suitable method for the mining industry. (for reasons given later)

[Disadvantages]

1. Difficult to understand.

Since technical terms such as DCF and NPV are used they must be understood.

2. It is difficult to accurately forecast future cash flows (Income and Expenditure).

Future income and expenditure are estimated under various preconditions but over the long term (more than 10 years) accurate estimation is impossible.

3. The selection of an appropriate discount rate is difficult.

NPV varies greatly with the discount rate used, but selection of the appropriate rate is difficult.

#### 4. A Suitable Asset Valuation Method for the Erdenet Mine

Each of the three asset valuation methods introduced here has its advantages and disadvantages and, theoretically, they are all correct. However, the suitability of the method for a given company also depends on the industry to which the company belongs. Here we would like to concentrate on investigating the most appropriate method for the Erdenet mine in its industry context.

We conclude that the widely-internationally-used DCF method is the most appropriate for a mine. Support for this proposal follows.

The net asset method is seemed to have the strongest resemblance to the method employed up to now for determining the selling prices for the privatization of state-owned companies in Mongolia. However, in the case of mining companies like Erdenet Mine, the relationship between the book value of the assets held by the company and the value of the company itself is remote.

Therefore, we must say that it is impossible to estimate the value of the company based on the book value of its assets. Specifically speaking, in the case of Erdenet Mine, the value of the mine should be based on the underground resources which will be explored and sold in the future. However, the deposits themselves are owned by the government and are not counted as one of the assets

held by the company. Accordingly, if book value is used to calculate the value of the Erdenet mine there is a possibility of undervaluation.

If this problem is borne in mind it is possible to use this method but, in the case of the Erdenet mine we run into an extremely difficult problem. This problem is the finding of a current market value, in dollars, for equipment purchased, in the past, from the former Soviet Union. The problem of finding this value is immense. In any case, there is no guarantee that such prices would be appropriate. In other words, it is in practice impossible to put an accurate value on the mine's assets.

Secondly, for the PE method there are few cases worldwide of the acquisition of similar mines and the data are insufficient for a judgment to be made.

Furthermore, even if an example of the acquisition of a similar mine existed, the grade and state of ore reserves vary hugely from mine to mine and necessary transportation costs also differ. So, since future income and expenditure are different for different mines, using another mine's PE Ratio to estimate an asset value would be misleading and thus, not recommendable.

Using the DCF method to value assets covers the defects of the other two methods. Namely, future profits can be considered in terms of the realization, by exploitation, of underground ore reserves and, since past investment in Tugriks or Roubles does not enter directly into the calculations, the problem of revaluation does not arise. Furthermore, all conditions peculiar to the Erdenet mine, such as grade of reserves, can be included in the calculation. An actual calculation method will be considered later.

Of course, this method also has its limitations and the market transaction price of the enterprise cannot be accurately determined beforehand. The previously mentioned difficulties such as that of estimating income over the long term and selecting the rate to use when discounting the cash flows to present value also apply to the case of Erdenet Mine.

However, using this method after understanding the limitations has its advantages. At the very least, it permits the understanding of the investors' decision criteria.

## 5. DCF Asset Valuation

In this section an actual DCF method asset valuation procedure is explained.

### 5-1 Technical Concept

First of all, to facilitate an understanding of the DCF method, some technical concept will be explained.

#### (1) Future Value and Present Value

In the DCF method, basically, the value of a company can be found from the future cash flows to be generated by the company (Cash flow calculation will be treated later).

It should be noted that future cash flows are not used as they stand but, to take account of the passage of time, must be discounted at the specified discount rate. To facilitate understanding of this process, we will explain the meaning of the "Future Value" and "Present Value" of a sum of money.

Consider a 1 year bank deposit under the following conditions:



Interest rate of the bank deposit: 10% p.a.

Principal amount deposited: Tg 1.0 million

If 1 year later, the principal amount plus interest are withdrawn, the total amount is Tg 1.1 million as shown in the following calculation;

$$\text{Tg 1.0 million} \times (1 + 10\%) = \text{Tg 1.1 million}$$

Assuming an interest rate of 10% a sum of Tg 1.0 million at present will, after 1 year, have a value of Tg 1.1 million.

We describe this in the following terms.

“Future Value (FV) in 1 year time” of the current Tg 1.1 mil. equals to Tg 1.0 mil.

“Present Value (PV)” of Tg 1.1 mil. in 1 year time equals to Tg 1.0 mil.

If the same amount is deposited for 2 or 3 years and interest is reinvested then the total of principal plus interest after 2 and 3 years are as follows:

$$\text{After 2 years } \text{Tg 1.0 mil.} \times (1 + 10\%)^2 = \text{Tg 1.21 mil.}$$

$$\text{After 3 years } \text{Tg 1.0 mil.} \times (1 + 10\%)^3 = \text{Tg 1.33 mil.}$$

Generally expressed, the relationship between future value and present value is as follows:

$$PV \times (1 + i)^n = FV$$

$$PV = FV \times 1 / (1 + i)^n$$

Given the future value of a sum of money, its present value can be calculated in this manner.

When seeking the present value of future cash flows, since the cash flows

are discounted by the value  $1/(1+i)^n$ , the representation of a stream of future cash flows by their present value is known as Discounted Cash Flow.

(2) DCF

In the DCF method the total future DCF is regarded as the value of the company. Here we will consider why DCF is used.

Suppose there are two companies A and B, and we will consider which company has the higher value. Suppose the companies will generate future cash flows as shown below (for the sake of simplicity a period of only 3 years is considered.) The cash flows here have not yet been discounted and are expressed as future values.

As is clear from the table, for both A and B the total investment over 3 years is 100 and the total profit is 150. So, expressed as a future value, the total cash flow for both companies is 50. Accordingly, if cash flows are considered, as they stand, as future values we conclude that both companies have the same value.

Company A	0	1	2	3	Total
(-) Investment	100				100
(+) Profit		50	50	50	150
Net Cash Flow	-100	+50	+50	+50	50

Company B	0	1	2	3	Total
(-) Investment	100				100
(+) Profit		100	25	25	150
Net Cash Flow	-100	+100	+25	+25	50

Next we will find the Discounted Cash Flows for the companies by discounting the net cash flows to present value using the equation given previously, and compare the totals. This total value of DCFs is known as the Net Present Value (NPV) of the concerned enterprise.

Now, as can be seen from the following table, assuming an interest rate of 10%, A's NPV is 24.3 and B's is 30.4. In the DCF method, this NPV itself is considered to be the value of the company and so we conclude that the value of B is the higher.

Company A	0	1	2	3	Total
Net Cash Flow (FV)	-100.0	+50.0	+50.0	+50.0	+50.0
DCF (@10%) (PV)	-100.0	+45.5	+41.3	+37.6	+24.3
					(NPV)

Company B	0	1	2	3	Total
Net Cash Flow (FV)	-100.0	+100.0	+25.0	+25.0	+50.0
DCF (@10%) (PV)	-100.0	+90.9	+20.7	+18.8	+30.4
					(NPV)

In this way, by using DCF it is possible to adjust cash flows, expressed in future values, for the passage of time (i.e. the notion of interest) and evaluate the worth of a company.

### (3) NPV

As already explained, Net Present Value (NPV) of an enterprise is the total of the Discounted Cash Flows (DCF) which are the future cash flows expressed as present values. This NPV expresses, in itself, the value of the company. We

explain this in a different manner below.

Company B above generates, from its business in the future (3 years for the sake of simplicity), total profits of 50.0 expressed as a future value. Expressed as the current value, i.e. discounted to present value, this becomes 30.4. This means that an investor currently considering purchasing B will not suffer a loss if he purchases it now for less than 30.4.

In this way, from the investor's point of view, the NPV of the future cash flows the company will produce shows the maximum price of the company at present. This method treats company acquisition as an investment activity and calculates an appropriate purchase price through a rational decision-making process.

## 5-2 Cash Flow Computation Method

The cash flows for each year are calculated as follows.

(Direct calculation method)

Cash Flow is Cash Outflow subtracted from Cash Inflow:

$$\text{Cash Flow} = \text{Cash Inflow} - \text{Cash Outflow}$$

Accordingly, in order to find the cash flows, it is sufficient to directly calculate the totals of cash flowing in and out for each year. Here, cash inflows are sales proceeds and other cash receipts, and cash outflows are operating and capital expenses paid in cash.

Cash inflows and outflows also arise from disbursement and repayment of loans, interest payments and other such sources. However, when a company is valued, we focus our attention only on operating cash flows produced by the

company and financial expenses are not usually considered.

Since depreciation and similar expenses do not involve any actual cash disbursement, they are not included in the cash outflows.

(Indirect calculation method)

It is possible to calculate the annual cash flow by calculating backwards from the figures in income statement as follows.

Net Income (after tax)

+) financial expenses

+) depreciation expense

+) other non-cash expenses

–) capital expenditure (replacement/additional investment, etc.)

–) Increase in working capital (inventory increase etc.)

---

Annual Cash Flow

### 5-3 Computation Period

NPV can be computed from cash flows calculated as above but, in reality, there is no fixed rule for selecting the number of years over which the computation should take place.

In the case of a mine, since it is certain that no income will be generated after the underground reserves are exhausted, it is unnecessary to calculate beyond this time.

Taking this "Mine Life" into consideration NPV is usually calculated from cash flows over 15-20 years.

Calculating cash flows over an excessively long period, such as 50 or 100 years, in order to increase the value of the enterprise is meaningless. This is because cash flows in the distant future, when discounted to present value, become almost worthless. For example, using a discount rate of 10%, \$100,000 in 50 years time has a present value of only \$850.

#### 5-4 Discount Rate

As previously mentioned, the discount rate used to calculate NPV is controversial. The present value of a future cash flow is greatly influenced by this rate. For example, NPV calculated using a discount rate of 10% may have a positive value whereas that calculated with a rate of 20% is negative. Consequently, the determination of discount rate is extremely important.

By investing in a particular project, an investor expects to make a certain profit. This profit should be the same as that produced by investing in another project with the same level of risk. This required return is generally called the "opportunity cost of capital." To calculate the NPV of a company, this "opportunity cost of capital" is usually used as the discount rate.

However, it is extremely difficult to specify the "opportunity cost of capital." Using the interest rate as a yardstick for the "opportunity cost" is a simple and rational approach. For a cash flow in dollars, the dollar interest rate is used as a reference. As an example, if an investor's cash flows for a project are discounted at the interest rate of the current bank deposit and yield a positive NPV, this means that investing in the project will give higher returns than depositing the same funds in the bank. If the risk of the project is considered, the above can be thought of as a minimum condition to be satisfied.

When looked at from the investment point of view, the investors target investment return (yield) is used as the discount rate for valuing a company. Accordingly if target returns are high then the value of a company is lower and vice versa.

If the project is funded 100% by shareholder's equity it is fine to discount future cash flows at the required rate of return but, in the real world, debt is also employed. The effect of tax benefit related to the debt must be reflected on when deciding on the discount rate to apply and a weighted average cost for shareholder's equity and debt is calculated and this is sometimes used as the discount rate.

In any case, because the discount rate is sometimes decided by the valuers (i.e. investors), in reality, often NPV is calculated at several discount rates and the final decision is left up to the investors.

## 5-5 Procedures and Considerations when Applying the Method to the Mining Industry

### (1) Actual valuation procedures

#### ① Special Features of Mine Evaluation

Erdenet undertakes the mining of minerals and, through this activity, reduces its underground resources. Thus the enterprise has the limitation of being based on so-called "wasting assets" and, however large the quantity of minerals it possesses, has a fixed lifespan.

In this case the target of the valuation is the underground mineral reserves but these have no intrinsic value. The value is decided by the profits from the sales of concentrate processed using facilities and equipment in which capital has

been invested in the past. Accordingly, the economic life of the mine has no connection with the useful engineering life of its machine structures, but is the length of time for which it is possible to continue economic operations.

However huge the past investment, this has no connection with the valuation of the mine. When it is no longer possible to continue operations and make a profit, however good the machine, it is totally useless.

On this basis alone, no method other than DCF can be considered as appropriate for mine valuation.

### ② Data Necessary for Mine Asset Valuation

- Quantity and grade of ore reserves
- Production scale
- Initial expenses (capital expenditure)
- Operation income and expenditure
- Rate for valuation (discount rate)

Operating lifespan (years) is calculated from the quantity of recoverable reserves (planned pit quantity) and the production scale (ton/day or ton/year).

Initial and operating expenses are calculated based on production. Sales proceed come from ore grades and market prices. These are combined to give annual profits and discounted to present value to give a value for the mine.

### ③ Deciding on the Scale of Operations

Generally unit production cost decreases and profits increase with increased production, above the break-even point. However, if technical



limitations, or equipment efficiency limitations are exceeded, a point is reached where the progressive cost decrease becomes a progressive increase. This point is the optimum operating level.

On the other hand, even though unit cost increases somewhat it is possible to maximize gross profit by further increasing the scale of production. As a maximal profit operation level, naturally this point conforms with the ideals of the enterprise's management.

If we define:

\*X: Production quantity (corresponding to break-even point)

C: Production cost per ton

G: Total fixed costs (costs not related to production quantities)

V: Average variable cost (variable cost per ton)

Then a measure of production quantity is given by the equation:

$$X \times C = G + XV$$

$$\text{i.e. } X = G / (C - V)$$

#### ④ Operating lifespan

Presently, an operating lifespan of 10-15 years is thought to apply.

Particularly in the case of a mine, income in 20 or 30 years time will have very little effect on the valuation. Therefore, as a first step, ore reserves in excess of those that can be mined in 15 years were omitted from the ore reserve calculations and do not affect the valuation.

In the draft modernization plan in the main report 15 years was also adopted as the standard.

#### ⑤ Initial Expenses

The valuation is closely connected with the initial expenses. The expenses for the various equipment, machinery buildings and structures, and construction necessary for the mining and processing of the total targeted reserves should be calculated without omission. It is better to estimate conservatively and, generally, a contingency of 10-15% is desirable.

During operation of the mine, replacement investment will be necessary to maintain the status quo, furthermore if it is decided to increase profits from the current level the necessary equipment for this must be added in. The necessary functional maintenance and the investment required for this purpose, must be estimated.

#### ⑥ Production Expenses

Here production expenses means only costs incurred in production. Consequently, commodity, labor, operating, and other sales expenses, general administration expenses, headquarters expenses etc. are included under general expenses. Naturally, depreciation and welfare expenses should also be included under this heading. This may differ from Erdenet's current accounting practice.

When using actual production results as a reference source for valuation, low costs are not necessarily a sign of good management. Cutting back production expenses shortsightedly may permit maintenance of production level for a specified period but cause problems in the long run.

Production expenses are generally expressed per ton of crude ore or concentrate but, for profit estimation, it is better to look at the expenses per ton of recovered metal (in this case copper and molybdenum) and the difference in income per ton.

Experience shows that, if impossibly high targets are set for exploitability and processing recoverability then, in many cases, expenses increase disproportionately to profits.

#### ⑦ Depreciation Expense

Depreciation expense for fixed assets is naturally a factor of production expenses but, in the DCF method, it is included in the cash flow of initial expenses, and must be removed from production expenses to avoid double counting.

#### ⑧ Adjustment of Actual Production Cost Results

As a pit operation level gets deeper, so the production conditions deteriorate. For example, the rock beds become harder, carriage expenses rise and more spring water is encountered. A corresponding increase in production expenses must be expected. Furthermore, an increase in primary minerals and other changes in ore grade contribute to an increase in mineral processing costs.

#### ⑨ Copper Price Estimation and Forecast Sales Proceeds

Estimating prices, even over the short term, is difficult, and forecasting prices in the distant future is an even more troublesome problem.

Generally, base metals are an international commodity and their price changes are large compared with other products. Supply and demand are greatly affected by social and political factors. Consequently, future prices must be estimated based on past statistics combined with possible influencing factors.

These various influencing factors can, basically, be reduced to two types: International commodity price levels (change in currency value) and the supply/demand relationship (change in exchange value).

If, for a while, there is no big change in the supply/demand relationship, both copper price and production expenses can be thought of as varying with the general price index. Accordingly, the effect of copper price changes, arising from commodity price levels, on the mine valuation is small.

The effect on the mine valuation of long term forecasts compared with those over a period of ten years, say, are made unimportant by the very nature of the DCF procedure, which converts to present value.

#### ⑩ Forecast and Actual Returns

Mine valuation involves the forecasting of the average annual return realized over the long-term future operating period of the mine, which is, strictly, expected forecast returns. If we refer to past years' average returns, we are limited to a period of 3-5 years. If forecasts for the first few years are fairly accurate, forecast errors for late years can be thought of as having comparatively little effect.

Future trends should be ascertained and the results should be revised as much as possible in response to those trends.

#### (11) Discount Rate

Refer to 5-4.

#### (2) Various Problems with Valuation

Attention should be paid to the following points:

① Appropriate production scale and operational lifespan are decided from the recoverable ore reserves, a factor directly affecting mine valuation.

Since the operating lifespan is 10-15 years values greater than this have little effect. A production scale which maximizes present value should be

selected.

## ② Risk factors in the mining industry

In a developed mine, such as Erdenet, the in-pit ore quantity (actual ore) is the target of mining and since this is valued at actual value, there is little risk and it is easy to estimate the profit. However, in the mining industry operations are generally planned including "speculative ore," and "speculative value" is a factor.

③ Investment trend must be decided according to the mine's development stage.

A mine's development is classified into 4 stages:

- preparation (infancy)
- development (youth)
- exploitation (maturity)
- degeneration (old age)

Estimation of initial and operating expenses requires a clear view of future trends. Fortunately, Erdenet can be regarded as being in the latter half of its youth. The necessary new investment arising from the obsolescence of the equipment, which has been operating for 15 years and the change in the state of the ore reserves should act as a warning against excessive optimism.

## ④ Mine valuation and mining company valuation

A mining company carries on business centered on a mine but, in many cases, with the passage of time it diversifies, changing from being a restricted business entity to embrace divisions which carry on continuing business activities resembling a general enterprise. For the divisions resembling general

enterprises asset valuation based on book value can be used. However, DCF is certainly an alternative method which can be used.

In our modernization plan, we propose that the continuing business divisions be set up as independent companies and, in case of separation, a different valuation method can be used.

⑤ Valuation as collateral

In the West, when a mine is financed, a consortium is established and a mine foundation mortgage is set up.

The mining rights as well as almost all the mining fixed assets, such as land, buildings, various equipment and rights are mortgaged. In this case too, the DCF method is used but estimated returns stop at 2-3 years so collateral value is based on short-term forecasts.

In a period of unusually bad business conditions there is no alternative but to base the collateral value of the mine on the depressed income at that time.

In some cases both the resale value of assets and the value of the income from the mine are estimated and the larger of these becomes the collateral value.

⑥ Absolute mine valuation is impossible.

This valuation method is largely based on forecasts rather than facts. If the time of valuation changes then the value also changes. Mine asset valuation is relative, and it must be understood that it is not absolute.

## 6. Case Study

Below is shown an actual example of a mine asset valuation as a case study. This is strictly nothing more than an example calculation of asset values using the DCF method and all data is fictitious. We calculated cash flows over 20

years from 1995 and discounted them at rates of 5%, 10%, and 15% to arrive at NPV. The results are as below.

Discount Rate	Enterprise Value
5%	US\$727.8 mil.
10%	US\$498.0 mil.
15%	US\$366.4 mil.

Valuation of companies - DCF approach

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Ore Grade	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.75%
Concentrate Grade	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%
Tons of Mill feed per year	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Concentrate Recovery	80.00%	80.00%	80.00%	80.00%	80.00%	80.00%	80.00%	80.00%	80.00%	80.00%	80.00%
Concentrate produced per year	426.7	426.7	426.7	426.7	426.7	426.7	426.7	426.7	426.7	426.7	400.0
Concentrate Price	500	500	500	500	500	510	510	510	510	510	515
Sales	213.3	213.3	213.3	213.3	213.3	217.6	217.6	217.6	217.6	217.6	206.0
Direct Operating Costs	128.0	128.0	128.0	128.0	128.0	130.6	130.6	130.6	130.6	130.6	123.6
Depreciation	30.0	30.0	30.0	30.0	30.0	33.0	33.0	33.0	33.0	33.0	35.0
Profit before Tax	55.3	55.3	55.3	55.3	55.3	54.0	54.0	54.0	54.0	54.0	47.4
Taxation	22.1	22.1	22.1	22.1	22.1	21.6	21.6	21.6	21.6	21.6	19.0
Profit after Tax	33.2	33.2	33.2	33.2	33.2	32.4	32.4	32.4	32.4	32.4	28.4
add: Depreciation	30.0	30.0	30.0	30.0	30.0	33.0	33.0	33.0	33.0	33.0	35.0
less: Replacement / Expansion CAPEX	5.0	5.0	5.0	5.0	5.0	5.5	5.5	5.5	5.5	5.5	5.5
less: Increase of Working Capital	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Cash Flow	58.2	58.2	58.2	58.2	58.2	59.9	59.9	59.9	59.9	59.9	57.9
DCF @ 5.0%	55.4	52.8	50.3	47.9	45.6	44.7	42.6	40.6	38.6	36.8	33.9
DCF @ 10.0%	52.9	48.1	43.7	39.8	36.1	33.8	30.8	28.0	25.4	23.1	20.3
DCF @ 15.0%	50.6	44.0	38.3	33.3	28.9	25.9	22.5	19.6	17.0	14.8	12.5





DISCUSSION PAPERS ②

# VALUATION OF COMPANIES

THE STUDY ON

THE ERDENET MINE MODERNIZATION AND DEVELOPMENT PROGRAM  
IN MONGOLIA

Japan International Cooperation Agency (JICA)

Mitsui Mineral Development Engineering Co., Ltd. (MINDECO)

# Page 1 : Methods of Business Valuation

- ① Net Asset Approach
- ② Price - Earnings Multiple (PE) Approach
- ③ Discounted Cash Flow (DCF) Approach

## Page 2 : Net Asset Approach - ①

Value of the Company = Net Asset Value

= Total Assets – Total Liabilities

When liquidation of the company is considered, valuation of Net Asset is meaningful.

Revaluation of the following items is required.

- out-dated machines and equipment
- inflation of equipment price
- bad debts
- liabilities in foreign currency

## Page 3 : Net Asset Approach - ②

[Merit]

- easy to understand
- useful for liquidation of the company

[Demerit]

- difficulty of asset valuation
  - machines made in former - CMEA countries
  - intangible assets (goodwill, quality of management, etc.)
- future income cannot be considered
- business value does not necessarily correspond with the book value of the company especially with the mining industries

## Page 4 : PE Approach - ①

$$\text{PE Ratio} = \frac{\text{Sales Price}}{\text{Annual Net Income}}$$

$$\text{Value of the Company} = \frac{\text{Annual Net Income of the Company}}{\text{PE Ratio}}$$

PE Ratio differs according to the industry.

Consideration of other elements (such as country risk) is required.



## Page 6 : DCF Approach - ①

Value of the Company = Total of Discounted Cash Flow (DCF) of future operation of the company

= Net Present Value (NPV) of the future Cash Flow discounted at a certain rate

Cash Flow = annual cash inflow - annual cash outflow



## Page 7 : DCF Approach - ②

- [Merit]
- consideration of future income is possible (the company can be regarded as a Going Concern)
  - adopted generally by foreign investors
  - suitable for valuation of companies in the mineral resources sector

- [Demerit]
- difficult to understand
  - difficulty in accurately determining future revenue and costs
  - difficulty in adopting appropriate discount rate

# Page 8: Future Value and Present Value-①

(assumption)

Interest rate for  
the bank deposit = 10.0% p.a.

original principal = tg 1.0 million

Income (principal and interest)

over a period of one year :

$$\frac{\text{Tg. 1.0 mil.}}{\downarrow} \times (1 + 10\%) = \frac{\text{Tg. 1.1 mil.}}{\uparrow}$$

Present Value (PV)

Future Value (FV)

## Page 9: Future Value and Present Value-2

$$1 \text{ year} \quad Tg \ 1.0 \text{ mil.} \times (1 + 0.1) = Tg \ 1.1 \text{ mil.}$$

$$2 \text{ year} \quad Tg \ 1.0 \text{ mil.} \times (1 + 0.1)^2 = Tg \ 1.21 \text{ mil.}$$

$$3 \text{ year} \quad Tg \ 1.0 \text{ mil.} \times (1 + 0.1)^3 = Tg \ 1.33 \text{ mil.}$$

$$PV \times (1 + i)^n = FV$$

$$PV = FV \times \frac{1}{(1 + i)^n}$$

**i** : interest rate (discount rate)

**n** : year

# Page 10 : Future Cash Flow - ①

Which company is preferable for investors?

[Company A]	year	0	1	2	3	Total
(-) investment		100				100
(+) income			50	50	50	150
Net Cash Flow		-100	+50	+50	+50	

[Company B]	year	0	1	2	3	Total
(-) investment		100				100
(+) income			100	25	25	150
Net Cash Flow		-100	+100	+25	+25	

# Page 11 : Future Cash Flow - ②

[Company A]	year	0	1	2	3	Total
Net Cash Flow		- 100	+ 50	+ 50	+ 50	50
Discounted Cash Flow (discounted at 10%)		- 100	45.5	41.3	37.6	24.3

Net Present Value of C/F (A) = Tg 24.3 mil.

[Company B]	year	0	1	2	3	Total
Net Cash Flow		- 100	+ 100	+ 25	+ 25	50
Discounted Cash Flow (discounted at 10%)		- 100	90.9	20.7	18.8	30.4

Net Present Value of C/F (b) = Tg 30.4 mil.

# Page 12 : Cash Flow of the Company

Cash - In	Revenue (Equity) (Borrowing)
Total	Cash Inflow
Cash - Out	Operating Cost Capital Expenditure (Interest Payment) (Repayment of the Borrowing)
Total	Cash Outflow

Net Cash Flow = Cash Inflow – Cash Outflow



