# AN ANALYSIS OF MINERAL LEASING SCHEMES FOR USE ON INDIAN LANDS

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF MINING AND GEOLOGICAL ENGINEERING

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE
WITH A MAJOR IN MINING ENGINEERING

In the Graduate College

THE UNIVERSITY OF ARIZONA

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## ACKNOWLEDGMENTS

Research that leads the author into previously unknown fields for him relies heavily on information provided by individuals in those fields. I am particularly grateful to my advisor Dr. T. J. O'Neil and to Dr. D. P. Harris for continually steering me in the right direction.

Special thanks are due to Addison Smith who helped me to gain an understanding of the Papago Indian Tribe, and to Mr. W. E. Strickland, attorney, Strickland and Altasser, and Mr. Crowther, Bureau of Indian Affairs, for helping me identify some of the problems facing Indian tribes who lease land. I am also grateful for the assistance given to me by personnel belonging to mining companies around Tucson who released technical data and identified problems that arise from leasing. I would like to thank Mr. R. B. Crist of ASARCO, Mr. R. Teissere of Duval Corporation, Mr. D. Hammer of Newmont Mining Company, Mr. J. Lacy, partner, DiConcini, McDonald, Brammer, Yetwin and Lacy, P.C., and Mr. R. Sievwright, attorney, Twitty, Sievwright and Mills. Finally I would like to thank Dr. J. Daemen for being on my committee, Ms. H. R. Hauck for all the patience, time and care she spent trying to turn my thoughts into words, and Joan Farmer for typing the manuscript.

I was particularly fortunate to have been awarded the 1977 Silver Jubilee Travel Scholarship by the Institution of Mining and Metallurgy and to be supported by my parents. Without this support

and the continual encouragement of my family this thesis might never have been finished.

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## ABSTRACT

Leases are used to make land available for development by other parties when owners are not prepared to develop it themselves. Recently new goals have been proposed for leasing and new agreements may be required to meet them. This thesis attempts to determine what is the optimum lease agreement for leasing Indian lands. Currently a 10% net smelter return (NSR) agreement is used. Indian tribes would like lease agreements that help to cover expenses of tribal programs and allow them to participate in a project's success.

Alternate leasing agreements were evaluated on a model of a porphyry copper deposit to determine which schemes gave both acceptable discounted cash flow return on investment to the lessee and lease payments to the lessor. It was found that a modified percentage of predepletion and pre-tax income schemes best satisfy the Indian's leasing requirements. They give the lessee the highest returns providing that the tribe is prepared to share some of the project's financial risks. If the Indians are not prepared to share these risks or do not want to carefully monitor the agreement, a %NSR scheme is better. The study indicated that a 10% NSR may be too high for most common low-grade porphyry copper deposits and therefore this rate should not be used for all projects.

# CHAPTER 1

## INTRODUCTION

Various leasing schemes have been developed to acquire a property's mineral rights when other methods of acquisition are deemed inappropriate. These schemes first appeared during the Roman era to enable Roman subjects to mine conquered lands and still ensure that Rome received the financial benefits of conquest from the mines. The civil code of justice developed under the Roman Empire, among other things, considered that all mineral rights are separated from the surface rights and belong to the state (Gordon, 1971). Although the original advantages of the state owning the mineral rights were economic and strategic, many present-day governments use this authority in other ways to achieve different goals.

An alternative legal system in common use today is that of English common law developed from the Anglo-Saxon and Norman legal codes. One of the major differences between the two legal systems is that private ownership of mineral rights is permitted under common law. At the end of the thirteenth century, King John of England faced a rebellion of his feudal barons; in return for their continued allegiance he made several concessions in a document called the Magna Carta. One of these concessions was to allow the barons to own the mineral rights to their land and to lease these rights to a third party, with a share of the lease payments made to the king (Gordon, 1971).

These two legal systems have since spread around the world--the civil code through most European countries and their former colonies and the common-law system through the former British colonies. The United States uses a derivative of the common-law system to determine most of its minerals on public lands, although it bases the U.S. federal leasing program on guidelines developed from civil law. In the last 15 years leasing systems have caused controversies in many countries mainly because the host governments often believed that operators were exploiting resources and unfairly compensating the government-owner. These countries also want a greater say in the development of their resources with the result that many leasing agreements have been reviewed, and nationalization of some properties has taken place.

Originally land was leased simply to raise money for the owner. While this is still important today many socioeconomic objectives are also being pursued. This thesis considers these new objectives and the leasing schemes available to meet them.

To illustrate the problem of leasing land, this thesis examines various lease terms for porphyry copper deposits on Indian lands in the southwestern United States. The Indian perspective was gained through interviews with members and advisors of the Papago Indian Tribe of southern Arizona. The problems involved with Indian mineral leases are similar to those encountered recently in developing countries.

Historically the term royalty has been given to these annual lease payments. Internal Revenue Service (IRS) defines a royalty as (Breeding, Burke and Burton, 1977, p. 202):

> A royalty interest, for Federal tax purposes, is a right to oil and gas or minerals in place that entitles its owner to a specified fraction, in kind or in value, of the total production from the property, free of expense of development and operation. It is, therefore, a mineral interest, stripped of the burdens and rights of developing the property.

This is also the definition of a royalty used in this thesis. All the agreements, including those which make allowances for operating costs, are referred to as lease agreements and the payments for these schemes are called lease payments.

# CHAPTER 2

## CURRENT GOALS OF LEASING AGREEMENTS

Leasing schemes were originally designed to provide lessors with compensation for the use of their property and the depletion of nonrenewable resources. The goals of current royalty schemes vary widely to reflect the different political goals and economic requirements of individual owners. This chapter categorizes leasing goals proposed in different parts of the world and emphasizes many recent modifications of leasing agreements. Many goals are shown to be incompatible because they are based on different premises. Thus, it is important to establish the owner's requirements prior to the negotiations.

### Financial Goals

Lease payments can be structured to satisfy different financial needs. Practically all owners require a guaranteed minimum payment to compensate for removing mineral resources from their property. Also, the owner expects the minimum payment to continue during nonproducing periods. This goal can be achieved by rental agreements or by guaranteed minimum lease payments. Frequently prepayments are made against future royalties to meet minimum payment requirements.

Some mining companies operating on Indian lands recently have sought to renegotiate the mining leases because low copper prices have made the deposits uneconomic at current mining costs. The companies

believe that the 10% net smelter return (NSR) royalty as required by the Code of Federal Regulations is too high. They wanted it lowered and preferably related to other parameters less dependent on the commodity price. The Papago Indians were prepared to grant temporary relief until more favorable market conditions returned. They also wanted to see more members of the tribe employed at the mine.

The two parties appear to have two different perspectives on leasing and the study attempts to identify them more closely. A leasing scheme is proposed to resolve these differences and to achieve most of the objectives of both parties. The study considers other leasing schemes available to overcome these problems and evaluates them with a computer-simulated financial model of a porphyry copper deposit. The study seeks to establish relationships between the leasing agreements, to discover which scheme best satisfies the objectives of both parties and to put into perspective the effect of leasing agreements on the project's success relative to the effects of other mining parameters such as capital costs or commodity prices.

The lessor nearly always attempts to link payments to the revenues received by the lessee because this allows the lessor to share in any unexpected windfalls (unexpected profits) that the operator makes from rising commodity prices or the discovery of new orebodies. It should be noted that the lessor also bears a greater share of the risk with this type of agreement and will receive smaller payments if the lessee's revenues decline. The U.S. government frequently uses this method in mineral leasing.

Competitive bidding for mineral leases often results in greater income to the lessor than when negotiated leasing schemes are used. Examples of systems are royalty bidding. However, instead of generating higher revenues these methods may postpone the development of some areas or commodities by having a royalty rate set so high that the deposit proves uneconomic until the rate is renegotiated.

The fair market value concept has been proposed by the U.S. government for their mineral leases (U.S. Code, 1966a). The U.S. government encounters problems with this concept because it conflicts with other federal objectives such as an orderly and timely development of the orebody and because the definition of fair market value is unclear. Whether the concept is supposed to be based on the value the land could achieve under other uses (U.S. Congress, 1974) or on the appraised mineral value of the land (U.S. Code, 1966b) is unclear. However, the government interprets the term as being the highest bid that the Department of Interior receives under competitive bonus bidding conditions (Ferrar, 1974).

The concept of determining fair market value for a deposit has the following faults: Firstly, by using the concept as the sole requirement instead of observing other goals the orderly and timely development of the project may be prevented. Secondly, too high leasing rates may preclude the development of more marginal deposts. Although there are shortcomings to the concept of fair market value it can be implemented under any leasing system although supervision or regulations may be required.

Although the leasing rate may be set to achieve all of the lessor's current goals, inflation may completely destroy the effect. Royalty schemes based on fixed payments per ton are particularly susceptible to inflation because the commodity's price and the operating costs may both rise due to inflation while the royalty remains constant in fixed dollars which are declining in value. Adjustments for inflation can be included to offset this effect, otherwise frequent renegotiations may be necessary. Leasing agreements related to a percentage of the annual profits can be used instead. The problem with inflation is especially critical in lesser developed countries where inflation may exceed 20 percent per annum.

## Utilization of Resources

Concern is expressed in many countries of the manner in which national resources are exploited. This concern is a response to both a desire to be less dependent on foreign resources and to conserve minerals. Thus more socioeconomically orientated goals are being proposed for leasing. These goals often seek efficient utilization and complete extraction of resources even if this increases the mining costs for the operator.

Lessors of public lands are concerned that the resource be extracted to its economic limit (that point at which the marginal revenue from additional or equals the marginal cost of extracting it). The operator must be encouraged to continue mining until this point is reached. While it is possible to encourage mining to the economic limit of the deposit, the economic limit of the total resources is

constantly changing and thus additional work done to ensure the deposit is fully extracted may not be in the overall interests of the lessor. If a profit-sharing scheme is used these lessors are also concerned that the most efficient operator leases the deposit because profits and therefore lease payments will be affected. An inefficient operator will have higher operating costs than a more efficient rival, therefore the total profits should be lower. Although one cannot ensure that the most efficient operator leases the deposit, handicaps such as entry barriers caused by large bonus payments may exclude this operator. On the other hand, if competition for the lease increases it becomes more likely that the best operator will lease the deposit because this company could afford to pay more for the lease. Under certain circumstances a larger operator may be preferred to a rival who is thought to be able to operate at a lower mining cost because the larger operator either may have more experience in the field or has readily available equipment and labor.

Competition for coal and oil leases can be promoted by reducing the size of the leased area, by removing financial barriers, and by encouraging exploration on the property prior to leasing (Ferrar, 1974). Competition for federal leases could be increased by encouraging both the bidders and the U.S. Geological Survey to examine the lands before bidding (Kalter and Tyner, 1978). Studies by Going (1972) suggest that the larger companies spend the greatest amounts of money looking for one big deposit whereas smaller firms spend less on exploration but make large payments for other orebodies that surround these big finds. Competition for federal coal leases is inspired by the proximity of

other producers and not the size and quality of estimated reserves as would be expected (Dick, 1975), so other considerations are often relevant.

Although it may be important to lease the deposit to the most efficient operator there are often other criteria that should be considered when choosing a lessee such as political strength in a country or market share of an industry. Therefore it is possible that the high bidder is not the best operator for the lease when all the leasing goals are considered.

## Effect of Leasing on a Region

Governments have encouraged mining firms to come into their countries because mining can provide both a source of income and strategic minerals. It can also promote a region's economic development and encourage other industrial activity in the area. As a result, taxes and lease payments occasionally are reduced for firms that invest in remote regions. However some governments, especially those of underdeveloped countries, may try to alter the terms once the industry is established. The governments become unhappy when the companies make large profits and pay low taxes.

In contrast, some regions are so intensely developed that there are conflicting land uses proposed for the mineralized area. In these areas if mining is considered less desirable than these other uses, mining may be excluded. Mining may also be excluded due to ecological or environmental considerations. Lease terms can be tailored to ensure that the operator takes immediate account of the full impact of its

actions. This is preferable to allowing the impacts of mining to accumulate until the mine is worked out because then the company is often unwilling to spend additional money on the project. Large bonds posted prior to mining will ensure mining companies comply with environmental regulations. It appears that mining has a different impact on each community and both the deposit's location and the attitude of the local residents influence the ease with which land is leased.

## Risk

Any company developing a new mine is exposed to large risks primarily because of geological, mining, and market uncertainties; but frequently political risks are also important. Joint ventures and government participation have been used successfully to reduce or spread this risk. Government participation may reduce both the political and the financial risk and loans can be more easily secured for the project. Kalter and Tyner (1978) and Van Meurs (1971) considered the effect of risk on leasing schemes. They proposed profit-sharing agreements to reduce the lessee's risks whenever the lessor is prepared to participate in the project's development.

Unfortunately various components of mining legislation can increase a project's financial risks (e.g., the capital costs of pollution controls). The investment risks are greater for large ventures although if they are managed by integrated companies, other risks such as market or political risks can be absorbed more easily by the firm because of its diversity. Small firms bound to one project become very susceptible to market risks.

The risks involved in exploration are very high, and exploration permits should try to reduce some of these risks. Ferrar (1974) suggests that leasing risks can be reduced by allocating coal lands in a checkerboard fashion because this allows a prospective lessee to study the production history and the geology of the surrounding tracts prior to bidding. Sophisticated leasing agreements are needed to overcome the complex effects of risk on exploration and mining ventures. These agreements commonly prove difficult to design and expensive to monitor.

## Complexity of Leasing Schemes

Most lessors and lessees prefer leasing schemes that are straightforward to evaluate and monitor because these schemes reduce both the administration and monitoring costs. Although simplistic leasing agreements are often satisfactory many lessors prefer to spend more time designing more complex leasing agreements because they may be more advantageous, such as provisions to share windfall profits. Complex agreements may reduce the risk involved in a venture--and firms are prepared to make higher lease payments for this benefit--however these agreements also increase the administration cost. Another with complex leasing schemes is that the lease terms need to be very carefully defined. If the terms are vaguely defined the lessor and the lessee may both try to interpret the lease in their favor and this may result in litigation.

## Renewal

Special problems arise if a lease expires and becomes due for renewal. In the past it appears that the deposit was either completely worked out or renewal was automatic after a possible adjustment in the leasing rate. Indeed many private leases do not appear to have an expiration date but rather include payment provisions that apply until the minerals are mined to their economic limit. In the United States, many federal leases have been granted for twenty-year periods and have been renewed by the lessee without many changes in the lease terms. Recently the federal leasing program has been subjected to greater public scrutiny and therefore the lessee can expect to encounter more problems when renewing leases in the future.

For many leases on public lands, the major problems associated with any renewal scheme are that many of the criteria used to establish the inital lease no longer apply. The initial investment may have been recouped and therefore the financial risk should be much lower. The modest amount of annual new investment removes any basis for computing the project's rate of return and it becomes difficult to evaluate the fairness of the proposed scheme. Provisions for geological uncertainty can be avoided because after twenty years geologists should be fairly certain of the major mineralization controls and of the location of the remaining ore reserves. Because the operator may have already recouped the investment in the mine and established a work force it seems unlikely that any other mining company could offer better leasing terms. Therefore the lessor is really forced to negotiate only with the current operator.

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New objectives are therefore important for leasing property in a renewal situation. The scheme should prolong the mine's economic life and encourage the extraction of the orebody to its economic limits. Leasing schemes that force the project's premature abandonment must be avoided. This is best achieved by using leasing schemes that allow credit for operating costs to the lessee.

Another major problem that arises when renewing leases is assessing what represents a fair return to the lessor and operator. The lessor realizes that the operator has probably recouped the initial investment and made a profit and considers that the lessor is entitled to the greater share of any future profits. If the operator's share of the profits is too small the operator's incentive to completely mine out the deposit may be reduced.

Many payment schemes have been proposed for lease renewals but possibly the most effective one shares the annual profits between the two parties. Prior to the introduction of such a scheme, checks should be made to ascertain that the mining company has received a fair rate of return on its investment (currently considered by mining companies to be around 15 percent). A profit-sharing scheme has recently been adopted by the Colville Indians for leasing the Mt. Tolman prophyry copper-molybdenum property in the State of Washington (Engineering and Mining Journal, 1978).

## Summary

Many different objectives are currently being proposed for mineral leases in response to changing attitudes toward mining. Although

the traditional goal of leasing has been to maximize income, many governments are discovering that other goals suit them better. Alternative leasing schemes help governments achieve many socioeconomic goals including the efficient and complete recovery of a depletable resource. Governments may be tempted to use lease agreements favorable to the lessee to promote the economic development of a region. Alternatively they have found out that lease provisions can be used to overcome problems of conflicting land uses and bonds can ensure that reclamation requirements are met.

Lease terms have been altered to reduce some of the risks a mining company has to bear, and new goals have been identified for lease renewals. Since leasing objectives have changed dramatically in recent years, leasing agreements will have to adapt to meet these new goals. New schemes developed to meet this need are considered in Chapter 3.

# CHAPTER 3

## AN ANALYSIS OF CURRENT LEASING SCHEMES

This chapter provides a detailed analysis of several alternate leasing schemes. These schemes are usually designed prior to the exploration of the leased area and cover both the exploration and the development of a project. These schemes are grouped under four general headings: royalty schemes, rental schemes, profit-sharing schemes, and less common leasing schemes. Refinement of these forms are discussed under the appropriate headings.

The leasing of public and Indian land in the United States is currently controlled by legal restrictions and regulations. There are arguments that these controls do not necessarily achieve the lessor's objectives and several modifications to the leasing regulations are being considered by the various federal regulatory agencies. Because there is discussion as to whether leasing should continue to be controlled by the present regulations this chapter considers both current mine leasing schemes and leasing schemes that do not satisfy present regulations but might be suitable for future mineral leasing.

### Royalty Schemes

A royalty is a payment based on the production of the lease. The royalty can be either a payment per unit produced (e.g., 10¢ per ton of coal produced) or a percentage of the value of the commodity

(e.g., 10% NSR). Royalty schemes are required for leasing public land in the United States for certain minerals. For hard-mineral leasing the royalty is determined by regulations whereas for some oil leasing the royalty may be determined by competitive bid. Bids for the lease area are usually made prior to exploration, and because this system has proved successful for oil leasing, bids are considered in this section as a method of leasing mineral deposits. The royalty schemes considered are: fixed royalty with a bonus bid, fixed bonus with a royalty bid, and sliding-scale royalties with a bonus bid and a fixed royalty.

Fixed Royalty with a Bonus Bid

A fixed royalty with a bonus bid scheme requires the lessor to set the royalty rate prior to bidding on a bonus. The bonus is a sum of money given to the lessor at the start of the lease term. The bonus payment ensures that the lessor receives an undiscounted return for the deposit regardless of whether the lease is ultimately productive.

The characteristics of this leasing scheme are:

1. The bonus bid represents a high front-end cost and this acts as a powerful incentive for firms to quickly explore and develop the property to its workable limits or to abandon the lease. These front-end capital investments are unrelated to subsequent operating costs and therefore do not alter later production decisions (Harris and Brock, 1976).
2. The bids are simple for the lessor to administer and evaluate and no additional leasing decisions are required until the lease is renewed.

3. There is increased risk sharing by the lessor, as royalty increases, with consequent lessening of initial capital requirements and increased competition. Lessor revenues may be higher because of increased risk sharing providing that the deposit is not prematurely shut down (Leland, Norgaard, and Pearson, 1974).
4. The most efficient firm tends to get the lease. On the average, bonus bidding schemes will lead the most efficient firm to offer the highest bid and, thus, secure the lease.
5. The operator will lose the bonus if the deposit proves unworkable, although bidders may keep bids low reflecting the high risk involved in developing the project.
6. The bonus reduces the amount of money an operator has to develop the property and this may act as a significant entry barrier for the smaller firm.
7. If the royalty is set too high, the deposit may not be developed or it may be prematurely shut down and resources could be sterilized (Figure 1). "Economic (social) efficiency requires production to occur until marginal cost equals price. Royalties raise marginal costs above their market level, leading to premature stoppage of oil lifting on a lease" (Leland and others, 1974, p. 28; Figure 2). Any scheme that includes a royalty payment (fixed or bid) will suffer from this disadvantage.

Overall this scheme works well for leases that have fairly low risks associated with their development, and has proved an effective

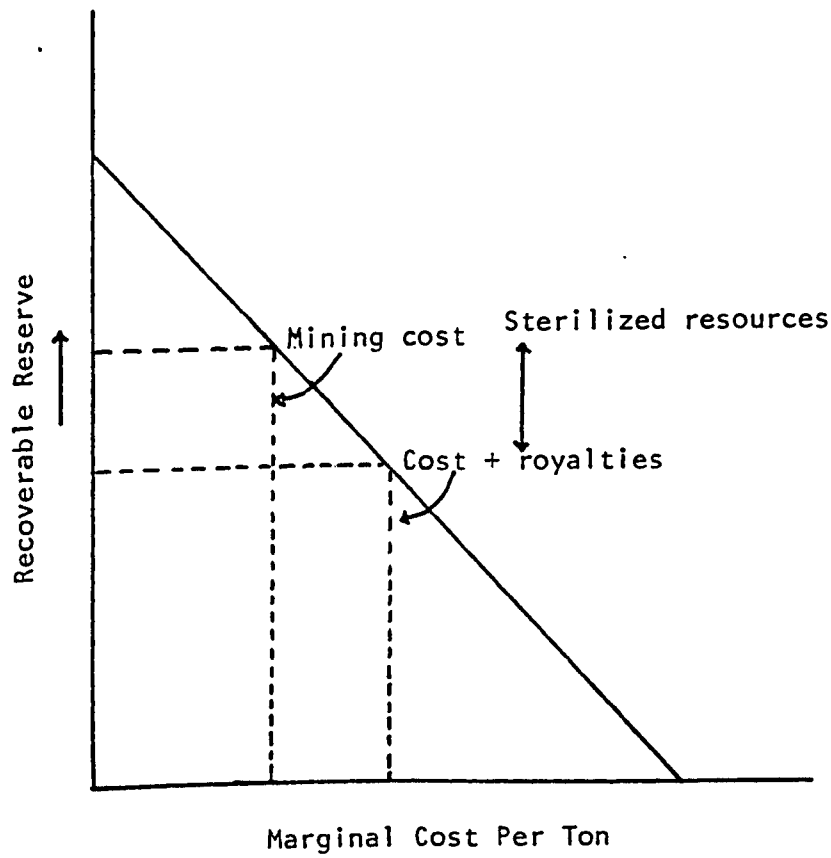



Figure 1. Illustration of how royalty schemes sterilize resources

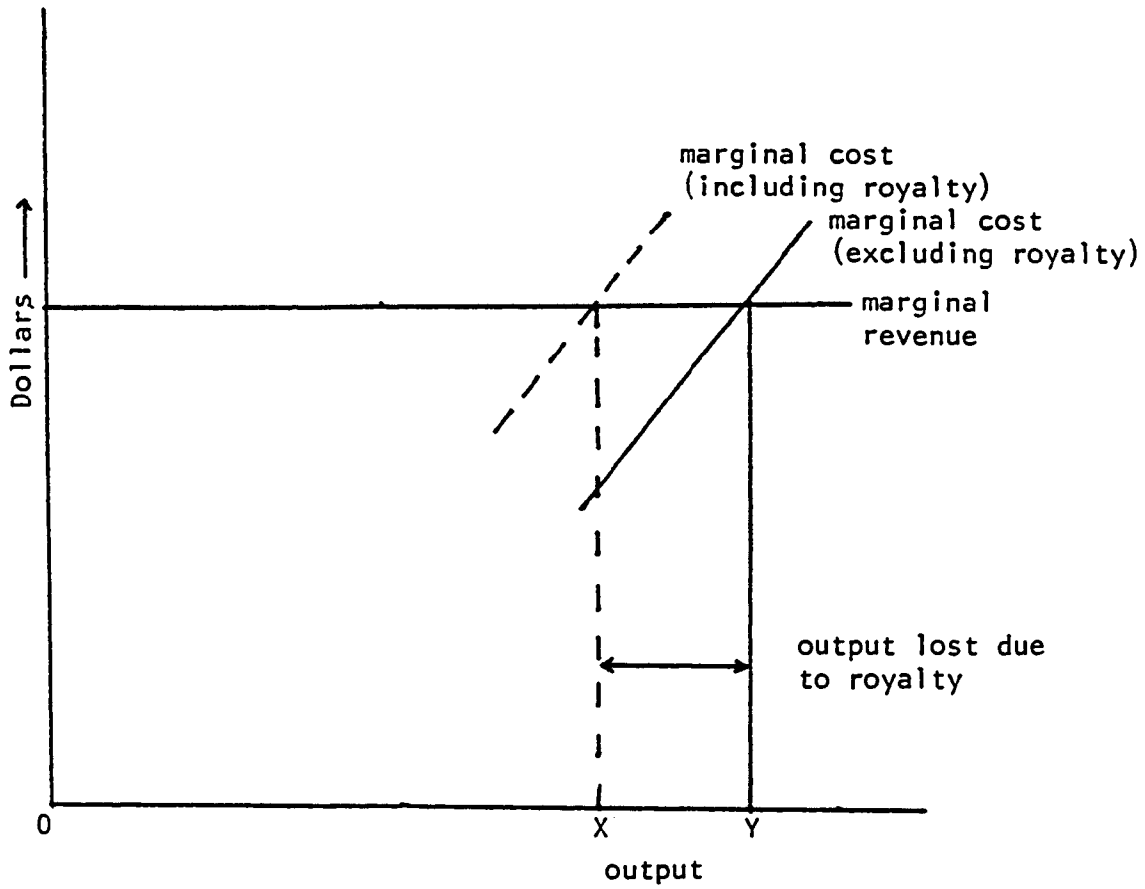



Figure 2. Illustration of how a royalty can lead to a deposit's being abandoned before it is completely mined out --after Mead, 1975

X = abandonment point with royalty

Y = point at which mine is abandoned if no royalty is levied

leasing system in the past because it is simple to evaluate and administer. Modifications have been proposed by Harris and Brock (1976) to overcome the problems associated with bonus payments. They suggest schemes for oil leasing that either delay the bonus until the deposit it discovered or that pay the bonus in installments throughout the producing life of the deposit. By delaying the bonus until the orebody is evaluated the firm is left with more capital for exploration. However the possibility that the firm may speculate on the property increases. By breaking the bonus into installments payable throughout the mine's life the problem of delaying the development of resources may be partially avoided. The firm may still have large financial incentives to develop the orebody quickly because if the mine was prematurely abandoned the operator would still be liable for the remainder of the bonus payment.

Fixed Bonus with a Royalty Bid

The fixed bonus with a royalty bid scheme requires the bonus to be fixed and royalty bids to be made. Presumably the size of the bonus would affect the magnitude of the winning royalty bid.

The characteristics are:

1. The scheme allows the lessor to share in a greater amount of risk, the degree of which varies according to the royalty rate bid. The lessor determines the amount of risk sharing by settin the bonus at high or low levels. This increased risk sharing can lead to higher royalties being bid. The lessee also benefits from having lower investment risks.

2. In the event that windfall profits are made the lessor should receive higher payments than under bonus bidding with a fixed royalty agreement.
3. Any monies committed by the high bonus in the first scheme would be free for further exploration and development expenditures by the lessee in the second scheme.
4. As previously described, royalties can force premature abandonment of the deposit or prevent the development of marginal tracts. However, since these royalites are likely to be higher than those proposed for a fixed royalty with a bonus bid leasing scheme, the problem is likely to be accentuated.
5. Low-grade deposits can only be extracted by achieving significant scale economies through mining large tonnages and operating with very low unit profit margins. A leasing scheme that requires a percentage royalty reduces this margin and may make the deposit uneconomic.
6. If a payment per unit of production royalty method is used, inflation will reduce the lessor's annual royalty when measured in fixed dollars.
7. The amount of risk shared with a percentage value royalty may be too much for the lessor, as the lessor's return is very dependent on the commodity price. The lessor may prefer to use a payment per unit of production royalty to avoid sharing in the risks of fluctuating commodity price. The scheme chosen depends on the lessor's attitude to risk and whether the lessor

considers there are better investments available than the mined commodity.

8. "High royalty bids may preclude a firm's ability to meet its future royalty pledge to the Government, resulting in a delay in the production of an economic property" (Harris and Brock, 1976, p. 84).
9. Like any percentage royalty scheme strict definitions of all costs and permitted deductions are needed to ensure payment of the property royalties.

Any schemes using a percentage net smelter return royalty require less monitoring than other arrangements. In both schemes the bonus should encourage the company to bring the property into production as quickly as possible to recover the bonus. High royalties may prevent the development of some leased lands or bring about their premature abandonment. This is often of maximum importance to many public lessors and thus the alternate leasing schemes should be considered.

## Sliding-Scale Royalties

> Sliding-scale royalty schemes attempt to reconcile the primary defect of royalty bidding. The sterilization of marginal reserves, by making royalty payments commensurate with [profitability, therefore the sliding scale can be based on items like ore grade, commodity price, production or total estimated ore reserves]. . . . Sliding-scale royalty schemes attempt to make these adjustments "automatic"--according to a prescribed formula--rather than subject to negotiations between the Government and a firm (Harris and Brock, 1976, p. 90).

Occasionally a fixed royalty may be used for most of the mine's life but a sliding-scale scheme may be introduced toward the end to reduce the royalty and encourage the total recovery of the resource. The

sliding-scale royalty should be introduced at the point where the marginal revenue equals the marginal cost including royalty (X, Figure 2). It would ideally be set so that the royalty decreases to zero as the acceptable profit goes to zero. Then the royalty should not prevent the resource being extracted to its economic limit (Figure 2).

The characteristics are:

1. A sliding-scale scheme adjusts to changing profitability where other royalty rates could make the deposit uneconomic to continue mining. This would allow additional ore reserves to be recovered and may avoid the premature abandonment of the deposit.
2. The scheme is useful because it is based on the ability of the lessee to pay. Traditional %NSR royalty schemes take no account of the lessee's profits, and the situation can exist whereby the royalty plus the operating costs exceed the revenues.
3. Although the point at which the sliding-scale royalty is introduced is predetermined (X, Figure 2), it may be difficult to determine in practice. This problem is magnified for producers who work with a very small per unit profit margin and extract large tonnages to make a profit (e.g., the Southwest porphyry copper producers) because the royalty may significantly reduce their per unit profit. The small profit margin makes it difficult to identify the point of introduction for the scheme. It is also critical for the correct royalty rate to be used

because a combination of fluctuating prices and high royalties may make the deposit unworkable.

4. Adjustments may be required to prevent inflation destroying many of the system's benefits. If the royalty rate is based upon commodity price, for example, inflation could cause costs and prices to rise; the royalty payment and the revenue will also rise, but it is possible that the combination of higher costs and royalties could make the deposit uneconomic.
5. Sliding-scale agreements are complex and there is a risk that many disagreements over the interpretations of the provisions will arise and perhaps result in litigation. A lessor unsure of how this agreement works may question the lease payments.
6. Additional administrative costs may be incurred due to the need to monitor additional variables (i.e.,ore grade, commodity price, or other variables on which the royalty rate is based).

Harris and Brock (1976) have proposed two modifications for sliding-scale royalty schemes for use in oil and gas leases. It is possible that similar principles can be used for mining leases. Payments for both reserve depletion and production rate schemes should include a fixed cash bonus and a royalty bid. The winning royalty rate could then be used as a base rate on which the sliding-scale modification could be applied.

Reserve Depletion Modification. The reserve depletion royalty modification lowers the royalty to the minimum allowable rate in later

years of a mine's productive life. The winning royalty bid would be considered as the base royalty. Extra provisions would allow for the royalty in any one year to decrease in response to the depletion of renewable reserves.

This modification could lower the annual royalty rate to the minimum allowable rate as the reserves are depleted using the following formula proposed by Harris and Brock (1976, p. 91):

$$RLTY_M = RLTY_0 \quad 1 - \left( \frac{\sum_{t=1}^{M} P_t}{R} \right)$$

where

$RLTY_M$ = royalty rate (as decimal fraction) for year n

$RLTY_0$ = royalty bid

$P_t$ = production in year t

R = total recoverable reserves

M = 1, 2 ... n

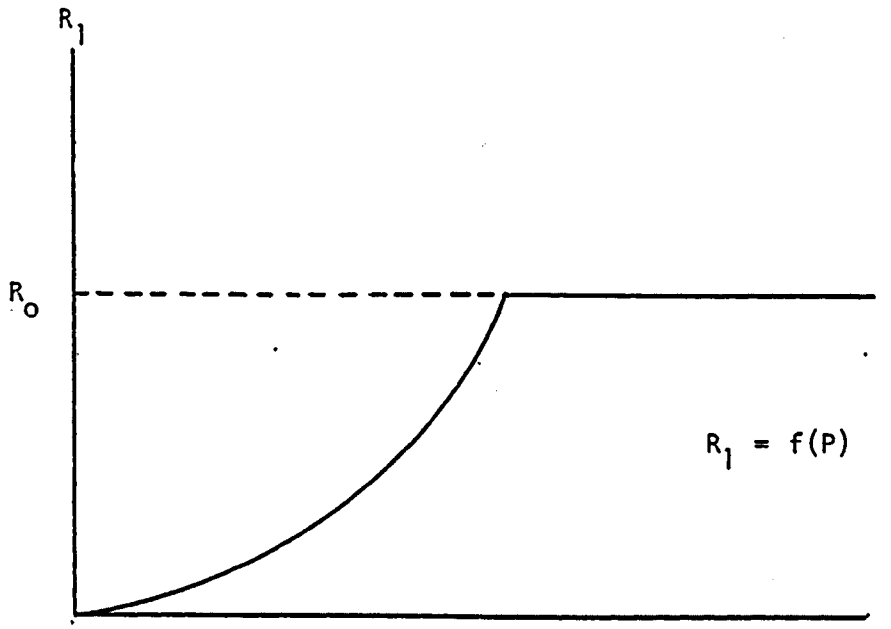
A weakness of the scheme is that it is difficult to accurately estimate the ore reserves prior to development. If the ore reserves are overestimated then the lessee may make a payment in the early years or possibly be forced to abandon the deposit before it is mined out. Alternatively, if the ore reserves are underestimated the firm

will not make payments in later years and receive unexpected profits from monies that would have gone to the lessor if the deposit was correctly evaluated. Therefore to avoid problems with estimating the reserves incorrectly, continual updates of the reserves must be made.

The modification reduces royalties toward the end of the mine's life to ensure that the deposit is worked out. Furthermore, "it depresses a firm's risk by transferring its liability to the production phase of the reservoir's depletion" (Harris and Brock, 1976, p. 91). Overall the scheme has positive features, but the problems of estimating the total reserves detract from them. This scheme is not as attractive as a royalty bid modification based on production rates.

Production Rate Modification. Here the lessor would specify a royalty schedule that varies with the production and potential operators would bid on an additional base royalty (Figure 3). Harris and Brock (1976, p. 91) suggest that,

> This schedule might be described as a function of P, the production rate per unit of time (month, day). In such a case $R_1$, the royalty schedule for a given production rate, might be algebraically described as follows:
>
> $$R_1 = f(P)$$
> $$\text{subject to } R_1 < R_0.$$
> where $R_0$ = maximum royalty rate (Figure 3a)
>
> . . . Industry would be informed as to the nature of the above royalty equation prior to a sale. In a sale, industry would bid on the royalty increment, $R_2$, to be added to the royalty prescribed by the schedule [Fig. 3b]. For example, if industry were to bid a royalty of 20 percent, ($R_2$ = 20), the royalty to be paid to Government would be: $R = R_1 + 20$.



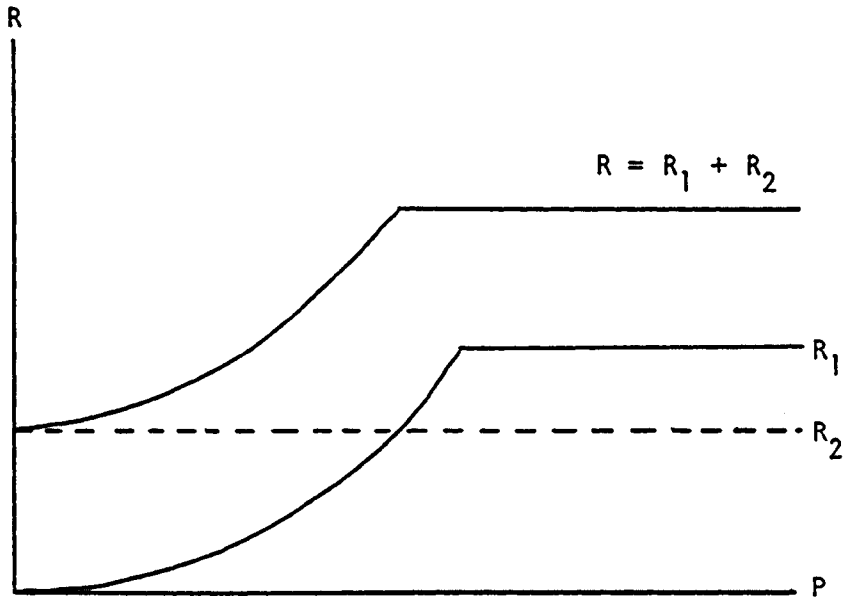




Figure 3. Royalty bidding modification based upon production data--after Harris and Brock (1976, p. 92)

This scheme would mean that the lessee would make lower payments when the production is low. This is commonly during the start-up period, depressed periods, and toward the end of a mine's life, all periods when the lessee is frequently struggling to meet high payments. However, the scheme should generate high royalty payments when the mine is operating at its maximum capacity. In boom periods production may increase and the lessor will benefit accordingly.

The scheme shares most of the advantages of the reserve depletion modification with the added advantage of simplicity of administration (Harris and Brock, 1976). Furthermore, the production rate does not require estimation of reserves and the operator can set the production rate to maximize the returns on investment.

The disadvantages with the scheme arise from problems of competition. If the competition for the lease is very strong the base rate may rise to a level which causes the significant sterilization of resources and the early abandonment of some depostis (Harris and Brock, 1976). If there is little competition for a lease, then very low base royalties will be offered. If the lessor anticipates this by setting a high sliding-scale royalty, problems could still arise in stituations when the producer dominates the world market for that particular commodity, for example De Beers and its influence on the diamond market, although this is a pretty uncommon situation. The producer may withhold production from the market to maximaze later revenues and by so doing will pay lower royalities in the near term.

On balance, a sliding-scale royalty system based on total production merits consideration as a possible modification of

> the existing leasing system [for oil leases]. The sliding-scale royalty system based on production rates would be an improvement over the existing [fixed royalty] system. A sliding-scale royalty [based on production] scheme has been used successfully by the State of California in the leasing of its offshore lands (Harris and Brock, 1976, p. 92).

Although there appear to be significant advantages to using sliding-scale royalties and their modifications, these schemes may become less common in the future because both operators and lessors are becoming disillusioned with them. Some lessors have expressed concern about such schemes (Strickland, 1978) because in their experience they have not realized as high payments from the property as they expected. Some operators also dislike the scheme because inflation has led to rising commodity prices and these cause higher royalty rates to be levied. These high royalties have then made the deposit unworkable (Strickland, 1978).

Because both parties have previously had trouble with sliding-scale royalties there is apprehension to the introduction of any version of a sliding-scale scheme. Although such a method appears attractive because it promotes a fuller recovery of a resource, it is often very complex to use. This resistance to its introduction may dictate that alternative royalty schemes should be considered.

## Profit-sharing Agreements

Profit-sharing agreements must specify accounting procedures for defining the profit associated with a lease. Once a suitable definition has been made, a specified fraction is paid to the lessor. In

the United States some lessors who are exempt from U.S. taxes such as Indian tribes may prefer to take a pretax share of the profits.

The characteristics are:

1. This is one of the best methods for sharing a venture's risks. "A profit-sharing plan will share risk more effectively than any other schemes" (Leland and others, 1974, p. 45). Furthermore, this is the only leasing scheme that shares geological, market, and production uncertainties with the lessor.
2. If the risk is lowered more firms may bid for the lease and the greater competition should increase the amounts bid.
3. The profit-sharing scheme helps the lessor share equitably in any windfall profits the firm may make.
4. The leasing scheme should not influence a firm's production decision (Harris and Brock, 1976); that is royalties should approach zero at the same time as profits. No mineral would thus remain unmined solely because of royalty payments.
5. It is difficult to set a fair rate of profit sharing. The rate that should be used depends on the definition of profit because the more items subtracted, the higher the percentage will have to be to generate similar payment. If the percentage is set too high then the lessee may lose the incentive to mine and the lease may be abandoned; if set too low the lessee may make profits in excess of those anticipated. The British Government opted for a profit-sharing scheme to encourage operators to develop the North Sea oil fields. They resolved the problem of setting rates by allowing an operator to recover 170 percent of

the project's investment before levying a 50-70 percent pre-tax payment on the profits (Kalter and Tyner, 1975). This allowed the firm to choose the development pattern and only the operator's decision influenced the rate of return on investment. This scheme also removes diligence requirements and promote the total recovery of the resource.

6. Lessees are tempted to include discretionary cost items to reduce their profit base, and therefore the lessor may face increased costs for monitoring the agreement.
7. Such a leasing scheme could favor vertically integrated firms because large corporations could make excessive profits at other stages of the operation and show very poor profits at the production stage. Thus an independent price setting mechanism is needed to evaluate the value of the ore when passed to another stage of an integrated corporation.

It appears that the potential economic advantages of profit-sharing schemes warrant a study of the most efficient ways to implement them. If monitoring costs are prohibitive then schemes that combine profit-sharing with a bonus should be considered. Experience in the oil industry suggests that a low level of payments should go to the lessor until the lessee's investment is recovered, after which a significantly higher percent of the pre-tax profits will provide the operator and the lessor with substantial returns (Kalter and Tyner, 1975).

## Terms Commonly Included in Lease Agreements

In addition to the lease agreement used, prepayment, minimum royalty and rentals clauses are usually included in a lease. A prepayment clause is included to ensure lessor receives payments during the period prior to the property being brought into production. Minimum royalties are annual payments of a specified minimum amount which are due regardless of production from the property. Minimum royalties are commonly recoverable from future production accruing to the royalty interest in excess of the specified minimum. Payments under such a minimum royalty clause, whether or not represented by earned production, would be treated by the lessor as royalty income subject to depletion (Breeding and others, 1977).

These minimum royalties are set at the time the lease is drawn up and are set as some fraction of the expected annual lease payment. Because the payment is related to the expected annual lease payment the minimum royalty can be very large when compared with payments due from rental provisions.

Fixed annual rental payments are made to the lessor according to the amount leased. This provision is also used to provide a lessor with an annual revenue under all conditions although the rental is more commonly used to compensate the lessor for loss of revenue from alternative surface uses.

The method is used for both exploration and mining leases and rents are based on the acreage of the lease. Most federal leases provide for an annual rental of not less than 25 cents per acre for the

first year, 50 cents per acre for the second through fifth years, and $1 per acre for the sixth and each and every year thereafter during the continuance of the lease (Harris, Piper, and McFarlane, 1977). The rental payments are kept low to encourage the company to spend more on exploration and development although annual rent increases are usually made to stimulate the rapid exploration of the area and to deter land speculation (Gordon, 1971).

## Less Common Leasing Schemes

Modified leasing schemes and new leasing schemes are being proposed to meet new leasing goals. Leasing schemes that link the payment to such mining parameters as ore production, average ore grade, and the production rate have been put forward to ensure the deposit is completely worked out. Other schemes have been proposed that give the owner more participation in the venture. This may be a preferable alternative to a mining company facing either expropriation or exorbitant royalties. It is doubtful, however, that stock-sharing schemes and joint ventures, which are described below, are legal for leasing public lands in the United States.

### Commodity Pledges

A commodity pledge is similar to a rental payment but is denominated in tons of metal rather than in dollars (Leland and others, 1974).

The advantages are that the leasing scheme shares the market risks by determining the dollar value of the mineral at the time it is

due and may give the owner the option of being paid in the commodity or in dollars. The operator may be given the option to delay development of the property if the firm has other deposits from which the commodity payment can be made.

The disadvantages here are that like any rental, payments in kind can cause premature shutdowns. Commodity pledges could be sufficiently high to eliminate expected future profits, lending to premature abandonment of the deposit (Leland and others, 1974). It appears that the scheme has no real advantages over rentals combined with profit sharing or royalty schemes, except when the lessor has a need for the mineral products involved.

Ore Grade

A percentage net smelter return royalty scheme calculated from an equation based on the mined ore's average grade could be used for leasing. Such a leasing scheme is most effective for developing a standard lease for a series of mines each having different reserves and profit margins, but of similar geology and mining conditions. Such a leasing scheme allows the lessor to participate in windfalls and reduces royalties toward the end of the mine's life when the average grade usually declines. The scheme also encourages the operator to take lower grades and thus promote ore conservation and total extraction of the orebody.

This system breaks down when commodity prices fall because the operator has to choose between increasing the mine's production or the mine's average grade to maintain revenues. Often, the only feasible

alternative is to increase the average grade; this increases the royalty which exacerbates the situation. The large porphyry copper producers however did not respond in this manner during the period of depressed copper prices as they elected to trim production costs instead. Furthermore the scheme may prevent the mining of deep deposits because the scheme may be uneconomic as mining costs rise with depth, especially for the marginal ores. It appears then that this leasing scheme is only suitable for certain types of deposits. Because it is a working scheme it should not be overlooked for future projects. However, the geological setting should be considered before such a leasing scheme is implemented.

Stock Sharing

A scheme that gives or sells the operating company's stock to the lessor is considered here. The lessor receives it as a bonus payment and gets paid regular dividends instead of lease payments. The firm then operates to maximize the investors' return from the project and the lessor gets the same benefits as any other stockholder. Monitoring arrangements become unnecessary. Firms can reduce dividends by increasing retained earnings or spending money on new acquisitions. If the lessor is a government, as long as national controls exist to prevent expatriation of funds then these withheld dividends will be used to increase local investment and indirectly benefit the state. If the lessor is an individual it is hoped that these withheld benefits will help him even more in the future.

Several countries already use similar schemes. At Tara, Eire, the Irish government received a 25 percent equity interest in the mine and a 4.5% NSR in return for assigning the land to Northgate Exploration Company (Mining Engineering, 1977). The Botswana government received 15 percent of the operator's free equity and 7½ percent of gross income royalty for leasing the Selebi-Pickwe mine.

The problems encountered with such schemes arise from the issuance of stock--both the type and the amount. It seems unlikely that a large multinational company will be prepared to issue large amounts of stock in return for a property because a large concentration of stock in a new property could threaten the company's control of its operations. Furthermore the stock of an integrated company reflects the profitability of all aspects of the company--not just the mine, and therefore the scheme does not meet some of the scheme's objectives. Therefore it may be better to form a small local holding company and issue the lessor stock in this instead. Overall the scheme has useful applications but large problems will have to be overcome first.

Joint Venture

Joint ventures require the owner to share in the development and operating expenses of the operation for which he receives a proportional share of the revenues. This scheme permits the host government to share in the development of its resources and is probably the best scheme to share revenues. Unfortunately many owners do not have sufficient capital to get involved in these ventures and therefore joint ventures with governments are uncommon. Some owners argue that their

deposit represents their capital contribution but at present companies are reluctant to accept this, although they may in the future. It seems likely that many leasing agreements will follow this route in the future as burgeoning capital costs often prevent a single operator from developing a deposit and as owners demand a greater say in the development of their resources.

### Management Contracts

Prosperous owners or owners that previously expropriated mineral deposits may offer management contracts to qualified firms to mine their deposits. The mining company receives a fixed fee for mining and developing a deposit, while the owner receives all the profits from the venture. In practice severe problems have arisen in setting the operator's fee and from the operator's trying to maximize his revenues at the owner's expense. Also national goals influence the mine's investment decisions and thus poor results for the nation have been reported in practice. However, the scheme still appears attractive to several African copper-producing countries. The depressed copper prices may lead to several of these countries reconsidering, and it would not be surprising if many owners turned to joint ventures for developing their mineral deposits instead.

## Conclusion

Traditional leasing schemes are still the most important methods for transferring mineral rights to developers when outright purchase is impossible. Modifications of these leasing schemes are being

used to help lessors achieve new objectives. Frequent renegotiations of leases indicate that the problem is not solved and more research into developing better leasing schemes is still required. The next decade will probably see much greater participation in schemes that provide specific incentives for the development of resources such as profit-sharing agreements, joint ventures, and stock sharing.

Current leasing goals of ensuring that deposits are completely worked out and of achieving high or fair payments for the owner can be met using a combination of the leasing schemes currently available. The greater the share of the risk that the lessor accepts, the more chance there is of them receiving fair payments commensurate with the amount of risk shared for their deposits. Leasing schemes that share risk should be used, and probably the best available is a profit-sharing agreement. Profit-sharing agreements used in combination with a minimum annual prepayment against lease payments should not prevent the development of any resource; however, in the longer run the lack of profits available for new investment may reduce the amount of resources developed. Whatever schemes are selected in the future one must expect them to be more complex and require more sophisticated analysis to monitor them.

# CHAPTER 4

## MINERALS LEASING ON INDIAN LANDS

The previous chapter examined leasing schemes in general, and it appears that the only common element among these schemes is that each has been tailored to meet local requirements. Thus to determine what requirements must be satisfied if a successful lease is to be drawn for a Southwest porphyry copper deposit on Indian land, representatives of an Arizona Indian tribe and of Arizona mining companies were interviewed.

At the time of this investigation, new leases were being proposed for two porphyry copper deposits on the Papago Indian Reservation west of Tucson, Arizona. The need for new leases was due to a number of of factors, among them being a recent change in the goals of the tribe and the low copper prices that made the properties uneconomical to mine under current conditions. To define the problems, representatives of the Papago Tribe, including tribal members, their advisors and lawyers, and the Bureau of Indian Affairs were personally interviewed for their views on leasing Indian lands. Mining company personnel from exploration and land acquisition departments were also interviewed for company and personal points of view. Each interview lasted between one and two hours, during which time notes were taken, which were subsequently written up in detail. Initially several prepared questions were used for the interview, but these were later rejected in favor of a more

flexible format, which permitted the interviewee to give his personal assessment of practical solutions to the problems.

On completion of the interview process, the major points of agreement and conflict were identified and the cause of each grievance evaluated. A model of a porphyry copper deposit was then made, and some controls put on its location, nature of mineralization, and mining rates. Several leasing schemes were proposed to overcome some of the identified problems, and the feasibility of each scheme was evaluated using the model. This chapter, however, discusses only the basic concerns of lessees and lessors in mining on Indian lands.

## Viewpoint of the Indians

Information on the Indian viewpoint was gathered by interviewing representatives of the Papago Tribe and their advisors. The views expressed in the following pages reflect these attitudes and beliefs. Although many of the comments reported in this section reflect the views of one or more of the individuals interviewed, these views may not necessarily reflect attitudes of other American Indians. Indeed, probably the most significant point that was brought out during the interview process was that many of the tribesmen and their advisors could not agree on what the Indians wanted or how they should get it. Formal interviews were conducted with the Papago mining director, the tribal attorney, and a realty specialist with the Bureau of Indian Affairs. Conversations were held with the vice-chairman of the Papago Indian Tribe and various individuals employed by the Tribal Council.

## Papago Tribal Structure

Traditionally the Papago Tribe had no formal leader, except in time of war when a chief was chosen for his fighting or negotiating ability (Smith, 1978). Because it was unusual for the tribe to have a chief, the village headman acted on behalf of his village and frequently signed treaties with the white man, who interpreted these as tribal rather than village agreements. Because the treaty was signed by the village headman, who did not represent the tribe, other villages did not regard it as binding. However, the white man presumed that it would be honored by the whole tribe and this led to grave misunderstandings and subsequent mistrust.

Today the Papago Tribe is run by a tribal council, members of which are commonly elected from each district in the reservation. The headman is called the "tribal chairman," and both he and his assistant are elected by popular vote of the tribe.

## Tribal Philosophies

The Indians have not only changed their social structure in response to the white man, but many of their beliefs and ideologies have been altered too. Traditionally, the Indians did not believe in private ownership of land. To them this was like owning the air and the sky, but they understood the tenure of land for perpetual use and occupancy of the tribe (Lavell and Black, 1976). Despite this concept of ownership, enterprising Indians sold land to the white man, although these same Indians failed to see why they should vacate the land after the sale. Today most Indians have modified their beliefs to accept

the concept of land ownership, partially in response to the prices offered by prospective developers of mineralized land. Interestingly, as a result of this change in beliefs, some Indians now suggest that they rightfully own North America because of their aboriginal possession and exchanges (Sekaquaptewa, 1976).

The Indians value their environment and culture very highly, and are prepared to forego many benefits to preserve their habitat (Wilkinson and Strauss, 1976; Smith, 1978). In the past they rejected bids from mining companies for their land, but this attitude is changing as the Indians realize they need revenue. However, economic development is still a controversial issue within the Papago Tribe.

An example of this debate surfaced during informal hearings of the Papago Indian Tribe on the proposed Vekol mine (U.S. Department of the Interior, 1978). Arguments arose because most of the people from Kohatk, the nearest village, were against the project. Their reasoning was that a mine would destroy the surroundings, generate dust and noise, leave scars on the landscape, and contribute to an increase in road accidents. They also feared that the water from the tailings ponds would pollute the drinking water and that blasting shock waves might damage their homes. Ironically, at a previous district meeting similar points were made but the district people came out in favor of the project, and like some of the Kohatk residents, the district people favored the mine because they expected that the revenue from the mining operation would provide the village with new houses, electricity, and water and sewage systems. Thus, although conflicting desires may be expressed by tribal members, any mining

company venturing onto a reservation must be prepared to help the local people achieve an improved quality of life if it wishes to win Indians' approval and support for any mining plans.

Another reason that Indians are reluctant to lease land to mining companies is that in the past Indians have been frugal in the use of their natural resources. Indians took minerals only for their personal use so that resources could be preserved for future generations and so that destruction of the landscape would be minimized (MacDonald, 1976). Although present generations will be unaffected by the pollutants because they move so slowly toward the water table, the Indians' concern is to protect water supplies for future generations (Smith, 1978). This policy of preserving resources for the benefit of future generations is a path which most developing nations or individuals would not follow so rigorously. Many people would prefer to exploit the deposit now and enjoy the revenue now or invest the returns for their future benefit, but the Indian leaders argue that they would probably yield to pressures from their constituencies to spend these revenues for current expenses instead of finding suitable capital investments. Thus they believe that perhaps the best interests of future generations is being served by not exploiting their resources. The Indians also think that future generations might develop to such an economic level that they could make more efficient use of the resources themselves. Many regard this as preferable to destroying part of the environment to provide resources for the white man's use (MacDonald, 1976).

On a different note, the Indians are often criticized for being slow to make decisions when negotiating agreements with the mining companies (Ferguson, 1976). The Indians are prepared to wait to develop their resources because they regard a mineral deposit as a source of income that can be tapped at any time--but only once. Futhermore, they are unconcerned about the possibility of substitution or changes in the commodity market, considering that if they own a commercial mine today, it may be more profitable sometime in the future, and hence they may receive higher revenues then. Overall the Indians have a different business outlook than many mining companies, and it is likely that these alternative approaches may cause problems during negotiations for a lease.

## Tribal Conflicts

As might be expected with any emerging nation, there is some internal debate over the best route a tribe should take to develop itself. While this does surface occasionally, for the most part the biggest conflicts for the tribes are with their advisors and the mining companies (Ferguson, 1976).

The federal government is the Indians' trustee and as such is responsible for ensuring that the Indians are treated fairly in mineral leasing matters. The Indians are advised by the Bureau of Indian Affairs (BIA) on behalf of the government. The Indians worry that in being the beneficiary of a trust administered by the federal government they may bear the burden of the government's conflict of interest. At times Indian leasing goals do not coincide with national policies, and therefore, the Indians believe that their best interests cannot be

represented by the BIA. An example of this may arise as the government tries to develop western United States coal lands possibly on Indian lands. Because no federal leases are being issued for coal lands at the present time (Coal Age, 1978) one would expect mining companies to try even harder to lease Indian lands with known coal reserves and one wonders whether the BIA will encourage this or not. The Council on Economic Priorities' 1974 (p. 30) study of the federal coal leasing program, neatly summarized the fundamental role confusion and possibility of conflict of interest of the BIA in the mineral leasing program.

> . . . . In its role as Indian trustee, the BIA is instructed by law to help tribes make decisions in their own best interests. As an agency of the Department of the Interior, the BIA has a responsibility to promote the orderly and timely development of natural resources. The BIA has no clear directive to follow when our energy hungry society [in the form of the Federal Government] is clamoring for coal development, but when mining might not be in the best interest of a tribe that lives on coal-bearing land.

The Indians believe that in the past they have not always been fairly represented by the BIA (Dick, 1975) and now they mistrust many of their BIA advisors.

The Indians are also concerned that the BIA is presently inadequately staffed to help them in their emerging role and, hence, believe that the BIA is a source of obstruction rather than help (MacDonald, 1976). Indeed "an increasing number of tribes, feeling that the advice they receive from the USGS and the BIA is suspect, are hiring independent legal counsel to advise them on mineral leasing" (Dick, 1975, p. 62).

Additionally, some Indians side with their advisors and the mining companies to promote mining, and some of the remaining Indians

then charge the first group with selling out to the white man. Furthermore, the Indians have frequently found themselves in the role of the weaker negotiator because they need money to support their tribal projects, and the tribe may frequently suffer as a result. Some Indian tribes, notably the Northern Cheyenne, have therefore explored legal avenues to revise several of their old agreements because they believe the royalty terms of their coal leases are "unconscionable" ("Petition of Northern Cheyenne," 1974). This action has often been triggered by the apparently high profits a firm makes when commodity prices rise rapidly.

## Tribal Goals for Mineral Leasing

Although the Indians have been unhappy with leasing in the past, a reevaluation of their goals may simplify future royalty negotiations. The long-term goal of many tribes is to fund the tribal budget from current ventures and use the excess revenues to form "partnerships" with mining companies to work future mines. The Indians do not expect to put up any initial money, regarding the ore deposit as their share of capital. However, they are prepared to share future production costs from their share of the production revenues. The Navajo Tribe has an arrangement like this for coal leasing and their mineral program is proving very successful. The Colville Indians in eastern Washington have agreed to a 50:50 sharing of the pre-tax revenues after the mining company (AMAX Inc.) has been allowed a brief period to recover its investment capital (Engineering and Mining Journal, 1978).

Since the Indians are primarily leasing to generate revenues, an examination of the manner in which the Papago Tribe distributes these monies may provide a key to some of the barriers that have arisen between the Indians and the mining firms. Fifty percent of the revenues are retained by the tribe to pay for tribal expenses and to fund tribal services, 47 percent are divided equally among the tribal districts for subsequent distribution to the villages, and the final 3 percent are paid directly to the villagers disturbed by the mining. The benefit achieved by the affected village is only slightly greater than that achieved by other villages, and the local people tend to resent this. The local villagers expect that enough revenue will be made available to improve both their houses and their standard of living.

A second major goal of many tribes is to elevate tribal employment levels. For example, unemployment is around 60 percent on the Papago Reservation (Smith, 1978). This goal can be achieved by persuading the mining companies to employ local labor and to provide on-the-job training for skilled personnel. A problem arises here because Indians have little tradition as wage earners and they have a different attitude toward work than white men. Indians find it hard to adapt to a white man's working environment because they are unused to delegating authority. Furthermore, the concept of regular working hours is often alien because the Indian traditionally worked on a flexible schedule to meet his own needs and days off for personal reasons or festivals were common (Smith, 1978). Mining companies have found both these concepts hard to accept because production schedules are disrupted, worker

discipline is eroded, and a man's absence may make a job more hazardous for his colleagues. However, if Indian land is to be mined, both Indian and company attitudes may have to change.

Indians emphasize different qualities in their lifestyle to those qualities emphasized by white men. The white man designs mining plans to maximize the profit from an operation. The high capital cost of mining equipment requires it to be worked 24 hours a day to maximize profit. Therefore the white man schedules equipment for continous operation 24 hours a day realizing that financial incentives will make the employees accept these hours. Other things can be more important to the Indians. Because the Indian does not always adapt to the white man's routine, some people consider him less efficient. In view of the large capital outlays in mining, companies find it hard to tolerate this attitude toward work. For this reason the mines on and around the Papago Reservation have found it difficult to employ Indians and even harder to retain them. There does appear to be hope for the future though. The Navajo Tribe, who has taken a more positive attitude toward mining than some other tribes, currently provides 70 percent of the total work force at Utah International's coal mine in New Mexico (Grogin, 1978).

The Indians require an employment program that trains not only laborers, but craftsmen and supervisors as well. Although the lease should not specify levels of responsibility for the Indians, the Indians hope that tribesmen will be given opportunities to become managers and that Indians be trained in skills that will benefit the community once the mine is worked out. In other words, they would rather

Indians worked in the maintenance department than as drillers or rock-bolters, because mainenance skills are more broadly applicable to other businesses.

Some tribes are "beginning to insist that the lessee provide some sort of social service for the tribe. One coal company [Consolidation Coal Company], for instance, promised to build a $1.5 million health center for the Northern Cheyenne in order to obtain a coal lease on their reservation" (Dick, 1975, p. 64). "This objective is still embryonic, though it is becoming more significant in coal and uranium leases with relatively poor tribes such as the Northern Cheyenne" (Dick, 1975, p. 87).

Indian Attitudes Toward Mining Companies

The Indians believe that after the lease is signed the mining companies lose interest in them, but the tribe wants to participate in the project. Thus, being informed of mine plans through visits of mine personnel to council meetings if very important to the Indians (Crowther, 1978). The Indians are trying to negotiate leasing agreements with the companies that will ensure that the Indians are involved in the venture. The Indians would also like the mine personnel to show more interest in the village activities.

Leasing schemes being proposed reflect this attitude. "The Northern Cheyenne are considering the possibility of forming a corporation to mine their own coal" (Dick, 1975, p. 88). The Navajos have drawn up a lease agreement with Exxon to mine a uranium deposit. "At the end of the six-year exploration period, the lease gives the Navajo

the option of either receiving royalty payments as they would under a traditional mineral lease or becoming a 49 percent partner with Exxon in the mining of uranium" (Dick, 1975, p. 88). Currently both parties are petitioning the Secretary of the Interior to approve the "joint venture" in spite of the BIA's condemnation of the agreement. Smaller tribes wish to follow suit. Although they do not have as much capital available as the Navajo Tribe to promote joint ventures, the smaller tribes still consider joint ventures possible. The smaller tribes regard the deposit as their initial stake in the project and will use their share of the revenues to meet some of the operating expenses. This they believe will make the operation into a feasible joint venture. However, many tribes will require advance royalties and a guaranteed income to meet their tribal commitments until they receive their share of the profits. The inclusion of these provisions often make joint ventures with the Indians unattractive for mining companies.

Summary

Overall, the Indians consider that the mining companies need to develop a greater understanding of tribal culture and goals and many people in the industry agree with this. Mining companies must attempt to understand Indian business practices, the importance they attach to protecting their environment and preserving their resources for future generations, and the importance desert tribes attach to maintaining the quality of their water supply. Increased Indian employment will also become important in negotiations because such a policy can be used to

alleviate the problems of low wages and high unemployment on the reservation.

Probably the best lease scheme for the Indians will be some type of profit-sharing venture, because the Indians wish to participate but do not have the capital available to invest in a joint venture. If this scheme is accepted, strict definitions of all costs and variables are needed to overcome serious accounting problems. To enable a tribe to meet its financial commitments, provisions for advance minimum payments should be included. The payment should be a pre-tax profit-sharing scheme, the percentage being set low initially but rising after the firm has recovered its capital. The payment should be subject to a minimum annual payment, although this will be used as a credit against future royalty payments.

## Viewpoint of the Mining Companies

Formal interviews were conducted with representatives of various local mining companies and law firms for material in this section. People interviewed included the manager of a land department, a property engineer, an assistant manager of exploration, two attorneys, and other people engaged in the mining industry.

Deposits are irregularly distributed because they are created by geological controls, and discovering orebodies is an expensive and risk-intensive business. The mining company must acquire the deposit by lease or purchase if a new mine is to be opened. The mining company tries to determine the extent of mineralization prior to acquiring the

property, but frequently it will acquire a lease for a deposit that later proves uneconomical to mine.

The decision to develop a new mine has a big impact on most companies because of the large capital investment required. The financial investment for a large porphyry copper mine is at least $150-200 million. This may severely limit the funds available for other projects or require the project to be financed through loans. Sometimes this change in the company's debt-equity ratio can affect the company's stock performance and possibly affect the company's credit rating. However, the firm hopes the new mine will be profitable and increase the company's capital available to invest in other projects, while the additional income may protect the firm from downturns in the economy and improve the company's long-run stability.

## Leasing on Indian Land

### Exploration Leases

Indian land may be leased using either a "walk-on type" permit or a "preference right" permit. For example, the "walk-on type" is available on the Papago Reservation to anybody for a fixed monthly payment, either $5 per acre for a limited area or $200 for an unlimited area and allows surface geological and geophysical work. The "walk-on type" permit is "non-exclusive." Therefore if a deposit is discovered. the permit holder has to bid against other companies for the right to develop the property. Unfortunately, the high risk and capital expenditures involved in prospecting have proved too great a deterrent for

property, but frequently it will acquire a lease for a deposit that later proves uneconomical to mine.

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the mining companies to use this permit thus the method does not generate much money for the Indians. A few "preference right" permits have been made available. These are permits that give the exploration company the mining rights to any orebody discovered but require a mining agreement to be drawn up in advance of exploration. The permits are individually negotiated and feature escalating payments or area reductions to encourage diligence. All three porphyry copper deposits discovered on the Papago Reservation were found by exploration teams operating under this type of permit.

Mining Leases

A firm prefers to own the land on which it mines, hence the firm will attempt to purchase any prospective mining property. If this is not possible, the firm may enter into a mining lease for the minerals. On federal or state land this involves paying royalties and complying with regulations. If the land is privately held, a lease may be drawn with a buy-out clause. This clause limits the total royalty payments a mining company can be expected to make, after payment of which the property belongs to the company. An advantage of this arrangement for the company is that the royalty payments are tied to production and the company may abandon the property without paying the full purchase price should the deposit prove uneconomical. All these schemes are in use in the United States and are regarded by the mining companies and investors as acceptable means of acquiring a deposit--equally as stable as outright purchase.

Because a large portion of the public domain has been explored, greater interest and activity can be expected on other lands, notably Indian reservations. One advantage of mining on Indian lands is that the tribe or its members own all the land required for the mine, mill, tailings disposal, waste dumps, and plant, as well as the water rights in the area; and negotiations can be limited to one group.

Indian mining leases are governed by U.S. Code of Federal Regulations (CFR) (1970a). These are commonly cited as being very restrictive and a formidable disincentive to mining. The major problem is they are valid for 10 years and renewable only so long as "the deposit is producing in paying quantitites" (U.S. CFR, 1970a). With fluctuating metal prices and long delays in getting environmental approval for a project, this 10-year period can become a serious problem for the company, because its lease can expire before the mine is in production. Uncertainty as to what "producing in paying quantities" means and lack of a force-majeure clause make Indian land less attractive to investors.

## Royalties

Past problems between the Indians and mining companies were often caused by the Indians thinking that they were being paid unfair royalties (Ferguson, 1976). Royalty payments for Indian land are also set by U.S. CFR (1970a) at 10 percent of the gross value of the ore at mine site for minerals other than oil and coal. In the case of coal, the royalty was 10¢ per ton of mine run (U.S. CFR, 1970a), and Indians believed that his royalty was too low in relation to the large profits earned on some coal deposits (Dick, 1975). Although the new royalty

for coal is set at 12½% of value (Harris and others, 1977) the Indians do not distinguish between coal and metals, or between present and past leases and assume that all royalties are too low and this leads to problems for metal producers. Some Indians have also confused sales revenue with profit, not recognizing the effect of high operating costs and the need to recover the capital costs with an adequate return on investment.

Mining companies also encouter problems when dealing with the Indians. Part of this stems from the companies not realizing they are dealing with a different culture, with its own laws, customs, and goals, but rather assuming that Indians wish only to maximize their income. Indians also believe that mining companies have occasionally made matters worse in the past by negotiating contracts with promises of unrealistically high royalty rates and rapid development schedules in order to explore the land. Some firms then have threatened to abandon the prospect unless new contracts with lower rates are drawn up.

Mining companies also object to the %NSR royalty scheme because depressed copper prices have made several Southwest porphyry copper deposits struggle to support a 3.5 percent net smelter return royalty, let alone the 10 percent net smelter return as required by many Indian leases. The state of Arizona charges 5 percent net smelter return on state lands, but an allowance for transport and milling costs can be deducted before its calculation to give an effective rate of 3.5 percent. Despite this the state is currently considering lowering the royalty (Lacy, 1978).

The confusion created by differences in opinion between the Indians and their advisors over the objectives makes many mining companies question whether the Indians really wish to encourage mining. Ferguson (1976) suggests that the tribal council should help the tribe decide whether they wish to lease the land or not, and if they do, then the council should identify the tribes' major goals more clearly and establish a clear line of authority for decision making. This would enable the Indians to expedite development of an orebody, a factor that is critical when large investments are involved. Being able to act decisively would also increase the Indians' overall creditability in the eyes of the investors and encourage the exploration of Indian property.

Another major problem the mining company faces when it develops any Indian or federal land is that an environmental impact statement (EIS) has to be filed. The advantage of mining on Indian land is that if the tribe is in favor of the development, the tribe will support the firm's application. If the leased area is on federal lands, such as U.S. Forest Service lands, the prospective operator ususally does not have such support and it becomes harder to get approval for the EIS (O'Neil, 1978).

The Indians are also unhappy with the requirement to file an EIS because it delays the project's development. The Indians are concerned because approval can be withheld even after the project has satisfied their environmental standards. Indeed, Dick (1975, p. 36) reports "that the Navajo are taking steps, through an Environmental Protection Committee, to protect their environment and want to decide

themselves how this should be done." The Indian tribes have now been given permission by the Environmental Protection Agency to make their own designations for the prevention of a significant air quality deterioration on reservation lands (Will, 1976).

Indian Law

Another recent industry criticism of the Indians is that the mining company is subject to Indian law when it operates on the reservation. Although breach of contract suits could be held in federal courts, minor suits normally go before an Indian court. Mining companies are apprehensive at this, as certain undesirable ideosyncracies have been noticed in Indian courts. For some tribes any non-Indian attorney must get the tribal judge's prior approval to be present in court (e.g., Navajo Tribal Code, 1970) and the judge is required to apply the customs and usages of the tribe (Ferguson, 1976). Ferguson (p. 14) further says that:

> The apprehension is not allayed when it is learned that tribal judges are criticized for inadequacy, partiality, lack of judicial independence from the tribal council and the BIA, administrative chaos, inadequate appeals systems, disregard for the rudimentary components of due process of law, lack of means to enforce court judgments and apathy.

Another problem the prospective lessee faces is that Indians keep proposing joint development schemes for the deposit without providing financial resources. The Indians consider their share of the venture to be the orebody and expect the mining company to bear all financial risks. This situation is generally not acceptable to mining companies. The companies are not sure that the Indians have the

managerial experience to effectively monitor operations and fear that unnecessary and costly conflicts would arise.

Companies are also concerned that a tribe will attempt to satisfy tribal employment goals at the expense of the operation. They are concerned that when the Indians overcome their tight financial situation, the tribe will be in a stronger negotiating position and will use this to alter lease terms. Mining companies say that they are prepared to try joint ventures with the Indians when they believe that the Indians will behave as responsible business partners. However, mining companies may be forced into joint ventures if they wish to acquire Indian land in the future.

### Summary

In essence, it is the severe and sometimes unusual restrictions imposed on the operator by the regulating agencies and by the Indians that really deter mining companies from exploring and developing Indian land. Many problems that operators encounter on Indian land are due to the rapid change in goals of the tribal leadership.

## Royalty Schemes Used for Indian Leases

Several royalty schemes proposed as alternatives to a fixed 10% NSR are described here and evaluated in the following chapter. A net smelter return scheme has been used because it is simple to evaluate, monitor, and administer and because it minimizes negotiations. However, it can be generally considered too simplistic and unsuitable for a porphyry copper deposit because low copper prices may not support

both low ore grades and a fixed royalty rate. If the royalty payments are set too high the mining companies shy away and thus the royalty is effectively either delaying development of the orebody or possibly forcing the closure of mines.

Sliding-scale schemes have been proposed for some properties to provide the Indians with a more equitable return when commodity markets fluctuate. The scheme links the percentage NSR paid to the ore grade or the mineral price, so that the percentage increases when the mine generates higher revenues. Unfortunately, the system based on ore grade sometimes fails because firstly the operator frequently attempts to keep the average grade mined fairly constant over the mine's life and therefore the royalty rate will also remain fairly constant defeating the purpose of the scheme. Secondly, the grade may actually be lowered when commodity prices are high to increase the mineable ore reserves and lengthen the mine's life. In this case the royalty rate may decline during periods of high prices. If a sliding-scale scheme is based on commodity prices the mine operator suffers because of the effect of inflation on commodity prices, and unless adjustments are made the operator faces both increased royalties and mining costs.

A scheme that takes a percentage of the income left after all sources of revenues are accounted for and all costs subtracted has been proposed to avoid problems caused by inflation. Schemes like percentage of pre-tax profits, after-tax profits, or cash flows might be preferred to other schemes provided they include a substantial minimum

payment. Although strict accounting controls are required, such income-sharing methods allow the Indians to participate in the venture without unduly interfering with the mining company's investment decisions.

## Conclusion

It appears that the main area of conflict between the Indians and the mining companies is due to a mistrust of each other. This mistrust is based on historic unplesantries experienced by both parties, and a few gestures of good will now by both parties could improve the situation. A good impression created by the mining companies could ease present negotiating problems and increase mutual trust.

The tribes suffer from having intratribal and external advisors with different objectives. Congress in the Indian Self-determination and Education Assistance Act (U.S. Code, 1970b) has mandated that the BIA ease its restrictions on the Indians and act as the tribes' guardian rather than their tutor. The BIA should give guidance to the Indians to help the tribe meet its short-term commitments and long-term goals.

A mining company must realize that the possibility for absolute control of an Indian deposit is remote, and hence it should actively cultivate a good relationship with its partner. This can be achieved by making concessions to the tribe, aiding neighboring villagers, generating a sense of community involvement in the mine, and helping the Indians achieve some of their objectives. In return a firm can expect a more pleasant negotiating atmosphere and more sympathy from the tribe during economic depressions.

A mining company must expect to pay royalties during depressions to retain a property. If the company stops operating it will have to make prepayments on future royalties to avoid losing the property. The tribes are commonly very dependent on mineral lease payments and frequently lack alternative sources of income. Although they are sympathetic to the mining company operating at a loss this dependence on lease payments for income means they expect payment to be made under all conditions or the operator to relinquish the lease. Because of this the Indians need operators that are diversified enough to withstand depressions.

# CHAPTER 5

## EVALUATION OF VARIOUS LEASING SCHEMES FOR POSSIBLE USE ON INDIAN LANDS

This chapter considers various arrangements to share the revenues generated by a mining venture. The leases considered would be negotiated prior to the initiation of any major exploration effort. Leases which are negotiated after the discovery of an orebody pose many additional problems not addressed in this thesis. Some leasing schemes discussed do not comply with current BIA regulations for leasing Indian lands; however, these are considered because some Indians do not consider that the existing regulations are adequate to meet their goals.

Each leasing scheme is evaluated by calculating the payments the Indians would receive from the lease and considering the effect these payments would have on the company's discounted cash flow return on investment (DCFROI). The lease payments are calculated as percentages of different items on a pro forma income statement (Table 1), which is which is an estimate of financial results for some period. The annual projections for the income statement are made for several different-sized orebodies using average production costs and for various commodity prices and royalty rates. The study tries to identify which royalty scheme generates the highest DCFROI for a certain level of total lease payments and to identify the percentages that can be taken for different royalty schemes to generate similar payments. Because the Papago Tribe suggested that the amount of risk associated with each payment

Table 1. Generalized pro forma income statement for each year of the DCFROI calculation

| Item Number | Item |
|---|---|
| 1 | Total net sales |
| | less Smelting changes |
| | Transportation to smelter changes |
| 2 | Net smelter return |
| | less Royalties |
| 3 | Gross income from mining |
| | less Operating costs |
| | Overhead and general costs |
| 4 | Operating income |
| | less Depreciation |
| 5 | Predepletion income |
| | less Depletion |
| 6 | Pre-tax income |
| | less Income taxes |
| 7 | Net profit |
| | add back Depreciation |
| | Depletion |
| 8 | Net Cash Flow from Operations |
| | less Capital Investment |
| 9 | Net Cash Flow |

method was important to them, this problem is also addressed in the evaluation of each scheme. The study also attempts to determine how sensitive the DCFROI is to the magnitude of the lease payment for different leasing schemes as compared to other parameters such as capital costs and the commodity price.

## Method of Analysis

The analysis is made by running amodified version of program WASH.CDC developed by H. P. Knudsen of the Department of Mining and Geological Engineering, The University of Arizona, to generate a pro forma income statement and resultant DCFROI for each set of mine data with constant copper grades and unit production costs.

Three types of preproduction negative cash flows were recognized according to their tax treatment.

1. Depreciable investment--cost of assets such as mine buildings and machines that are capitalized and recovered through depreciation.
2. Expensed and amortized investment--cost of items such as mine development that can either be deducted currently or capitalized and recovered through amortization.
3. Non-deductible expense--cost of items such as land that are non-deductible for tax purposes.

The future cash inflows are estimated on an annual basis using pro forma income statements. Lease payments are calculated as percentages of certain items on this pro forma income statement. These payments are deducted on the pro forma statement at different stages according to the system used and the final net cash flow used for DCFROI purposes.

In order to evaluate the various royalty arrangements a financial model of a porphyry copper deposit was used, the grade distribution, tonnage, and stripping ratio of which are representative of several such medium-sized deposits found in Arizona. The magnitude of the total lease payment and the DCFROI are used as the basis for the evaluation.

The computer program allows the analyst to study the effect of price on several leasing schemes by fixing all costs, thereby isolating the impact of copper price on the mine's profitability. All calculations are in 1978 dollars to eliminate the complication of inflation. Some of the other features included in the program are:

1. Five different royalty options.
2. Allowance for recovery of prepayments against future royalties.
3. Full benefits of percentage depletion.
4. An allowance for investment tax credits.
5. Mine development is expensed rather than capitalized so that the lessee can experience the maximum tax benefits.

Program ROYALT.CDC is written in FORTRAN IV for the DEC-10 computer (Appendix). It calculates the annual pro forma income statement, the annual lease payment, the sum of annual lease payments, and the DCFROI. The following information is stored in file MINE.DAT:

1. Number of preproduction years, projected life of mine, starting date of project, percentage for investment tax credit, lease payment rate, identifier code for lease scheme analyzed.
2. Commodity price, mill recovery, post-concentrator recovery, and grade of concentrate.

3. Cost of mining, stripping, milling, overhead, transportation, and smelting.
4. Minimum lease payment and algorithm to recover prepayments,
5. Capital investment in mine, mill, and other items.
6. Tonnage of ore and waste removed and average copper grade.

Items 5 and 6 above are put in for each year of the mine's life.

A background study of the sensitivity of the DCFROI to several mining parameters, the ore reserves, mine life, copper price, and capital cost, was made with selected %NSR royalties to facilitate evaluation of lease agreements. For each project configuration in this study data on operating cost, recoveries, income taxes, and tax credits were constant.

## Input Data

Ore Reserves and Mine Life. Several data files were prepared to evaluate the sensitivity of the DCFROI to ore reserves (Table 2), although the 146-million-ton deposit with a grade of 0.78% Cu (Mine 1, Table 2) was selected for evaluating different lease agreements. Mine 1 (Table 2) was selected because it modeled the characteristics of a porphyry copper deposit better than the other alternatives. Data for the modeled deposit were based on data available to the author for ore-reserve distributions of two medium-sized orebodies. Three hundred and forty-eight million tons of waste material including overburden were removed during the mine's life. Initially large amounts of waste were removed, but tonnages declined in later years. The annual tonnage of ore mined and the average grade of the ore were assumed to be

Table 2. Input data for modeled mines used for DCFROI sensitivity study

| | MINE | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Ore reserves (mm tons) | 146 | 146 | 146 | 146 | 176 |
| Cu grade (%) | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| Waste (mm tons) | 348 | 348 | 348 | 348 | 420 |
| Mine life (years) | 15 | 15 | 20 | 20 | 15 |
| Preproduction period (years) | 3 | 3 | 3 | 3 | 3 |
| Total capital cost ($ mm) | 156 | 123 | 123 | 156 | 156 |

constant throughout the evaluation (Table 3). To study the effect of mine life, mine lives of 15 and 20 years were assumed, both with 3-year preproduction periods.

Copper Prices. Copper prices of 77¢, 85¢, and 96¢ per pound were used to study the effect of copper price on the economics of the deposit, with and without selected lease agreements. The relative effects of the copper price and the lease agreement on the project were determined to evaluate which factor is more important to the project's success. A wide range of copper prices was used because this emphasized the effects of copper prices on different schemes, particularly profit-sharing schemes. A wide margin between price per unit and cost per unit gives large operating profit margins, and the Indians are very concerned that a dramatic increase in copper price

Table 3. Annual mine production

| Year | Ore Production (tons) | Grade (% Cu) | Waste (tons) | Copper Production Tons |
|---|---|---|---|---|
| 1978 | 0 | 0 | 0 | 0 |
| 1979 | 0 | 0 | 0 | 0 |
| 1980 | 0 | 0 | 0 | 0 |
| 1981 | 9,725,000 | 0.78 | 29,450,000 | 63,415 |
| 1982 | 9,725,000 | 0.78 | 26,960,000 | 63,415 |
| 1983 | 9,725,000 | 0.78 | 25,450,000 | 63,415 |
| 1984 | 9,725,000 | 0.78 | 24,450,000 | 63,415 |
| 1985 | 9,725,000 | 0.78 | 23,950,000 | 63,415 |
| 1986 | 9,725,000 | 0.78 | 23,450,000 | 63,415 |
| 1987 | 9,725,000 | 0.78 | 22,950,000 | 63,415 |
| 1988 | 9,725,000 | 0.78 | 22,450,000 | 63,415 |
| 1989 | 9,725,000 | 0.78 | 21,950,000 | 63,415 |
| 1990 | 9,725,000 | 0.78 | 21,450,000 | 63,415 |
| 1991 | 9,725,000 | 0.78 | 20,950,000 | 63,415 |
| 1992 | 9,725,000 | 0.78 | 20,450,000 | 63,415 |
| 1993 | 9,725,000 | 0.78 | 19,950,000 | 63,415 |
| 1994 | 9,725,000 | 0.78 | 19,450,000 | 63,415 |
| 1995 | 9,725,000 | 0.78 | 18,950,000 | 63,415 |

would allow the lessor to make a windfall profit while the Indians are relatively less compensated.

Capital Costs. The initial capital costs for the mine and mill are representative of costs for Arizonan open-pit porphyry copper operations. The most probable capital cost was estimated at $156 million for the 146-million-ton orebody (Table 4). The most probable capital

Table 4. Annual capitalized preproduction expenditures for the 146-million-ton orebody used to evaluate lease agreements

| | 1978 | 1979 | 1980 |
|---|---|---|---|
| Mine | $20,000,000 | $20,000,000 | $20,000,000 |
| Mill | 28,000,000 | 28,000,000 | 28,000,000 |
| Other | 4,000,000 | 4,000,000 | 4,000,000 |
| Total | 52,000,000 | 52,000,000 | 52,000,000 |

cost was determined by using known recent expenditures for similar operations, updated to 1978 dollars. It also seemed likely that capital costs will rise more rapidly in the future because there are likely to be more start-up delays due to the time required for the approval of environmental impact statements. A much lower total capital cost of $123 million was also used in this evaluation so that the effect of underestimating capital cost could be compared with

the effects of incorrectly estimating other items. Other orebodies with different combinations of capital costs and ore reserves were also considered, but these were less significant and were not used for the evaluation of lease agreements.

Operating Costs. Operating costs are based on projected costs for the same medium-sized porphyry copper deposits used for estimating ore reserves, although certain costs that reflect local conditions such as transportation cost have been adjusted to a reasonable local industry average (Table 5). The computer program makes no adjustment for inflation, calculating all revenues and costs in constant 1978 dollars.

Table 5. Operating costs used in the evaluation of different projects

| | Costs |
|---|---|
| Mining cost/ton ore | $0.36 |
| Stripping cost/ton overburden | $0.40 |
| Milling cost/ton ore | $1.94 |
| Treatment costs/lb contained copper | $0.20 |
| Transportation cost/ton concentrate | $7.20 |
| Overhead and general cost/ton ore | $0.80 |

Grades and Recoveries. The grades and recoveries are based on values reported for the same porphyry-copper deposits used to model the ore reserves and operating costs (Table 6). The same recoveries are used in all evaluations in this study.

Table 6. Grades and recoveries

| | Grade (% Cu) | Recovery (%) |
|---|---|---|
| Ore grade | 0.78 | |
| Concentrate grade | 28.0 | |
| Mill recovery | | 88 |
| Post-concentrator recovery | | 95 |

Taxes and Tax Credits. The lessor can take a 10 percent investment tax credit when the business property is placed in service. The credit can be taken if the investment for the mine facilities complies with Section 1.48-1(a)(e), U.S. CFR (1978). The credit can be carried back 3 years prior to the investment or forward 7 years and hence the mine can claim the credit after it begins to operate. This arrangement significantly reduces the project's tax liability in the first few years and increases the DCFROI. If no allowance were made for this during the negotiations the lessee's projected cash flow would appear to be less than it actually would be. For the purpose of

this study income taxes are considered to be 48 percent of pre-tax net income.

## Sensitivity of the DCFROI to Various Input Data

The relative sensitivity of the DCFROI to changes in ore tonnage, mine life, and capital cost was determined so that the effect of different lease agreements on the DCFROI could be put into perspective. Other input items such as ore grade, metallurgical recoveries, operating costs, and tax rates were kept constant. This background study was done using a %NSR agreement because this is the arrangement traditionally used for leasing Indian land.

Ore Reserves. A 146-million-ton (Model 1, Table 2) and a 176-million-ton orebody (Model 5, Table 2) with the same grade and the same stripping ratios were considered using copper prices of 85¢/lb and 96¢/lb for different net smelter return royalties. Figure 4 shows that a 13 percent increase in the copper price from 85¢/lb to 96¢/lb raises the DCFROI by at least 4.3% whereas a 21 percent increase in the ore tonnage from 146-million-tons to 176-million tons only increases the DCFROI approximately 3.3%. It therefore appears that the estimate of the copper price used in the evaluation is more significant than the estimate of the ore reserves. It was also noted that the effect of copper price and ore reserve on DCFROI changed with the royalty rate. In practice, of course, the 176-million-ton orebody would actually require either larger and more expensive equipment or a longer mine life. Both items would further reduce the DCFROI for the 176-million-ton project.

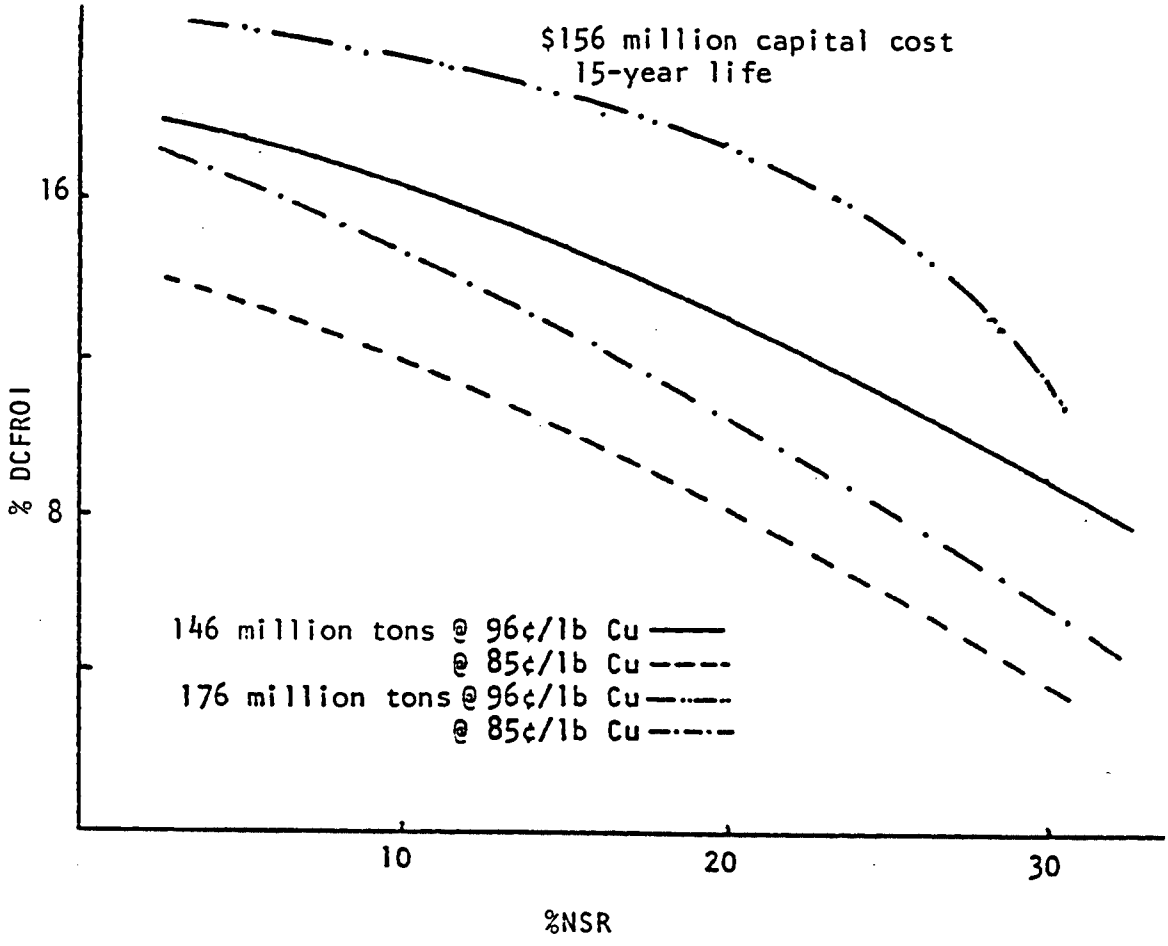



Figure 4. Relative impact of changes of %NSR royalty rates on the DCFROI for ore reserves and copper prices, Models 1 and 5

Mine Life. With a %NSR royalty and fixed production costs and copper prices the mine life has no effect on the total revenues derived from the deposit, and therefore on most lease agreements. Figure 5 shows that the deposit (Model 4, Table 2) with a 20-year life has a lower DCFROI than the same deposit (Model 1, Table 2) has with a 15-year-life for copper prices of 85¢/lb and 96¢/lb and for various

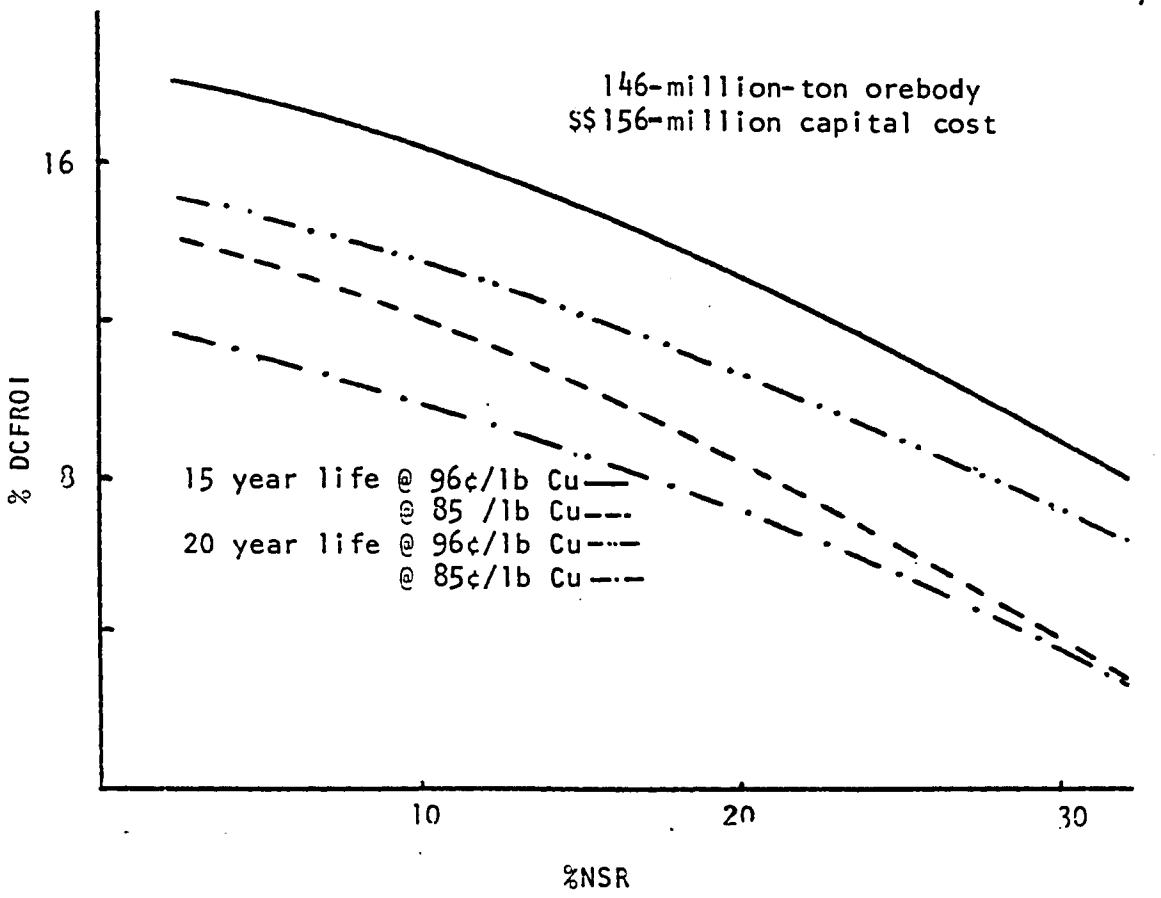



Figure 5. Relative impact of different %NSR royalty rates on the DCFROI for a shorter mine life and different copper prices, Models 1 and 4

%NSR royalties. Once again an increase in the copper price by 13 percent, from 85¢/lb to 96¢/lb, appears to have a greater impact on the DCFROI than the 25 percent decrease, from 20 years to 15 years, in the mine's life. However, with a shorter mine life capital costs tend to increase because larger equipment is required to mine the same ore reserves in a shorter period of time and therefore, in practice the DCFROI increase shown in Figure 5 would not be as indicated. Therefore if everything else remains constant, a shorter life will give the greater DCFROI for a given deposit.

Capital Cost. The initial capital cost forms the basis for calculating a project's DCFROI, and thus a control run was made to determine the sensitivity of the DCFROI to different capital costs. Figure 6 shows the effect of two different capital costs, $123 million (Model 2, Table 2) and $156 million (Model 1, Table 2), on a 146-million-ton orebody for copper prices of 85¢/lb and 96¢/lb with different %NSR royalties. The copper price is the other factor that

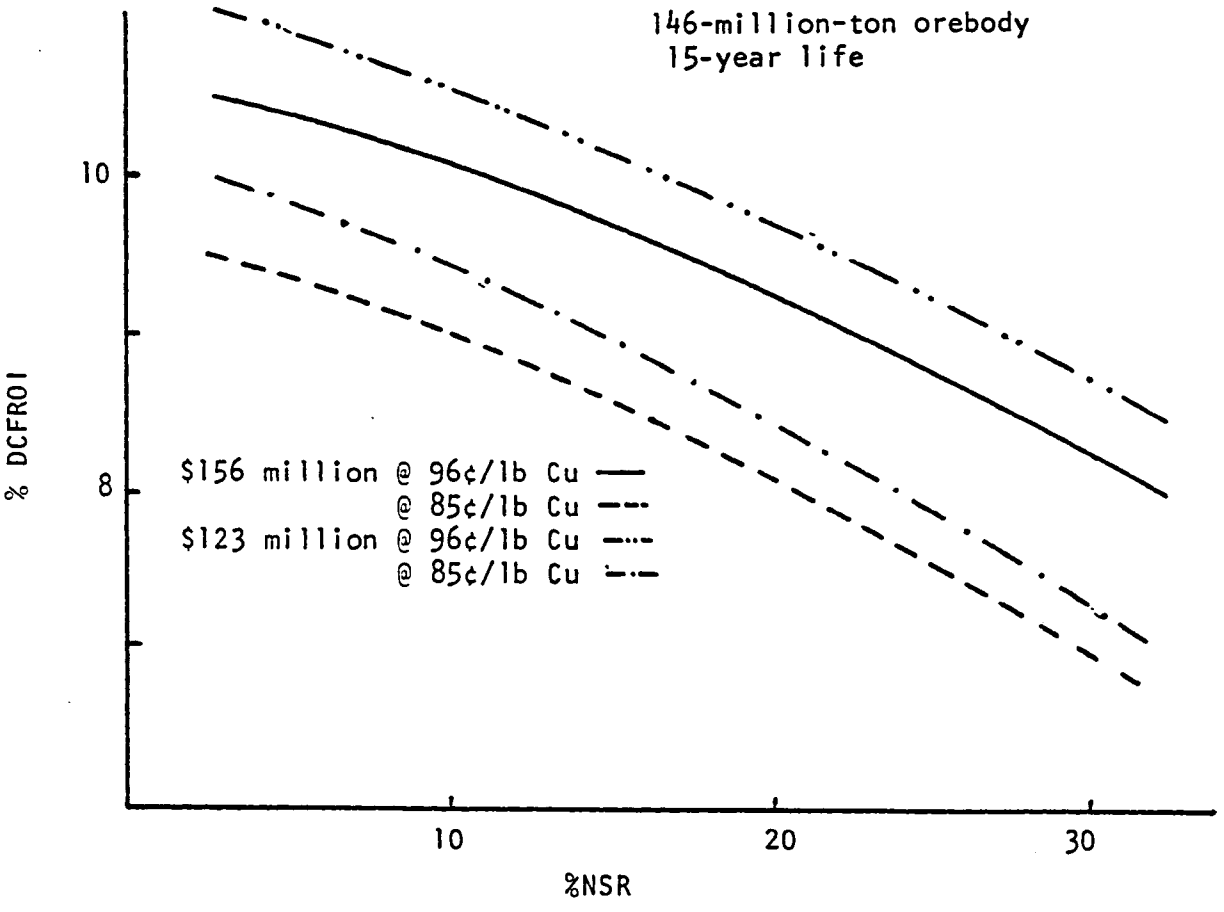



Figure 6. The relative effect of different %NSR royalty rates on the DCFROI for increased capital cost and copper prices, Models 1 and 2

controls this project's DCFROI, and an increase of 13 percent from 85¢/lb to 96¢/lb copper has a much greater impact on the DCFROI (at least 4.2 percentage points) than a 27 percent increase in the capital costs from $123 million to $156 million does (a maximum of 2.0 percentage points).

Figure 7 considers the more realistic conditions of both increased mine capital costs and a shorter mine life on the project's DCFROI for different copper prices and lease payments using Models 1

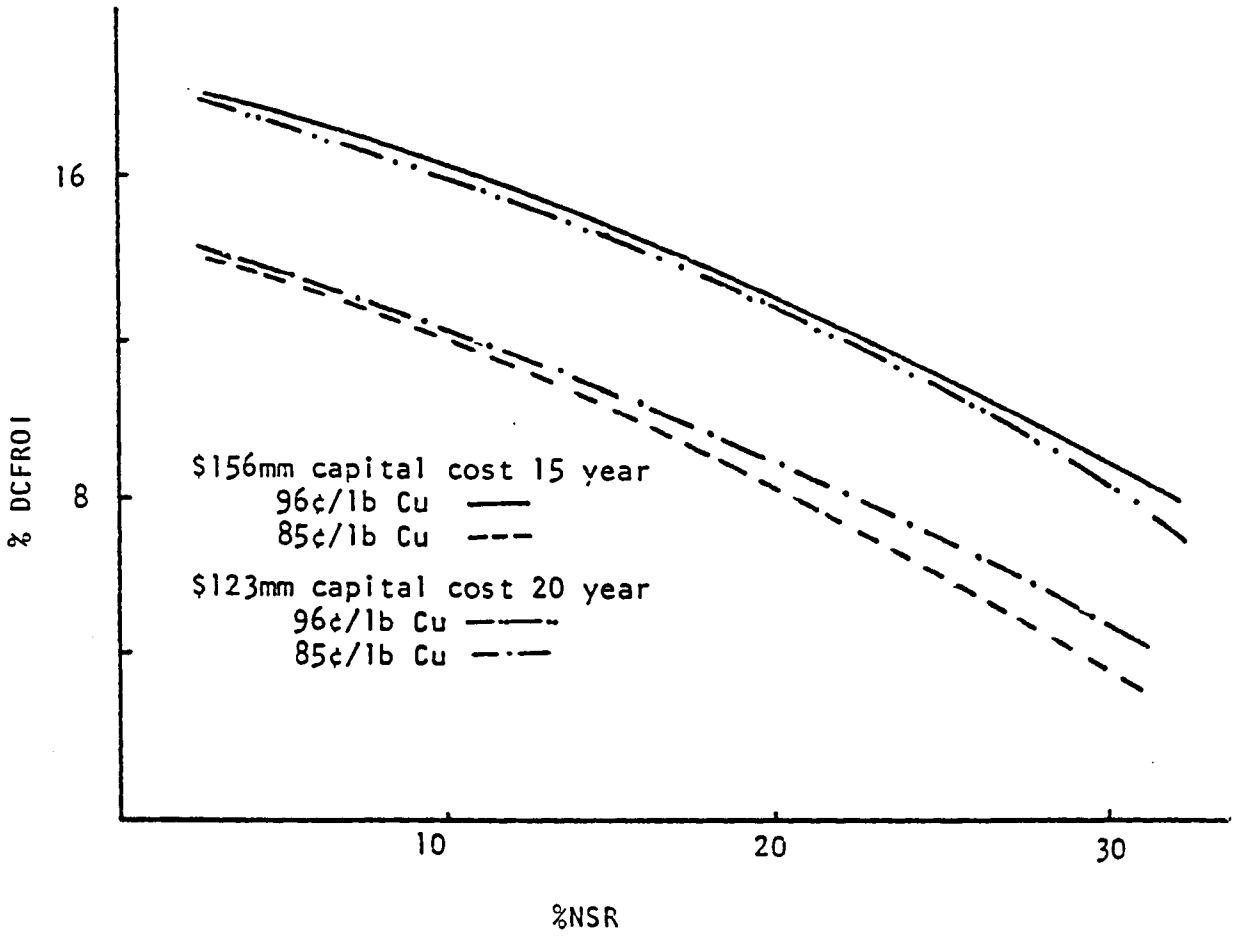



Figure 7. The relative effect of increasing capital cost and decreasing mine life on the DCFROI for different copper prices, Models 1 and 3

and 3 (Table 2). The figure suggests that shortening the mine life by 24 percent (from 20 to 15 years) can nearly offset a 27 percent increase (from $123 million to $156 million) in the mine's capital costs because the operator benefits from increased capital efficiency with larger equipment.

It is interesting that the project with the higher capital cost (Model 1, Table 2) gave slightly higher DCFROI's than the project with the lower capital costs (Model 3, Table 2) for the same %NSR when the copper price was 96¢/lb. However, Model 1 (Table 2) gave lower DCFROI's than the model with the lower capital cost when the price was 85¢/lb. For simplicity the operating economies of scale that might be achieved by increasing production rates have been ignored. However if these economies are considered there will be greater increases in the DCFROI for the project with the shorter life.

Summary. It appears that the most critical factor for estimating the effect of leasing schemes on the DCFROI is the copper price. Therefore the remainder of this study compares the effect of different leasing agreements on the DCFROI of a 146-million-ton orebody with a grade of 0.78% Cu which has a 15-year life, a capital cost of $156 million (Model 1, Table 2), fixed operating costs, and diffent copper prices. This study emphasizes the effects of different copper prices on leasing schemes because fluctuations in the copper market cause many of the conflicts over lease payments and in the negotiations accompanying them. Figure 8 shows the volatility of U.S. copper prices and illustrates how difficult it is to predict them.

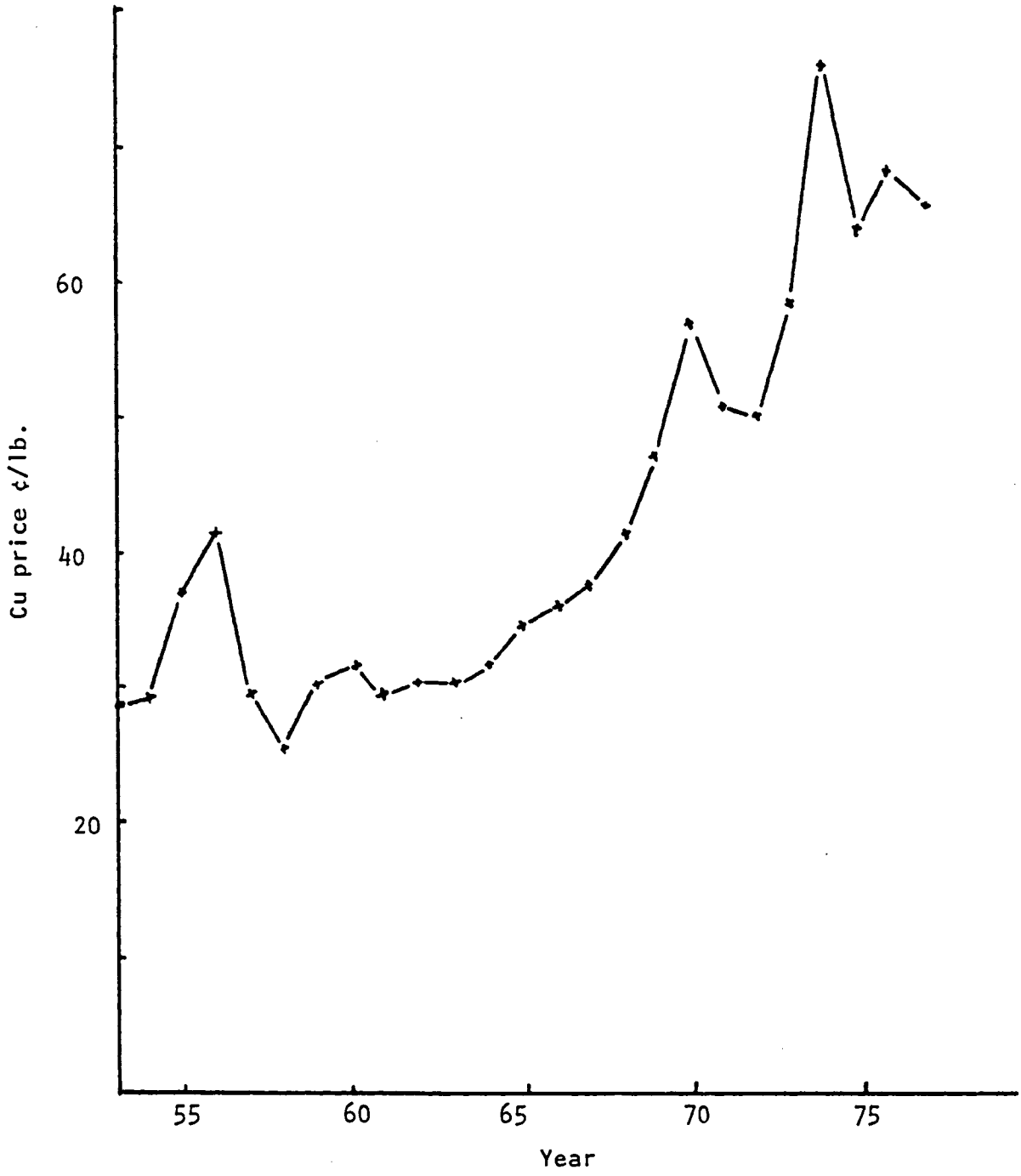



Figure 8. Copper price fluctuations between 1953-1977. Data from Metal Statistics, 1977 (Roditi, E., 1977).

## Results of Analysis

Several types of lease agreements were discussed in Chapters 3 and 4. Those evaluated in this study are described in more detail in this section. All agreements considered take a percentage of some item on the income statement (Table 1), and all the schemes are profit-sharing agreements excluding the NSR agreement. A profit-sharing royalty agreement used here refers to an agreement which permits the deduction of some or all on-site production costs in determining the royalty basis. The study compares the percentage of each item required to generate the same payment to that generated by a given %NSR. Furthermore, an attempt is made to establish whether the project is more sensitive to copper price variations than to the lease rate. It is then determined which lease agreement would give the highest DCFROI for a given total payment.

This study considers three types of lease payments: (1) those that treat the payment as a cost for depletion purposes, e.g., a percent NSR or a predepletion agreement; (2) those that are calculated after the depletion allowance has been deducted, e.g., a pre-tax agreement; and, (3) those that are calculated after the depletion allowance and taxes have been deducted, e.g., an after-tax or a cash flow agreement. Under IRS guidelines a "royalty" is considered a non-depletable cost when calculating the depletion allowance. The author has found in preliminary calculations that by considering the lease payment as a cost, the pre-tax, after-tax, and cash flow methods give results similar to a predepletion agreement for the lease analysis used.

Problems may arise during lease negotiations because several lease schemes have been loosely defined in the past. Pre-tax agreements have been proposed for leasing and no distinction has been made to determine whether this means a percentage of income before tax and depletion (Item 5, Table 1) or a percentage of pre-tax income (Item 6, Table 1). The problems arise from the different manner in which they treat the depletion allowance. Any owner of an economic interest, such as mineral interests, royalties, working interests, overriding royalties, net profits interests or certain production payments, is entitled to depletion on the income derived from production and sale of minerals from that property (Breeding and others, 1977). Because any owner of an economic interest (lessor) is entitled to a share in the depletion allowance the royalty payment is deducted (by the lessee) before its depletion allowance is calculated and therefore both the owner, and thus the operator can claim their share of the depletion allowance for the deposit. However, it is thought that the lessor's claim to a depletion allowance can be passed up and thus the lessee can receive all of the allowance (Breen, 1979). Because the Indian tribes are not liable for income tax it seems likely they will be prepared to allow the lessee to claim the full depletion allowance.

Pre-tax, after-tax, and cash-flow agreements are all economic interests and as such the owner can claim a depletion allowance. This study evaluates these schemes by deducting the lease payment directly from the item on which they are based without making any corresponding adjustment to the depletion basis. In this way all the depletion

allowance is being taken by the lessee and thus the IRS may consider that the taxable income is being underestimated. However, AMAX used a pre-tax arrangement to lease the property of the Colville Indians at Mt. Tolman setting a precedent for tax purposes and therefore this method should be acceptable for the IRS.

Risk

The method in this study used to evaluate the leasing schemes does not take into account the different amounts of risk involved with alternative schemes. Indians have suggested that they would like schemes that shared in the profitability of an operation, but they are concerned about the increase in financial risk this subjects them to. They then seek additional compensation for this increased risk. This additional compensation must either be from increased total expected payments or low initial payments with better payments after the company has recovered its invested capital. However, in many cases the Indians are not prepared to wait for those increased payments. Under a net smelter return agreement the Indians share in the risks of changes in the ore production, ore grade, the copper price, smelting and transport costs. A profit-sharing scheme is subject to these same risks, but also has the risks associated with changing mining and concentrating costs and efficiencies. If a profit-sharing agreement is set to generate the same total payment as a %NSR agreement for an orebody, the same percent increase in revenues and costs will not change this relationship (Table 7). Therefore, if inflation or other factors increase the profits and costs by an equal percentage, a

Table 7. Effect of increased cost and revenues on lease payments

| | Initial | 10% Increase in Revenues and Costs |
|---|---|---|
| Revenues | 10 | 11 |
| Cost | 5 | 5.5 |
| Profit | 5 | 5.5 |
| 10% NSR | 1 | 1.1 |
| 20% profit | 1 | 1.1 |

profit-sharing agreement is no riskier than a %NSR agreement. If revenues increase through increased ore production or copper prices or the costs decrease through increased efficiency by the operator, the profit-sharing agreement will generate a higher payment (Table 8).

Table 8. Effect of increasing revenues or decreasing cost of lease payment

| | Initial | Revenues Increased by 10% | Cost Decreased by 10% |
|---|---|---|---|
| Revenues | 10 | 11 | 10 |
| Cost | 5 | 5 | 4.5 |
| Profit | 5 | 6 | 5.5 |
| 10% NSR | 1 | 1.1 | 1 |
| 20% Profit | 1 | 1.2 | 1.1 |

If the costs increase or the revenues decrease then the lessor would be less affected by a %NSR scheme (Table 9). Consequently, if the Indians expect a depressed copper market and strong inflation in the future a %NSR is better for them. Therefore the Indians must decide whether the lessee is more likely to make windfall profits or experience a depressed market when selecting a scheme for leasing. It is difficult to negotiate a lease which participates in the upside benefits but which avoids the downside risks and still have a scheme that allows the Indians to share in a property's risks.

Table 9. Effect of decreased revenues or increased costs on a lease payment

| | Initial | Revenues Decreased by 10% | Costs Increased by 10% |
|---|---|---|---|
| Revenues | 10 | 9 | 10 |
| Costs | 5 | 5 | 5.5 |
| Profit | 5 | 4 | 4.5 |
| 10% NSR | 1 | 0.9 | 1 |
| 20% Profit | 1 | 0.8 | 0.9 |

Both %NSR and profit-sharing agreements should include provisions for prepayments against future lease payments and for a minimum annual payment to ensure that the lessor receives a payment even during times of no production. The effects of these provisions on the DCFROI for the project is evaluated in this study, and recommendations are made as to the appropriate level for such payments.

Lease Administration

The lessor monitors the lease to insure that lease terms are being fulfilled. The amount of monitoring required varies with the scheme used. The less monitoring the scheme requires, the more it is preferred because monitoring is an expense for the lessor. Frequently the lessor is poorly equipped to monitor an agreement and mining consultants have to be hired. One of the biggest problems with monitoring lease agreements is that items on the income statement used for the lease agreement (Table 1) are often poorly defined and arguments arise over which costs are permissible deductions when calculating the payment base. A lease that discusses the treatment of all likely deductions and that defines each item carefully can alleviate this problem.

A net smelter return agreement determines the royalty from a settlement sheet provided by an impartial third party--the smelter--and therefore less monitoring is required than for other schemes. A predepletion agreement uses the same revenues as a %NSR agreement but operating costs, general and administrative expenses, and depreciation are deducted before the payment is calculated. A major problem for both parties is deciding on how much general and administrative expense should be allocated to the project.

Proponents of after-tax schemes argue that the IRS monitors the scheme thereby protecting the lessor's interest. In light of the previous discussion on after-tax and cash-flow schemes this argument is questionable. Even if an after-tax scheme does overcome monitoring problems this supposes that the lessor will accept all the costs that

the IRS does and this may be to the detriment of the lessor. The cash-flow agreement has the same monitoring problems as an after-tax scheme. In this case, however, the lessee may wish to deduct annual capital expenditures; which, if acceptable to the lessor, requires further guidelines to minimize disagreements.

## Lease Payment Schemes

Percent Net Smelter Return. The percent net smelter return is calculated as a percentage of the revenues paid by the smelter to the operator and is the scheme most commonly used for base metal mineral leasing in the United States. The payment is calculated after the net smelter return (Table 1, Item 2) is determined. The DCFROI declines and the total lease payments increase as the royalty rate increases. Table 10 illustrates these relationships for the mining project modeled in Table 2.

Figure 9 indicates that the DCFROI is more sensitive to changes in copper price than to the same percentage change in the rate. A 13 percent increase in copper price, from 85¢/lb to 96¢/lb, at 10% NSR gives an increase in DCFROI of 4.4 points (from 11.7% to 16.1%). A similar decrease in %NSR from 10% to 8.7% NSR causes the DCFROI to rise only 1 point to 12.7% (from 11.7%).

It can be seen from Table 11 that the impact of a given percent change in ore reserves, mine life, and capital costs also have a greater effect on the DCFROI of the project than a similar percent change in the %NSR rate. Therefore the DCFROI appears to be less sensitive to changes in %NSR than any other parameter varied in

Table 10. DCFROI for Different Schemes

| Copper Price ¢/lb. | Payment ($mm) | % NSR | | % Predepletion | | % Pre-tax | | % After-tax | | % Cash Flow | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Required | DCFROI | Required | DCFROI | Required | DCFROI | Required | DCFROI | Required | DCFROI |
| 77 | 52.7 | 5 | 9.3 | 18 | 9.6 | 34 | 9.9 | 50 | 9.0 | 15.5 | 8.6 |
| | 105.56 | 10 | 7.6 | | | | | | | 31.0 | 6.0 |
| | 158.26 | 15 | 5.7 | | | | | | | | |
| | 211.11 | 20 | 3.6 | | | | | | | | |
| 85 | 60.39 | 5 | 13.3 | 13.75 | 13.5 | 23.25 | 13.8 | 39.5 | 13.7 | 13.45 | 12.6 |
| | 120.77 | 10 | 11.7 | 27.3 | 12.1 | 45.0 | 12.8 | | | 27.0 | 10.2 |
| | 181.16 | 15 | 10.0 | | | | | | | | |
| | 241.54 | 20 | 8.0 | | | | | | | | |
| | 301.93 | 25 | 6.1 | | | | | | | | |
| 96 | 70.85 | 5 | 17.5 | 11.2 | 17.7 | 16.5 | 17.7 | 30 | 16.5 | 12.5 | 16.4 |
| | 141.7 | 10 | 16.1 | 22 | 16.6 | 33.0 | 16.7 | 60 | 14.2 | 25 | 14.0 |
| | 212.55 | 15 | 14.5 | 7.5* | 16.5* | 37.5* | 15.8* | | | | |
| | 283.4 | 20 | 13.0 | | | | | | | | |
| | 354.25 | 25 | 11.0 | | | | | | | | |
| | 425.0 | 30 | 9.0 | | | | | | | | |

*with modified scheme

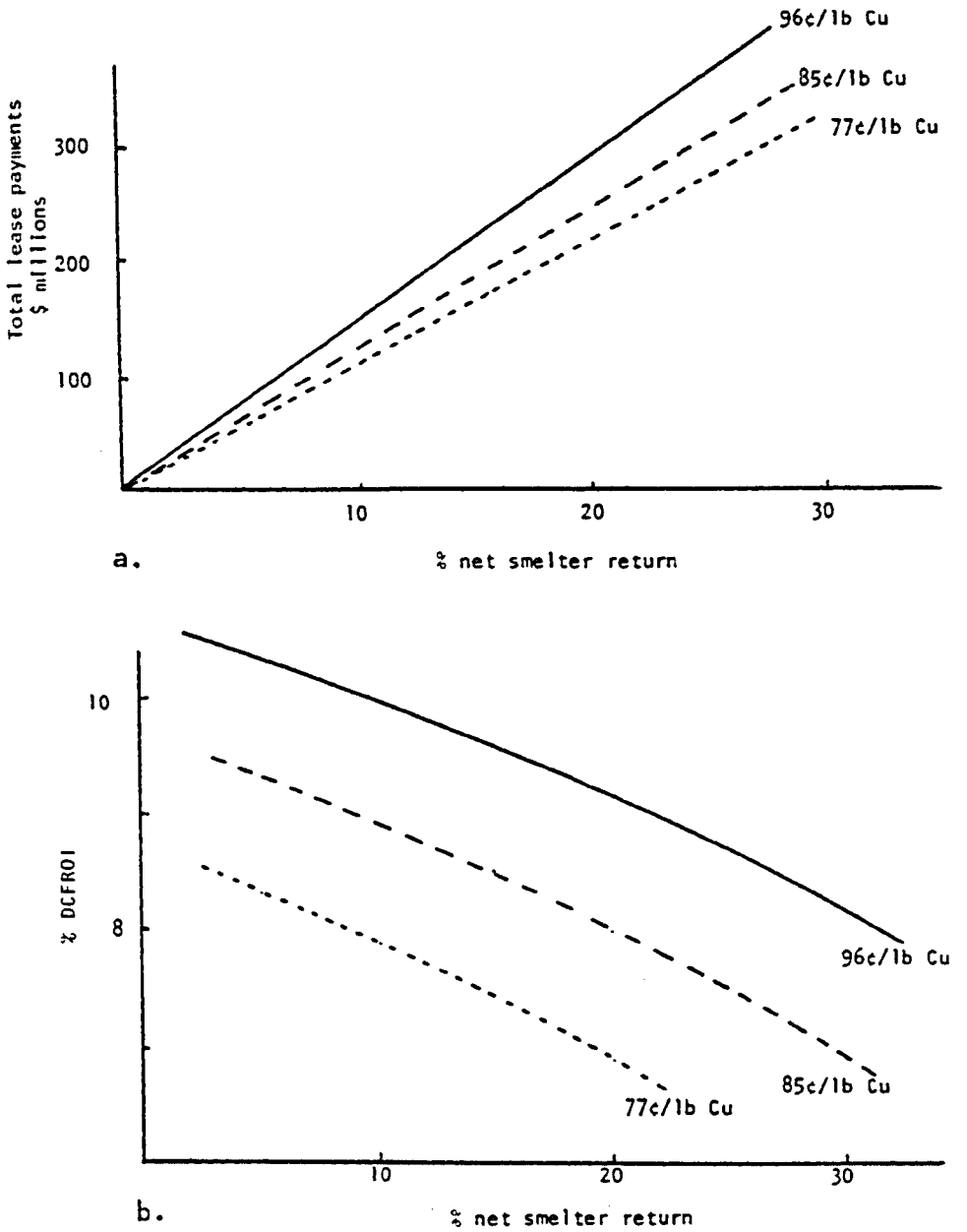



Figure 9. Effect of a percent net smelter return lease agreement on a given orebody, Mine 1

a. total lease payment

b. %DCFROI

Table 11. Sensitivity of DCFROI to %NSR agreements, ore reserves, mine life, and capital cost

Ore Reserves

| %NSR | Ore Reserves | % Change | %DCFROI | DCFROI Change |
|---|---|---|---|---|
| 10 | 146 | 0 | 14.6 | |
| 10 | 176 | 21% increase in ore reserves | 11.7 | -2.9 |
| 7.9 | 146 | 21% decrease in NSR | 12.0 | -2.6 |

Mine Life

| %NSR | Ore Reserves | % Change | %DCFROI | DCFROI Change |
|---|---|---|---|---|
| 10 | 15 | 0 | 11.7 | |
| 10 | 20 | 33% increase in mine life | 9.6 | -2.1 |
| 13.3 | 15 | 33% increase in NSR | 11.1 | -0.6 |

Capital Cost

| %NSR | Capital Cost | % Change | %DCFROI | DCFROI Change |
|---|---|---|---|---|
| 10 | 156 million | | 11.7 | |
| 10 | 123 million | 21% decrease in capital costs | 13.6 | +1.9 |
| 7.9 | 156 million | 21% decrease in NSR | 12.0 | +0.3 |

this study. However this is partly due to the levels of which the elasticities of the variables were measured.

The modified lease agreement that shared the NSR equally after a 15% DCFROI was achieved proved unsatisfactory because the new lease rate was too high and the project became unprofitable. A rate has to be set to allow the lessee to recover the project's costs and to receive a reasonable profit. It is difficult to set a net smelter return rate that will ensure that the operator will not abandon the deposit before the ore is recovered because the economies of a particular orebody are hard to predict 10-20 years into the future.

Percent Predepletion Income. The percent predepletion income agreement is considered because it is a method fo sharing revenues and risks. The payment is based on Item 5 of the pro forma income statement (Table 1). This scheme partially overcomes the problem of a project's being made uneconomic by a combination of high lease payments and high costs. Because a higher lease rate is required to generate a payment similar to that generated by a %NSR scheme, changes in setting the initial lease rate will affect neither the DCFROI nor the payment given to the Indians as much as the same change in points under a %NSR agreement.

A modification of the predepletion scheme was also considered. A fixed percent of the predepletion income is used for the lease payment until the lessee achieves a 15% DCFROI and after that the lease rate was increased. A DCFROI of 15 percent was chosen as the critical point for changing the lease rate because many mining companies

indicated that this is their minimum acceptable return on all capital investments. The lease rate was increased to 50 percent of the predepletion income because, in the absence of other guidelines, an equal sharing of the profits appeared to be a good place to start. Furthermore it is an interesting rate from a conceptual standpoint because, firstly, the lessor owns the land and wishes to share equally in the benefits of mining and secondly the lessee has achieved a desired return and therefore all additional profits are a bonus. Furthermore the lessee should recover its capital sooner than under a regular scheme because of the lower initial rate. This scheme should generate substantially increased lease payments in later years without forcing the mine into premature abandonment.

By taking a percentage of the predepletion income the lessee is able to claim the depreciation allowance as a cost. Again the price of copper has a more significant effect on both the total lease payments and the DCFROI than the lease rate (Figure 10). A 13 percent increase in copper price from 85¢/lb to 96¢/lb causes an increase in the total payment of $15 million to $62.2 million; however, a 50 percent increase from 10 to 15 percent in the predepletion rate is needed to generate the same payment at 85¢/lb copper (Figure 10). A 300 percent increase from 10 to 30 percent in the percent predepletion income will not cause the DCFROI to decline as much as if the copper price is lowered 11.5 percent (from 96¢/lb to 85¢/lb) (Figure 10).

However, this scheme does generate higher DCFROIs than a %NSR agreement for the same total lease payment (Figure 11). This is

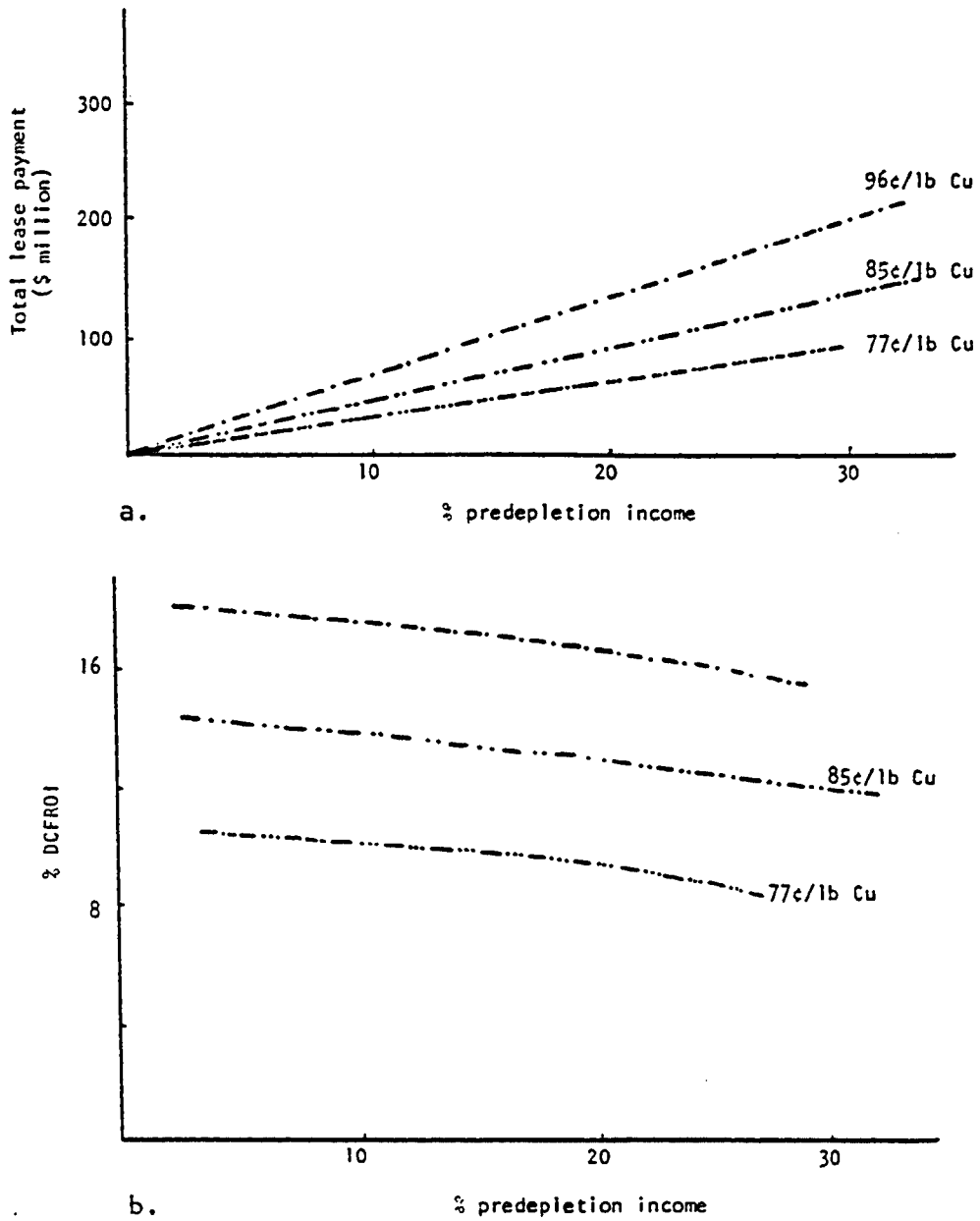



Figure 10. Effect of a percent predepletion mineral lease agreement on a given orebody, Mine 1

a. Total lease payments

b. %DCFROI

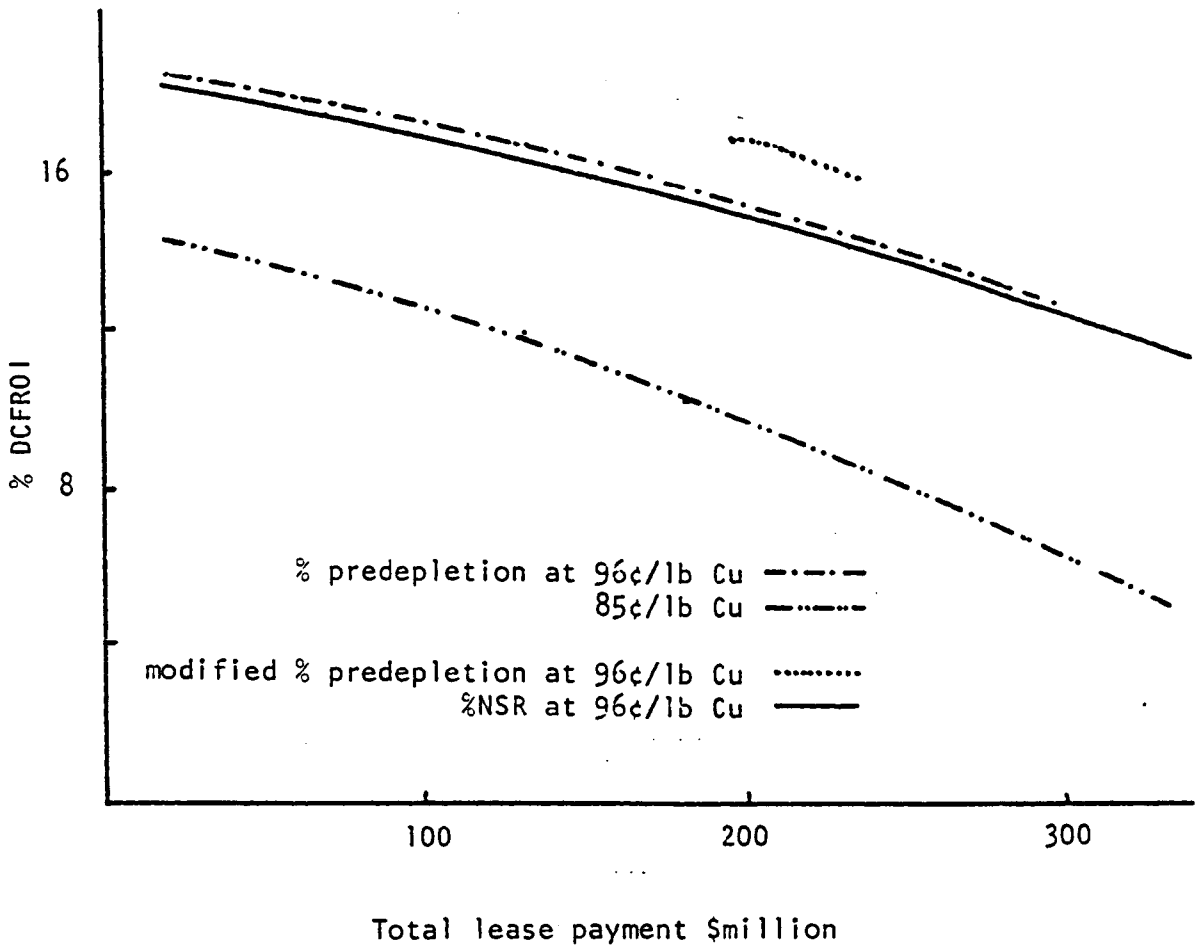



Figure 11. Comparison of the effects of predepletion and NSR agreements on the DCFROI of Mine 1 for different total lease payments

Lease rates to generate total payments are given in Table 10.

because the model mine handles more waste in early years and thereby makes lower lease payments and achieves a higher DCFROI.

It has already been shown that profit-sharing schemes such as a predepletion agreement require the lessor to bear more financial risks. An illustration of how the lessor could be compensated for this risk appears in Table 12. It is proposed that the predepletion lease rate

Table 12. Compensation for additional risks derived from a predepletion agreement

| | Lease Rate (%) | Total Payment (millions) | % DCFROI |
|---|---|---|---|
| Normal lease agreement (NSR) | 10 | $120.8 | 11.7 |
| % Predepletion scheme required to give similar payment to 10% NSR | 22 | $120.8 | 12.1 |
| % Predepletion scheme required to give similar DCFROI to 10% NSR | 30 | $132.5 | 11.7 |

be increased until the lessee receives the same return as under the 10% NSR agreement (11.7% DCFROI) while the lessor receives an additional $11.7 million as compensation for the increased risk. In this way both parties can benefit from the new agreement. However, ini-initially a %NSR agreement must be negotiated.

A modified predepletion scheme which gives the lessor 50 percent of the predepletion income after the lessee has achieved a 15% DCFROI (while making lease payment at a lower rate) gives much higher DCFROIs for a required total lease payment than an unmodified

predepletion or %NSR agreement (Table 10; Figure 11). A lower predepletion rate is used initially until the lessee achieves a 15% DCFROI. The scheme not only generates higher total payments (Figure 11) but it allows the lessee to recover the invested capital more quickly than with a fixed rate leasing scheme. The total payments were not greatly affected by the initial lease rate because high initial rates delayed the time at which the 15% DCFROI modification was introduced. If the ore grade or copper price rises then the modification will be used for a longer period and both parties can share equally in the higher profits. If the profits are due to increased mineable ore reserves the lessor will benefit equally with this modification whereas with an NSR agreement the lessor would receive a smaller share. The lessor may be prepared to accept lower initial payments although the higher payments would begin sooner and the percent value of the total payment may be higher. In the above analysis annual replacement capital is deducted before the annual cash flow is calculated. In this way all replacement capital is recovered in the year it is spent.

Percentage of Pre-tax Income. An agreement that shares the pre-tax income (Item 6, Table 1) is also considered. Here the lessee may be able to use a larger depletion allowance and a lower pre-taxable income base to offset the effects of a lease payment. Because the payment does not reduce the depletion allowance the firm's taxable income is lower than that for other schemes and increases in the payment can be partially offset by decreases in the income tax liability. As noted previously the legality of retaining the entire depletion

benefits by the lessee is uncertain. In this way the scheme can give high payments without significantly affecting the DCFROI of the project. A modified scheme that shared the pre-tax income equally after a 15% DCFROI is achieved is also considered.

It was found that a scheme that shares the pre-tax income requires lease rates at least 3 times those needed for a %NSR agreement to generate similar total payments for a copper price of 96¢/lb (Table 10). This figure becomes even greater when the copper price is lowered.

Figure 12 illustrates that again the effect of the copper price is much more important than the percentage leasing rate. A 13 percent increase in price from 85¢/lb to 96¢/lb raises the DCFROI by at least 3 points whereas total elimination of the lease rate (from 40% to zero) will only bring about a 1.6-points increase in the DCFROI at 85¢/lb.

Figure 13 compares the DCFROI for pre-tax and %NSR agreements for certain levels of payments. The unmodified pre-tax scheme generates a DCFROI about 0.8 points higher than those obtained using a %NSR agreement and a slightly higher DCFROI than a predepletion agreement (Table 10). The modified scheme generates large payments in the later years and gives the highest DCFROI for any lease agreement designed to generate a required total lease payments.

This type of agreement would appear to be one of the best available for leasing if the lease rate is set in a similar manner to that proposed for a predepletion scheme to compensate for risk (Table 12) because the Indians would be compensated for the increased risk by increased payments and the company would achieve higher DCFROIs than under other schemes. The results again suggest that some form

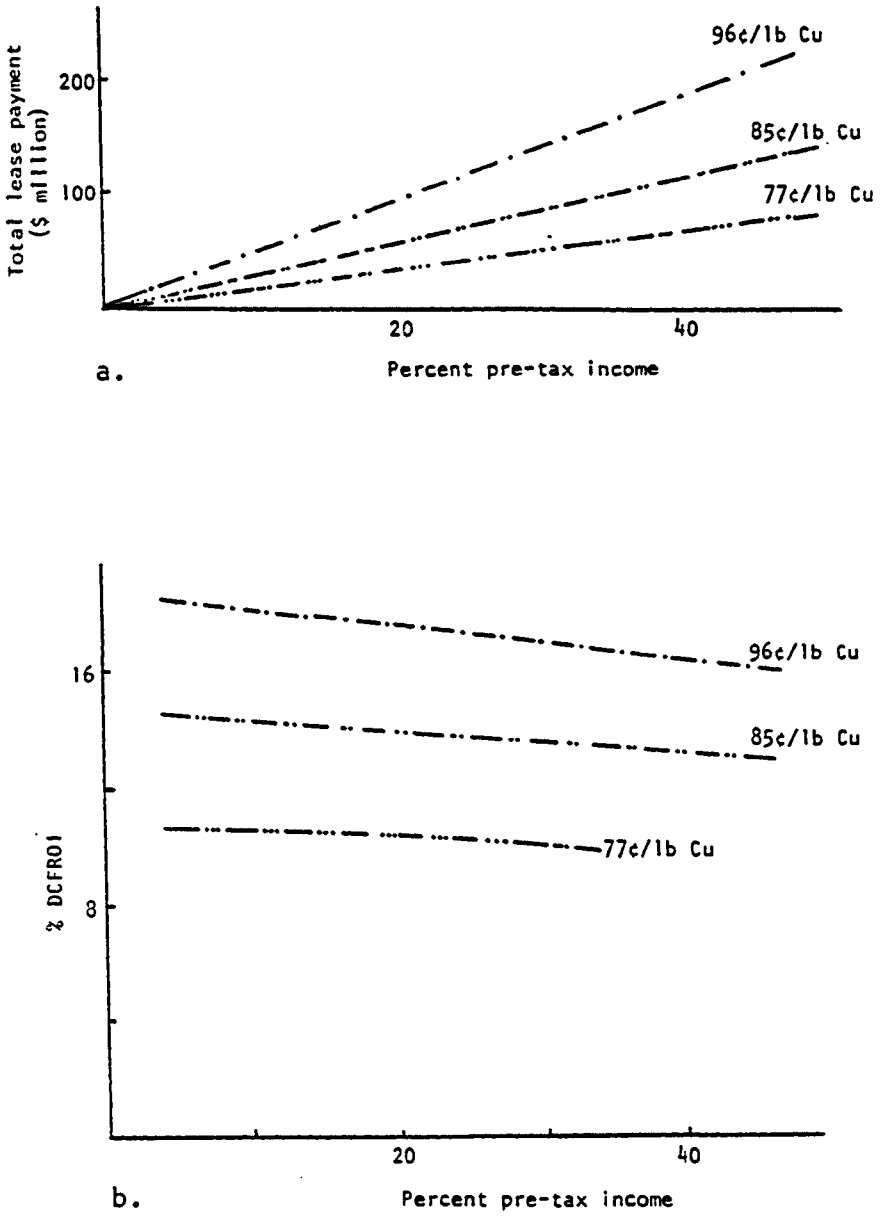



Figure 12. Effect of a percent pre-tax agreement on a given orebody, Mine 1

a. Total lease payment

b. %DCFROI

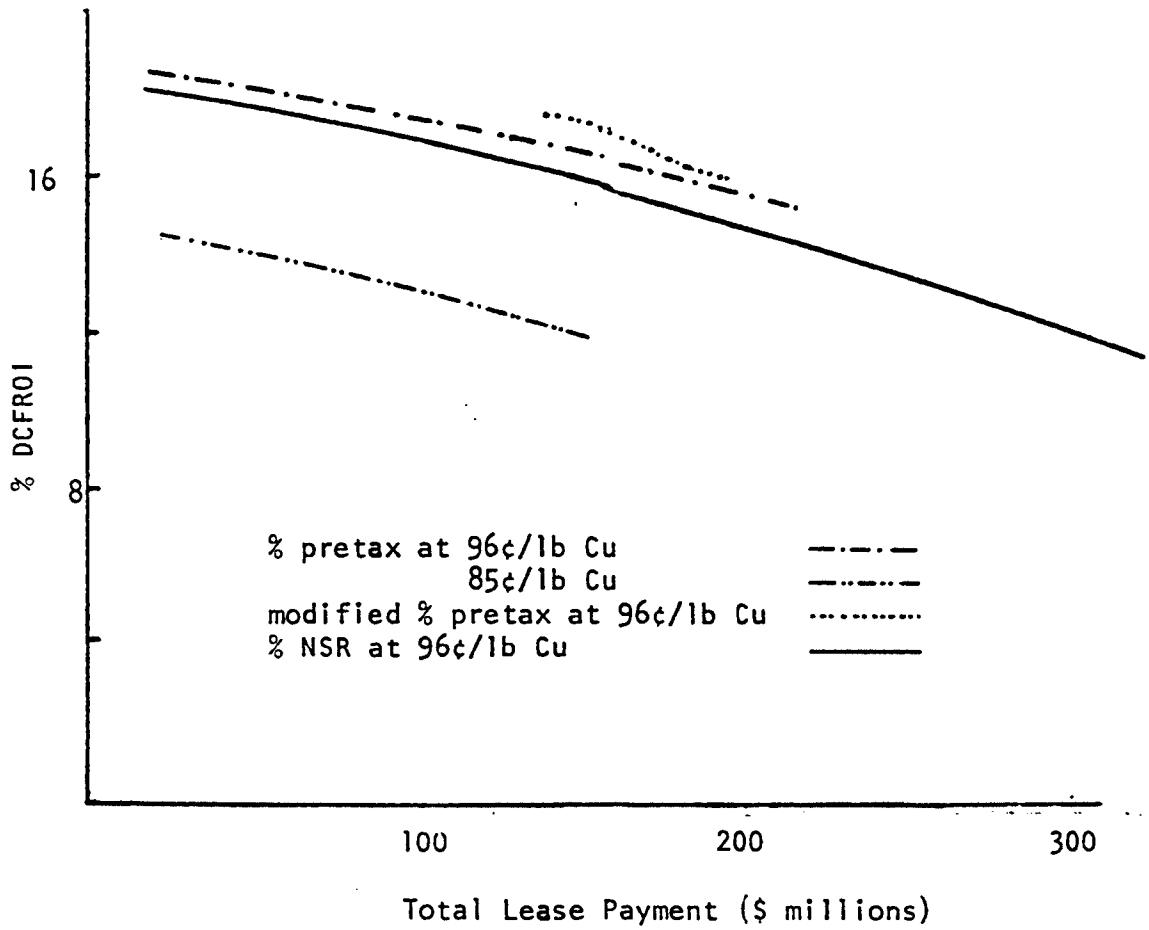



Figure 13. Comparison of the effects of pre-tax and %NSR agreements on the DCFROI of Mine 1 for different total lease payments

The percent lease rates required to generate these payments are listed in Table 10.

of pre-tax or predepletion agreement would appear optimum for both parties if the lessor is willing to accept some of the risks associated with the project. Furthermore because Indians often wish to leave resources for future generations they can be considered to have a low discount rate. Therefore schemes that have high later payments should also have a higher net present value for the Indians than a %NSR. scheme and thus might be preferred by the Indians.

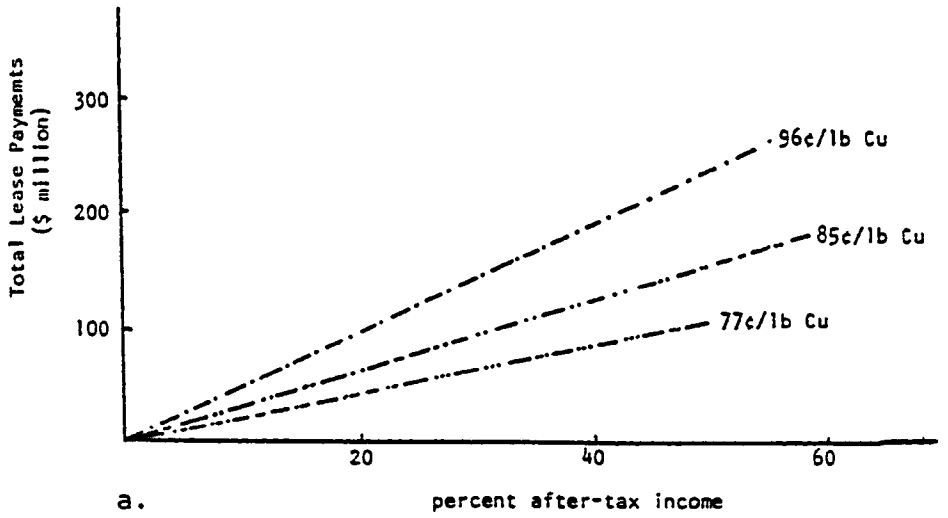
Percent of Profit after Tax. A percent of the profit after the income taxes have been deducted (Item 7, Table 1) is sometimes proposed for leasing because the scheme is based on the company's ability to pay and it allows the owner to participate in the gains and losses from leasing. Proponents of the scheme argue that the after-tax profit is already subject to scrutiny by other parties (notably the IRS) and therefore some monitoring by the lessor might be avoided. This argument ignores the facts that the payment is complex to calculate and that the IRS may approve deductions that are unacceptable to the lessor. Furthermore it is difficult to assess which taxes should be assigned to which property when the company has more than one operation and therefore this scheme may eventually require more monitoring than other schemes. Firms appreciate this scheme because some of the negative effects of a lease payment are offset by allowing non-cash expenses, depreciation, and depletion as deductions from the payment base (Item 7, Table 1).

A modification which shares the after-tax revenues equally after a lessee achieves a 15% DCFROI is also evaluated. However, the

very large lease rates required to generate payments comparable to those generated by a %NSR agreement may reduce the value of this particular modification (Table 10). At a price of 96¢/lb copper the scheme already requires a 60 percent lease rate to generate payments similar to those generated by a 10% NSR agreement. Therefore the modification should not be used or be set at a higher rate. The base on which the payment is calculated has been reduced by 48 percent from the pre-tax schemes and hence one would expect the leasing rates to be nearly double those used in other agreements.

Figure 14 shows that the total lease payment increases and the DCFROI decreases as the percentage of after-tax income increases. Interestingly the gradients of the % DCFROI vs % after-tax income curves vary with copper price, and thus it is not possible to predict the outcome for a particular copper price. The copper price has a much greater effect on the DCFROI than does an increase in the lease rate. A 13 percent increase in the price from 85¢/lb to 96¢/lb will produce an increase in the DCFROI of at least 3 percent; however, the lease rate would have to be reduced from 60 percent to zero to achieve a similar increase in the DCFROI.

There appears to be no justification for this scheme or the modified after-tax scheme because a %NSR agreement will give higher DCFROIs than an after-tax scheme for similar lease payments at any price (Figure 15). This is probably because a %NSR agreement lowers the taxable income and this partly offsets increased payments whereas an after-tax scheme does not. Furthermore the %NSR agreement is



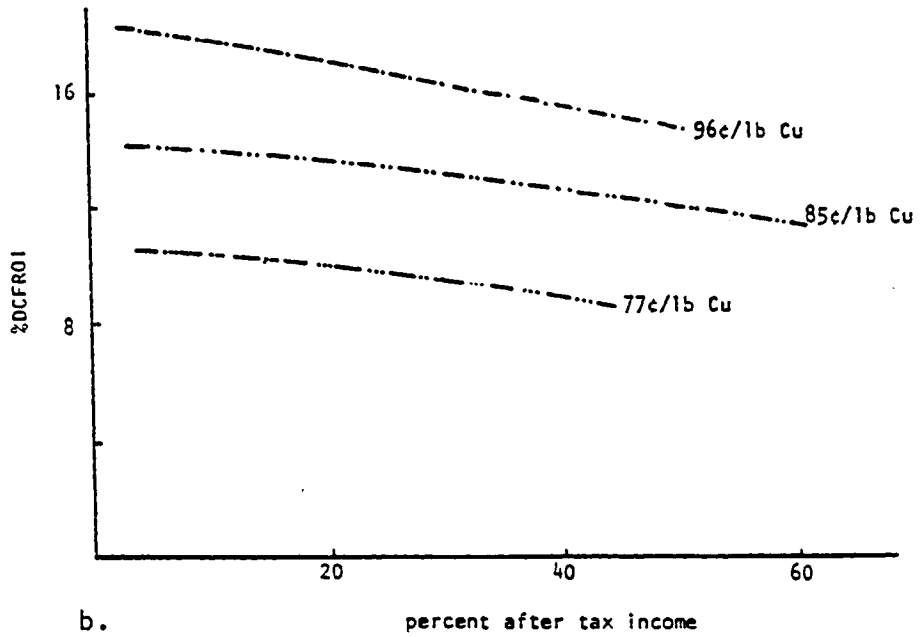




Figure 14. Effect of a percent after-tax lease agreement on a given orebody, Mine 1

a. Total lease payment

b. %DCFROI

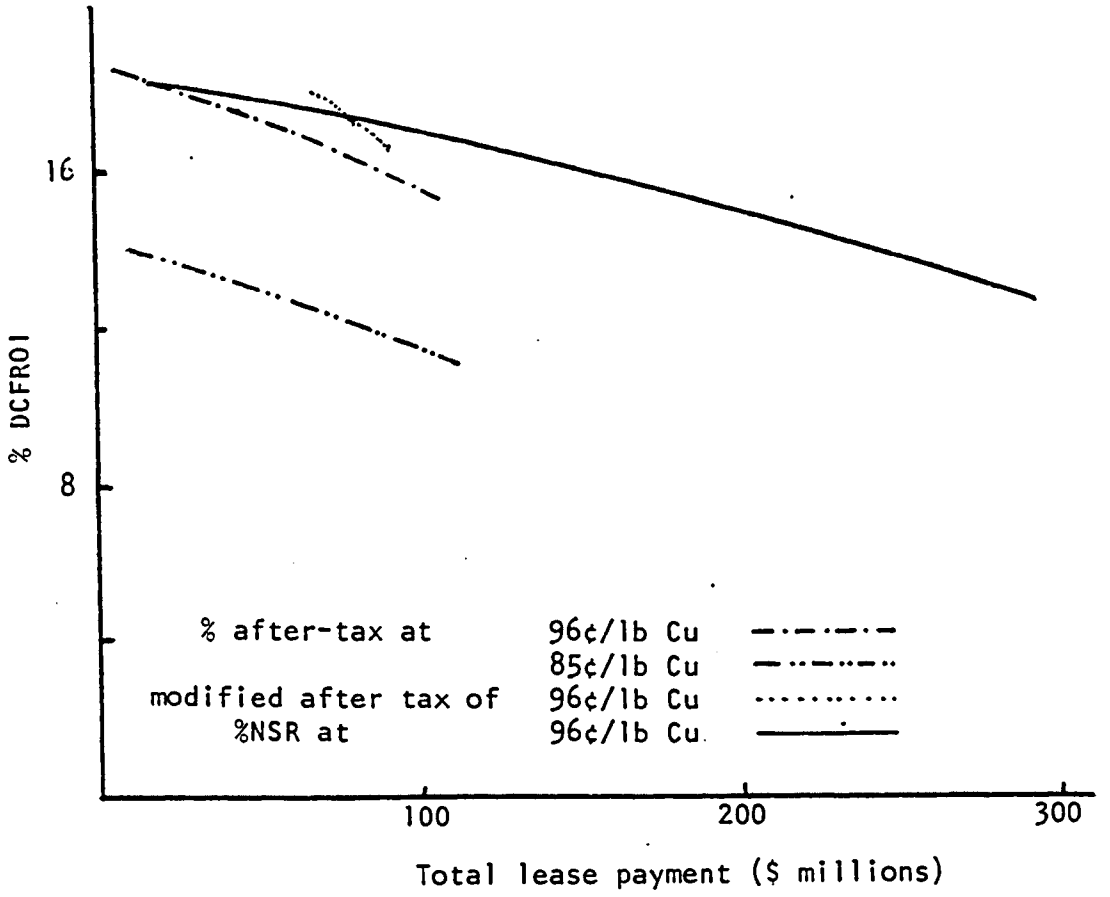



Figure 15. Comparison of the effects of percent after-tax agreements and a %NSR lease agreement on the DCFROI of Mine 1 for different total lease payments

Examples of the regional lease rates to generate required total payments are given in Table 10.

possibly simpler to administrate and requires the lessor to bear lower risks than with an after-tax agreement.

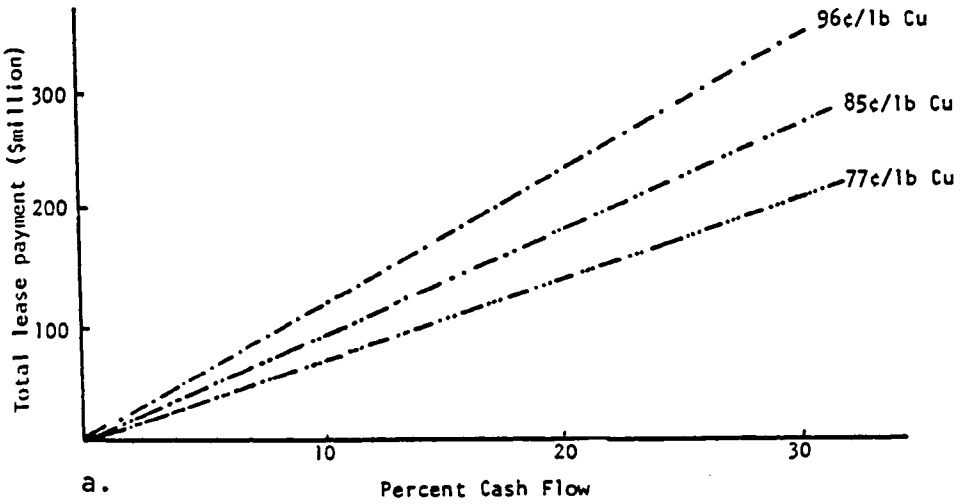
Percentage of Cash Flow. Lastly a scheme that shares the cash flow (Item 9, Table 1) is evaluated. The Indians appreciate this scheme because it allows them to receive a share of the depletion allowance. Therefore if the lease payments were based on this parameter many of the Indian's complaints could be overcome. Furthermore proponents suggest that the lease payment could be checked against annual data published for investors and some of the monitoring requirements would be removed. This, of course, would rarely be the case as few firms report publicly financial data in sufficient detail to avoid the need for periodic audits. Furthermore it might not be apparent from these reports how the company has assigned the tax and overhead charges to the mine and this could complicate monitoring. Because this item is based on the net cash flow the annual investment in a project will still need monitoring. Some mining companies may be opposed to this scheme because it shares the occasional "windfalls" with the lessor. The operators regard these windfalls as an integral part of the mining because they stimulate investor interest in what otherwise may be considered a quiet industry.

A modified scheme that requires low annual payments until a 15% DCFROI is achieved and then shares the cash flow equally for the remainder of the project's life is evaluated. After a 15% DCFROI is achieved the lessee is less concerned about the final DCFROI and is more concerned about generating positive future cash flows. Therefore

a scheme that share the cash flow equally should appear attractive to both parties leasing the deposit in the later years of the mine's life.

Because the percentage of cash flow agreement generates the required payment using a lower lease rate than for most profit-sharing agreements but still higher than those for a %NSR scheme (Table 10), a small change in the lease rate has a large effect on the DCFROI and the lease payment (Figure 16). Therefore it becomes critical to estimate the appropriate lease rate at the time the lease is drawn up.

The value of the unmodified scheme must be questioned when one sees that a %NSR agreement generates higher total payments for the Indians for a given DCFROI (Figure 17) and is simpler to monitor. However, Figure 17 also suggests that the modified cash flow agreement may be worth considering because it gives higher total payments than an NSR agreement for similar DCFROIs when low lease rates are used. However, the modified scheme has a limited range (Figure 17) because the initial lease rate can only be increased to a certain rate above which the modification will not come into effect (i.e., a 15% DCFROI cannot be attained). Therefore a predepletion agreement may be preferred. Figure 17 also shows that the modified cash flow agreement is inferior to the modified predepletion agreements for all levels of total lease payment. In summary it would appear any scheme based upon net cash flow should be avoided by the Indians because their interests could be better protected by either a %NSR or modified predepletion agreement.



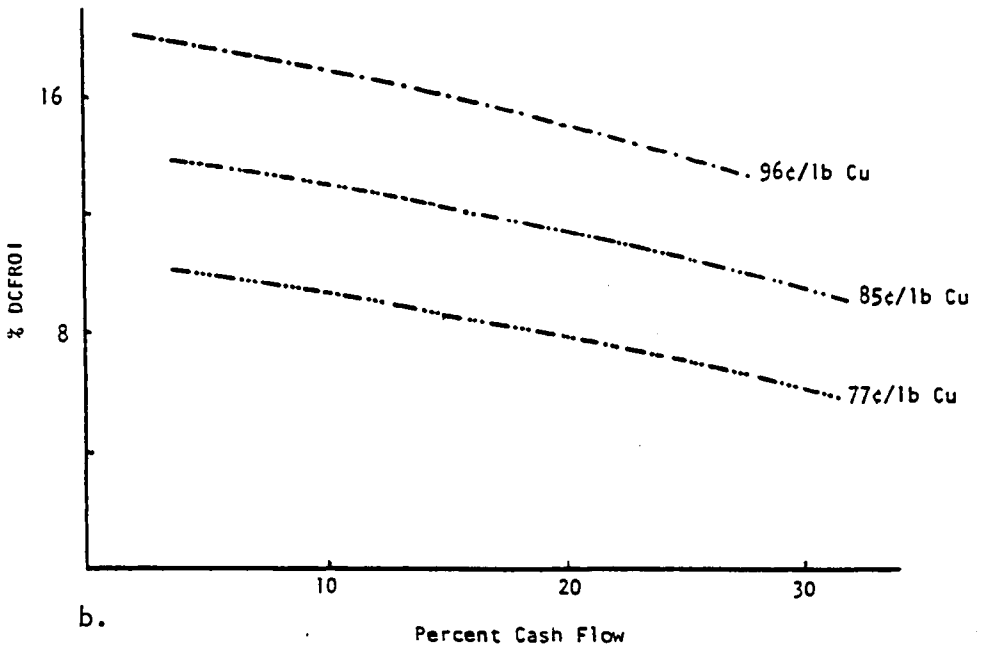




Figure 16. Effect of a percent cash-flow lease agreement on a given orebody, Mine 1

a. Total lease payment

b. %DCFROI

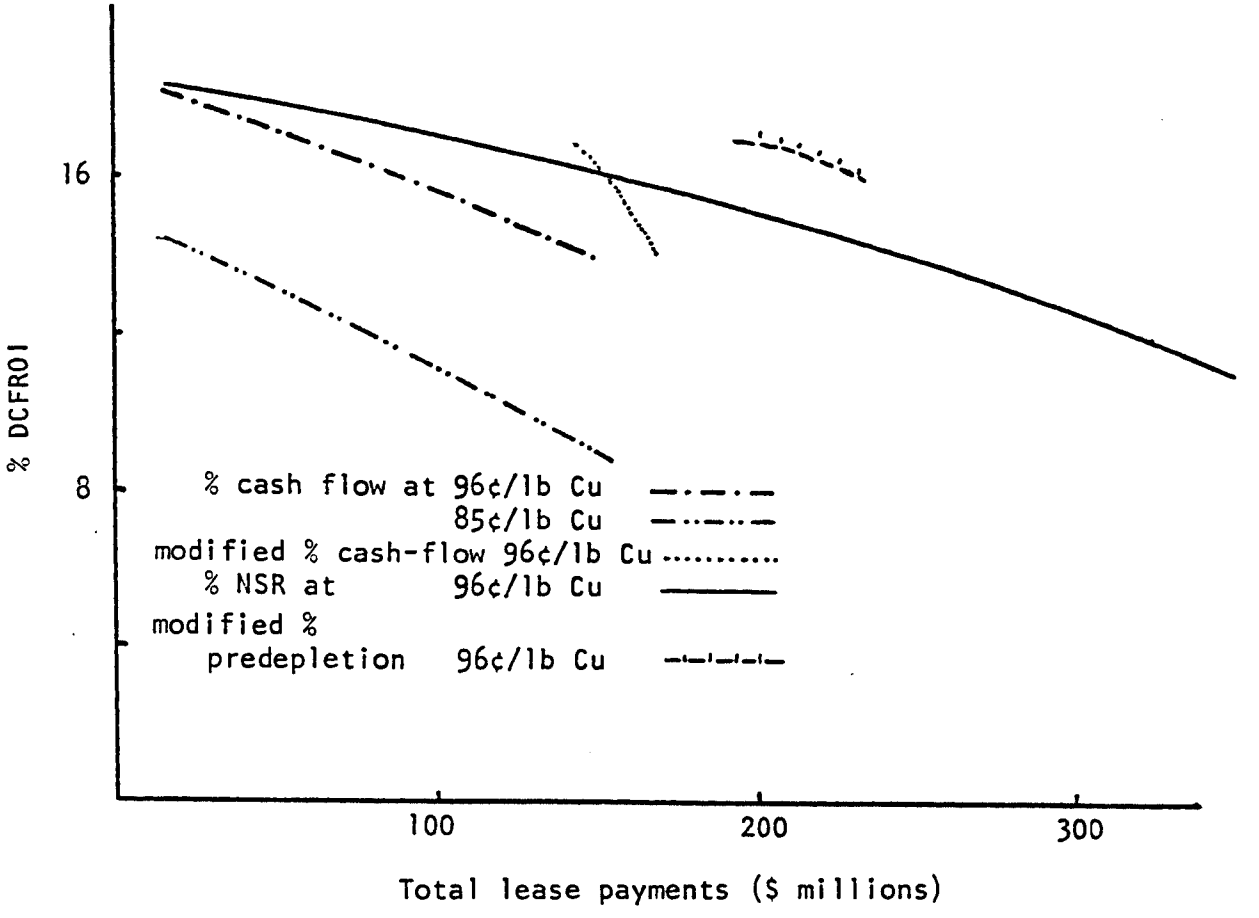



Figure 17. Comparison of the effects of percent cash-flow agreements on a %NSR agreement on the DCFROI of Mine 1 for different total lease payments

The lease rates required to generate total lease payments can be determined from Table 10.

Prepayment and Minimum Payment Clauses

Prepayments against future lease payments are usually included in a lease agreement to guarantee the lessor an annual income during the preproduction period. Minimum lease payments ensure that the lessor always receives a certain payment irrespective of the prevailing financial or mining conditions. The Papago Indian Tribe uses this guaranteed annual payment to meet the costs of financing tribal services and the Tribal Council.

These provisions are considered because they could affect the DCFROI. The credits accumulated by the lessee for prepayments and minimum payment provisions are often recovered later in the mine's life. Therefore the credits are more heavily discounted than the annual payments and this will reduce the DCFROI. In this study prepayments were made and the credits were recovered in the initial production years. Annual post-production minimum payments set equal to the annual prepayment were required for each year of production to ensure that a minimum payment was made despite any outstanding prepayment credits. The effect on the DCFROI of a minimum payment greater than the indicated production royalty payment was considered, although the effect of a temporary shutdown of the mine was not.

A percent predepletion agreement instead of a %NSR agreement was used for the study because the predepletion scheme generates payments only when the project makes a profit whereas the NSR agreement guarantees payments whenever there is production. Therefore although both schemes may require a minimum payment clause, the clause may be

more relevant with a predepletion agreement. The effect of preproduction or minimum payment clauses on pre-tax, after-tax, or cash-flow agreements was not considered because the results in Chapter 5 indicated that the predepletion agreement was possibly the best alternative for leasing.

A lease rate of 10 percent of predepletion income, approximately equivalent to a 5% NSR, was used for this study. The copper price was set at 77¢/lb and 96¢/lb so that the effect of prepayment and minimum payment provisions on the DCFROI could be studied for both marginal and more profitable orebodies.

Effect of the Size of the Prepayment or Minimum Payment on the DCFROI. The size of the prepayment and minimum annual payment was varied to determine its effect on the DCFROI. The payments were completely recovered from later production lease payments whenever the annual production base payments exceeded the minimum payments. In this way all of the prepayments were recovered early in the life of the mine. Some leases only provide for a partial recovery of lease credits through the excess of production over the minimum payments during any one year. This however was determined to have a serious negative impact on the DCFROI. Figure 18 shows that the DCFROI declines as the prepayment and minimum annual payments increase. The average annual lease payment for a 10 percent predepletion agreement at 96¢/lb Cu was $4.364 million, increasing the prepayment and minimum annual payment from 0 to 3 million caused the DCFROI to decline from 17.8% to 17.4% (-0.4 points). However, if the prepayment and minimum

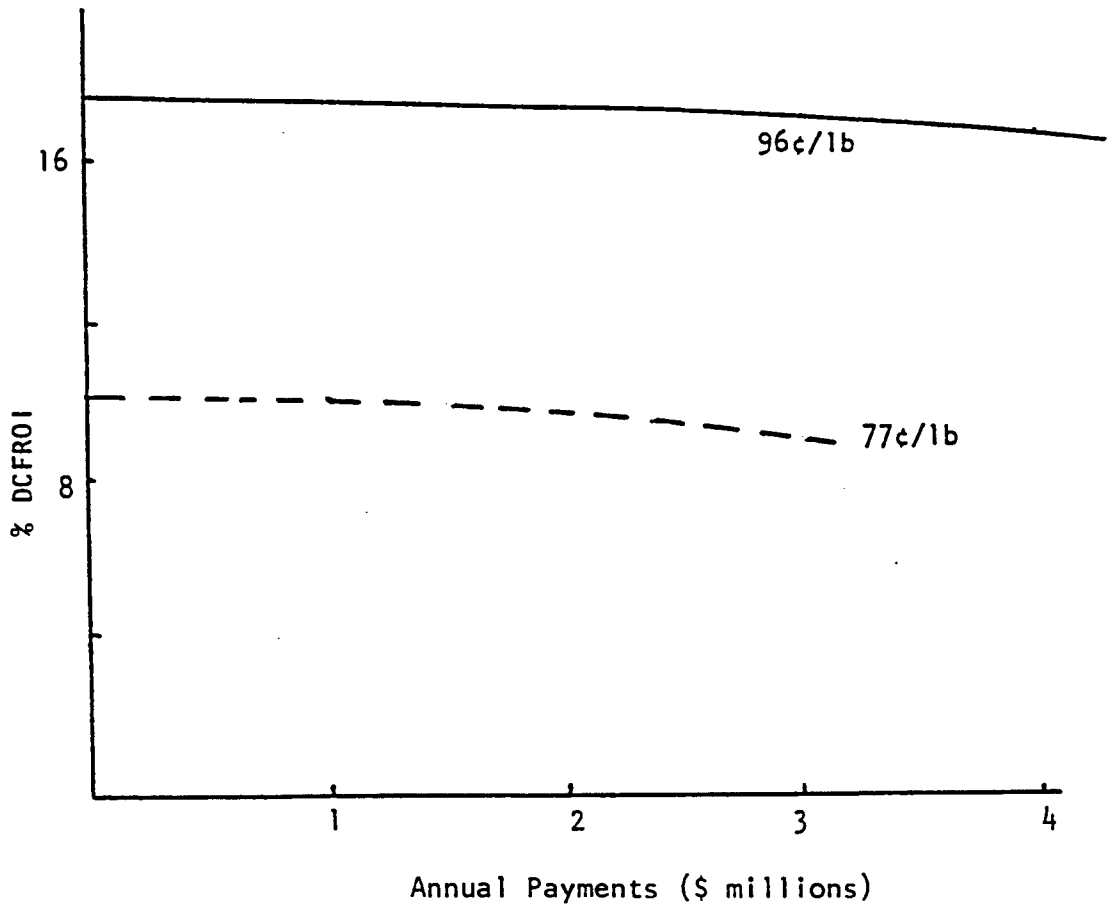



Figure 18. Impact of changing the level of annual prepayments or annual minimum payments on the DCFROI for different copper prices

annual payment were increased from $3 million to $4 million, and the DCFROI decreased from 17.4% to 17.0% (-0.4 points) indicating that the rate of decline of the DCFROI increases as the prepayment and minimum annual payment approaches the average annual payment. If the rate for a percent predepletion scheme with no prepayments or minimum provisions is raised from 10 to 14.5 percent, the DCFROI also declines from 17.8 to 17.4 percent (-0.4 points). Therefore setting the level of prepayments and minimum payments can be as important for the lessee as

setting the lease rate. The lessor should realize that a prepayment or minimum payment provision requires a lower lease rate with it to achieve the same DCFROI as a higher rate without these provisions. Therefore the lessor should weigh the value of the risk and the prepayments against the value of the difference of the total payments the lessor would receive with a higher lease rate.

Figure 18 indicates that the DCFROI declined in a similar manner for 77¢/lb Cu. The average annual payment was $1.95 million and as the prepayment and minimum annual payment were increased from 0 to $1 million the DCFROI declined from 10.2 to 10.1 percent. When the prepayment and minimum annual payment were increased to $2 million the DCFROI dropped to 9.7 percent. The model showed that the further in the future that credits for prepayments or minimum annual payments are postponed, the lower the DCFROI will be. This is because the credits are recovered in the future and hence they are discounted more heavily than the original payment. If a shutdown occurs during the mine life and the minimum payment is set so high that credits for it cannot be recovered from future lease payments, early abandonment of the mine may result. Some owners suggest that high holding charges will deter the operator from temporarily closing the mine and act as an incentive for the operator to continue producing. In light of the problems associated with using a high minimum lease payment one would expect that high holding costs would not encourage the continued production but rather they would promote the abandonment of the lease.

In summary it is suggested that the prepayment and minimum payments should be set so that they do not affect the DCFROI by more than 0.1 points. From Figure 18, prepayments up to $1.5 million would be suitable for copper at 96¢/lb and prepayments up to $1 million would be suitable for a copper price of 77¢/lb. Therefore a payment set between one-third and one-half the expected annual payment would probably be a reasonable compromise.

# CHAPTER 6

## SUMMARY AND CONCLUSIONS

Leasing schemes have become more refined since their introduction in Roman times. As time has progressed mineral leases have been designed for many different leasing goals, although their major function has been to maximize the lease payments for the lessor. Leasing schemes have been used as one method for making land available for exploration and exploitation of minerals and other commodities when the owners are not prepared to undertake production themselves.

The goals of leasing schemes vary with the type of owner of the deposit. Whereas a private owner may lease land and attempt only to maximize his income, a government may try to achieve socially orientated objectives in lieu of maximum income. This thesis identified many objectives that have been proposed in recent years by all types of lessors in the United States and abroad to determine if the existing lease agreements were still adequate to meet these goals. It was found that many new leasing goals are being proposed for various lessors, including those that call for the efficient and complete recovery of a depletable nonrenewable resource. Leasing agreements cannot ensure that any lessee develops the lease in an efficient manner. Leasing schemes can, however, encourage the complete recovery of a resource to its economic limit. Governments have discovered that by reducing lease payments they can promote the development of a

region, and that leasing provisions can be used to overcome problems of conflicting land uses. Leasing terms can also be adjusted to reduce some of the risks a lessee has to face.

The current leasing goals for U.S. public lands are those of ensuring that the deposits are completely worked out and that the government receives fair payments according to the risk shared. These goals can be met using a combination of the lease schemes already in use. However profit-sharing, joint-venture, and stock-sharing agreements may become more important in the future as some owners, notably foreign governments, wish to participate more actively in the development of their resources. It is apparent that not only is the type of owner important in determining the lease agreement but the nature of the deposit may also be critical. Therefore it seems very unlikely that any specific lease agreement proposed would be suitable for all leases.

Because no optimum lease agreement was identified, this study tried to determine which lease agreement would be best for a model of a porphyry copper deposit on Indian land. A porphyry copper deposit was chosen because Tucson, Arizona is in a porphyry copper geologic province and information about mining this type of deposit was available. Indian land was chosen partly because the regulations concerning public lands are already clearly defined whereas Indians are currently trying to change their regulations and partly because as more of the public and private land in the United States is explored and developed, companies are increasingly turning to the Indian land for future resources.

The Papago Indian Tribe of southern Arizona was chosen for the study because they have three known porphyry copper deposits on their reservation and, like many other Indian tribes, they question whether their current lease agreements are the best available to meet their requirements. The Papago Indian Tribe is prepared to give leases for mineral exploitation because they need the payments to finance different tribal needs. Although they want substantial lease payments, they also hope that leasing their lands will generate employment for members of the tribe.

The Bureau of Indian Affairs is the government's appointed trustee for Indian lands. In this capacity the BIA has been actively involved in approving leases for Indian land. Traditionally the BIA has used a minimum 10 percent net smelter return agreement for all Indian leases because it is easier to administer and monitor than alternative agreements and generates payments for the tribe whenever there is production. Some Indian tribes such as the Colville tribe, Washington, and the Navajo tribe, Arizona, have proposed profit-sharing agreements instead of %NSR agreements to meet some of their goals. This study compared several such schemes with a %NSR agreement to see whether some type of profit-sharing agreement might be more suitable for leasing the porphyry copper deposits of the Papago Indian Tribe.

This study evaluated the different lease agreements by determining for each scheme the DCFROI for a certain level of total lease payments. It was considered necessary that any new agreement give an

acceptable DCFROI for a particular lease payment. A background study was made to determine the relative sensitivity of the DCFROI to an NSR agreement, copper price, ore reserves, mine life, and capital cost so that the relative effect of a lease agreement on the DCFROI could be evaluated.

The economic analysis of Chapter 5 gave the following conclusions:

1. The DCFROI is most sensitive to fluctuating copper prices and more sensitive to changes in ore reserves, mine life and capital cost than to the same percent change in the lease rate at the levels selected. However, although the DCFROI was less sensitive to changes in the lease rate than to other parameters, an agreement with a high lease rate can still make the deposit unattractive to potential lessees. Therefore care is needed in selecting lease payment schemes.
2. From an economic standpoint no single scheme was identified as generally superior for leasing a porphyry copper deposit on Indian land. Rather three alternative schemes, a net smelter return, a predepletion and a pre-tax agreement, all proved attractive and the correct one should be chosen after considering both the lessor's financial situation and alternative leasing goals.
3. The traditional net smelter return scheme provides the tribe with a steady income for as long as the mine is in production. This scheme should be used for tribes who are not prepared to

share in all the financial risks of mining either because the mine represents the only source of income for the tribe and therefore a stable income stream is important or because the tribe lacks the confidence to share in additional mining risks that a profit-sharing scheme would involve. A net smelter return scheme has proved attractive in the past because only a limited amount of monitoring was needed because the royalty base was set by a third party--the smelter. However problems may arise as operators use other processes such as leaching to win copper because it is hard to interpret the subsequent revenues in light of the "net smelter return" language.

4. The study also indicated that the traditional 10% NSR was too high for the model orebody providing a DCFROI below the minimum acceptable rates for mining companies at 85¢/lb copper. The 10% NSR is probably too high for mining a low-grade porphyry copper deposit because the low profit margin cannot support high severance-type taxes (Lacy, 1969) such as a %NSR scheme. A high severance tax increases costs and necessitates an increase in cut-off grade. Porphyry copper deposits are characterized by very low average grades and large tonnages, they can only be mined because of the economies of scale associated with large tonnages. Therefore raising the cut-off grade significantly reduces the ore reserves and the mine may no longer prove attractive to mining companies (Lacy, 1969).

5. A predepletion lease payment agreement is recommended for lessors that are prepared to share in the financial and technical risks associated with mining. Examples of this type of lessor are tribes that have other sources of income and tribes that wish to share more of the operations risk in the expectancy of receiving higher total revenues than those associated with %NSR agreements. Some tribes wish to develop a greater trust with the lessee, other tribes wish to participate more in the venture. A predepletion scheme is the best available scheme to meet these goals. This type of agreement would also help the tribes understand the problems which the mining companies face trying to encourage tribal employment.
6. For the ore deposit modeled in this study a pre-tax agreement proved the most attractive scheme from an economic standpoint as it gave the highest DCFROI for given levels of payment. This scheme shares all the advantages and problems of a predepletion scheme but gives higher DCFROIs because the increased lease payments are offset by lower income taxes. The Colville Indians (Washington) use this type of agreement for leasing their copper-molybdenum deposit to AMAX.
7. If a lessor is prepared to use a predepletion or pre-tax scheme then the lessor should also consider modified schemes that use a low initial lease rate and raise it to 50% of the predepletion or pre-tax income after the company has received a satisfactory return on investment. The scheme is attractive

to lessors because significantly increased payments can be expected, however these payments will come in the future and the lessor shares more of the financial risks than with unmodified schemes. This scheme should be used by tribes that are prepared to speculate and invest in their own resources but are unable to consider joint-ventures with the owner because of lack of capital. Only tribes that have regular incomes sufficient to meet their tribal expenses should consider this modification.

8. After-tax and cash-flow schemes proved to be economically inferior for sharing the profits of an operation to either %NSR, predepletion, or pre-tax agreements. They also require more monitoring because problems may be encountered with reconciling the firm's tax reports with the profitability of individual properties.
9. Any scheme that allows costs as a deduction before calculating the lease payment require strict definitions of all costs and revenues in the lease if litigation is to be avoided. The lessor should expect higher monitoring costs with these schemes than with a %NSR agreement.
10. Pre-tax, after-tax and cash-flow schemes are all subject to a possible unfavorable tax ruling by the IRS. The lease payment is calculated on the base item and is not treated as a cost for depletion purposes. If the lessor elects to waive the right to a depletion allowance this method of calculating the lease payment will probably be satisfactory for the IRS;

however if the lessor was to claim a depletion allowance the schemes would have to be calculated differently (Breen, 1979). Because the Indians are not liable for federal taxes there is no justification for their claiming the depletion allowance. It is to the tribe's advantage to allow the company to claim the allowance and then use a pre-tax scheme because the tribe will receive higher lease payments which the company can offset against taxes. This appears to be the arrangement AMAX has drawn up with the Colville tribe (Engineering and Mining Journal, 1978).

11. Whichever leasing scheme is used, minimum payment provisions are required because they ensure that the lessor receives some compensation as long as the lessee wishes to hold the lease. Minimum payment provisions reduce the lessor's financial risk and can be used to meet current tribal expenses. The study indicated that the prepayment and minimum annual payment should be set at about 30-35 percent of the expected annual payment if the prepayments can be completely recovered from payments in the first years that the lease payments are above the minimum level. If the payment credits are not recovered in in the first 6 or 7 years of the mine's life then the DCFROI will begin to decline; therefore setting the minimum payment can become as important as setting the lease rate.

In summary it would appear that for a given level of total lease payments profit-sharing schemes give higher returns on invested

capital than net smelter return agreements. This is mainly a reflection on the model orebody because stripping was reduced over the life of the mine to make the orebody more profitable in later years and partially because the depreciation account declines with time which also raises the lease payment base to give higher payments in later years. Because future revenues are discounted a total lease payment that is comprised mainly of lease payments made in later years will have a higher DCFROI than a total lease payment that has the majority of the payment in the earlier years. Therefore a project that is expected to become less profitable in later years, such as one where the higher grade ore is exposed at the surface, may be equally suited by either a %NSR or a profit-sharing agreement.

If the tribe is prepared to share in the risks of developing a deposit that is expected to increase in profitability in later years both predepletion or pre-tax methods are optimum. However although a tribe stands to gain additional revenues under these schemes this study indicated that the economic advantage of different schemes were not so strong that other qualitative goals should be ignored. Therefore a lease agreement should be designed individually for each mine after consideration of the local conditions, both geological and sociological, that exist. Only in this way can an optimum lease agreement be achieved.

# APPENDIX

## PROGRAM ROYALT

```
C
C
C       PROGRAM ROYALT
C*************************************************************
C
C
C       PROGRAM ROYALT(INPUT,OUTPUT,TAPE 5=INPUT,TAPE 6=OUTPUT)
C
C*******THIS PROGRAM PERFORMS A FINANCIAL ANALYSIS FOR
C       AN OPEN PIT MINE WITH TWO PRODUCTS.
C       THIS PROGRAM CAN ALSO BE USED TO EVALUATE
C       DIFFERENT ROYALTY SCHEMES PROPOSED FOR A
C       PROJECT.
        COMMON /PROD/PDORE(40),CONCU(40),CONMO(40),GRCU(40),GRMO(40),
     1DMINE(40),OMILL(40),DOTHR(40),TCED(40),TPRC(40),
     2TNPRC(40),TSALE(40),EXPL(40),STRIP(40)
        COMMON /EX/DEPRA(40),DEPLE(40),TAXCR(40),TROY(40),TNET(40),
     1   CISUM(40),RPIS(40),RBASE(40),
     2  CRED(40),TCRE(40),TCCR(40),
     3  RIN(60),SOUT(60),SSIN(60),SSOUT(60),
     4  A,III
        COMMON /REV/GROSA(40),GROSE(40),GROSS(40),TAXIN(40),
     1   FIT(40),PROF(40),CFOPS(40),CF(40),PREDEP(40),TRANCU(40),
     2      TRANMO(40),TREAT(40),ROYCU(40),ROYMO(40),TCNA(40),
     3  TSTRIP(40),TGEN(40),TMILL(40),TOPER(40),TMINC(40)
        COMMON /CONST/IOUT,HEAD(20),LIFT,NSTART,RATE,PRCCU,PRCMO,
     1    RCOVC,RCOVM,PCNCU,PCNMO,
     2  FMINR,RFATE,FMNYE,NOPT,BONUS,NFLG,NROR,ROR,
     3  FITR,DEPRTC,DEPRTM,RTNEW
        DATA IPT,IOUT,WATER/21,22,1.12/
C       DATA IPT,IOUT,WATER/5,6,1.12/
        CALL IFILE(IPT,'MINE')
C
C*************************************************************************************
***
C
C
C       PROGRAM WRITER;  HARVEY P. KNUDSEN,
C               MODIFIED TO CONSIDER DIFFERENT LEASING SCHEMES
C               BY       DAVID G. CARLILE
C
C       INSTITUTION:     DEPT.OF MINING & GEOLOGICAL ENGINEERING
C                        UNIVERSITY OF ARIZONA, TUCSON
C
C       DATE:            5 DECEMBER 1978
C
C        THIS PROGRAM  PRODUCES A PRO FORMA INCOME STATEMENT
C        FOR THE LIFE IF THE MINE. IT ALSO CALCULATES THE FIRM'S DISCOUNTED
C        CASH FLOW RETURN ON INVESTMENT (DCFROI) AND THE SUM OF PAYMENTS
C        TO A LESSOR FOR DIFFERENT LEASING SCHEMES. DATA ON THE COMMODITY
C        PRICES,RECOVERIES AND OPERATING COSTS ARE REQUIRED. DATA ON THE
C        ANNUAL CAPITAL COSTS FOR BOTH THE MINE AND THE MILL, TOGETHER
C        WITH ANNUAL PRODUCTION DATA FOR ORE AND WASTE, AND THE MINERAL'S
C        AVERAGE GRADES ARE NEEDED.
C           THE PROGRAM CAN BE USED TO EVALUATE 5 DIFFERENT TYPES OF
C        LEASING AGREEEMENTS. A PRO FORMA INCOME STATEMENT IS PRODUCED
C        FOR EACH SCHEME WITH THE PAYMENT DEDUCTED AT THE CORRECT PLACE.
C        POSSIBLE LEASING AGREEMENTS EVALUATED BY THIS PROGRAM ARE:
C        1.   NET SMELTER RETURN; 2.   PRE DEPLETION INCOME; 3.   PRE-
C        TAX INCOME; 4.   AFTER-TAX PROFIT; 6.  CASH FLOW. A MODIFICATION
C        WHICH CALCULATES USES A NEW  LEASING RATE ONCE A SPECIFIED DCFROI HAS
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```
C       BEEN ACHIEVED IS AVAILABLE. A SECOND MODIFICATION RECALCULATES THE
C       LEASE PAYMENT AND RETURNS IT TO THE ROYALTY STAGE ON THE PRO
C       FORMA STATEMENT--THIS MODIFICATION SATISFIES IRS GUIDELINES FOR
C         PRE-TAX, AFTER-TAX, AND   CASH FLOW AGREEMENTS. PROVISIONS  FOR
C       DIFFERENT MINIMUM LEASE PAYMENTS AND EXTENDED CREDIT RECOVERY
C       PERIODS FOR PREPAYMENTS ARE ALSO INCLUDED.
C
C-------------------------------------------------------------------------
-------
C
C***THE FOLLOWING DATA IS REQUIRED TO RUN THIS PROGRAM:
C
C
C  COLUMN  FORMAT   NAME                DESCRIPTION
C
C  CARD ONE
C   1-80     20A4     HEAD      TITLE OF PROJECT
C
C  CARD TWO
C   1-5      I5       NOPRE     # OF PREPRODUCTION YEARS
C   6-10     I5       LIFE      MINE LIFE
C   11-15    I5       NSTART    CALENDER YEAR OF YEAR 1
C   16-25    F10.2    TXCR      ANNUAL TAX CREDIT
C   26-30    F5.2     RRATE       ANNUAL ROYALTY RATE
C   31       I1       NOPT      FLAG TO SELECT LEASING SCHEME, SET:
C                              1    NET SMELTER RETURN
C                              2    PRE-DEPLETION
C                              3    PRE TAX INCOME
C                              4    PRE TAX PROFIT BACK TO ROYALTY
C                              5    AFTER TAX PROFIT BACK TO ROYALTY
C                              6    ANNUAL CASH FLOW BACK TO ROYALTY
C                              7    AFTER TAX NET PROFIT
C                              8    NET CASH FLOW
C    32      I1       NROR      SET TO 1 FOR MIN DCFROI
C                               NOT AVAILABLE FOR NOPT 4,5 OR 6
C
C  CARD THREE
C   1-10     F10.0    PRCCU     PRICE OF COPPER
C  11-20     F10.0    RCOVC     MILL RECOVERY FOR COPPER
C  21-30     F10.0    PCNCU     POST CONCENTRATE RECOVERY COPPER
C  31-40     F10.0    CCUGR     CONCENTRATE GRADE FOR COPPER
C  41-50     F10.0    DEPPTC    DEPLETION RATE FOR COPPER
C
C  CARD FOUR
C   1-10     F10.0    PRCMO     PRICE OF MOLYBDENUM
C  11-20     F10.0    RCOVM     MILL RECOVERY FOR MOLYBDENUM
C  21-30     F10.0    PCNMO     POST CONC RECOVERY MOLYBDENUM
C  31-40     F10.0    CMOGR     CONCENTRATE GRADE FOR MOLYBDENUM
C  41-50     F10.0    DEPRTM    DEPLETION RATE FOR MOLYBDENUM
C
C  CARD FIVE
C   1-10     F10.0    FMINR     MINIMUM ANNUAL ROYALTY
C  11-20     F10.0    FMNYE     NO OF YEARS TO RECOVER PREPAYMENT ON ROYALTIES
C                               MUST BE GREATER OR EQUAL TO 1
C  21-30     F10.0    BONUS     INITIAL BONUS PAID
C  31-40     F10.3    RDR       MIN DCFROI REQUIRED BEFORE  SHARE RYTY EQUALLY
C  41-50     F10.0    FITR      FEDERAL INCOME TAX RATE
C  51-60     F10.0    RTNEW     NEW LEASE RATE AFTER 15 PERCENT DCFROI ACHIEVED
C
C  CARD SIX : OPERATING COSTS
C   1:10     F10.0    CMINE     MINING COST
```

```
C  11-20     F10.0    CSTRIP    STRIPPING COST
C  21-30     F10.0    CGEN      GENERAL COST
C  31-40     F10.0    CMILL     MILLING COST
C  41-50     F10.0    CTRANS    TRANSPORTATION COSTS
C  51-60     F10.0    CTREAT    TREATMENT COSTS
C
C  CARD SEVEN : INVESTMENT DATA FOR EACH YEAR
C   1:10     F10.0    DMINE     CAPITAL INVESTMENT IN MINE
C  11-20     F10.0    DMILL     CAPITAL INVESTMENT IN MILL
C  21-30     F10.0    DOTHR     OTHER INVESTMENT
C  31-40     F10.0    EXPL      EXPLORATIN COST FOR YEAR
C
C  CARD EIGHT : PRODUCTION DATA FOR EACH YEAR
C   1-10     F10.0    PDORE     ORE PRODUCTION
C  11-20     F10.0    STRIP     AMOUNT STRIPPED
C  21-30     F10.0    GRCU      AVERAGE COPPER GRADE
C  31-40     F10.0    GRMO      AVERAGE MOLYBDENUM GRADE
C
C
C*** CARDS SEVEN AND EIGHT ARE MADE FOR EACH YEAR OF THE MINE'S LIFE
C    THEY ALTERNATE SEVEN ,EIGHT;SEVEN,EIGHT..ETC.
C
C
C
C
C
C   DESCRIPTIONS OF OTHER VARIABLES GENERATED AND USED  BY THIS PROGRAM
C
C   VARIABLE                    DESCRIPTION
C
C   WATER   INCREASE IN WEIGHT OF ORE TRANSPORTED DUE TO WATER
C   R2ATE   LEASE RATE IN PERCENT
C   T2CR    TAX CREDIT RATE IN PERCENT
C   CONCU   ANNUAL COPPER PRODUCTION - POST CONCENTRATOR
C   CONMO   ANNUAL TONS OF MOLYBDENUM RECOVERED
C   GROSA   ANNUAL INCOME FROM COPPER PRODUCTION
C   GROSE   ANNUAL INCOME FROM MOLY PRODUCTUON
C   TRANCU  ANNUAL TRANSPORT COST FOR CU ORE TO SMELTER
C   TRANMO  ANNUAL TRANSPORT COST FOR MO ORE TO SMELTER
C   TROY    ANNUAL TOTAL ROYALTY
C   TSALE   TOTAL ANNUAL SALES
C   TCNA    TOTAL ANNUAL TAANSPORT COSTS
C   GROSS   GROSS INCOME FROM MINING
C   TMINC   TOTAL ANNUAL MINING COST
C   TSTRIP  TOTAL ANNUAL STRIPPING COST
C   TGEN    TOTAL ANNUAL GENERAL AND ADMINISTRATIVE EXPENSE
C   TMILL   TOTAL ANNUAL MILLING COSTS
C   TOPER   TOTAL ANNUAL OPERATING COSTS
C   TCED    TOTAL ANNUAL CAPITAL EXPENDITURES
C   TNPRC   TOTAL ANNUAL CAPITAL EXPENDITURES FOR DEPRECIATION
C   TNET    ANNUAL NET OPERATING INCOME
C   DEPRA   TOTAL OF DEPRECIATION ACCOUNT
C   PREDEP  ANNUAL PREDEPLETION INCOME
C   DEPLE   ANNUAL BASE FOR DEPLETION ON GROSS INCOME
C   BBNET   50 PERCENT OF PREDEPLETION INCOME
C   RBASE   ANNUAL BASE FOR CALCULATING LEASE  PAYMENT
C   RPIS    ANNUAL LEASE PAYMENT
C   TAXIN   ANNUAL PRE-TAX INCOME
C   FIT     ANNUAL FEDERAL INCOME TAX PAID
C   PROF    ANNUAL AFTER-TAX PROFIT
C   CFOPS   ANNUAL CASH FLOW FROM OPERATIONS
```

```
C    CF       ANNUAL CASH FLOW
C    CRED     ANNUAL CREDIT FOR EXCESS LEASE PAYMENT
C    TCRE     TOTAL CREDITS AVAILABLE FROM EXCESS LEASE PAYMENTS
C    TCCR     MAXIMUM CREDIT THAT CAN BE RECOVERED IN ANY YEAR
C    CISUM    ANNUAL TOTAL OF LEASE PAYMENTS
C    SOUT     ANNUAL NEGATIVE CASH FLOWS
C    RIN      ANNUAL POSITIVE CASH FLOWS
C    SSIN     SUM POSITIVE CASH FLOWS
C    SSOUT    SUM NEGATIVE CASH FLOWS
C    CCSUM    SUM OF LEASE PAYMENTS WITH NEW SCHEME
C*****************************************************************
C
         NP=0
         READ(IPT,4) HEAD
4        FORMAT(20A4)
         READ(IPT,5)NOPRE,LIFE,NSTART,TXCR,RRATE,NOPT,NROR
 5       FORMAT(3I5,F10.0,F5.2,I1,I1)
         READ(IPT,8)PRCCU,RCOVC,PCNCU,CCUGR,DEPRTC
         READ(IPT,8)PRCMO,RCOVM,PCNMO,CMOGR,DEPRTM
         READ(IPT,8)FMINR,FMNYE,BONUS,ROR,FITR,RTNEW
         LIFT = NOPRE + LIFE
C***READ IN OPERATING COSTS
         READ(IPT,8)CMINE,CSTRIP,CGEN,CMILL,CTRANS,CTREAT
C***READ IN INVESTMENT AND PRODUCTION DATA FOR EACH YEAR
         DO 10 J=1,LIFT
         READ(IPT,8)DMINE(J),DMILL(J),DOTHR(J),EXPL(J)
         READ(IPT,8)PDORE(J),STRIP(J),GRCU(J),GRMO(J)
8        FORMAT(8F10.0)
10       CONTINUE
C***PRINT OUT INPUT DATA HERE
         WRITE(IOUT,20)HEAD
   20    FORMAT(1H1,20A4)
         WRITE(IOUT,30)NOPRE,LIFE,PRCCU,PRCMO
   30    FORMAT(' NO OF PREPRODUCTION YEARS',T30,I5,/,' LIFE OF
     1      MINE',T30,I5,/,
     2'  PRICE OF COPPER',T30,F5.2,/,' PRICE OF MOLY ',T30,F5.2)
         DPRTC2=DEPRC*100
         DPRTM2=DEPRTM*100
         WRITE(IOUT,45)DPRTC2,DPRTM2
   45    FORMAT('DEPLETION RATE FOR COPPER',T30,F5.2,'PERCENT',/,
     1   ' DEPLETION RATE FOR MOLY',T30,F5.2,'PERCENT',/)
         WRITE(IOUT,40)RCOVC,PCNCU,CCUGR,RCOVM,PCNMO,CMOGR
   40    FORMAT(' MILL RECOVERY FOR COPPER',T30,F5.2,/,
     1    ' POST CONC RECOVERY (CU)',T30,F5.2,/,
     4    ' CONCENTRATE GRADE (CU)',T30,F5.2,/,
     2    ' MILL RECOVERY FOR MOLYBDENUM',T30,F5.2,/,
     3    ' POST CONC RECOVERY (MO)',T30,F5.2,/,
     5            ' CONCENTRATE GRADE (MO)',T30,F5.2)
         WRITE(IOUT,50)CMINE,CSTRIP,CGEN,CMILL,CTRANS,CTREAT
   50    FORMAT(' UNIT COSTS',/,' MINING COST',T30,F5.2,/,
     1    ' STRIPPING COST',T30,F5.2,/,' GENERAL COST',T30,F5.2,
     2     /,' CONCENTRATING COST',T30,F5.2,/,' TRANSPORTATION COSTS',
     3    T30,F5.2,/,' TREATMENT COSTS',T30,F5.2)
         R2ATE=RRATE*100.
         T2CR=TXCR*100.
         FITR2=FITR*100
         RNEW2=RTNEW*100
         GO TO (60,70,80,90,100,110,114,117)NOPT
   60    WRITE(IOUT,65)R2ATE
   65    FORMAT(/,'ROYALTY SCHEME',T30,F5.2,'   NET SMELTER RETURN',/)
         GO TO 115
```

```
   70    WRITE(IOUT,75)R2ATE
   75    FORMAT(/,'ROYALTY SCHEME ;',T30,F5.2,'   PRE  DEPLETION',/)
         GO TO 115
   80    WRITE(IOUT,85)R2ATE
   85    FORMAT(/,' ROYALTY SCHEME :',T30,F5.2,'   PRE TAX INCOME',/)
         GO TO 115
   90    WRITE(IOUT,95)R2ATE
   95    FORMAT(/,' ROYALTY SCHEME :',T30,F5.2,'   PRE TAX ROYALTY ',/)
         GO TO 115
  100    WRITE(IOUT,105)R2ATE
  105    FORMAT(/,' ROYALTY SCHEME :',T30,F5.2,'   AFTER TAX ROYALTY',/)
         GO TO 115
  110    WRITE(IOUT,113)R2ATE
  113    FORMAT(/,'ROYALTY SCHEME :',T30,F5.2,'  CASH FLOW ROYALTY',/)
         GO TO 115
  114    WRITE(IOUT,116)R2ATE
  116    FORMAT(/,' ROYALTY SCHEME :',T30,F5.2,'  AFTER TAX INCOME',/)
         GO TO 115
  117    WRITE(IOUT,118)R2ATE
  118    FORMAT(/,'ROYALTY SCHEME :',T30,F5.2,'  NET CASH FLOW',/)
         GO TO 115
  115    CONTINUE
         WRITE(IOUT,120)FMINR,FMNYE,BONUS,RNEW2
  120    FORMAT(' MINIMUM ROYALTY',T30,F10.0,/,
     1   ' YEARS TO RECOVER RYLTY CRDT',T30,F5.2,/,
     2   ' BONUS PAYMENT',T30,F5.2,/,
     3   ' LEASE RATE AFTER 15 DCFROI ',T30,F5.2,/)
         IF(NOPT.EQ.0)GO TO 132
         IF(NOPT.EQ.9)GO TO 132
         GO TO 134
  132    WRITE(IOUT,133)NOPT
  133    FORMAT(' WARNING NO LEASING SCHEME SELECTED, NOPT=',I1)
  134    CONTINUE
         WRITE(IOUT,130)FITR2,T2CR
  130    FORMAT(' FEDERAL INCOME TAX',T30,F5.2,/,
     1    ' INVESTMENT TAX CREDIT',T30,F5.2,/)
         IF(NROR.GT.1)GO TO 121
         IF(NROR.EQ.0)GO TO 121
         WRITE(IOUT,122)ROR
  122    FORMAT(' MIN ROR SET AT  =',T30,F10.4,/)
  121    CONTINUE
C***CALCULATE COPPER AND MOLY  PRODUCTION ON A YEARLY BASIS
         DO 140  I = NPEND,LIFT
         CONCU(I) = PDORE(I)*GRCU(I)*RCOVC*PCNCU/100.
         CONMO(I) = PDORE(I)*GRMO(I)*RCOVM*PCNMO/100.
  140     CONTINUE
C***CALCULATE INCOME FROM COPPER AND MOLY
         DO 150 I =NPREND,LIFT
         GROSA(I) =CONCU(I)*2000.*PRCCU
         TRANCU(I) =CONCU(I)*CTRANS*WATER/CCUGR/PCNCU
C        TRANMO(I) =CONMO(I)*CTRANS*WATER/CMOGR/PCNMO
         TREAT(I)=CONCU(I)*2000.*CTREAT
         GROSE(I) = CONMO(I)*2000.*PRCMO*.60
  150    CONTINUE
C*** CHECK TO SEE IF NSR ROYALTY
         IF(NOPT.GT.1)GO TO 160
C***CALCULATE NSR ROYALTY AND ADD IN COSTS
         DO 155 I=1,LIFT
         TROY(I) = (GROSE(I) +GROSA(I)-TREAT(I)-TRANCU(I))*RRATE
         ROYCU(I)=(GROSA(I)-TRANCU(I)-TREAT(I))*RRATE
         ROYMO(I)=(GROSE(I))*RRATE
```

```
  155   CONTINUE
        DO 156 I=1,LIFT
        RPIS(I)=TROY(I)
        DO 158 II=1,I
        CISUM(I)=CISUM(I)+TROY(II)
  158   CONTINUE
  156   CONTINUE
  160   CONTINUE
C
C*** PUT OTHER ROYALTIES INTO CORRECT POSITION ON INCOME STATEMENT
  999   CONTINUE
C***WRITE OUT ROYALTY PAID
        WRITE(IOUT,162)
  162   FORMAT(3X,'GROSE',15X,'TROY',15X,'GROSS')
C***CALCULATE GROSS INCOME FROM MINING
C
C
        DO 170 I = 1,LIFT
        TSALE(I) = GROSE(I) + GROSA(I)
        TCNA(I) =TRANCU(I) +TRANMO(I)
        GROSS(I)=TSALE(I)-TREAT(I)-TRANCU(I)-TRANMO(I)-TROY(I)
C        WRITE(IOUT,153)GROSE(I),TROY(I),GROSS(I)
  153   FORMAT(3(F10.0,10X))
  170      CONTINUE
C***CALCULATE OPERATING COSTS
        DO 180 I = NPEND,LIFT
        TMINC(I) = PDORE(I)*CMINE
        TSTRIP(I) = STRIP(I)*CSTRIP
        TGEN(I)=PDORE(I)*CGEN
        TMILL(I)=PDORE(I)*CMILL
        TOPER(I)=TMINC(I)+TSTRIP(I)+TGEN(I)+TMILL(I)
  180   CONTINUE
C***START WITH INVESTMENT ACCOUNTS NOW
C***     TOTAL UP NET PREPROD CAPITAL EXPENDITURES
        DO 190 I = 1,LIFT
        TCED(I) = DMINE(I) + DMILL(I) +DOTHR(I)
        TNPRC(I) = TCED(I)
  190   CONTINUE
        DO 200 I=1,LIFT
        TAXCR(I) = TCED(I)*TXCR
  200   CONTINUE
C***TOTAL UP INVESTMENT INTO DEPRECIATION ACCOUNTS
        DO 210 I=1,NOPRE
        AMT = TNPRC(I)*.3333
        DO 210 J = 1+NOPRE,20+NOPRE
        DEPRA(J) = DEPRA(J) + AMT/20.
  210   CONTINUE
        DO 220 I = 1,NOPRE
        AMT =TNPRC(I)*.6666
        L=0
        DO 220 J=1+NOPRE,10+NOPRE
        L=L+1
        K=11-L
        DEPRA(J)=DEPRA(J) +K*AMT/55.
  220   CONTINUE
        DO 230 I=NOPRE+1,LIFT
        AMT =TNPRC(I)
        DO 230 J=1,10
        K=11-J
        DEPRA(I+J-1)=DEPRA(I+J-1) +K*AMT/55.
  230   CONTINUE
```

```
C***START CASH FLOW COMPUTATION
        DO 240 I = 1,LIFT
C       TROY(I) = ROYCU(I) + ROYMO(I)
C***CALCULATE NET OPERATING INCOME
        TNET(I) = GROSS(I) -TOPER(I)-EXPL(I)
C***CALCULATE NET INCOME BEFORE DEPLETION
        PREDEP(I) = TNET(I) -DEPRA(I)
  240   CONTINUE
C***CHECK TO SEE IF PRE DEPLETION SCHEME OR MINIMUM RATE OF RETURN
        IF(NOPT.EQ.2)GO TO 250
        GO TO 260
  250   CONTINUE
        WRITE(IOUT,255)
  255   FORMAT('PREDEP(I)',4X,'RPIS(I)',7X,'RBASE(I)')
        DO 270 I=1,LIFT
        RBASE(I)=PREDEP(I)
  270   CONTINUE
        CALL ROYAL(RPIS,CISUM)
        DO 280 I=1,LIFT
        PREDEP(I)=PREDEP(I)-RPIS(I)
        ROYCU(I)=RPIS(I)
C       WRITE(IOUT,290)PREDEP(I),RPIS(I),RBASE(I)
  290   FORMAT(3(F10.0,10X))
  280   CONTINUE
  260   CONTINUE
C****CHECK TO SEE IF PRE-TAX,AFTER-TAX,OR CASH FLOW WITH RETURN ROYALTY
        IF(NOPT.EQ.4)GO TO 300
        IF(NOPT.EQ.5) GO TO 300
        IF(NOPT.EQ.6) GO TO 300
        GO TO 310
  300   CONTINUE
        CALL RTNRTY
        WRITE(IOUT,320)
  320   FORMAT(3X,'TROY',15X,'PREDEP',14X,'TAXIN')
        DO 330 I=1,LIFT
C       WRITE(IOUT,340)TROY(I),PREDEP(I),TAXIN(I)
  340   FORMAT(3(F10.0,10X))
  330   CONTINUE
        GO TO 9999
  310   CONTINUE
C***CALCULATE DEPLETION
        CALL DEPLT(DEPLE)
 9999   CONTINUE
C
CC***CALCULATE PRE TAX NET INCOME
        DO 350 I=1,LIFT
        TAXIN(I) = PREDEP(I) -DEPLE(I)
  350   CONTINUE
C***CHECK IF PRE-TAX INCOME PAYMENT SCHEME
C
        IF(NOPT.EQ.3)GO TO 342
        GO TO 344
  342   CONTINUE
        DO 346 I=1,LIFT
        RBASE(I)=TAXIN(I)
  346   CONTINUE
        CALL ROYAL(RPIS,CISUM)
        DO 348 I=1,LIFT
        TAXIN(I)=TAXIN(I)-RPIS(I)
  348   CONTINUE
  344   CONTINUE
```

```
C
C       WRITE(IOUT,360)III,CFIS(I),CRED(I),MINR,CFIS(I),
C      1  TCRE(I),TCCR(I)
C  360  FORMAT(3X,'III',6X,'CFIS(I)',3X,'CRED(I)',5X,'MINR',4X,'CFIS(I)',
C      1 3X,'TCRE(I)',3X,'TCCR(I)')
C
C***CALCULATE INCOME TAX
C
        DO 370 I = 1,LIFT
        FIT(I) =FITR*TAXIN(I)
        FIT(I) =FIT(I)-TAXCR(I)
        PROF(I) = TAXIN(I) -FIT(I)
  370   CONTINUE
C
C***TO CHECK IF  AFTER TAX SCHEME
C
        IF(NOPT.EQ.7)GO TO 380
        GO TO 390
  380   CONTINUE
        DO 400 I=1,LIFT
        RBASE(I)=PROF(I)
  400   CONTINUE
        CALL ROYAL(RPIS)
        DO 410 I=1,LIFT
        PROF(I)=PROF(I)-RPIS(I)
C       WRITE(IOUT,420)PROF(I),RPIS(I)
  420   FORMAT(2(F10.0,10X))
  410   CONTINUE
  390   CONTINUE
C
C***CALCULATE CASH FLOW FROM OPERATIONS
C
        DO 430 I=1,LIFT
        CFOPS(I) =PROF(I)+DEPLE(I)+DEPRA(I)
        CF(I) = CFOPS(I) -TNPRC(I)
  430   CONTINUE
        IF(NOPT.EQ.8)GO TO 440
        GO TO 490
  440   CONTINUE
C       WRITE(IOUT,450)
  450   FORMAT(3X,'CF(I)',15X,'RPIS(I)')
        DO 460 I=1,LIFT
        RBASE(I)=CF(I)
  460   CONTINUE
        CALL ROYAL(RPIS,CISUM)
        DO 470 I=1,LIFT
        CF(I)=CF(I)-RPIS(I)
C       WRITE(IOUT,480)CF(I),RPIS(I),RBASE(I)
  480   FORMAT(2(F10.0,10X))
  470   CONTINUE
  490   CONTINUE
        IF(NROR.EQ.1) CALL MINROR(RPIS,CISUM)
C
C***CALCULATE RATE OF RETURN--DISCOUNTED
C
        CALL DCFROI(CF,RATE,LIFT,IOUT)
        CALL OUTPUT
  650   CONTINUE
        STOP
        END
```

```
C*********************************************************************
C
      SUBROUTINE DEPLT
      COMMON /PROD/PDORE(40),CONCU(40),CONMO(40),GRCU(40),GRMO(40),
     1DMINE(40),DMILL(40),DOTHR(40),TCED(40),TPRC(40),
     2TNPRC(40),TSALE(40),EXPL(40),STRIP(40)
      COMMON /EX/DEPRA(40),DEPLE(40),TAXCR(40),TROY(40),TNET(40),
     1  CISUM(40),RPIS(40),RBASE(40),
     2  CRED(40),TCRE(40),TCCR(40),
     3  RIN(60),SOUT(60),SSIN(60),SSOUT(60),
     4  A,III
      COMMON /REV/GROSA(40),GROSE(40),GROSS(40),TAXIN(40),
     1  FIT(40),PROF(40),CFOPS(40),CF(40),PREDEP(40),TRANCU(40),
     2     TRANMO(40),TREAT(40),ROYCU(40),ROYMO(40),TCNA(40),
     3  TSTRIP(40),TGEN(40),TMILL(40),TOPER(40),TMINC(40)
      COMMON /CONST/IOUT,HEAD(20),LIFT,NSTART,RATE,PRCCU,PRCMO,
     1   RCOVC,RCOVM,PCNCU,PCNMO,
     2  FMINP,RRATE,FMNYE,NOPT,BONUS,NFLG,NROR,ROR,
     3  FITR,DEPRTC,DEPRTM,RTNEW

C     CALCULATE DEPLETION
      DO 105 J = 1,LIFT
      DEPLE(J)=DEPRTC*(GROSA(J)-TRANCU(J)-TREAT(J)-ROYCU(J))+
     1  DEPRTM*(GROSE(J)-TRANMO(J)-ROYMO(J))
      BBNET = .5*PREDEP(J)
      IF(DEPLE(J).GT.BBNET) DEPLE(J)=BBNET
      IF(DEPLE(J).LT.0.0) DEPLE(J) =0.0
105   CONTINUE
      RETURN
      END
C
C*********************************************************************
C
      SUBROUTINE ROYAL
      COMMON /PROD/PDORE(40),CONCU(40),CONMO(40),GRCU(40),GRMO(40),
     1DMINE(40),DMILL(40),DOTHR(40),TCED(40),TPRC(40),
     2TNPRC(40),TSALE(40),EXPL(40),STRIP(40)
      COMMON /EX/DEPRA(40),DEPLE(40),TAXCR(40),TROY(40),TNET(40),
     1  CISUM(40),RPIS(40),RBASE(40),
     2  CRED(40),TCRE(40),TCCR(40),
     3  RIN(60),SOUT(60),SSIN(60),SSOUT(60),
     4  A,III
      COMMON /REV/GROSA(40),GROSE(40),GROSS(40),TAXIN(40),
     1  FIT(40),PROF(40),CFOPS(40),CF(40),PREDEP(40),TRANCU(40),
     2     TRANMO(40),TREAT(40),ROYCU(40),ROYMO(40),TCNA(40),
     3  TSTRIP(40),TGEN(40),TMILL(40),TOPER(40),TMINC(40)
      COMMON /CONST/IOUT,HEAD(20),LIFT,NSTART,RATE,PRCCU,PRCMO,
     1   RCOVC,RCOVM,PCNCU,PCNMO,
     2  FMINR,RRATE,FMNYE,NOPT,BONUS,NFLG,NROR,ROR,
     3  FITR,DEPRTC,DEPRTM,RTNEW

      WRITE(IOUT,503)
503   FORMAT('RPIS(I)    RBASE(I)  CRED(I)   TCRE(I)
     1TCCR(I)   CISUM(I)')
C     WRITE(IOUT,501)RRATE,FMINR,FMNYE
501   FORMAT('RRATE =',F10.3,/,'FMINR =',F10.0,/,
     1  'FMNYE =',F10.3,/)
      DO 500 I=1,LIFT
       RPIS(I)=RBASE(I)*RRATE
C     WRITE(IOUT,502)RPIS(I),RBASE(I)
502   FORMAT(2(F10.0))
```

```
      IF(RPIS(I).GT.0)GO TO 510
      RPIS(I)=0.0
  510 CONTINUE
C     GO TO 1000
C***CHECK IF MINIMUM PAYMENT SATISFIED
      IF(RPIS(I).GT.FMINR)GO TO 520
      CRED(I)=CRED(I-1)+FMINR-RPIS(I)
      RPIS(I)=FMINR
C     WRITE(IOUT,504)RPIS(I),CRED(I)
  504 FORMAT(F10.0,10X,F10.0)
      GO TO 540
  520 CONTINUE
C
C***CHECK TO SEE IF ALL CREDITS RECOVERED
C
      TCRE(I)=CRED(I-1)+FMINR
      IF(RPIS(I).GT.TCRE(I))GO TO 550
C
C***CALCULATE PAYMENT ALLOWING FOR PREPAYMENTS AND MIN PAYMENT
      TCCR(I)=CRED(I-1)/FMNYE
      RPIS(I)=RPIS(I)-TCCR(I)
      IF(RPIS(I).GT.FMINR)GO TO 551
      CRED(I)=CRED(I-1)+FMINR-RPIS(I)-TCCR(I)
      RPIS(I)=FMINR
      GO TO 552
  551 CONTINUE
      CRED(I)=CRED(I-1)-TCCR(I)
  552  CONTINUE
C     WRITE(IOUT,505)RPIS(I),CRED(I),TCRE(I)
  505 FORMAT(F10.0,10X,2(F10.0))
      GO TO 540
  550 CONTINUE
C
C***CALCULATE PAYMENT AFTER CREDITS FROM PREPAYMENTS ALLOWED FOR
C
      TCCR(I)=CRED(I-1)/FMNYE
      RPIS(I)=RPIS(I)-TCCR(I)
      CRED(I)=CRED(I-1)-TCCR(I)
C     WRITE(IOUT,506)RPIS(I),CRED(I),TCRE(I),TCCR(I)
  506 FORMAT(F10.0,10X,3(F10.0))
  540 CONTINUE
  500 CONTINUE
C***SUM UP PAYMENTS
      DO 560 I=1,LIFT
      DO 570 II=1,I
      CISUM(I)=CISUM(I)+RPIS(II)
  570 CONTINUE
      WRITE(IOUT,507)RPIS(I),RBASE(I),CRED(I),TCRE(I),
     1 TCCR(I),CISUM(I)
  507 FORMAT(6(F10.0))
  560 CONTINUE
      RETURN
      END
C
C*****************************************************************
C
      SUBROUTINE RTNRTY
C   THESE VARIABLES ARE USED IN SUBROUTINE RTNRTY
C   THE LEASE PAYMENT IS EITHER DEDUCTED FROM THE  GROSS INCOME OR THE
C   PREDEPLETION INCOME TO CALCULATE THE DEPLETION BASE
C   THIS SUBROUTINE ONLY GOOD FOR ONE MINERAL.A SCHEME TO
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C    CALCULATE THE PAYMENT FOR TWO MINERALS WOULD REQUIRE
C    TWICE AS MANY VARIABLES AS THIS SUBROUTINE IF THE
C    DEPLETION ALLOWANCE IS CALCULATED BY TREATING THE LEASE
C    PAYMENTS AS A COST FOR DEPLETION.
C    RB       ESTIMATED LEASE PAYMENT(USED PREDEPLETION INC FOR DEPLE.)
C    RD       ESTIMATED LEASE PAYMENT (USED GROSS INC. FOR DEPLETION)
C    GROSB    GROSS INC FROM MINING (USED PREDEPLETION INC. FOR DEPLE.)
C    GROSD    GROSS INCOME FROM MINING (USED GROSS INC DEPLETION)
C    TNETB    OPERATING INCOME   USED PREDEPLETION INC. FOR DEPLE.)
C    TNETD    OPERATING INCOME (USED GROSS INC. FOR DEPLETION)
C    PTNIB    PREDEPLETION INCOME(USED PREDEPLETION INC FOR DEPLE.)
C    PTNID    PREDEPLETION INCOME(USED GROSS INC. FOR DEPLETION)
C    TAXIB    PRETAX INCOME (USED PREDEPLETION INC FOR DEPLE.)
C    TAXID    PRE-TAX INCOME (USED GROSS INC FOR DEPLETION)
C    FITB     FEDERAL INCOME TAX(USED PREDEPLETION INC FOR DEPLE.)
C    FITD     FEDERAL INCOME TAX (USED GROSS INC. FOR DEPLETION)
C    PROFB    NET PROFITS (USED PREDEPLETION INC FOR DEPLE.)
C    PROFD    NET PROFITS (USED GROSS INC FOR DEPLETION)
C    CFOPD    CASH FLOW FROM OPERATNS(USED PREDEPLETION INC FOR DEPLE.)
C    CFOPD    CASH FLOW FROM OPERATIONS(USED GROSS INC FOR DEPLETION)
C    CFB      CASH FLOW (USED PREDEPLETION INC. FOR DEPLE.)
C    CFD      CASH FLOW (USED GROSS INC FOR DEPLETION)
         COMMON /PROD/PDORE(40),CONCU(40),CONMO(40),GRCU(40),GRMO(40),
     1DMINE(40),DMILL(40),DOTHR(40),TCED(40),TPRC(40),
     2TNPRC(40),TSALE(40),EXPL(40),STRIP(40)
         COMMON /EX/DEPRA(40),DEPLE(40),TAXCR(40),TROY(40),TNET(40),
     1    CISUM(40),RPIS(40),RBASE(40),
     2   CRED(40),TCRE(40),TCCR(40),
     3   RIN(60),SOUT(60),SSIN(60),SSOUT(60),
     4   A,III
         COMMON /REV/GROSA(40),GROSE(40),GROSS(40),TAXIN(40),
     1    FIT(40),PROF(40),CFOPS(40),CF(40),PREDEP(40),TRANCU(40),
     2       TRANMO(40),TREAT(40),ROYCU(40),ROYMO(40),TCNA(40),
     3   TSTRIP(40),TGEN(40),TMILL(40),TOPER(40),TMINC(40)
         COMMON /CONST/IOUT,HEAD(20),LIFT,NSTART,RATE,PRCCU,PRCMO,
     1     RCOVC,RCOVM,PCNCU,PCNMO,
     2   FMINR,RRATE,FMNYE,NOPT,BONUS,NFLG,NROR,ROR,
     3   FITR,DEPRTC,DEPRTM,RTNEW
         DIMENSION BNET(40),PTNID(40),PTNIB(40),TAXID(40),
     1   TAXIB(40),FITD(40),FITB(40),PROFD(40),PROFB(40),
     2   CFOPD(40),CFOPB(40),RD(40),RB(40),GROSD(40),GROSB(40),
     3   TNETD(40),TNETB(40),PREDPD(40),PREDPB(40),CFD(40),CFB(40)
         DO 600 I=1,LIFT
C***CALCULATE DEPLETION
         DEPLE(I)=DEPRTC*(GROSA(I)-TRANCU(I)-ROYCU(I))+
     1   DEPRTM*(GROSE(I)-TRANMO(I)-ROYMO(I))
         BNET(I)=.5*PREDEP(I)
         IF(DEPLE(I).LT.0.0)DEPLE(I)=0.0
         IF(BNET(I).LT.0)BNET(I)=0.0
         TAXID(I)=PREDEP(I)-DEPLE(I)
         TAXIB(I)=PREDEP(I)-BNET(I)
  600    CONTINUE
C***CHECK IF PRE-TAX INCOME SCHEME
         IF(NOPT.EQ.4)GO TO 610
         GO TO 620
  610    CONTINUE
C***CALCULATE TWO PAYMENTS ON PRETAX INCOME ACCORDING TO DEPLETION SCHEME
         DO 630 I=1,LIFT
         RD(I)=TAXID(I)*RRATE
         RB(I)=TAXIB(I)*RRATE
  630    CONTINUE
```

```
        GO TO 640
  620   CONTINUE
C***CALCULATE INCOME TAX
        DO 650 I=1,LIFT
        FITD(I)=FITR*TAXID(I)
        FITB(I)=FITP*TAXIB(I)
        FITD(I)=FITD(I)-TAXCR(I)
        FITB(I)=FITB(I)-TAXCR(I)
        PROFD(I)=TAXID(I)-FITD(I)
        PROFB(I)=TAXIB(I)-FITB(I)
  650   CONTINUE
C***CHECK FOR AFTER TAX SCHEME
        IF(NOPT.EQ.5)GO TO 660
        GO TO 670
  660   CONTINUE
        DO 680 I=1,LIFT
        RD(I)=PROFD(I)*RRATE
        RB(I)=PROFB(I)*RRATE
  680   CONTINUE
        GO TO 640
  670   CONTINUE
        DO 690 I=1,LIFT
        CFOPD(I)=PROFD(I)+DEPLE(I)+DEPRA(I)
        CFOPB(I)=PROFB(I)+BNET(I)+DEPRA(I)
        CFD(I)=CFOPD(I)-TNPRC(I)
        CFB(I)=CFOPB(I)-TNPRC(I)
        RD(I)=CFD(I)*RRATE
        RB(I)=CFB(I)*PRATE
  690   CONTINUE
  640   CONTINUE
        DO 695 I=1,LIFT
        IF(RD(I).LT.0)RD(I)=0.0
        IF(RB(I).LT.0)RB(I)=0.0
  695   CONTINUE
C
C***SEND BACK TO CORRECT PLACE FOR ROYALTY IN PRO FORMA STATEMENT
C
C***CALCULATE ALL THROUGH  STATEMENT AGAIN --UP TO DEPLETION
        DO 700 I=1,LIFT
        GROSD(I)=GROSS(I)-RD(I)
        GROSB(I)=GROSS(I)-RB(I)
        TNETD(I)=GROSD(I)-TOPER(I)-EXPL(I)
        TNETB(I)=GROSB(I)-TOPER(I)-EXPL(I)
        PREDPD(I)=TNETD(I)-DEPRA(I)
        PREDPB(I)=TNETB(I)-DEPRA(I)
  700   CONTINUE
        DO 710 I=1,LIFT
        DEPLE(I)=DEPRTC*(GROSA(I)-TRANCU(I)-RD(I))
        IF(DEPLE(I).LE.0)DEPLE(I)=0.0
        BNET(I)=.5*(PREDPB(I))
        IF(BNET(I).LE.0)BNET(I)=0.0
        WRITE(IOUT,715)DEPLE(I),BNET(I),RD(I),RB(I)
  715   FORMAT(4(F10.0))
        IF(DEPLE(I).GT.BNET(I))GO TO 720
        TROY(I)=RD(I)
        GROSS(I)=GROSD(I)
        TNET(I)=TNETD(I)
        PREDEP(I)=PREDPD(I)
        GO TO 730
  720   CONTINUE
        TROY(I)=RB(I)
```

```
      GROSS(I)=GROSB(I)
      TNET(I)=TNETB(I)
      PREDEP(I)=PREDPB(I)
      DEPLE(I)=BNET(I)
  730 CONTINUE
  710 CONTINUE
      DO 740 I=1,LIFT
      DO 750 II=1,I
      CISUM(I)=CISUM(I)+TROY(II)
  750 CONTINUE
  740 CONTINUE
      RETURN
      END
C
C*************************************************************************
C
      SUBROUTINE MINPOR
      COMMON /PROD/PDORE(40),CONCU(40),CONMO(40),GRCU(40),GRMO(40),
     1DMINE(40),DMILL(40),DOTHR(40),TCED(40),TPRC(40),
     2TNPRC(40),TSALE(40),EXPL(40),STRIP(40)
      COMMON /EX/DEPRA(40),DEPLE(40),TAXCR(40),TROY(40),TNET(40),
     1  CISUM(40),RPIS(40),RBASE(40),
     2  CRED(40),TCRE(40),TCCR(40),
     3  RIN(60),SOUT(60),SSIN(60),SSOUT(60),
     4  A,III
      COMMON /REV/GROSA(40),GROSE(40),GROSS(40),TAXIN(40),
     1  FIT(40),PROF(40),CFOPS(40),CF(40),PREDEP(40),TRANCU(40),
     2     TRANMO(40),TREAT(40),ROYCU(40),ROYMO(40),TCNA(40),
     3  TSTRIP(40),TGEN(40),TMILL(40),TOPER(40),TMINC(40)
      COMMON /CONST/IOUT,HEAD(20),LIFT,NSTART,RATE,PRCCU,PRCMO,
     1  RCOVC,RCOVM,PCNCU,PCNMO,
     2  FMINR,RRATE,FMNYE,NOPT,BONUS,NFLG,NROR,ROR,
     3  FITR,DEPRTC,DEPRTM,RTNEW
      DIMENSION CCSUM(40)
C
C***SUBROUTINE TO WORK OUT NEW ROYALTY PAYMENT IF MIN DCFROI ACHIEVED
      ROR=1+ROR
      WRITE(IOUT,905)
  905 FORMAT(3X,'L',7X,'SOUT',7X,'RIN',7X,'SSIN',7X,'SSOUT')
      L=0.0
      DO 900 K=1,LIFT
      IF(CF(K).GT.0)GO TO 920
C***TO SUM UP NEGATIVE CASH FLOWS
      SOUT(K)=-CF(K)
      RIN(K)=0.0
      GO TO 930
  920 CONTINUE
C***TO SUM UP POSITIVE CASH FLOWS
      RIN(K)=CF(K)
      SOUT(K)=0.0
  930 CONTINUE
C***CHECK TO SEE IF REQUIRED DCFROI ACHIEVED
C
      L=L+1
C***DIVIDE BY DISCOUNT RATE
      A=(ROR**(L))
      RIN(L)=RIN(K)/A
      SOUT(L)=SOUT(K)/A
      WRITE(IOUT,940)L,SOUT(L),RIN(L)
  940 FORMAT(3(F10.0))
C***TO SUM UP DISCOUNTED PAYMENTS
```

```
        SSIN(L)=(SSIN(L-1)+RIN(L))
        SSOUT(L)=(SSOUT(L-1)+SOUT(L))
        WRITE(IOUT,950)L,SOUT(K),RIN(K),SSIN(K),SSOUT(K)
  950   FORMAT(5(F10.0))
C***CHECK TO SEE IF DCFROI ACHIEVED
        IF(III.EQ.1)GO TO 960
        IF(SSIN(L)-SSOUT(L).GT.0)GO TO 970
        III=0.0
        GO TO 960
  970   CONTINUE
        III=1
C
C***CALCULATE NEW SET OF ROYALTIES BECAUSE MIN ROR ACHIEVED
C
C***ASSIGN NEW ROYALTIES ACCORDING TO MODIFIED OLD SCHEMES
        GO TO (975,990,992,991,991,991,1050,1090)NOPT
C***CALCULATE NEW NSR ROYALTY
  975   CONTINUE
C
        DO 985 I=I,LIFT
        TROY(I+L)=(GROSA(I+L)-TREAT(I+L)-TRANCU(I+L))*RTNEW
        GROSS(I+L)=TSALE(I+L)-TREAT(I+L)-TRANCU(I+L)-TRANMO(I+L)
     1-TROY(I+L)
        TNET(I+L)=GROSS(I+L)-TOPER(I+L)-EXPL(I+L)
        PREDEP(I+L)=TNET(I+L)-DEPRA(I+L)
  985   CONTINUE
        GO TO 995
  990   CONTINUE
        DO 1015 I=1,LIFT
C***CALCULATE NEW PREDEPLETION PAYMENT
        PREDEP(I+L)=TNET(I+L)-DEPRA(I+L)
        RPIS(I+L)=PREDEP(I+L)*RTNEW
        PREDEP(I+L)=PREDEP(I+L)-RPIS(I+L)
 1015   CONTINUE
  995   CONTINUE
C***CALCULATE NEW DEPLETION ALLOWANCE
        DO 1020 I=1,LIFT
        DEPLE(I+L)=DEPRTC*(GROSA(I+L)-TRANCU(I+L)-TREAT(I+L)
     1-TROY(I+L)-RPIS(I+L))+DEPRTM*(GROSE(I+L)-TRANMO(I+L))
        BBNET=.5*(PREDEP(I+L))
        IF(DEPLE(I+L).GT.BBNET)DEPLE(I+L)=BBNET
        IF(DEPLE(I+L).LT.0.0)DEPLE(I+L)=0.0
 1020   CONTINUE
C***CALCUATE PRE-TAX INCOME
        DO 1030 I=1,LIFT
        TAXIN(I+L)=PREDEP(I+L)-DEPLE(I+L)
 1030   CONTINUE
C
        GO TO 994
  992   CONTINUE
C***CALCULATE NEW PRE-TAX PAYMENT
C
        DO 996 I=1,LIFT
        TAXIN(I+L)=PREDEP(I+L)-DEPLE(I+L)
        RPIS(I+L)=TAXIN(I+L)*RTNEW
        TAXIN(I+L)=TAXIN(I+L)-RPIS(I+L)
  996   CONTINUE
  994   CONTINUE
C
C***CALCULATE NEW INCOME TAX
C
```

```
        DO 998 I=1,LIFT
        FIT(I+L)=FITR*TAXIN(I+L)
        FIT(I+L)=FIT(I+L)-TAXCR(I+L)
        PROF(I+L)=TAXIN(I+L)-FIT(I+L)
  998   CONTINUE
        GO TO 1040
C***CALCULATE NEW AFTER TAX INCOME
 1050   CONTINUE
        DO 1060 I=1,LIFT
        PROF(I+L)=TAXIN(I+L)-FIT(I+L)
        RPIS(I+L)=PROF(I+L)*RTNEW
        PROF(I+L)=PROF(I+L)-RPIS(I+L)
 1060   CONTINUE
C***CALCULATE CASH FLOW
 1040   CONTINUE
        DO 1080 I=1,LIFT
        CFOPS(I+L)=PROF(I+L)+DEPLE(I+L)+DEPRA(I+L)
        CF(I+L)=CFOPS(I+L)-TNPRC(I+L)
 1080   CONTINUE
        GO TO 1100
C***CALCULATE NEW NET CASH FLOW PAYMENT*
 1090   CONTINUE
        DO 1110 I=1,LIFT
        CF(I+L)=CFOPS(I+L)-TNPRC(I+L)
        RPIS(I+L)=CF(I+L)*RTNEW
        CF(I+L)=CF(I+L)-RPIS(I+L)
 1110   CONTINUE
 1100   CONTINUE
C
C***TO SUM UP PAYMENTS
        DO 1214 I=1,LIFT
        CCSUM(I)=CCSUM(I-1)+RPIS(I)
 1214   CONTINUE
C
        GO TO 960
  991   CONTINUE
        WRITE(IOUT,1111)
 1111   FORMAT('ERROR IN DATA OPTIONS 3,4,5,6 DO NOT WORK
     1WITH THIS OPTION')
  960   CONTINUE
  900   CONTINUE
CC***SUM UP PAYMENTS
        DO 1160 I=1,LIFT
C       DO 1170 II=1,I
        CISUM(I)=CCSUM(I)
C 1170  CONTINUE
C
 1160   CONTINUE
        RETURN
        END
C
C*******************************************************************************
C
        SUBROUTINE OUTPUT
        COMMON /PROD/PDORE(40),CONCU(40),CONMO(40),GRCU(40),GRMO(40),
     1DMINE(40),DMILL(40),DOTHR(40),TCED(40),TPRC(40),
     2TNPRC(40),TSALE(40),EXPL(40),STRIP(40)
        COMMON /EX/DEPRA(40),DEPLE(40),TAXCR(40),TROY(40),TNET(40),
     1   CISUM(40),RPIS(40),RBASE(40),
     2  CRED(40),TCRE(40),TCCR(40),
     3  RIN(60),SOUT(60),SSIN(60),SSOUT(60),
```

```
     4   A,III
         COMMON /REV/GROSA(40),GROSE(40),GROSS(40),TAXIN(40),
     1    FIT(40),PROF(40),CFOPS(40),CF(40),PREDEP(40),TRANCU(40),
     2       TRANMO(40),TREAT(40),ROYCU(40),ROYMO(40),TCNA(40),
     3   TSTRIP(40),TGEN(40),TMILL(40),TOPER(40),TMINC(40)
         COMMON /CONST/IOUT,HEAD(20),LIFT,NSTART,RATE,PRCCU,PRCMO,
     1     RCOVC,RCOVM,PCNCU,PCNMO,
     2   FMINR,RRATE,FMNYE,NOPT,BONUS,NFLG,NPOR,ROR,
     3   FITR,DEPRTC,DEPRTM,RTNEW
         DIMENSION NYEAR(40)
C***OUTPUT PRODUCTION AND NET CAPITAL INVESTMENT INFORMATION
         DO 5 I=1,LIFT
    5    NYEAR(I) = NSTART + I-1
         NT=LIFT/10
         NT1 = NT*10
         IF(NT1.LT.LIFT) NT =NT +1
         DO 10 J = 1,NT
         K = J*10 -9
         L = J*10
         IF(L.GT.LIFT) L = LIFT
         WRITE(IOUT,85)HEAD
85       FORMAT(1H1,20A4)
         WRITE(IOUT,95)(NYEAR(I),I=K,L)
         WRITE(IOUT,100)(PDORE(I),I=K,L)
101      FORMAT(15X,' COPPER GRADE  ',10F10.4)
         WRITE(IOUT,101)(GRCU(I),I=K,L)
         WRITE(IOUT,102)(GRMO(I),I=K,L)
         WRITE(IOUT,245)(STRIP(I),I=K,L)
245      FORMAT(' OVERBURDEN: TONS',13X,10F10.0)
102      FORMAT(17X,' MOLY GRADE  ',10F10.4)
100      FORMAT(' ORE PRODUCTION: TONS',9X,10F10.0)
         WRITE(IOUT,105)(CONCU(I),I=K,L)
         WRITE(IOUT,106)(CONMO(I),I=K,L)
         WRITE(IOUT,110)(DMINE(I),I=K,L)
         WRITE(IOUT,111)(DMILL(I),I=K,L)
         WRITE(IOUT,112)(DOTHR(I),I=K,L)
95       FORMAT(25X,'YEAR ',10(6X,I4))
110      FORMAT(' CAPITALIZED EXPENDITURES',/,23X,' MINE',2X,10F10.0)
111      FORMAT(23X,' MILL',2X,10F10.0)
112      FORMAT(23X,' OTHER ',10F10.0)
105      FORMAT(' COPPER PRODUCTION:       TONS ',10F10.0)
106      FORMAT(' MOLYBDENMUM PRODUCTION: TONS ',10F10.0)
         WRITE(IOUT,125)(TCED(I),I=K,L)
121      FORMAT(23X,' TOTAL ',10F10.0)
         WRITE(IOUT,130)(TAXCR(I),I=K,L)
125      FORMAT(' TOTAL CAPITALIZED EXPENDITURE',10F10.0)
130      FORMAT(' INVESTMENT TAX CREDIT',8X,10F10.0)
10       CONTINUE
C***OUTPUT REVENUE AND OPERATING COST DATA
         DO 20 J = 1,NT
         K = J*10  -9
         L = J*10
         IF(L.GT.LIFT) L = LIFT
         WRITE(IOUT,85)HEAD
         WRITE(IOUT,95)(NYEAR(I),I=K,L)
         WRITE(IOUT,140)(GROSA(I),I=K,L)
140      FORMAT(' NET SALES',/,22X,' COPPER ',
     1    10F10.0)
         WRITE(IOUT,145)(GROSE(I),I=K,L)
145      FORMAT(18X,' MOLYBDENUM ',10F10.0)
         WRITE(IOUT,143)(TSALE(I),I=K,L)
```

```
143     FORMAT(' TOTAL NET SALES',14X,10F10.0)
        WRITE(IOUT,166)(TROY(I),I=K,L)
166     FORMAT(' LESS:',14X,'ROYALTIES ',10F10.0)
        WRITE(IOUT,142)(TCNA(I),I=K,L)
142     FORMAT(9X,'TRANSPORTATION COSTS ',10F10.0)
        WRITE(IOUT,244)(TREAT(I),I=K,L)
244     FORMAT(14X,'TREATMENT COSTS ',10F10.0)
        WRITE(IOUT,150)(GROSS(I),I=K,L)
150     FORMAT(' GROSS INCOME FROM MINING',5X,10F10.0)
        WRITE(IOUT,155)(TMINC(I),I=K,L)
155     FORMAT(' LESS OPERATING COSTS',/,16X,' MINING COSTS ',10F10.0)
        WRITE(IOUT,156)(TSTRIP(I),I=K,L)
156     FORMAT(13X,' STRIPPING COSTS ',10F10.0)
157     FORMAT(15X,' MILLING COSTS ',10F10.0)
        WRITE(IOUT,170)(TGEN(I),I=K,L)
        WRITE(IOUT,157)(TMILL(I),I=K,L)
170     FORMAT(15X,' GENERAL COSTS ',10F10.0)
        WRITE(IOUT,161)(TNET(I),I=K,L)
161     FORMAT(' NET OPERATING INCOME',9X,10F10.0)
        WRITE(IOUT,177)(DEPRA(I),I=K,L)
177     FORMAT(16X,' DEPRECIATION ',10F10.0)
C
C***CHECK IF PREDEPLETION LEASE PAYMENT
C
        IF(NOPT.EQ.2)GO TO 400
        GO TO 410
  400   WRITE(IOUT,420)(RPIS(I),I=K,L)
  420   FORMAT(' PREDEPLETION PAYMENT',9X,10F10.0)
  410   CONTINUE
C
        WRITE(IOUT,178)(PREDEP(I),I=K,L)
178     FORMAT(' PRE-DEPLETION NET INCOME'5X,10F10.0)
        WRITE(IOUT,180)(DEPLE(I),I=K,L)
180     FORMAT(14X,' LESS DEPLETION ',10F10.0)
C
C***CHECK IF PRE-TAX INCOME PAYMENT
C
        IF(NOPT.EQ.3)GO TO 491
        GO TO 492
  491   WRITE(IOUT,493)(RPIS(I),I=K,L)
  493   FORMAT(' PRE-TAX INCOME  PAYMENT',6X,10F10.0)
  492   CONTINUE
C
        WRITE(IOUT,185)(TAXIN(I),I=K,L)
185     FORMAT(' PRE-TAX NET INCOME'11X,10F10.0)
        WRITE(IOUT,195)(FIT(I),I=K,L)
195     FORMAT(5X,' LESS FEDERAL INCOME TAX ',10F10.0)
C***CHECK IF AFTER TAX PAYMENT
        IF(NOPT.EQ.7)GO TO 430
        GO TO 440
  430   WRITE(IOUT,450)(RPIS(I),I=K,L)
  450   FORMAT(' AFTER TAX PAYMENT',12X,10F10.0)
  440   CONTINUE
        WRITE(IOUT,200)(PROF(I),I=K,L)
200     FORMAT(' NET PROFIT',19X,10F10.0)
        WRITE(IOUT,210)(DEPRA(I),I=K,L)
205     FORMAT(19X,' DEPLETION',1X,10F10.0)
        WRITE(IOUT,205)(DEPLE(I),I=K,L)
210     FORMAT(' ADD BACK',7X,' DEPRECIATION',1X,10F10.0)
        WRITE(IOUT,215)(CFOPS(I),I=K,L)
215     FORMAT(' NET CASH FLOW FROM OPERS',5X,10F10.0)
```

```
      WRITE(IOUT,220)(TNPRC(I),I=K,L)
220   FORMAT(' LESS CAPITAL INVESTMENT',6X,10F10.0)
C
C***CHECK FOR PERCENTAGE OF CASH FLOW PAYMENT
C
      IF(NOPT.EQ.8)GO TO 480
      GO TO 481
  480 WRITE(IOUT,226)(RPIS(I),I=K,L)
  226 FORMAT(' CASH FLOW PAYMENT',12X,10F10.0)
  481 CONTINUE
      WRITE(IOUT,225)(CF(I),I=K,L)
225   FORMAT(' NET CASH FLOW',16X,10F10.0)
      WRITE (IOUT,228)(CISUM(I),I=K,L)
 228  FORMAT(1HO,'SUM OF INDIAN PAYMENTS',7X,10F10.0)
20    CONTINUE
      WRITE(IOUT,230) RATE
230   FORMAT(' DISCOUNTED CASH FLOW RATE OF RETURN =',F10.3,' :')
      RETURN
      END
C
C*************************************************************
C
C       THIS IS THE DISCOUNTED RATE OF RETURN CALMOLATION PROGRAM
      SUBROUTINE DCFROI(CF,DCFR,NTL,IOUT)
C     THIS SUBROUTINE COMPUTES DISCOUNTED CASH FLOW RATE OF RETURN
C     DISCOUNTED CASH FLOW IS DEFINED AS THE *DISCOUNT RATE* AT
C     WHICH TWO PRESENT WORTHS OF TOTAL POSITIVE AND NEGATIVE CASH FLOWS
C     ARE EQUAL
      DIMENSION PIN(60),POUT(60),CF(60)
      DIMENSION WORTH(6),TVEST(6),COMP(6)
      JTIME = NTL
      DO 65 KK = 1,JTIME
      IF(CF(KK)) 60,60,61
   60 POUT(KK) = -CF(KK)
      PIN(KK) = 0.0
      GO TO 65
   61 PIN(KK) = CF(KK)
      POUT(KK) = 0.0
   65 CONTINUE
C     BEGIN DISCOUNTED RATE OF RETURN COMPUTATION
C     INT=TRIAL DISCOUNT RATE ... NO FRACTIONAL PERCENTAGE
C     TOL=TOLERANCE BETWEEN POSITIVE AND NEGATIVE CASH FLOWS
C     KEY AND NKEY ARE SWITCHES FOR GOING THROUGH PROPER LOOP
C     R=(1.0+DISC)
C     PIN(I)=I-TH YEAR POSITIVE CASH IN
C     POUT(I)=I-TH YEAR NEGATIVE CASH OUTLAY
C     COMP(K)=DISCOUNT RATE BEING STORED FOR COMPARISON
C     WORTH(K)=TOTAL POSITIVE CASH FLOWS AT A GIVEN DISCOUNT RATE
C     TVEST(K)=TOTAL NEGATIVE CASH FLOWS AT A GIVEN DISCOUNT RATE
C     PCASH=FINAL,TOTAL POSITIVE CASH FLOW AT THE INTERNAL ROI RATE
C     TNCASH=FINAL TOTAL NEGATIVE CASH FLOW AT THE INTERNAL ROI RATE
C     ROI(L)=THE INTERNAL ROI FOR L-TH SIMULATION.
C
C     CHECK IF UNDISCOUNTED TOTAL POSITIVE CASH FLOW IS GREATER THAN TOTAL
C     NEGATIVE CASH FLOWS
C
      NEGROI=0
      SPIN=0.0
      SPOUT=0.0
      DO 1 I=1,JTIME
      SPIN=SPIN+PIN(I)
```

```
    1 SPOUT=SPOUT+POUT(I)
      IF(SPIN-SPOUT) 2,2,6
    2 WRITE(IOUT,101)
  101 FORMAT(  /10X,'THE VENTURE IS NOT WORTH CONSIDERATION')
      ROI = -0.0
      NEGROI=NEGROI+1
      GO TO 99
C
C
C     SET THE STARTING TRIAL DISCOUNT RATE AT 15 PERCENT
C
    6 INT=15
      TOL=100.0
      KEY=1
      NKEY=1
C
C     BEGINNING OF APPROXIMATE DISCOUNT RATE COMPUTATION
C
    7 DISC=FLOAT(INT)/100.0
C
C     UPPER AND LOWER LIMITS ON ROI ARE NOW BEING CHECKED.
C     FIRST CHECK IF LOWER LIMIT IS REACHED
C
      IF(DISC)45,46,47
   45 WRITE(IOUT,129)
      GO TO 99
   46 IF(NKEY-2)48,50,48
C
C     LOOP 49 INDICATES THAT LOWEST POSSIBLE R.O.I. IS ZERO
C
   49 ROI = 0.0
      GO TO 99
   48 IF(KEY-1)45,49,45
   50 IADD=1
      PCASH=SPIN
      TNCASH=SPOUT
      GO TO 18
C
C     CHECK IF UPPER LIMIT IS REACHED
C
   47 IF(DISC-1.5)31,31,32
C
   32 WRITE(IOUT,129)
  129 FORMAT(1H1,'LOGIC ERROR IN P.W. COMPUTATION')
      GO TO 99
   31 PP=1.0
      R=(1.0+DISC)
C
C     NOW COMPUTE PRESENT WORTH OF TOTAL POSITIVE AND NEGATIVE CASH
C     FLOWS
C
      PCASH=0.0
      DO 8 NK=1,JTIME
      PP=PP*R
    8 PCASH=PCASH+PIN(NK)/PP
      PP=1.0
      TNCASH=POUT(1)
      DO 9 NK=2,JTIME
      PP=PP*R
    9 TNCASH=TNCASH+POUT(NK)/PP
C
```

```
C      NOW COMPARE TOTAL POSITIVE CASH FLOWS WITH TOTAL NEGATIVE CASH
C      FLOWS
C
       IF(ABS(PCASH-TNCASH)-TOL)10,10,11
   10  ROI = INT
       GO TO 99
   11  IF(PCASH-TNCASH) 12,12,13
C
C
C      INCREASE INTEREST RATE FOR LOOP NO. 13 AND DECREASE FOR LOOP NO.12
C
   13  IF(KEY+NKEY-2)15,14,15
   14  KEY=2
   15  IF(NKEY-1)17,16,17
   16  INT=INT+5
       GO TO 7
   17  IADD=1
       GO TO 18
C
C      STATE NO. 18 IS THE LOOP FOR COMPUTING P.W. FOR 4 MORE TIMES
C
   12  IF(KEY+NKEY-2)20,19,20
   19  NKEY=2
   20  IF(KEY-1)22,21,22
   21  INT=INT-5
       GO TO 7
   22  IADD=-1
C
C      BEGINNING OF FINEP DISCOUNT RATE COMPUTATION
C
   18  WORTH(1)=PCASH
       TVEST(1)=TNCASH
       COMP(1)=INT
         TYPE 989,INT,TVEST(1),WORTH(1)
C
       DO 26 IC=2,6
   26  WORTH(IC)=0.0
       DO 23 IC =2,6
       INT=INT+IADD
       DINT=INT
       DISC=DINT/100.0
       PP=1.0
       R=(1.0+DISC)
C
       DO 24 NK=1,JTIME
       PP=PP*R
   24  WORTH(IC)=WORTH(IC)+PIN(NK)/PP
       PP=1.0
       TVEST(IC)=POUT(1)
       DO 25 NK=2,JTIME
       PP=PP*R
   25  TVEST(IC)=TVEST(IC)+POUT(NK)/PP
         TYPE 989,INT,TVEST(IC),WORTH(IC)
989      FORMAT(I5,2F10.0)
   23  COMP(IC)=INT
C
C      NOW BEGIN COMPARISON OF DIFFERENCES AMONG TOTAL NEGATIVE CASH
C      FLOWS AND TOTAL POSITIVE CASH FLOWS
C
       SMALL=ABS(WORTH(1)-TVEST(1))
       NT1=1
```

```
      SMAL2=ABS(WORTH(2)-TVEST(2))
      NT2=2
      IF(SMAL1-SMAL2)35,35,36
   36 STOR1=SMAL1
      NTOT1=NT1
      SMAL1=SMAL2
      NT1=NT2
      SMAL2=STOR1
      NT2=NTOT1
C
C     NARROW THE INTERVAL TO THE NEAREST PERCENT
C
   35 DO 30 IC=3,6
      DEL=ABS(WORTH(IC)-TVEST(IC))
      IF(SMAL1-DEL)37,37,38
   38 STOR2=SMAL1
      NTOT2=NT1
      SMAL1=DEL
      NT1=IC
C
      SMAL2=STOR2
      NT2=NTOT2
      GO TO 30
C
C     CHECK IF NEW DIFFERENCE *DEL* LIES IN BETWEEN
C
   37 IF(SMAL2-DEL)30,30,39
   39 SMAL2=DEL
      NT2=IC
   30 CONTINUE
C
C     ADD UP TOTAL DIFFERENCE IN PRESENT WORTH DUE TO ONE PERCENT
C     DIFFERENCE IN RATE
C
      DIFFER=SMAL1+SMAL2
      IF(COMP(NT1)-COMP(NT2))40,45,41
   40 ROIPER=COMP(NT1)+SMAL1/DIFFER
      GO TO 42
   41 ROIPER=COMP(NT1)-SMAL1/DIFFER
C
C     TRUNCATE COMPUTED ROI TO NEAREST TENTH OF ONE PERCENT
C
   42 PCASH=WORTH(NT1)
      TNCASH=TVEST(NT1)
      IROI=ROIPER*10.0
      ROI=FLOAT(IROI)/10.
C
   99 DCFR = ROI
        RETURN
      END
```

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