Circular 137
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Computer Program for Monte Carlo Economic Evaluation of a Mineral Deposit

by Ronald J. Roman and George W. Becker

New Mexico State Bureau of Mines and Mineral Resources

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by Ronald J. Roman and George W. Becker

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Socorro, 1973

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ABSTRACT

Raising capital to develop a mineral property depends largely upon good economic evaluations. The program outlined here is designed to help promoters take advantage of computer science in analyzing potential mineral areas. The New Mexico State Bureau of Mines and Mineral Resources provides computer time for running the program, and assistance in adapting the program to individual needs. Results of the economic evaluation, however, are only as good as the data provided for the evaluation. The importance of this aspect of the evaluation, therefore, is emphasized.

INTRODUCTION

Before any business venture can attract risk capital the promoter must demonstrate that this venture will yield a return on investment commensurate with the risk involved. The usual procedure has been to prepare an estimated cash flow statement for the business venture listing all incomes and expenditures for the life of the venture, and to calculate a return on investment (ROI) for the venture.

In addition to an estimated cash flow statement a sensitivity analysis is usually included in the report. The sensitivity analysis shows the changes in ROI to be expected if input estimates are wrong, that is, how sensitive the ROI is to each input item.

During the past 10 years a third dimension has been added to financial analysis: probability. *Monte Carlo simulation* sets forth in quantitative terms the elements of uncertainty in estimating the various cash flow items. Monte Carlo simulation differs from the sensitivity analysis. In Monte Carlo simulation, the evaluator recognizes and defines the uncertainty in the estimated deposit size, feed grade, recovery and every other input variable; and these uncertainties are transformed into uncertainties in the ROI calculated.

The purpose of this circular is to present a versatile computer program which uses data supplied by the promoter to calculate the expected ROI, make a sensitivity analysis and do a Monte Carlo simulation on the venture. The techniques of financial evaluation are not discussed, but several good references on this topic are listed in the bibliography.

Punched decks can be ordered from the Bureau at $10 each.

PROGRAM DESCRIPTION

The program (see Appendix 1) involves the following steps:

1) Reading in data describing the probability distribution of 14 variables important to the cash flow statement
2) Picking discrete values for each of the 14 variables from the distribution of each; performing the necessary calculations to obtain an ROI
3) Developing a probability distribution of the ROI by repeating step 2 the desired number of times
4) Determining the probability of the venture attaining any ROI
5) Printing the results of the above calculations
6) Performing a sensitivity analysis on the ROI by incriminating each of the variables independently, (+) and (-) 10% and calculating the resulting ROI by repeating steps 2-5.

TABLE 1 — *Information on first data card*

Input	Columns	Format
Number of repetitive calculations for ROI	1 —10	I10
Depreciation method to be used: 1 = straight line 2 = double declining balance 3 = sum of year digits	20	
Depletion allowance	21 —30	F10.3
Key for sensitivity analysis	31-40	110

TABLE 2 — *List of variables used to determine ROI*

Variable Number	Variable
1	Tons of ore in deposit
2	Ore grade—metal A
3	Ore grade—metal B
4	Recovery—metal A
5	Recovery—metal B
6	Price—metal A
7	Price—metal B
8	Mining cost
9	Milling cost
10	Royalty
11	Mine—capital cost
12	Mill—capital cost
13	Exploration & development costs
14	Mining rate

Reading in Data

Input is of two types: 1) data particular to the calculation such as depreciation method selected, and 2) data particular to the deposit as tonnage and grade. The first data card contains the information listed in table 1.

For most normal work the number of repetitive calculations for ROI can be left at 1,000.

The sensitivity key indicates if the user wants a sensitivity analysis run. If a sensitivity analysis is not wanted, any negative integer is punched in columns 31-40; if a sensitivity analysis is desired, zero is punched in column 40.

The next 14 data cards contain data on the values of 14 variables (see table 2) which can enter into the ROI calculation.

Fig. 1 shows the data used in the example problem. The data on each variable are listed on a separate data card using a 4E13.7 format. The first entry represents the type of distribution followed by that variable. Rectangular-1.0E+00, Normal-2.0E+00, Skewed-3.0E+00, and Constant-4.0E+00. The next 3 entries are for the distribution characteristics A, B, and C. For a rectangular distribution A and B represent the lower and upper limits of the variable, respectively. The characteristic C is not used. In a rectangular distribution, a variable can assume any value between A and B with equal probability.

For a normal distribution, B represents the mean of the distribution and A represents the standard deviation. Again the characteristic C is not used.

For a skewed distribution, A, B, and C represent the lowest probable value of the variable, the most probable value and the highest probable value, respectively.

In addition to the three types of distribution described above, the program also accepts constants for any of the 14 variables for cases in which the values of the variable are known with certainty. Fig. 2 shows examples of rectangular, normal, skewed and constant distributions. Provision has been made for a two-metal ore. If the ore contains only one metal, dummy data cards must be used. A dummy data card must contain a valid distribution index and zero for the value of the variable.

Some thought must be given to the selection of a distribution for each variable. The normal distribution should not be used if an irrational value can be randomly picked from the defined distribution. Irrational values can be selected when a variable has fixed limits (such as 0 to 100 percent for recovery) and when the standard deviation selected for that distribution is large. A normal distribution can be used for variables such as grade and tons of ore in the deposit; however, the standard deviation used should insure little probability of picking an irrational value. The skewed distribution does not present this problem and can conveniently be used to replace the normal distribution should a problem arise. The A and C characteristics of the skewed distribution are the absolute minimum and maximum values respectively that the variable can obtain.

Picking Discrete Values

After the program receives the input data, a single value for each variable is selected from probability distribution of the variables by using a random number generator called RANDOM and the ROI determined in the standard manner. The mine life in years is calculated by dividing the total deposit tonnage by the operating rates (tons per year). If the mine life is over 25 years the calculations are limited to 25 years, and the working capital is not recovered at the end of this time. If the mine life is less than 25 years the working capital is recovered and counted as income for the last year of mine life.

The computer program rounds off the operating life of the mine to the nearest whole number of years. Beyond this stage in the program, the mine life overrides the deposit size. The program will indicate a slight discrepancy between the tons of ore in the deposit and the total tons of ore mined. This discrepancy is less for mines with longer lives. Therefore, attempts should be made by the user to insure that the mine life determined after randomly picking a deposit size and mining rate from their given distributions is never less than 5 years. This minimum mine life does not limit the use of the program

IBM

FORTRAN Coding Form

PROGRAM | PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH | PAGE OF | CARD ELECTRO NUMBER*

PROGRAMMER | DATE

STATEMENT NUMBER	CONT.	FORTRAN STATEMENT	IDENTIFICATION SEQUENCE
		DISTRIBUTION A B C VARIABLE CARD I.D.	
		1000 1 15 0 DATA CARD 1	
		2.0E+00 1.0E+07 1.0E+08 TNDEP DATA CARD 2	
		2.0E+00 6.0E-04 5.5E-03 GRDA DATA CARD 3	
		2.0E+00 2.0E-05 3.0E-04 GRDB DATA CARD 4	
		3.0E+00 7.0E-01 8.5E-01 9.3E-01 REC0VA DATA CARD 5	
		3.0E+00 5.0E-01 7.0E-01 8.5E-01 REC0VB DATA CARD 6	
		2.0E+00 7.0E-02 5.5E-01 PRCA DATA CARD 7	
		2.0E+00 1.5E-01 1.6E+00 PRCB DATA CARD 8	
		2.0E+00 1.0E-01 7.5E-01 CMINE DATA CARD 9	
		2.0E+00 2.0E-01 1.7E+00 CMILL DATA CARD 10	
		1.0E+00 2.5E-01 5.0E-01 R0YAL DATA CARD 11	
		2.0E+00 5.0E+05 3.0E+06 CCMINE DATA CARD 12	
		2.0E+00 2.0E+06 1.0E+07 CCMILL DATA CARD 13	
		4.0E+00 1.0E+06 CED DATA CARD 14	
		4.0E+00 5.0E+03 RMINE DATA CARD 15	

*A standard card form, IBM electro 888157, is available for punching statements from this form.

Figure 1 — Data card for problem presented in Appendix I.

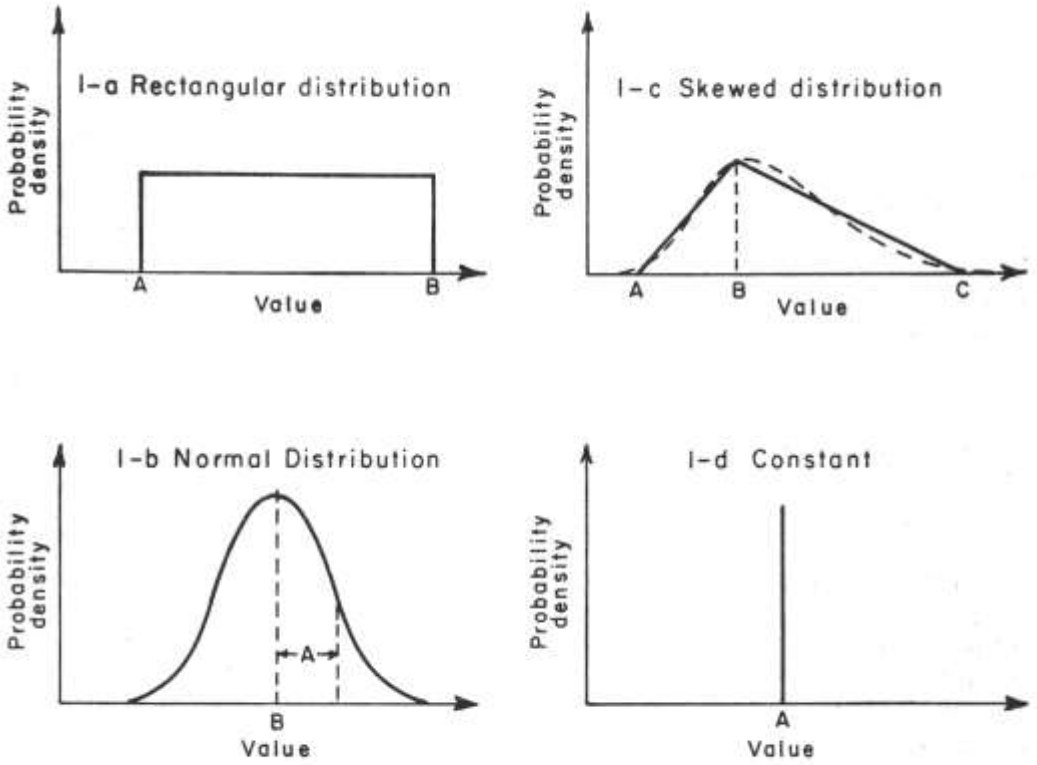

Figure 2 – Types of variable distribution.

because optimum economics exist for mine lives between 10 to 20 years generally. Any mine-mill operation having less than a 5-year life will probably be more economic if the life were increased to 10 to 20 years, and the mining rate proportionally decreased. From values of grade, recovery and market price of the concentrate, the annual income is calculated. Annual costs are determined by adding mining cost, milling costs, royalty and miscellaneous costs. Miscellaneous costs are taken as 20 percent of annual sales. Working capital requirements are assumed to be 15 percent of sales. Depreciation is calculated on a 15-year life, or mine life, whichever is lower. Exploration and development costs are pre-operational expenses. They are added to the capital expense and recovered by the same depreciation method selected for depreciating capital costs. Depletion is taken at the rate read from card 1 on the gross income minus royalty, or 50 percent of net income for depletions, whichever is less. No allowance was made for calculating book depletion. Taxes are calculated as 50 percent of net income for taxes. In the function FTAX, in addition to net income for taxes, the capital investment and gross sales are also past; therefore, property taxes, severance taxes, and gross receipts taxes can be calculated. The user must re-write statement 0002 of function FTAX if these other taxes are to be included.

Developing Probability Distribution

To develop a probability distribution for the ROI, the procedure outlined for picking discrete values for each variable and calculating the ROI is repeated 1,000 times. The 1,000 ROI's calculated have a distribution as a result of the probability distributions of the individual variables. The ROI's calculated are ordered in ascending sequence to facilitate the printing of the results.

Printing the Results

The program output has 4 sections. Appendix II is a partial output for the data listed in fig. 1. The first section lists the input data used. The type of distribution and distribution characteristics are listed, together with the average value of the variable found by taking the arithmetic average of the 1,000 randomly picked values for that variable.

Second, the results of the Monte Carlo simulation are printed giving the probability of attaining any ROI. The results of the Monte Carlo simulation are printed in three forms. The first page lists, in 5-percent increments, the probability of exceeding a specified ROI. On the second page is plotted a frequency distribution of the ROI taken in increments of 2 percentage points. The third page shows the cumulative probability distribution: the probability of obtaining an ROI equal to or greater than any specified ROI.

Third, the estimated cash flow statement is printed based on the average value of the variables.

Fourth, miscellaneous notes on the economic evaluation are printed after the last sensitivity analysis is completed.

Performing the Sensitivity Analysis

The sensitivity analysis is performed on each variable by both increasing and decreasing the constants for the variable's distribution 10 percent. If the variable follows a normal distribution, only the mean is adjusted; the standard deviation remains the same. If the variable follows a rectangular distribution both limits are increased and decreased 10 percent. However, for the skewed distribution in which the variable has the units of percent, the mode is increased and decreased 10 percent. The upper limit is shifted the lesser of 10 percent of 100 - C, or 10 percent of C. The lower limit is shifted the lesser of 10 percent of A, or, 10 percent of 100 - A. If the units of a variable assigned a skewed distribution are other than percent the A, B, and C characteristics are increased and decreased 10 percent. Once the variable's distribution has been adjusted, steps 2 through 5 are repeated.

Program Modifications

Recognizing that each deposit represents a unique situation, and that each company has its own modification to the standard ROI calculation, the program has been carefully documented and subdivided into subroutines and function subprograms to facilitate modifications.

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Appendix I-Listing of computer program.

```
C A MONTE CARLO APPROACH TO AN EVALUATION OF A MINING VENTURE
C
C  INPUT VARIABLES
C       ITER = # OF ITERATIONS (ALSO # OF SAMPLES FOR EACH VAR),CARD 1 : COL 1-10
C       NDEPR = INDICATOR FOR TYPE OF DEPRECIATION TO BE USED; 1 = ST LINE
C               2 = D D BALANCE, 3 = SUM OF YEARS; CARD 1 COL 11-20
C       RDEPL = RATE OF DEPLETION IN FRACTIONAL %; CARD 1 COL 21-30
C       K2 = INDICATOR FOR SENSTIVITY ANALYSIS; NEG=NO, ZERO=YES
C            CARD 1 COL 31-40
C       1000          1          .15          -1                    EXAMPLE DATA
C       V(I,1) = TYPE OF DIST (1-RECT,2-NORM,3-SKEW,4-CONST),
C                CARD I : COL 1-13
C       V(I,2-4) = VALUES PERTINENT TO PARTICULAR DIST, CARD I : COL 14-52
C       2.0E+00       1.0E+07       1.0E+08       0.0E+00     (EXAMPLE DATA)
C  OTHER VARIABLES
C       CED = EXPLORATION AND DEVELOPMENT COSTS ($)
C       RMINE = MINING RATE (TONS/DAY)
C       TNDEP = TONS IN DEPOSIT (TONS)
C       N = YEARS OF LIFE OF DEPOSIT (YEARS)
C       K1 = COUNTER TO INDICATE IF LIFE OF DEP IS ARTIFICIALLY SET(0 OR 1)
C       GRDA = GRADE OF PRODUCT A (FRACT)
C       GRDB = GRADE OF PRODUCT B (FRACT)
C       RECOVA = RECOVERY OF PRODUCT A (LBS/YEAR)
C       RECOVB = RECOVERY OR PRODUCT B (LBS/YEAR)
C       GPVA = GROSS PRODUCT VALUE OF A ($/YEAR)
C       GPVB = GROSS PRODUCT VALUE OF B ($/YEAR)
C       GPV = TOTAL GROSS PRODUCT VALUE ($/YEAR)
C       WCAP = WORKING CAPITOL ($)
C       CMISC = MISCELLANEOUS COSTS ($)
C       CMINE = COST OF MINING ($/YEAR)
C       CMILL = COST OF MILLING ($/YEAR)
C       ROYAL = ROYALTY COSTS ($/YEAR)
C       TOTC = TOTAL OPERATING COST ($/YEAR)
C       CCMINE = CAPITOL COST OF MINE ($)
C       CCMILL = CAPITOL COST OF MILL ($)
C       DEPREC(I) = DEPRECIATION FOR YEAR I ($)
C       ADPREC(I) = AVERAGE DEPRECIATION FOR YEAR I ($)
C       DEPL(I) = DEPLETION FOR YEAR I ($)
C       ADEPL(I) = AVERAGE DEPLETION FOR YEAR I ($)
C       NCF(I) = NET CASH FLOW FOR YEAR I ($)
C       ROI(K) = RETURN ON INVESTMENT FOR THE KTH SET OF SAMPLES (FRACT)
C
0001          REAL*4 DEPREC(15),ROI(1001),V(14,5),ADPREC(25),NCF(25)
0002          DIMENSION DEPL(25),ADEPL(25),VT(3),LL(3)
0003          COMMON ITER,RITER
C
C             INPUT
0004          READ 3000,ITER,NDEPR,RDEPL,K2
0005     3000 FORMAT(2I10,F10.3,I10)
C             SAVES TIME TO HAVE FLOATING PT FORM OF ITER
0006          RITER=FLOAT(ITER)
0007          READ 2000,((V(K,J),J=1,4),K=1,14)
0008     2000 FORMAT(4E13.7)
0009          GO TO 5
C
C             LOOP FOR SENSITIVITY ANALYSIS
0010        3 DO 200 L=1,14
0011          DO 200 M=1,2
0012          DO 6 I=1,14
0013        6 V(I,5)=0.
0014          DO 4 I=1,25
0015          ADEPL(I)=0.
0016        4 ADPREC(I)=0.
C
C             CHANGE VARIABLE TO MEASURE THE SENSITIVITY
0017          CALL SSENS(L,M,V,VT,LL)
C
C             LOOP FOR SAMPLING
0018        5 DO 100 I=1,ITER
C
C             SAMPLE FOR CED
0019          CED=DIST(13,V)
C
C             SAMPLE FOR RMINE
0020          RMINE=DIST(14,V)
C
C             SAMPLE FOR TNDEP
0021          TNDEP=DIST(1,V)
C
C             CALC YEARS OF LIFE OF DEPOSIT FOR THIS SET OF SAMPLES (MAX = 25)
0022          N=FYEARS(TNDEP,RMINE,K1)+.5
C
C             SAMPLE FOR GRDA
0023          GRDA=DIST(2,V)
C
C             SAMPLE FOR GRDB
0024          GRDB=DIST(3,V)
C
C             SAMPLE FOR RECOVA & CONVERT FROM FRACT TO LBS/YEAR
0025          RECOVA=DIST(4,V)*GRDA*730000.*RMINE
C
C             SAMPLE FOR RECOVB & CONVERT FROM FRACT TO LBS/YEAR
0026          RECOVB=DIST(5,V)*GRDB*730000.*RMINE
C
C             SAMPLE FOR PRICE OF A & CONVERT FROM $/LB TO $/YEAR
0027          GPVA=DIST(6,V)*RECOVA
C
```

```
C       SAMPLE FOR PRICE OF B & CONVERT FROM $/LB TO $/YEAR
0028          GPVB=DIST(7,V)*RECOVB
C
0029          GPV=GPVA+GPVB
0030          WCAP=.15*GPV
0031          CMISC=.2*GPV
C
C       SAMPLE FOR CMINE & CONVERT FROM $/TON TO $/YEAR
0032          CMINE=DIST(8,V)*RMINE*365.
C
C       SAMPLE FOR CMILL & CONVERT FROM $/TON TO $/YEAR
0033          CMILL=DIST(9,V)*RMINE*365.
C
C       SAMPLE FOR ROYAL & CONVERT FROM $/TON TO $/YEAR
0034          ROYAL=DIST(10,V)*RMINE*365.
C
0035          TOTC=CMINE+CMILL+ROYAL+CMISC
C
C       SAMPLE FOR CCMINE
0036          CCMINE=DIST(11,V)
C
C       SAMPLE FOR CCMILL
0037          CCMILL=DIST(12,V)
C
C       CALC DEPREC FOR THIS SET OF SAMPLES
0038          CALL SDEPRC(NDEPR,N,CCMINE+CCMILL+CED,DEPREC,ADPREC)
C
0039          DO 10 J=1,N
C
C       CALC DEPL FOR THIS SET OF SAMPLES
C       DEPLETION IS THE MIN OF : RDEPL OF GROSS INCOME FOR DEPLETION OR
C                                 50% OF NET INCOME FOR DEPLETION
0040          DEPL(J)=AMIN1(RDEPL*(GPV-ROYAL),.5*(GPV-TOTC-DEPREC(J)))
0041          ADEPL(J)=ADEPL(J)+DEPL(J)/RITER
C
0042          NCF(J)=GPV-TOTC-FTAX(GPV-TOTC-DEPL(J)-DEPREC(J),CCMINE+CCMILL,
             1GPVA+GPVB)
0043       10 CONTINUE
C
C       CALC ROI FOR THIS SET OF SAMPLES
0044          ROI(I)=FROI(CED+CCMINE+CCMILL+WCAP,NCF,N-1,K1,WCAP)
C
0045       100 CONTINUE
C
C       ROI ARRAY IS SORTED IN ASCENDING ORDER TO CALC PROB OF OCCURR
0046          CALL SORT(ROI,ITER,4,1,4)
C
C       PRINT RESULTS
0047          CALL OUTPUT(ADEPL,ADPREC,V,ROI)
C
C       CHECK FOR SENSITIVITY ANALYSIS
0048          IF(K2.EQ.0) GO TO 210
0049          IF(K2.LT.0) GO TO 205
C
C       CHANGE VARIABLE TO INPUT FORM
0050          DO 155 I=1,3
0051          IF(LL(I).EQ.0) GO TO 200
0052          II=LL(I)
0053       155 V(L,II)=VT(I)
C
0054       200 CONTINUE
C
C       PRINT ANY SPECIAL NOTES
0055       205 CALL NOTES(NDEPR,RDEPL)
0056          CALL EXIT
0057       210 K2=1
0058          GO TO 3
0059          END
```

TOTAL MEMORY REQUIREMENTS 001810 BYTES

```
0001                FUNCTION DISTIN,V)
                C   CALLS SAMPLING ROUTINES BASED ON VALUE OF V(I,1) AND ACCUMULATES
                C   AN AVERAGE IN V(I,5)
0002                DIMENSION V(14,5)
0003                REAL NORM
0004                COMMON ITER,RITER
0005                NN=V(N,1)
0006                GO TO (10,20,30,40),NN
0007             10 DIST=RECT(V(N,2),V(N,3),RANDOM(DUMMY))
0008                GO TO 50
0009             20 DIST=NORM(V(N,2),V(N,3),RANDOM(DUMMY))
0010                GO TO 50
0011             30 DIST=SKEW(V(N,2),V(N,3),V(N,4),RANDOM(DUMMY))
0012                GO TO 50
0013             40 DIST=V(N,2)
0014             50 V(N,5)=V(N,5)+DIST/RITER
0015                RETURN
0016                END
```

TOTAL MEMORY REQUIREMENTS 00037C BYTES

```
0001                FUNCTION FYEARS(DEP,RATE,K1)
                C   CALC YEARS OF LIFE OF DEPOSIT (YEARS)
0002                FYEARS=DEP/RATE/365.
0003                IF(FYEARS.GT.25.) GO TO 1
0004                K1=0
0005                RETURN
0006             1  FYEARS=25.
0007                K1=1
0008                RETURN
0009                END
```

TOTAL MEMORY REQUIREMENTS 00020C BYTES

```
0001                FUNCTION FROI(A,B,N,K1,WCAP)
                C   USES NEWTON RAPHSON METHOD FOR APPROXIMATING ROOTS TO
                C   CALC RETURN ON INVESTMENT(FRACT)
0002                DIMENSION B(25)
0003                X=.1
0004                DO 20 J=1,25
0005                F=0.0
0006                FP=0.0
0007                D=.001*X
0008                N1=N-1
0009                DO 10 I=1,N1
0010                S=(1.+X)**(-I)
0011                IF(S.LT..001) GO TO 16
0012                F=F+B(J)*S
0013                FP=FP+B(J)*(1.+X+D)**(-I)
0014             10 CONTINUE
0015                IF(K1.EQ.0) GO TO 13
0016                F=F+B(J)*(1.+X)**(-N)
0017                FP=FP+B(J)*(1.+X+D)**(-N)
0018                GO TO 16
0019             13 F=F+(B(J)+WCAP)*(1.+X)**(-N)
0020                FP=FP+(B(J)+WCAP)*(1.+X+D)**(-N)
0021             16 F=F-A
0022                FP=(FP-A-F)/D
0023                IF(ABS(FP).LE.1.0E-10) GO TO 21
0024                T=X-F/FP
0025                IF(ABS(X-T).LE..002.AND.T.GT.0.0) GO TO 25
0026                X=T
0027             20 CONTINUE
0028             21 T=0.0
0029             25 FROI=T
0030                RETURN
0031                END
```

TOTAL MEMORY REQUIREMENTS 00051C BYTES

```
FORTRAN IV     MODEL 44  PS        VERSION 3,  LEVEL 3    DATE  72126

 0001                SUBROUTINE SDEPRC(N,NUMYRS,CAPC,DEPREC,ADPREC)
               C     CALC DEPRECIATION,N = 1 ST LINE, 2 D D BALANCE, 3 SUM OF YEARS ($)
 0002                REAL*4 DEPREC(15),ADPREC(25)
 0003                COMMON ITER,RITER
 0004                IF(NUMYRS.LE.15) GO TO 80
 0005                K=15
 0006                RK=15.
 0007                GO TO 90
 0008             80 K=NUMYRS
 0009                RK=FLOAT(K)
 0010             90 GO TO (100,200,300),N
 0011            100 DO 110 I=1,K
 0012                DEPREC(I)=CAPC/RK
 0013                ADPREC(I)=ADPREC(I)+DEPREC(I)/RITER
 0014            110 CONTINUE
 0015                RETURN
 0016            200 SUM=0.0
 0017                DO 210 I=1,K
 0018                DEPREC(I)=(CAPC-SUM)*2./RK
 0019                ADPREC(I)=ADPREC(I)+DEPREC(I)/RITER
 0020                SUM=SUM+DEPREC(I)
 0021            210 CONTINUE
 0022                RETURN
 0023            300 SUM=K*(K+1)/2.
 0024                DO 310 I=1,K
 0025                J=K-I+1
 0026                DEPREC(I)=CAPC*J/SUM
 0027                ADPREC(I)=ADPREC(I)+DEPREC(I)/RITER
 0028            310 CONTINUE
 0029                RETURN
 0030                END

 TOTAL MEMORY REQUIREMENTS 000434 BYTES



 0001                FUNCTION RECT(A,B,R)
               C     SAMPLES FROM A RECT DIST GIVEN A RANDOM NUMBER
 0002                RECT=B-R*(B-A)
 0003                RETURN
 0004                END

 TOTAL MEMORY REQUIREMENTS 000168 BYTES



 0001                REAL FUNCTION NORM(S,U,R)
               C     SAMPLES FROM A NORMAL DIST GIVEN A RANDOM NUMBER
 0002                T=SQRT(ALOG(R**(-2)))
 0003                Z=T-(2.515517+.802853*T+.010328*T**2)/(1.+1.432788*T+.189269*T**2
                    1+.001308*T**3)
 0004                NORM=S*Z+U
 0005                RETURN
 0006                END

 TOTAL MEMORY REQUIREMENTS 000288 BYTES



 0001                FUNCTION SKEW(A,B,C,R)
               C     SAMPLES FROM A SKEWED DIST GIVEN A RANDOM NUMBER
 0002                SKEW=SQRT((1.-R)*(B-A)*(C-A))+A
 0003                IF(SKEW.LE.B) GO TO 9
 0004              5 SKEW=C-SQRT(R*(C-B)*(C-A))
 0005              9 RETURN
 0006                END

 TOTAL MEMORY REQUIREMENTS 000260 BYTES
```

```
0001                FUNCTION RANDOM(DUMMY)
                C   RANDOM NUMBER GENERATER
0002                DATA I/1/
0003                INTEGER A,X
0004                IF(I .EQ. 0) GO TO 1
0005                I=0
0006                M=2**20
0007                FM=M
0008                X=566387
0009                A=2**10+3
0010              1 X=MOD(A*X,M)
0011                FX=X
0012                RANDOM=FX/FM
0013                RETURN
0014                END
```

TOTAL MEMORY REQUIREMENTS 000288 BYTES

```
0001                SUBROUTINE SSENS(I,J,V,VT,LL)
                C   CHANGES VARIABLE BY + OR - 10% FOR SENSITIVITY ANALYSIS
0002                DIMENSION V(14,5),F(2),VT(3),LL(3),G(2)
0003                DATA F/.9,1.1/,G/-1.,1./
0004                N=V(I,1)
0005                GO TO (10,20,30,40),N
0006             10 DO 11 K=1,2
0007                VT(K)=V(I,K+1)
0008                LL(K)=K+1
0009             11 V(I,K+1)=V(I,K+1)*F(J)
0010                LL(3)=0
0011                RETURN
0012             20 VT(1)=V(I,3)
0013                LL(1)=3
0014                LL(2)=0
0015                V(I,3)=V(I,3)*F(J)
0016                RETURN
0017             30 DO 35 K=1,3
0018                VT(K)=V(I,K+1)
0019                LL(K)=K+1
0020                IF(V(I,K+1).LT.1.) GO TO 33
0021                V(I,K+1)=V(I,K+1)*F(J)
0022                GO TO 35
0023             33 V(I,K+1)=V(I,K+1)+G(J)*.1*AMIN1(1.-V(I,K+1),V(I,K+1))
0024             35 CONTINUE
0025                RETURN
0026             40 VT(1)=V(I,2)
0027                LL(1)=2
0028                LL(2)=0
0029                V(I,2)=V(I,2)*F(J)
0030                RETURN
0031                END
```

TOTAL MEMORY REQUIREMENTS 000558 BYTES

```
0001                FUNCTION FTAX(AINCBT,TCCOST,TGPV)
                C   CALC TAX AS A FUNCTION OF AVERAGE INCOME BEFORE TAXES,
                C   TOTAL CAPITAL COSTS,AND TOTAL GROSS PRODUCT VALUE
0002                FTAX=.5*AINCBT
0003                RETURN
0004                END
```

TOTAL MEMORY REQUIREMENTS 0001CC BYTES

```
0001              SUBROUTINE OUTPUT(ADEPL,ADPREC,V,ROI)
0002              REAL*4 ADPREC(25),ATAX(25),AINCOT(25),AINCAT(25),V(14,5),
                 1ROI(1001),CF(25),P(20),ADEPL(25)
0003              COMMON ITER,RITER
0004              DATA P/1.,.95,.9,.85,.8,.75,.7,.65,.6,.55,.5,.45,.4,.35,.3,.25,
                 1.2,.15,.1,.05/
0005              PRINT 1000
0006           1000 FORMAT('1'/'4'55X'DATA USED'/
                 1'-',10X,'VARIABLE',13X,'DIST',10X,'LOW',13X,'MODE',12X,
                 2'HIGH',10X,'STD DEV',12X,'AVERAGE'/)
0007              DO 200 I=1,14
0008              GO TO (101,102,103,104,105,106,107,108,109,110,111,112,113,114),I
0009            101 PRINT 1001
0010           1001 FORMAT('0TONS IN DEPOSIT (TONS)')
0011              GO TO 120
0012            102 PRINT 1002
0013           1002 FORMAT('0GRADE OF A (FRACT)')
0014              GO TO 120
0015            103 PRINT 1003
0016           1003 FORMAT('0GRADE OF B (FRACT)')
0017              GO TO 120
0018            104 PRINT 1004
0019           1004 FORMAT('0RECOVERY OF A (FRACT)')
0020              GO TO 120
0021            105 PRINT 1005
0022           1005 FORMAT('0RECOVERY OF B (FRACT)')
0023              GO TO 120
0024            106 PRINT 1006
0025           1006 FORMAT('0PRICE FOR A ($/LB)')
0026              GO TO 120
0027            107 PRINT 1007
0028           1007 FORMAT('0PRICE FOR B ($/LB)')
0029              GO TO 120
0030            108 PRINT 1008
0031           1008 FORMAT('0COST OF MINING ($/TON)')
0032              GO TO 120
0033            109 PRINT 1009
0034           1009 FORMAT('0COST OF MILLING ($/TON)')
0035              GO TO 120
0036            110 PRINT 1010
0037           1010 FORMAT('0ROYALTY ($/TON)')
0038              GO TO 120
0039            111 PRINT 1011
0040           1011 FORMAT('0CAPITAL COST OF MINE ($)')
0041              GO TO 120
0042            112 PRINT 1012
0043           1012 FORMAT('0CAPITAL COST OF MILL ($)')
0044              GO TO 120
0045            113 PRINT 1013
0046           1013 FORMAT('0EXPLOR AND DEVELOP COST ($)')
0047              GO TO 120
0048            114 PRINT 1014
0049           1014 FORMAT('0MINING RATE (TONS/DAY)')
0050            120 KK=V(I,1)
0051              GO TO (5,10,15,20),KK
0052                5 PRINT 1102,V(I,2),V(I,3),V(I,5)
0053           1102 FORMAT('+',T32,'REGT',T42,F15.5,T58,15('-'),T74,F15.5,T90,15('-'),
                 1T106,F15.5)
0054              GO TO 200
0055               10 PRINT 1101,V(I,3),V(I,2),V(I,5)
0056           1101 FORMAT('+',T32,'NORMAL',T42,15('-'),T58,F15.5,T74,15('-'),T90,F15.
                 15,T106,F15.5)
0057              GO TO 200
0058               15 PRINT 1103,V(I,2),V(I,3),V(I,4),V(I,5)
0059           1103 FORMAT('+',T32,'SKEWED',T42,F15.5,T58,F15.5,T74,F15.5,T90,15('-'),
                 1T106,F15.5)
0060              GO TO 200
0061               20 PRINT 1105,V(I,2),V(I,5)
0062           1105 FORMAT('+',T32,'CONST',T42,15('-'),T58,F15.5,T74,15('-'),T90,15('-
                 1'),T106,F15.5)
0063            200 CONTINUE
0064              INT=5*ITER/100
0065              PRINT 8000,(P(I),ROI((I-1)*INT+1),I=1,20)
0066           8000 FORMAT('1'/'4'40X' AFTER TAX ROI BASED ON MONTE CARLO METHOD'//
                 1' '40X'PROBABILITY OF ROI BEING GREATER THAN'/' '40X,30('-')/
                 2' '50X'PROBILITY                    ROI'//(' '50X,0PF4.2,20X,2PF4.1))
0067              CALL PLOT1(ROI,ITER)
0068              CALL PLOT2(ROI,ITER)
0069              V(6,5)=V(6,5)*V(4,5)*V(2,5)*V(14,5)*730000.
0070              V(7,5)=V(7,5)*V(5,5)*V(3,5)*V(14,5)*730000.
0071              V(8,5)=V(8,5)*V(14,5)*365.
0072              V(9,5)=V(9,5)*V(14,5)*365.
0073              V(10,5)=V(10,5)*V(14,5)*365.
0074              AGPV=V(6,5)+V(7,5)
0075              AWCAP=.15*AGPV
0076              ACMISC=.2*AGPV
0077              ATOTC=V(8,5)+V(9,5)+V(10,5)+ACMISC
0078              ANCF=AGPV-ATOTC
```

```
0079                DO 55 I=1,25
0080                AINCBT(I)=ANCF-ADPREC(I)-ADEPL(I)
0081                ATAX(I)=FTAX(AINCBT(I),V(11,5)+V(12,5),AGPV)
0082                AINCAT(I)=AINCBT(I)-ATAX(I)
0083                CF(I)=ANCF-ATAX(I)
0084             55 CONTINUE
0085                N=FYEARS(V(1,5),V(14,5),K)+.5
0086                ROI(ITER+1)=FROI(V(11,5)+V(12,5)+V(13,5)+.15*(V(6,5)+V(7,5)),
                   1CF,N,K,.15*(V(6,5)+V(7,5)))
0087                V135=-V(13,5)
0088                V115=-V(11,5)
0089                V125=-V(12,5)
0090                AWCAP1=-AWCAP
0091                PRINT 5000,(I,I=1,12),V135,V115,V125,AWCAP1,
                   1(V(6,5),I=1,12),(V(7,5),I=1,12),(AGPV,I=1,12),(V(8,5),I=1,12),
                   2(V(9,5),I=1,12),(ACMISC,I=1,12),(V(10,5),I=1,12),(ATOTC,I=1,12),
                   3(ANCF,I=1,12),(ADPREC(I),I=1,12),(ADEPL(I),I=1,12),
                   4(AINCBT(I),I=1,12),(ATAX(I),I=1,12),(AINCAT(I),I=1,12),
                   5(CF(I),I=1,12)
0092             5000 FORMAT('1',T40,'ESTIMATED CASH FLOW (THOUSAND DOLLARS)'/
                   1'0YEAR',T25,'0',12(5X,I2)/
                   2'0FIXED CAPITOL'/
                   3'    EXP & DEV',T22,-3PF7.0/
                   4'    MINE',T22,F7.0/
                   5'    MILL',T22,F7.0/
                   6'0WORKING CAPITOL',T22,F7.0/
                   7'0PRODUCT VALUE'/
                   8'    A',T29,12(F6.0,1X)/
                   9'    B',T29,12(F6.0,1X)/
                   A'    TOTAL',T29,12(F6.0,1X)/
                   B'0PRODUCTION COSTS'/
                   C'    MINE',T29,12(F6.0,1X)/
                   D'    MILL',T29,12(F6.0,1X)/
                   E'    MISC',T29,12(F6.0,1X)/
                   F'    ROYALTY',T29,12(F6.0,1X)/
                   G'    TOTAL',T29,12(F6.0,1X)/
                   H'0OPERATING INCOME',T29,12(F6.0,1X)/
                   I'0DEPRECIATION',T29,12(F6.0,1X)/
                   J'0DEPLETION',T29,12(F6.0,1X)/
                   K'0INCOME BEFORE TAXES',T29,12(F6.0,1X)/
                   L'0TAX',T29,12(F6.0,1X)/
                   M'0NET INCOME AFTER TAXES',T29,12(F6.0,1X)/
                   N'0CASH FLOW',T29,12(F6.0,1X))
0093                PRINT 6000,(I,I=13,25),
                   1(V(6,5),I=1,13),(V(7,5),I=1,13),(AGPV,I=1,13),(V(8,5),I=1,13),
                   2(V(9,5),I=1,13),(ACMISC,I=1,13),(V(10,5),I=1,13),(ATOTC,I=1,13),
                   3(ANCF,I=1,13),(ADPREC(I),I=13,25),(ADEPL(I),I=13,25),
                   4(AINCBT(I),I=13,25),(ATAX(I),I=13,25),(AINCAT(I),I=13,25),
                   5(CF(I),I=13,25)
0094             6000 FORMAT(//'0',T40,'ESTIMATED CASH FLOW (THOUSAND DOLLARS)'/
                   1'0YEAR',T24,13(I2,5X)/
                   2'0FIXED CAPITOL'/
                   3'    EXP & DEV'/
                   4'    MINE'/
                   5'    MILL'/
                   6'0WORKING CAPITOL'/
                   7'0PRODUCT VALUE'/
                   8'    A',T22,-3P13(F6.0,1X)/
                   9'    B',T22,13(F6.0,1X)/
                   A'    TOTAL',T22,13(F6.0,1X)/
                   B'0PRODUCTION COSTS'/
                   C'    MINE',T22,13(F6.0,1X)/
                   D'    MILL',T22,13(F6.0,1X)/
                   E'    MISC',T22,13(F6.0,1X)/
                   F'    ROYALTY',T22,13(F6.0,1X)/
                   G'    TOTAL',T22,13(F6.0,1X)/
                   H'0OPERATING INCOME',T22,13(F6.0,1X)/
                   I'0DEPRECIATION',T22,13(F6.0,1X)/
                   J'0DEPLETION',T22,13(F6.0,1X)/
                   K'0INCOME BEFORE TAXES',T22,13(F6.0,1X)/
                   L'0TAX',T22,13(F6.0,1X)/
                   M'0NET INCOME AFTER TAXES',T22,13(F6.0,1X)/
                   N'0CASH FLOW',T22,13(F6.0,1X))
0095                PRINT 9000,ROI(ITER+1)
0096             9000 FORMAT(//'0AFTER TAX ROI = ',2PF4.1,5X,'(BASED ON AVE VALUES OF VA
                   1RIABLES)')
0097                RETURN
0098                END

TOTAL MEMORY REQUIREMENTS 00198C BYTES
```

```
0001                SUBROUTINE PLOT1(ROI,ITER)
                C   PLOT ROI VS FREQUENCY
0002                DIMENSION ROI(1001),A(100)
0003                DATA A/100*'*   '/
0004                I2=2
0005                K=0
0006                PRINT 1000
0007           1000 FORMAT('1',18X,'0')
0008                DO 100 J=1,ITER
0009                IF(ROI(J).EQ.0.) GO TO 100
0010                IF(ROI(J)*100..GT.I2) GO TO 20
0011                K=K+1
0012                GO TO 100
0013             20 IF(K.EQ.0) GO TO 40
0014                IF(K.GT.100) K=100
0015                DO 50 M=1,3
0016                PRINT 2000,(A(L),L=1,K)
0017           2000 FORMAT(' ',20X,100A1)
0018             50 CONTINUE
0019                PRINT 3000,I2,(A(L),L=1,K)
0020           3000 FORMAT(' ',17X,I2,1X,100A1)
0021             40 I2=I2+2
0022                K=1
0023                IF(I2.EQ.18) PRINT 4000
0024           4000 FORMAT('+',10X,'ROI')
0025            100 CONTINUE
0026                PRINT 5000
0027           5000 FORMAT(' ',40X,'FREQUENCY')
0028                RETURN
0029                END

TOTAL MEMORY REQUIREMENTS 0005C4 BYTES


0001                SUBROUTINE PLOT2(ROI,ITER)
                C   PLOTS PROBABILITY DISTRIBUTION OF THE ROI
0002                DIMENSION N(36),ROI(1001)
0003                DATA N1/'    '/,N2/'*   '/
0004                PRINT 1000
0005           1000 FORMAT('1'//////////)
0006                P=1.1
0007                L=(ITER-1)/20
0008                DO 100 I=1,L
0009                DO 10 M=1,36
0010             10 N(M)=N1
0011             40 J=(I-1)*(ITER-1)/50+1
0012                K=ROI(J)*100.+.5
0013                IF(K.EQ.0) GO TO 30
0014                N(K)=N2
0015             30 PRINT 3000,N
0016           3000 FORMAT(' ',12X,36(A1,2X)/'+'10X'|')
0017                IF(MOD(I-1,5).NE.0) GO TO 100
0018                P=P-.1
0019                PRINT 2000,P
0020           2000 FORMAT('+',5X,F4.2)
0021            100 CONTINUE
0022                PRINT 4000,(I,I=2,36,2)
0023           4000 FORMAT(' ',5X,'0.00'/'0',10X,120('-')/'0',10X,'0',3X,18(I2,4X)/
                   1'0',35X,'ROI')
0024                RETURN
0025                END

TOTAL MEMORY REQUIREMENTS 0004E0 BYTES


0001                SUBROUTINE NOTES(NDEPR,RDEPL)
0002                IDEPL=100.*RDEPL+.9
0003                PRINT 1111
0004           1111 FORMAT('2'30X'NOTES'/'+'30X,5('_')/'0'33X'DEPRECIATION -- METHOD U
                   1SED --')
0005                GO TO (222,333,444),NDEPR
0006            222 PRINT 2222
0007           2222 FORMAT('+'65X'STRAIGHT LINE')
0008                GO TO 555
0009            333 PRINT 3333
0010           3333 FORMAT('+'65X'DOUBLE DECLINING BALANCE')
0011                GO TO 555
0012            444 PRINT 4444
0013           4444 FORMAT('+'65X'SUM OF YEARS')
0014            555 PRINT 5555,IDEPL
0015           5555 FORMAT('0'33X'DEPLETION ALLOWANCE -- 'I2'% OF THE GROSS PRODUCT VA
                   1LUE')
0016                PRINT 6666
0017           6666 FORMAT('0'33X'WORKING CAPITAL -- 15% OF THE GROSS PRODUCT VALUE'/
                   1'0'33X'MISCELLANEOUS COSTS -- 20% OF THE GROSS PRODUCT VALUE')
0018                RETURN
0019                END

TOTAL MEMORY REQUIREMENTS 000428 BYTES
```

DATA USED

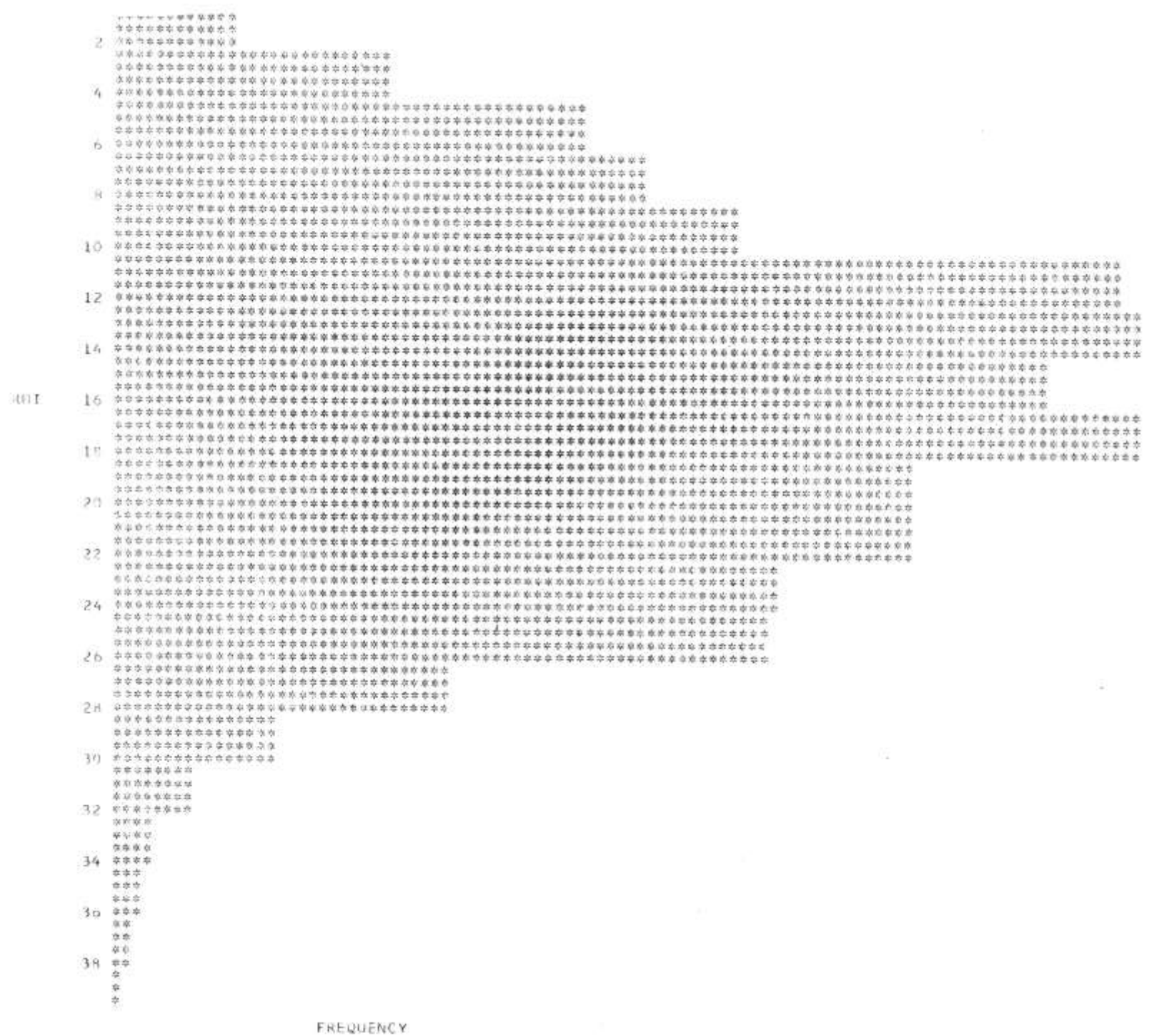
VARIABLE	DIST	LOW	MODE	HIGH	STD DEV	AVERAGE
TONS IN DEPOSIT (TONS)	NORMAL	----------	100000000.00000	----------	10000000.00000	99983136.00000
GRADE OF A (FRACT)	NORMAL	----------	0.00550	----------	0.00060	0.00555
GRADE OF B (FRACT)	NORMAL	----------	0.00030	----------	0.00002	0.00030
RECOVERY OF A (FRACT)	SKEWED	0.70000	0.85000	0.93000	----------	0.82690
RECOVERY OF B (FRACT)	SKEWED	0.50000	0.70000	0.85000	----------	0.68503
PRICE FOR A ($/LB)	NORMAL	----------	0.55000	----------	0.07000	0.55191
PRICE FOR B ($/LB)	NORMAL	----------	1.60000	----------	0.15000	1.60658
COST OF MINING ($/TON)	NORMAL	----------	0.75000	----------	0.10000	0.75737
COST OF MILLING ($/TON)	NORMAL	----------	1.75000	----------	0.20000	1.75298
ROYALTY ($/TON)	RECT	0.25000	----------	0.50000	----------	0.37840
CAPITAL COST OF MINE ($)	NORMAL	----------	3000000.00000	----------	500000.00000	3024730.00000
CAPITAL COST OF MILL ($)	NORMAL	----------	10000000.00000	----------	2000000.00000	10061363.00000
EXPLOR AND DEVELOP COST ($)	CONST	----------	1000000.00000	----------	----------	1000000.00000
MINING RATE (TONS/DAY)	CONST	----------	5000.00000	----------	----------	5000.00000

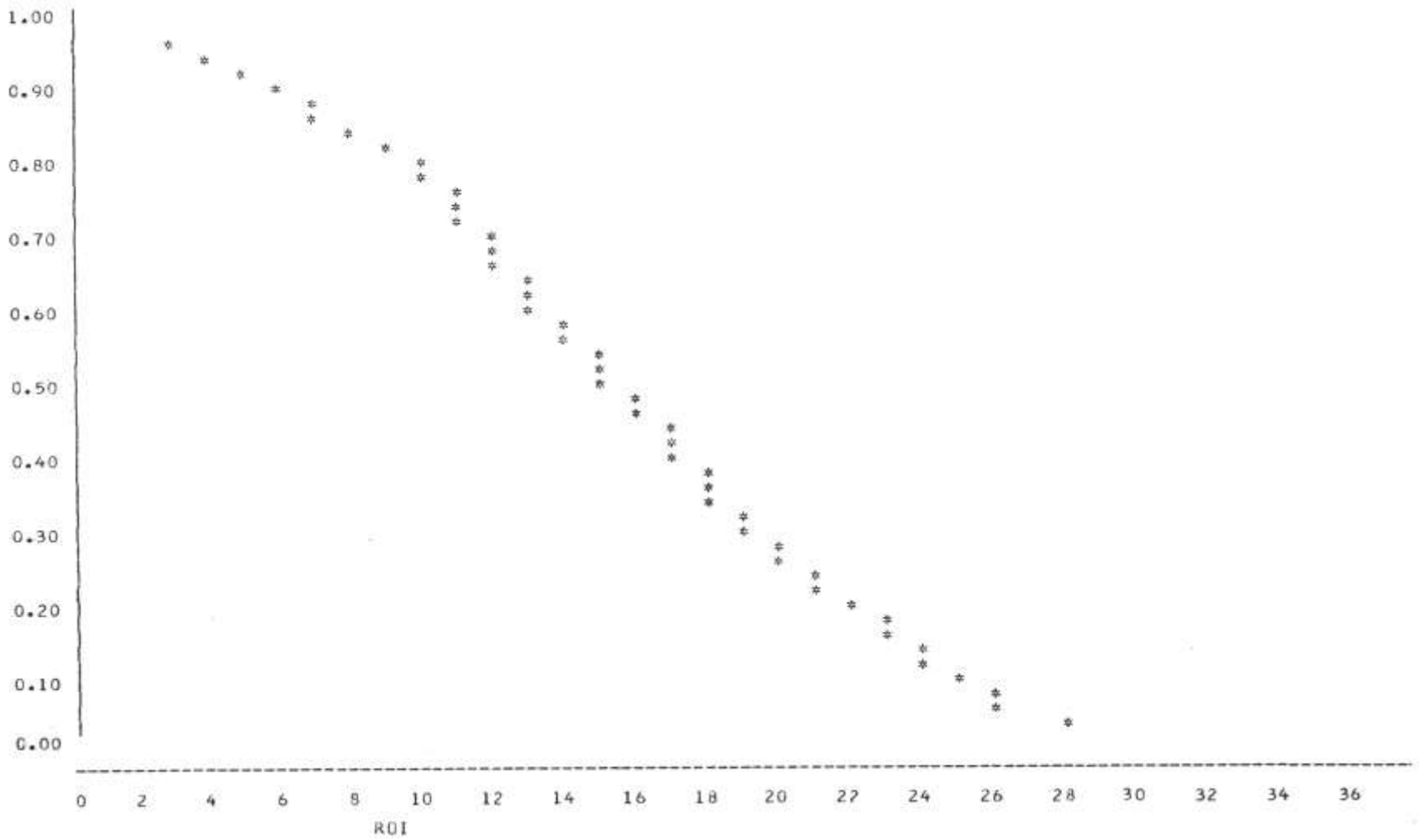
AFTER TAX ROI BASED ON MONTE CARLO METHOD

PROBABILITY OF ROI BEING GREATER THAN

PROBILITY	ROI
1.00	0.0
0.95	3.6
0.90	5.9
0.85	7.8
0.80	9.6
0.75	10.8
0.70	11.7
0.65	12.5
0.60	13.3
0.55	14.3
0.50	15.5
0.45	16.4
0.40	17.3
0.35	18.1
0.30	19.3
0.25	20.5
0.20	22.0
0.15	23.4
0.10	24.9
0.05	27.0

Appendix 11-Partial output for data listed in Figure 1.


FREQUENCY


1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
ROI

ESTIMATED CASH FLOW (THOUSAND DOLLARS)

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12
FIXED CAPITAL													
EXP & DEV	-1000.												
MINE	-3025.												
MILL	-10061.												
WORKING CAPITAL	-1569.												
PRODUCT VALUE													
A		9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.
B		1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.
TOTAL		10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.
PRODUCTION COSTS													
MINE		1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.
MILL		3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.
MISC		2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.
ROYALTY		690.	690.	690.	690.	690.	690.	690.	690.	690.	690.	690.	690.
TOTAL		7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.
OPERATING INCOME		3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.
DEPRECIATION		939.	939.	939.	939.	939.	939.	939.	939.	939.	939.	939.	939.
DEPLETION		1016.	1016.	1016.	1016.	1016.	1016.	1016.	1016.	1016.	1016.	1016.	1016.
INCOME BEFORE TAXES		1132.	1132.	1132.	1132.	1132.	1132.	1132.	1132.	1132.	1132.	1132.	1132.
TAX		566.	566.	566.	566.	566.	566.	566.	566.	566.	566.	566.	566.
NET INCOME AFTER TAXES		566.	566.	566.	566.	566.	566.	566.	566.	566.	566.	566.	566.
CASH FLOW		2521.	2521.	2521.	2521.	2521.	2521.	2521.	2521.	2521.	2521.	2521.	2521.

ESTIMATED CASH FLOW (THOUSAND DOLLARS)

YEAR	13	14	15	16	17	18	19	20	21	22	23	24	25
FIXED CAPITAL													
EXP & DEV													
MINE													
MILL													
WORKING CAPITAL													
PRODUCT VALUE													
A	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.	9252.
B	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.	1210.
TOTAL	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.	10462.
PRODUCTION COSTS													
MINE	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.	1382.
MILL	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.	3210.
MISC	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.	2092.
ROYALTY	690.	690.	690.	690.	690.	690.	690.	690.	690.	690.	690.	690.	690.
TOTAL	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.	7375.
OPERATING INCOME	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.	3087.
DEPRECIATION	939.	939.	939.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DEPLETION	1016.	1016.	1016.	1320.	1320.	1320.	1320.	1320.	1320.	1320.	1320.	1320.	1320.
INCOME BEFORE TAXES	1132.	1132.	1132.	1767.	1767.	1767.	1767.	1767.	1767.	1767.	1767.	1767.	1767.
TAX	566.	566.	566.	883.	883.	883.	883.	883.	883.	883.	883.	883.	883.
NET INCOME AFTER TAX	566.	566.	566.	883.	883.	883.	883.	883.	883.	883.	883.	883.	883.
CASH FLOW	2521.	2521.	2521.	2203.	2203.	2203.	2203.	2203.	2203.	2203.	2203.	2203.	2203.

AFTER TAX ROI = 15.7 (BASED ON AVE VALUES OF VARIABLES)

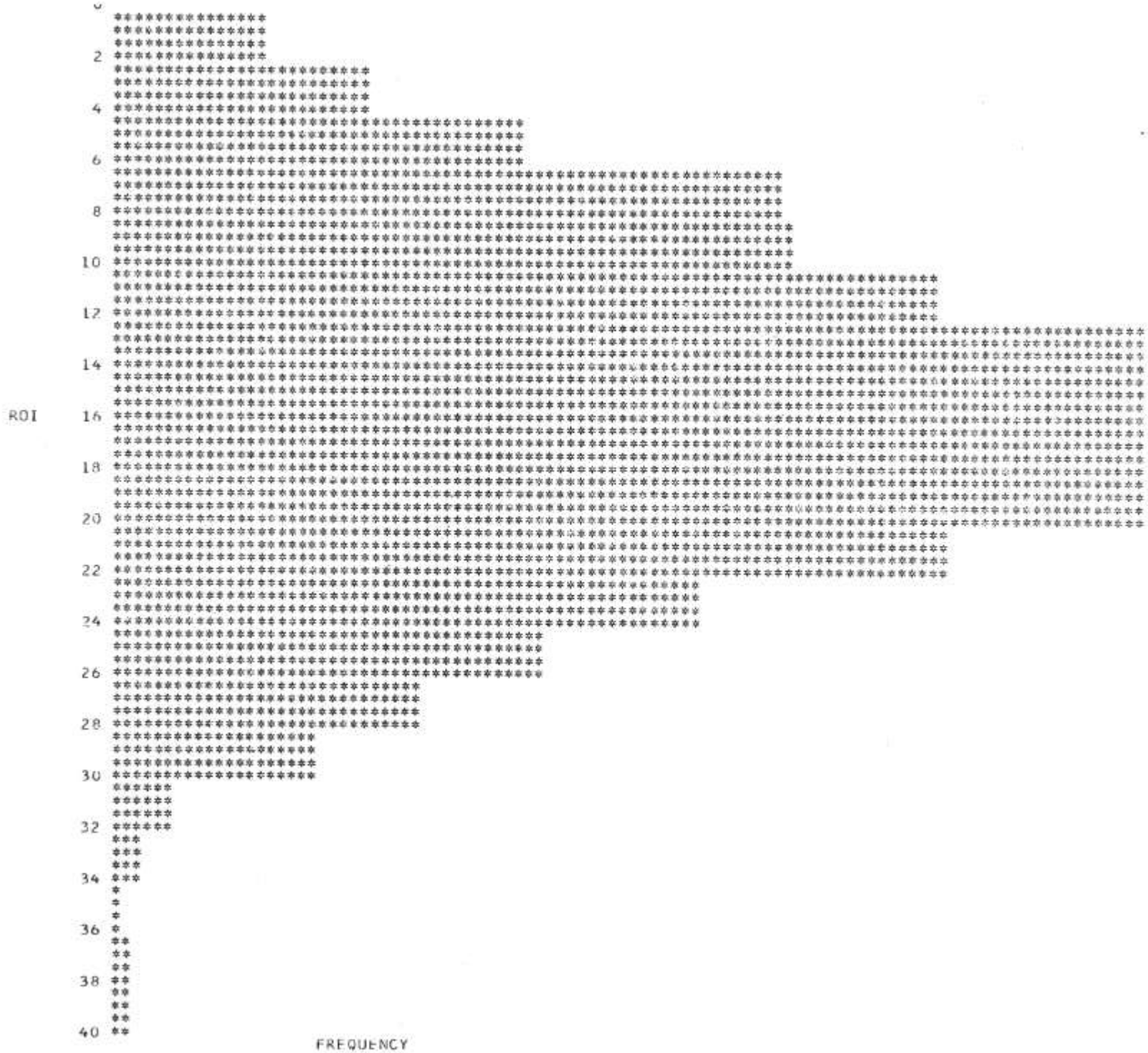
DATA USED

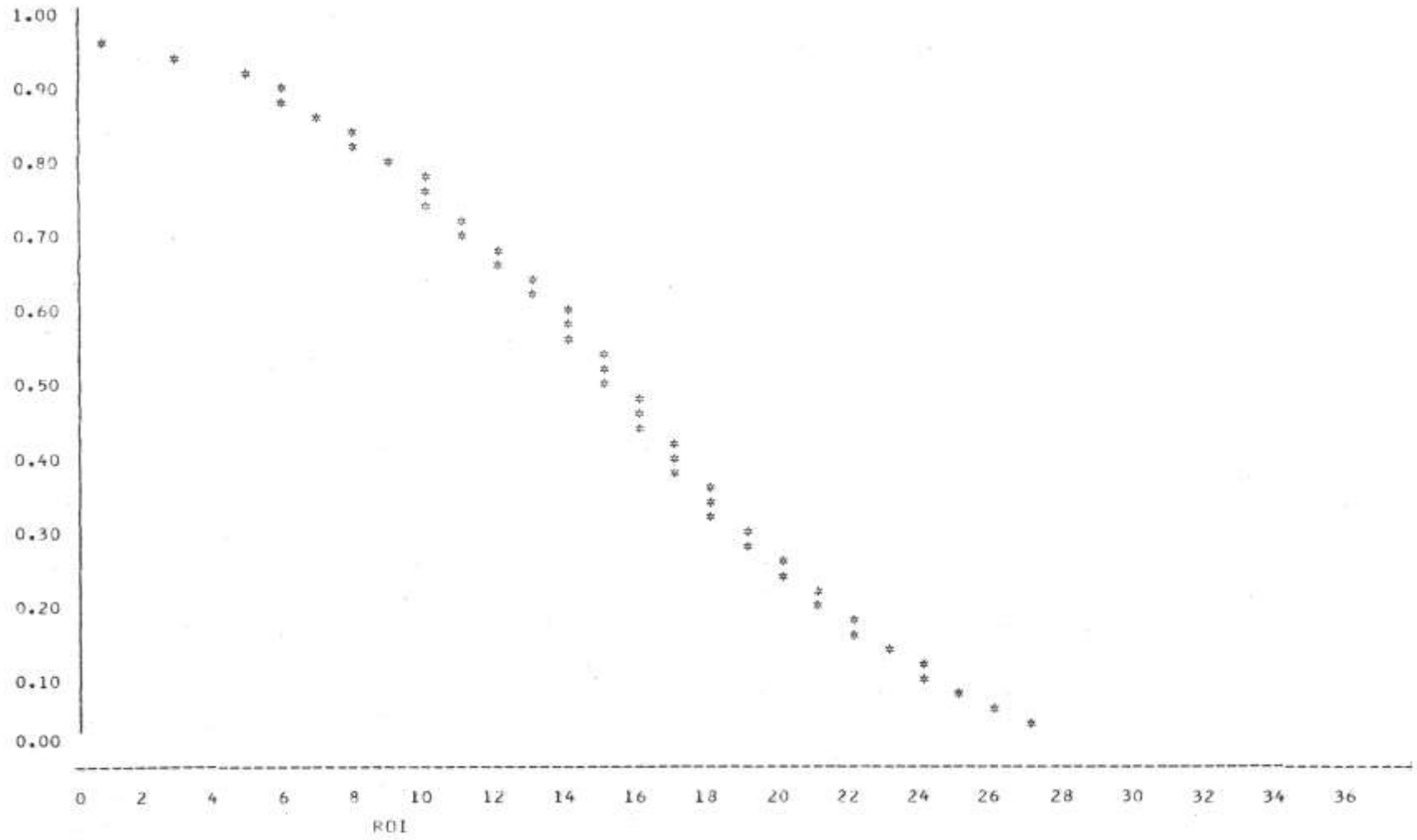
VARIABLE	DIST	LOW	MODE	HIGH	STD DEV	AVERAGE
TONS IN DEPOSIT (TONS)	NORMAL	----------	89999984.00000	----------	10000000.00000	90327216.00000
GRADE OF A (FRACT)	NORMAL	----------	0.00550	----------	0.00060	0.00549
GRADE OF B (FRACT)	NORMAL	----------	0.00030	----------	0.00002	0.00030
RECOVERY OF A (FRACT)	SKEWED	0.70000	0.85000	0.93000	----------	0.82630
RECOVERY OF B (FRACT)	SKEWED	0.50000	0.70000	0.85000	----------	0.68030
PRICE FOR A ($/LB)	NORMAL	----------	0.55000	----------	0.07000	0.54849
PRICE FOR B ($/LB)	NORMAL	----------	1.60000	----------	0.15000	1.59940
COST OF MINING ($/TON)	NORMAL	----------	0.75000	----------	0.10000	0.74726
COST OF MILLING ($/TON)	NORMAL	----------	1.75000	----------	0.20000	1.73857
ROYALTY ($/TON)	RECT	0.25000	----------	0.50000	----------	0.37277
CAPITAL COST OF MINE ($)	NORMAL	----------	3000000.00000	----------	500000.00000	3017440.00000
CAPITAL COST OF MILL ($)	NORMAL	----------	10000000.00000	----------	2000000.00000	9959325.00000
EXPLOR AND DEVELOP COST ($)	CONST	----------	1000000.00000	----------	----------	1000000.00000
MINING RATE (TONS/DAY)	CONST	----------	5000.00000	----------	----------	5000.00000

AFTER TAX ROI BASED ON MONTE CARLO METHOD

PROBABILITY OF ROI BEING GREATER THAN

PROBILITY	ROI
1.00	0.0
0.95	2.6
0.90	5.6
0.85	7.4
0.80	9.1
0.75	10.1
0.70	11.4
0.65	12.6
0.60	13.6
0.55	14.3
0.50	15.3
0.45	16.1
0.40	17.0
0.35	18.0
0.30	18.8
0.25	19.8
0.20	21.0
0.15	22.5
0.10	24.3
0.05	27.1


ROI
FREQUENCY


1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
ROI

ESTIMATED CASH FLOW (THOUSAND DOLLARS)

YEAR	0	1	2	3	4	5	6	7	8	9	10	11
FIXED CAPITAL												
EXP & DEV	-1000.											
MINE	-3017.											
MILL	-9959.											
WORKING CAPITAL	-1539.											
PRODUCT VALUE												
A		9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.
B		1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.
TOTAL		10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.
PRODUCTION COSTS												
MINE		1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.
MILL		3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.
MISC		2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.
ROYALTY		680.	680.	680.	680.	680.	680.	680.	680.	680.	680.	680.
TOTAL		7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.
OPERATING INCOME		2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.
DEPRECIATION		932.	932.	932.	932.	932.	932.	932.	932.	932.	932.	932.
DEPLETION		977.	977.	977.	977.	977.	977.	977.	977.	977.	977.	977.
INCOME BEFORE TAXES		1084.	1084.	1084.	1084.	1084.	1084.	1084.	1084.	1084.	1084.	1084.
TAX		542.	542.	542.	542.	542.	542.	542.	542.	542.	542.	542.
NET INCOME AFTER TAXES		542.	542.	542.	542.	542.	542.	542.	542.	542.	542.	542.
CASH FLOW		2451.	2451.	2451.	2451.	2451.	2451.	2451.	2451.	2451.	2451.	2451.

ESTIMATED CASH FLOW (THOUSAND DOLLARS)

YEAR	13	14	15	16	17	18	19	20	21	22	23	24	25
FIXED CAPITAL													
EXP & DEV													
MINE													
MILL													
WORKING CAPITAL													
PRODUCT VALUE													
A	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.	9074.
B	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.	1188.
TOTAL	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.	10263.
PRODUCTION COSTS													
MINE	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.	1364.
MILL	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.	3173.
MISC	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.	2053.
ROYALTY	680.	680.	680.	680.	680.	680.	680.	680.	680.	680.	680.	680.	680.
TOTAL	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.	7269.
OPERATING INCOME	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.	2993.
DEPRECIATION	932.	932.	932.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DEPLETION	977.	977.	977.	1287.	1287.	1287.	1287.	1287.	1287.	1287.	1287.	1287.	1287.
INCOME BEFORE TAXES	1084.	1084.	1084.	1706.	1706.	1706.	1706.	1706.	1706.	1706.	1706.	1706.	1706.
TAX	542.	542.	542.	853.	853.	853.	853.	853.	853.	853.	853.	853.	853.
NET INCOME AFTER TAX	542.	542.	542.	853.	853.	853.	853.	853.	853.	853.	853.	853.	853.
CASH FLOW	2451.	2451.	2451.	2140.	2140.	2140.	2140.	2140.	2140.	2140.	2140.	2140.	2140.

AFTER TAX ROI = 15.4 (BASED ON AVE VALUES OF VARIABLES)

NOTES

DEPRECIATION -- METHOD USED -- STRAIGHT LINE

DEPLETION ALLOWANCE -- 15% OF THE GROSS PRODUCT VALUE

WORKING CAPITAL -- 15% OF THE GROSS PRODUCT VALUE

MISCELLANEOUS COSTS -- 20% OF THE GROSS PRODUCT VALUE

JOB USED 07A00 TO 11520 = 039K

CPU TIME 00:39:49

595 CARDS READ 9,674 LINES PRINTED