



Information Circular 9307

**PREVAL: Prefeasibility Software
Program For Evaluating
Mineral Properties**

Version 1.01

Users Manual

Using Lotus 1-2-3 release 2.01 or newer

By R. Craig Smith

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

day/yr	day per year	mi	mile
\$	dollar	%	percent
\$/st conc	dollar per short ton concentrate	RAM	Random access memory
\$/st ore	dollar per short ton ore	st	short ton
f.o.b.	free on board	st/day	short ton per day
g/mt	gram per metric ton	st mi	short ton mile
k	thousand	tr oz	troy ounce
km	kilometer	tr oz/st	troy ounce per short ton
lb	pound		

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PREVAL: PREFEASIBILITY SOFTWARE PROGRAM FOR EVALUATING MINERAL PROPERTIES

By R. Craig Smith¹

ABSTRACT

This report presents the software documentation for PREVAL, a prefeasibility mineral property evaluation program developed by the U.S. Bureau of Mines on a Lotus 1-2-3² spreadsheet. It is presented in a step-by-step "users manual" format. Appendixes contain the technical assumptions, program default values, and a summary printout detailing capital and operating costs and cash-flow analysis.

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²Reference to specific products does not imply endorsement by the U.S. Bureau of Mines.

INTRODUCTION

PREVAL is a software program developed on a Lotus 1-2-3 spreadsheet for prefeasibility valuation of mineral properties. It is a composite of many products developed by the U.S. Bureau of Mines for various aspects of mineral property evaluation, such as the Cost Estimating System (CES) handbooks and the economic analysis program (MINSIM). It was developed to enhance studies for the Minerals Availability and Mineral Land Assessment programs. The cost models used in PREVAL were developed by Thomas W. Camm, mining engineer, Bureau of Mines, Western Field Operations Center, Spokane, WA. The Federal tax routines were developed by Gary R. Peterson, mineral economist, Bureau of Mines, Minerals Availability Field Office, Denver, CO.

PREVAL is unique in that it utilizes aspects of expert systems programming to ask questions, make decisions, and then allow for user override. The software is designed to make an estimate of the total cost of production for a mineral property when not much is known about the mineral potential. The system works best for comparing the relative values of mineral properties and playing the "what if" game. The user should be cautious, however; the

results should not be used as definitive numbers for any one property. Also, the individual cost components for each model should not be used separately because they are less accurate than the total cost estimate.

The PREVAL advantage is that estimates can become more accurate, when better information about a property is obtained, by allowing the user to modify program defaults through the menu system. For example, PREVAL uses a gold recovery of 70% for heap leach processing; however, if analytical tests of the ore indicate a recovery of 76%, then the menu system can be used to change the program default of 70% to 76%. Thus, the results can be "improved" if the user has additional information about the ore body.

PREVAL is essentially one giant macro. When the file is retrieved into 1-2-3, the program starts running automatically. It asks questions, processes information, asks more questions, and so on until the user has worked through the entire macro. The last thing the program asks is whether the user wants a printout or to just display the summary within the spreadsheet.

GETTING STARTED

Before trying to access the program, copy the disk to the directory that contains the copy of Lotus 1-2-3. This step is very important because PREVAL is an autocxecute program whereby "getting" the file automatically starts the program. Furthermore, the PREVAL spreadsheet is purposely left **unprotected**, to allow the user to modify program defaults, so it is very easy to accidentally write over cell information.

In order to run PREVAL, the user must have Lotus 1-2-3 release 2.01 or newer installed on the PC. PREVAL

requires 640 K of RAM. It is assumed that the user is acquainted with Lotus, but being a proficient operator is not necessary. New Lotus users should go through the tutorial program before running PREVAL.

Now follow the instructions in the Lotus manual to start the program. When the blank spreadsheet screen appears, the user may now retrieve PREVAL and start the evaluation.

ACCESSING PREVAL

To access PREVAL, first get to the Lotus menu by pressing "/" for the menu (without the quotes), then press "F" for File, and then press "R" for Retrieve. Notice that the menu has several files, highlight "INTRO" or type in the file name "INTRO." INTRO is a small file that introduces the PREVAL program, includes a Bureau disclaimer, and then accesses and automatically starts the PREVAL program. The user can also highlight "PREVAL" or type in "PREVAL" as a shortcut that bypasses INTRO.

The first screen to appear when PREVAL is accessed is shown in figure 1. This is the main menu, which allows one of three things to be done: **RUN** the program, **MODIFY** data within the program, or **QUIT** and exit the program. The user can make a selection by one of two methods: highlighting the appropriate word in the menu by using the arrow keys and pressing "Enter" or by typing the first letter of the word for the desired function.

Start with **RUN**. When running PREVAL, keep the following in mind. First, after selecting RUN, note the

```

AA250:                                     MENU
RUN  MODIFY  QUIT
- RUN - This will begin the evaluation.  AE   AF   AG   AH
      AA   AB   AC   AD
250
251
252                                     WELCOME TO THE MAIN MENU
253
254                                     OF THE PREFEASIBILITY METHODOLOGY SYSTEM
255                                     (PREVAL)
256
257                                     PLEASE CONTINUE BY ENTERING YOUR SELECTION
258
259
260      - RUN - This will begin the evaluation.
261      - MODIFY - This will allow you to change evaluation criteria.
262      - QUIT - Exit the system.
263
264
265
266
267
268
269
17-Jan-92 12:22 PM                                CMD      CALC      NUM

```

Figure 1.—Main menu screen.

mode indicator in the upper right-hand corner of the screen. The mode indicator will show a flashing "WAIT" while it is working. At any time throughout the program, do not enter any data until the mode indicator shows "READY." Be patient because PREVAL has a lot of work to do after each set of data is entered.

Second, the cursor (or highlighted cell on the screen) is always positioned at the cell where the user is required to enter information. CAUTION, always use the "enter" key to enter data. If the "arrow" keys are used, the macro does not input the information and will not run properly.

Also, enter a value where required. This includes "0" (zero) rather than a blank because Lotus does not necessarily interpret a blank as meaning "0." The same is true for "Y" or "N" entries. A blank entry will be misinterpreted by the macro.

Third, if data were inadvertently typed incorrectly and "ENTER" was not pressed, use the "Backspace" key to edit the data. However, if data were entered incorrectly and "Enter" was pressed, it cannot be changed! Stop the macro and restart PREVAL. Please refer to the section on Stopping and Restarting PREVAL.

RUNNING PREVAL

If "R" for RUN was pressed or "RUN" highlighted and "Enter" pressed, one of two possible screens may appear depending on previous program use. The first screen to appear begins with a few "bells" and is actually a two-part screen that first asks the name of the property to be evaluated (fig. 2). Type in the property name, check what was typed by looking in the upper menu area, and then press "Enter." The second part of the screen will appear. Type in user's name and press "Enter."

If the above screen does not appear, then the following screen will appear (fig. 3). This screen is displayed when PREVAL has been modified to use the production rate override capability rather than the automatic calculation method. This capability will be discussed more fully in the Sensitivity Analysis section. But for now, if the screen

appears, press "ALT" P to put PREVAL in automatic calculation mode and figure 2 will appear.

The next screen (fig. 4) asks for the in situ ore reserve estimate in short tons. Enter a value and press "Enter." Once again, always make sure that the mode indicator is "READY" before entering data. Do not use commas when entering the estimate.

The next screen asks for the in situ grades for the commodities valid for PREVAL (fig. 5). For commodities requiring percent (%), a value of 0.7% would be typed as "0.7" and 12.5% would be typed as "12.5." Press "Enter" after each value is typed. Notice that PREVAL will not skip any commodities. This is because PREVAL requires a value entered for each commodity. Remember to use "0" (zero) rather than a blank or the letter "o" for commodities that do not occur in the ore body.

```

B11: [W30]                                READY

      A          B          C          D          E
1
2
3      Welcome to the U.S. Bureau of Mines
4      Prefeasibility Software Package
5      for Mineral Property Evaluations
6
7
8      What is your property name?
9      Test Mine
10     Property evaluated by?
11
12
13
14
15
16
17
18
19
20
17-Jan-92  12:24 PM          CMD      CALC      NUM

```

Figure 2.—Welcome screen.

```

AQ84: (H) [W4] 'Return to Menu by pressing "Alt" M          READY

      AQ  AR  AS  AT  AU  AV  AW  AX  AY      AZ      BA      BB      BC
84
85
86          ***** NOTICE *****
87      The last evaluation was run with the production rate
88      manually set rather than calculated by PREVAL.
89
90      If you want to manually change the production rate, press
91      "ALT" M and use the MENU to make changes.
92
93      If you want to return to automatic calculation by PREVAL, press
94      "ALT" P
95
96      If you want to continue with the current override rate, press
97      ALT" R
98
99          10,000 ton/day override rate
100
101
102
103
17-Jan-92  12:31 PM          NUM

```

Figure 3.—Production rate override screen.

B7: (,0) [W30]

READY

	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
17-Jan-92	12:35 PM		CMD	CALC	NUM

The following geological questions will determine the mining rate, mining method, and beneficiation process.

What is the in situ ore reserve estimate in short tons?

Figure 4.—Reserve estimate screen.

D5: [W12]

READY

	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
17-Jan-92	12:36 PM		CMD	CALC	NUM

Please enter the in situ grades. For inappropriate commodities enter zero.

Gold	tr oz/st Au
Silver	tr oz/st Ag
Lead	% Pb
Zinc	% Zn
Copper	% Cu
Molybdenum	% MoS ₂
Platinum	tr oz/st Pt
Palladium	tr oz/st Pd
Nickel	% Ni

(Enter the appropriate value or zero)

Figure 5.—Grade estimate screen.

The next screen is either a two-part or three-part screen, depending on some of the answers (figs. 6, 7, and 8). The first part asks the depth to the top of the ore body (fig. 6).

PREVAL uses a default value of 200 feet as the cutoff between open pit and underground mine method selection. If, for example, there is a near-surface vein system that obviously will be mined by underground methods, the program can be "fooled" by entering a value greater than 200 feet (to top of the ore body) in order for PREVAL to

select the proper underground mining method, or the user can override any mining method selection on a later screen.

Part two of this screen asks questions about the type of ore body in order to further refine mining method selection (fig. 7). Bedded and stratiform deposits include sedimentary-, metamorphic-, and igneous-hosted deposits that display layering or stratabound characteristics. Examples are Mississippi Valley Type lead-zinc deposits and Stillwater Complex platinum-group metal deposits.

```

D2: [W12]                                READY

      A          B          C          D          E
1
2      How deep to the top of the ore body?          feet
3
4      How deep to the bottom of the ore body?      feet
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19      All questions must be answered with Y or N or a number.
20
17-Jan-92  12:38 PM                      CMD      CALC      NUM

```

Figure 6.—Depth to ore body screen.

```

D9: [W12]                                READY

      A          B          C          D          E
1
2      How deep to the top of the ore body?          100 feet
3
4      How deep to the bottom of the ore body?      800 feet
5
6
7
8      Is this a flat-bedded/stratiform deposit?
9                                          (Y or N)
10     Is the ore body massive/disseminated?
11                                          (Y or N)
12     Is this a vein deposit?
13                                          (Y or N)
14
15
16
17
18
19     All questions must be answered with Y or N or a number.
20
17-Jan-92  12:39 PM                      CMD      CALC      NUM

```

Figure 7.—Type of deposit screen.

Note: If the answer is "Y" to the first question, PREVAL automatically answers "N" to the other two questions and continues to the next screen. The same applies to the second question.

Massive and disseminated deposits generally refer to very large, irregular ore bodies such as porphyry copper and stockwork molybdenum systems, and sedimentary-hosted gold deposits. Vein deposits are self-explanatory and if "Y" is entered for this question, two more questions appear on the same screen (fig. 8).

Figure 8 will appear if the answer is "Y" for a vein deposit; otherwise, PREVAL will skip to figure 9. If the "Y" was entered for the vein deposit, PREVAL will ask for vein width and dip. It is very important to enter values for these questions because they are crucial for proper mining method selection.

The next screen is a two-part screen (figs. 9 and 10). Figure 9 asks about the relative strength of the ore. Note again that PREVAL helps the user when the answer is "Y"

D17: [W12] 68

READY

	A	B	C	D	E
1					
2		How deep to the top of the ore body?		100 feet	
3					
4		How deep to the bottom of the ore body?		600 feet	
5					
6					
7					
8		Is this a flat-bedded/stratiform deposit?			
9			n		(Y or N)
10		Is the ore body massive/disseminated?			
11			n		(Y or N)
12		Is this a vein deposit?			
13			y		(Y or N)
14		What is the average vein width?			
15				7 feet	
16		What is the average dip?			
17				68 degrees	
18					
19		All questions must be answered with Y or N or a number.			
20					
17-Jan-92	12:53 PM		CALC	NUM	

Figure 8.—Width and dip screen.

C3: [W12]

READY

	A	B	C	D	E
1					
2		Is the ore strength:			
3			weak		(Y or N)
4			moderate		(Y or N)
5			strong		(Y or N)
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17		Answer all questions with Y or N.			
18					
19					
20					
17-Jan-92	12:55 PM		CMD	CALC	NUM

Figure 9.—Ore strength screen.

by filling in the other answers and continuing on to the second part of the screen.

Figure 10 asks about the strength of the waste or wall rock. As this point, PREVAL is still trying to determine the best mining method, and knowing the breaking strength of the rock improves the mining method selection. **IMPORTANT! Before answering these questions, read the next paragraph.**

The next screen is a tabulated summary, by mining method, of appropriate conditions for mining method

selection indicated by "X"'s. The bottom line is a total that is used to pick a mining method (fig. 11). If two or more methods have the same total, the program picks a mining method based on economics. **CAUTION, this screen is set to a 5-second timer. Do not attempt to enter data or press "Enter" while this screen is displayed. The program will automatically continue after 5 seconds.** The next screen (fig. 12) will automatically appear. It summarizes the selected mining method and offers the option to override the selection.

```

C7: [W12]                                READY

      A          B          C          D          E
1
2      Is the ore strength:
3          weak y          (Y or N)
4          moderate N      (Y or N)
5          strong N        (Y or N)
6      Is the wall rock strength:
7          weak            (Y or N)
8          moderate        (Y or N)
9          strong          (Y or N)
10
11
12
13
14
15
16
17      Answer all questions with Y or N.
18
19
20
17-Jan-92 12:59 PM          CMD          CALC          NUM

```

Figure 10.—Rock strength screen.

```

AJ9: (H)                                WAIT

      AJ          AK          AL          AM          AN          AO          AP          AQ          AR          AS          AT          AU          AV          AW          AX          AY
9      Questions          open          sublev          room &          shrink          cut &          block
10     pit          stope          pillar          VCR          stope          fill          cave
11     -----
12     dep >200
13     dep<=200          X
14     bed >200
15     bed<=200
16     mas >200
17     mas<=200
18     vein<=20          X          X
19     vein >20
20     dip > 60          X          X          X
21     dip <=60
22     weak ore          X
23     mod ore
24     strong
25     wk waste          X
26     mod waste
27     strong
28     TOTAL          3          1          0          1          2          2          0

```

Figure 11.—Mining method selection summary screen.

If satisfied with PREVAL's selection in figure 12, enter the number of the method selected and press "Enter." Otherwise, select the appropriate mining method, type in the number, and press "Enter."

The next screen (fig. 13) shows the type of mill models included in PREVAL. Select the method to be used and enter the number. To get additional information describing which method is most appropriate for the type of ore to be processed, type in "help" and press "Enter." The next screen will give a brief summary of the types of

ores that are best handled by each mill method (fig. 14). Review the information, select the appropriate number, and "Enter."

At this point, PREVAL's next screen could be one of three possibilities depending on previously entered data. If a flotation mill was selected and too many commodity grades were entered for that mill, the following screen will appear (fig. 15).

Basically, PREVAL will not decide which commodities will be recovered for flotation mills when more

C20: [W12]

READY

	A	B	C	D	E
1		Based on your geologic information:			
2		The mining method selected is:		Small Open Pit	
3		The optimum mining rate is:	3241	st/day ore	
4			6482	st/day waste	
5			260	operating days/yr	
6			2	preproduction years	
7			11	production years	
8			90	% ore recovery	
9			3	% dilution	
10		If you wish to change the mining method,			
11		choose from the following methods:		1 - Large Open Pit	
12				2 - Small Open Pit	
13				3 - Sublevel Stope	
14				4 - Room & Pillar	
15				5 - VCR	
16				6 - Shrinkage Stope	
17				7 - Cut & Fill	
18				8 - Block Cave	
19					
20		Select mining method number:		(Number)	
17-Jan-92	01:03 PM		CMD	CALC	NUM

Figure 12.—Selected mining method screen.

C19: [W12]

READY

	A	B	C	D	E
1					
2					
3		The following mill models have been developed for this			
4		spreadsheet. If you do not know which model to use,			
5		type "help" instead of the number. Information will be			
6		provided to help you select a model.			
7					
8		Mill model choices:			
9			1 - CCD plant		
10			2 - CIP plant		
11			3 - Heap Leach plant		
12			4 - Float/Roast/Leach plant		
13			5 - Free Milling (gravity) plant		
14			6 - SX/EW (Cu leach) plant		
15			7 - Flotation (1 product) plant		
16			8 - Flotation (2 product) plant		
17			9 - Flotation (3 product) plant		
18					
19		Select mill model number:		(number or "help")	
20					
17-Jan-92	01:06 PM		CMD	CALC	NUM

Figure 13.—Mill model selection screen.

concentrates could be produced than the mill design indicates. This is purposely done because commodity price fluctuations or mineralogic characteristics should be considered by the evaluator, not PREVAL, in order to determine which commodities can or should be recovered. If this screen appears, either select a new mill, for example, two- or three-product flotation mills, or change grades (delete some commodity grades). If "Change Grades" is selected, the following screen will appear (fig. 16).

The commodities shown on the screen are the only ones that need to be modified because each would be produced as a separate concentrate. The precious metals are not affected because they are recovered as byproducts within the concentrates. If sufficient numbers of commodities have not been deleted, PREVAL returns to the same screen until enough deletions have been made to be valid for the mill method.

```

C19: [W12]                                READY

      A              B              C              D              E
1
2  1 - CCD plant:  Use for Au ore with high Ag values. Can also be used
3                  for carbonaceous ore although CIP is cheaper process.
4  2 - CIP plant:  Use for siliceous, carbonaceous, or complex refractory
5                  Au ore. Also use for high-grade oxidized Au ore.
6  3 - Heap Leach plant: Use for low-grade oxidized Au ore.
7  4 - Float/Leach plant: Use for sulfide Au ore (tellurides,
8                  pyrrhotite, arsenopyrite, pyrite, etc.)
9  5 - Free Milling (gravity) plant: Use for free Au ores.
10 6 - SX/EW (Cu leach) plant: Use for oxide Cu dump leach. Must be
11    evaluated separately if flotation plant also used.
12 7 - Flotation (1 product): Use for base and precious-metals recovery
13    (Mo, PGM ores, Cu/Au/Ag, Ag, Pb/Ag, Pb, Zn ores).
14 8 - Flotation (2 product): Use for base and precious metals recovery
15    (Cu/Mo, Pb/Zn, Cu/Zn ores, all +/- Au and Ag, etc.).
16 9 - Flotation (3 product): Use for base and precious metals recovery
17    (massive sulfides, complex vein ores, +/- Au and Ag, etc)
18
19 Select mill model number:                (number)
20
17-Jan-92 01:11 PM                        CMD      CALC      NUM

```

Figure 14.—Mill model description screen.

```

D9: [W12]                                READY

      A              B              C              D              E
1
2                  CAUTION
3
4  You have entered too many commodity grades for this mill.
5  You must either select another flotation
6  mill or delete some of the commodity grades.
7
8
9  Select mill:                                (Y or N)
10
11 Change grades:                             (Y or N)
12
13
14
15
16
17
18
19
20
17-Jan-92 01:26 PM                        CMD      CALC      NUM

```

Figure 15.—Caution screen.

The next possible screen to appear is shown in figure 17. If the user selected lead, zinc, copper molybdenum, or nickel as concentrate products, then transportation distance and mode must be determined for each commodity. Appendix C contains a map and list of North American smelter and refinery locations, as well as types of commodities treated at each facility. Appendix D is a rail transportation system map, included as an aid for determining rail transportation routes to these facilities. The screens are identical for each commodity except

molybdenum. This screen contains a note at the bottom stating that transportation is optional because the price used in PREVAL, and often the quoted price, is based on f.o.b. mill. If PREVAL's price is used, enter "0" (zero) for distance and "N" for shipping. If PREVAL's price is changed, make sure whether the quote is f.o.b. or delivered cost. It may be necessary to use the molybdenum transportation screen.

Once again, PREVAL may show one of two possible screens. One may ask if the deposit is a Mississippi Valley

```

D3: [W12]                                READY

      A              B              C              D              E
1
2      Enter in situ grades:
3
4      Lead              % Pb
5      Zinc              % Zn
6      Copper            % Cu
7      Molybdenum        % MoS2
8      Nickel            % Ni
9
10
11
12
13
14
15
16
17
18
19
20
17-Jan-92  01:27 PM          CMD      CALC      NUM
  
```

Figure 16.—Change grades screen.

```

D8: [W12]                                READY

      A              B              C              D              E
1
2      The following questions will determine transportation
3      charges for concentrates. Please refer to the
4      documentation for smelter locations and routes.
5
6      Lead Concentrate:
7      What is the estimated truck distance?
8
9      What is the estimated rail distance?
10
11      Are concentrates shipped overseas?
12
13
14
15
16
17
18
19
20
17-Jan-92  01:39 PM          CMD      CALC      NUM
  
```

Figure 17.—Transportation screen.

Type ore deposit (fig. 18). This screen will appear only if lead and zinc ore grades were entered and copper, molybdenum, and nickel values were zero. The reason this question is asked is that Mississippi Valley Type ores have significantly different mill recoveries than other types of deposits. Based on the answer, PREVAL will pick the appropriate recoveries.

The last screen to appear says "CONGRATULATIONS" and asks if the user wants to print the summary or not (fig. 19). If "Y" for yes is entered, it will automatically start printing the summary file. **IMPORTANT! Check the printer control codes before entering "PRINT"**

for the summary print file. Check the section "Macro Defaults" in this documentation to set up the control codes for the printer. If "N" for no is entered, it will automatically go to the top of the summary print file within the spreadsheet so the user can look through the summary. At this point, the macro execution is complete. The arrow keys may be used to move around the spreadsheet. The spreadsheet map in Appendix B may be used for assistance. **Be careful not to enter any data accidentally while looking around in the spreadsheet. It may affect how PREVAL runs.** A comments area is outlined by stars (*), at the top of the D (cell E 805), as a safe area to enter

```

D3: [W12]                                READY

      A          B          C          D          E
1
2      Is this a Mississippi Valley Type ore deposit?
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
17-Jan-92 01:42 PM          CMD          CALC          NUM

```

Figure 18.—Mississippi Valley Type screen.

```

D9: [W12]                                READY

      A          B          C          D          E
1
2      CONGRATULATIONS!
3      You have completed a PREVAL evaluation.
4      You may now look at the summary by going to the
5      printfile summary or you may print the summary.
6
7
8
9      Print the summary:
10
11
12
13
14
15
16
17
18
19
20
17-Jan-92 01:30 PM          CMD          CALC          NUM

```

Figure 19.—Print summary screen.

any specific information about each run. If the results of the evaluation are satisfactory, send the summary to the printer. Make sure the printer setup control codes have been set, then press: "/" for the menu, "P" for print, "P"

for printer, "R" for range, type "prnfl" for the range name, "Enter," and "G" for go. After the print is completed, the upper Lotus menu will reappear. Simply press "Q" to be interactive within the spreadsheet again.

STOPPING AND RESTARTING PREVAL

If a mistake has been made, it is not necessary to run through the entire macro before starting over. The user may stop the macro at any time by pressing the "Ctrl" and "Break" keys at the same time. This will produce a beep and the mode indicator will have a flashing "ERROR." Next press the "Esc" key. The macro is now

completely terminated and PREVAL is ready to restart. To restart PREVAL, press the "Alt" and "M" keys at the same time. This will return to the main menu where the user can RUN, MODIFY, or QUIT the program. Simply highlight which function is wanted and press "Enter" or type the first letter of the function.

MODIFYING PREVAL DEFAULTS

PREVAL contains two types of defaults; operational defaults and information defaults. Operational defaults are assumptions, logic statements, values, equations, and command statements that are integral parts of the macro and macro execution. The defaults discussed in this documentation are kept to a minimum and are considered important for user knowledge and/or operation. These "defaults" should not be changed because the macro may not operate properly if changed.

Information defaults are values that can be changed through the MODIFY category of PREVAL's main menu. These defaults include operating and capital cost adjustment factors, mill recoveries, strip ratios, transportation rates, etc.

OPERATIONAL DEFAULTS

The printer control codes are set for a wide carriage printer at 240 characters. In order to change the printer codes, consult the Lotus or printer manual. Whichever is used, changes need to be made through the menu in PREVAL. To do this, get out of the autoexecute mode of the program by pressing "Ctrl" and "Break" keys at the same time. Then press the "Esc" key. The mode indicator (upper right hand corner) will change from "ERROR" to "READY." It is now possible to move about within the spreadsheet and make changes. The printer codes are the first line of the macro located in cell "BE1." To change the codes, go to cell BE1 by pressing "F5" and typing in "BE1," then press "Enter." The screen now shows the contents of cell BE1. Change the control codes by typing the new control code information and pressing "Enter." The codes can also be changed by first pressing the edit key "F2," then typing in the new printer control codes, and pressing "Enter." It would be a good idea to make this

change permanent, so press "/" for the menu, "F" for file, "S" for save, and "Enter." Now wait until the mode indicator, upper-right portion of the screen, indicates "READY." Printer control codes are now saved. Start the program again by pressing "Alt" and "M" keys at the same time.

There are numerous operational defaults within the macro which will not be discussed. Most have to do with the logic of running the macro, but others are assumptions and values that are an integral part of macro execution. Most of these will become apparent with the use of the program. Some examples of operational defaults are listed below:

- Preproduction years are either 2, 3, or 4 years, and are predetermined by mining method. Small open pit uses 2 preproduction years. Cut and fill, sublevel/longhole, room and pillar, shrinkage, and large open pit use 3 preproduction years. Block cave uses 4 preproduction years.
- Preproduction expenditures are apportioned 70% to capitalization and 30% to amortization. Amortization period is 5 production years. However, if life-of-mine is less than 5 years, then amortization is life-of-mine.
- Working capital is included in the capital costs and is based on 90 days of operating expenses.
- Debt to equity ratio is 60% debt to 40% equity.
- State taxes are based on 5% of net taxable income. Running PREVAL under the various State tax regimes will not significantly change the cash-flow summary.
- Salvage value of mine and mill equipment is zero. It is assumed that the actual salvage value from a real operation will be equal to end-of-life reclamation cost. Therefore, reclamation costs are not addressed.
- The beneficiation plant is assumed to be on-site. Smelting and refining of concentrates are handled offsite by contract services.

- Precious-metal transportation costs to a refinery are minimal. They are not addressed in PREVAL.

INFORMATION DEFAULTS

Information defaults are accessed through the main PREVAL menu (fig. 1.). When in the spreadsheet but not running the program, press "Alt" and "M" keys at the same time to get to the PREVAL MENU. If running the program, refer to the documentation section called "Stopping and Restarting PREVAL."

At the main menu (fig. 1), some of the defaults used in PREVAL can be changed by highlighting the word "MODIFY" or typing "M" for modify. The next screen to appear (fig. 20), shows which categories of information can be modified by the user. Only one category, COSTS, has a submenu for further modification of defaults (fig. 21). Accessing these categories is accomplished in the same manner by highlighting the word in the Lotus menu or by typing the first letter of the word. PREVAL then sends the user to an area in the spreadsheet where changes can be made directly in the cells used by the macro or to libraries of data that PREVAL accesses.

```

AA290:
METBAL PRICE COSTS FINANCE STRIP TONS QUIT
- Modifies mine/mill recoveries.
      AA      AB      AC      AD      AE      AF      AG      AH      MENU
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
17-Jan-92 01:46 PM
CMD      CALC      NUM
  
```

PREFEASIBILITY METHODOLOGY SYSTEM
MODIFICATION MENU
PLEASE CONTINUE BY ENTERING YOUR SELECTION

```

      METBAL - Modifies mine/mill recoveries.
      PRICE  - Modifies commodity prices.
      COSTS  - Cost modification menu.
      FINANCE - Modifies financial assumptions.
      STRIP  - Modifies the 2:1 strip ratio.
      TONS   - Modifies the production rate (tons of ore/day).
      QUIT   - Returns to main menu.
  
```

Figure 20.—Modification menu screen.

```

AA310:
MINE/MILL TRANSPORT SMELT/REF QUIT
- Modifies mine/mill operating and capital costs.
      AA      AB      AC      AD      AE      AF      AG      AH      MENU
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
17-Jan-92 01:47 PM
CMD      CALC      NUM
  
```

PREFEASIBILITY METHODOLOGY SYSTEM
COSTS MENU
PLEASE CONTINUE BY ENTERING YOUR SELECTION

```

      MINE/MILL - Modifies mine/mill operating and capital costs.
      TRANSPORT - Modifies transportation costs.
      SMELT/REF - Modifies smelter/refinery charges and pay-fors.
      QUIT      - Returns to main menu.
  
```

Figure 21.—Costs menu screen.

IMPORTANT! When accessing a category within "MODIFY," the macro moves to the appropriate area in the spreadsheet, and stops executing. Notice the message in the Lotus menu, which tells the user to make changes in the appropriate cells, and then press "Alt" and "M" keys at the same time. This starts the macro again and returns to the main menu. After moving to the area or library to be modified, use the arrow keys to move around to the specific cells. Be careful not to write in other cells because damage could occur to the macro. Remember, almost all cells are unprotected. Use the spreadsheet areas and library diagrams, shown in Appendix D, as a reference when working with MODIFY. These diagrams show by column-letter and row-number the total area the libraries take up.

If changes are made to any cell in the spreadsheet, PREVAL can be rerun with this new information by

pressing "Alt" and "M" keys at the same time to restart the menu. To recalculate the existing spreadsheet, based on these changes, press the "F9" key (recalculate). Read the price determination section for more information on the "F9" capability. Note: Modifications in the "FINANCE" menu can only be made after a property has been run through PREVAL. All of the other modification menus may be changed before or after a PREVAL run.

If changes are made and the file is saved, the changes will be permanent within PREVAL if the file is saved as "PREVAL.WK1." Remember this when PREVAL is used to evaluate another property. The changes made now for a particular property may not be valid changes for the next property evaluated. If the user is not sure what has been changed, the original disk can be recopied to start with the original PREVAL version.

SENSITIVITY ANALYSIS

After an evaluation has been completed and the results in the print file have been studied, the user may start analyzing the property for those items that most affect the economics of the operation; for example, how the price of gold affects the economics of the property. To do this, press "ALT" and "M" keys at the same time, press "M" for modify, and press "P" for price. Now use the arrow keys to highlight the value for gold, change the price to \$300, and press "ENTER." To see how the economics change, press the "F5" key (go to), type in "LOOK," and press "ENTER." This sends the user to the D area that calculates DCFROR and NPV. Now press the "F9" key and see how the numbers change.

Note: The Lotus NPV and IRR commands require a narrow range for proper closure to an estimate. If the "ERR" statement appears in the summary, the target percent can be changed to recalculate the spreadsheet. To do this, go to cell F994 and change the 15% target number to another number. Press the "F9" key to recalculate. This may also be done for the 0% target number in cell J994.

Another desirable analysis to perform is the optimization of production rate. PREVAL calculates the optimum production rate using Taylor's Rule, which is discussed in Appendix A. This rule is a rather conservative estimation technique and does not work well for certain types of operations. Heap leach mining operations is one example. The principle in heap leach mining is to move a large amount of material very quickly because ore processing

(leaching) takes a long time. This modification can be easily handled through the "TONS" modification in the MODIFY MENU.

IMPORTANT! When the "TONS" modification is used, always use a tonnage higher than what was previously used, never a lower tonnage because PREVAL cannot add to the calculated mine life. PREVAL, however, can reduce mine life when the production rate is increased.

PRICE DETERMINATION

Price determinations are another feature that can be performed with PREVAL. After running a property through PREVAL, press the "F5" key (go to), type "LOOK," and press "ENTER." The DCF and NPV area of the D is now shown. First, determine the rate of return (ROR) wanted for the price determination. Use the arrow keys to highlight the number (cells F994 and J994), and enter a new value. Press "F9" and look at the values for NPV and DCFROR. If the values are large, change the price of the commodity being evaluated to a lower value; use the MENU system to change prices. Next, press "F5" and type "LOOK" to get back to the DCF and NPV area of the D. Now press "F9" to recalculate the spreadsheet. Check to see how close to zero the NPV is. Repeat this procedure of changing commodity price until the NPV is zero or within a few thousand dollars of zero. At that point, the commodity price for the specified ROR has been determined.

APPENDIX A.—PREVAL TECHNICAL ASSUMPTIONS

INTRODUCTION

One of the Bureau's many functions is the evaluation of mineral potential for land management agencies, primarily the Forest Service, the Bureau of Land Management, and the Bureau of Indian Affairs. Evaluations have been conducted over the last 20 years for Wilderness Study Areas, RARE II studies, Minerals Availability Supply (MAS) studies, and a variety of miscellaneous studies, primarily for land-use and long-term planning purposes. As a result of these efforts, the Bureau has developed several methodologies that assist and simplify the overall evaluation process. These include the Bureau's Cost Estimating System (CES) and the economic analysis system (MINSIM). The Bureau's latest methodology, PREVAL, now combines all aspects of property evaluation into one complete software package, and is enhanced by aspects of expert system programming. Although the software was developed for Government use, it is also useful to the mining industry, especially for the explorationist. PREVAL was developed using Lotus 1-2-3, release 2.01, which requires the user to have a PC with Lotus 1-2-3, release 2.01 or newer. This appendix will outline the criteria and assumptions used in the PREVAL system and how they relate to other industry methods of evaluation.

There are many levels of property evaluation between raw prospect discovery and development of a minable reserve. Raw prospect evaluation requires only identified mineralization of potential economic significance whereas property development requires a complete feasibility study with quantitative values supported by a high degree of confidence. Exploration is the first stage of property evaluation and may require expenditures of millions of dollars just to find one property worth developing. The goal of the explorationist, obviously, is to evaluate the greatest number of properties at the least possible cost and correctly select the property or properties most likely to be economic deposits. This can be done economically and efficiently at the early exploration stage if the appropriate evaluation techniques are used with a thorough understanding of their limits, accuracies, and assumptions.

Methods of evaluation vary widely, but the basic criteria for economic evaluation include selection of mining and beneficiation methods, mine-life optimization, capital and operating cost estimation, material balances, marketable products and prices, smelter/refinery schedules and pay-fors, transportation, and economic analysis (fig. A-1). In addition, sensitivity analysis should also be performed to give the explorationist evaluation data such as minimum tons and grade required for break-even economics or minimum commodity price requirements. All of these criteria are included in PREVAL.

EVALUATION CRITERIA

The previously mentioned evaluation criteria not only provide the basis for mineral property evaluation but also provide an avenue for more sophisticated analyses. Besides establishing a common denominator for property comparisons, the PREVAL system can be used in modeling applications. One modeling application is valuation of multiple mine and mill plans in order to optimize cash-flow. But before any modeling or evaluation can be done, the explorationist must at least have an estimate of the potential tonnage and grade of a prospect.

Tonnage and Grade

In order to evaluate a property, PREVAL requires the evaluator to estimate the potential ore tonnage and an average grade. These are the most subjective decisions to be made at the early exploration stage. They cannot be avoided, but can be tempered into plausible estimates. Explorationists must utilize their expertise to look at a prospect's hard data, the geologic environment, existing mines and ore deposits that occur within that environment, estimate tons and grade consistent with the expected geologic models and existing deposits, and finally, adjust the estimate by property-specific considerations. Once an estimate is derived, the valuation procedure can begin. Worst and best case scenarios should also be considered, and evaluated with PREVAL to define a range.

Mine and Mill Selection

Selecting the most efficient and economic mine and mill methods is the most important aspects of property evaluation. Once again, at the early exploration stage, subjectivity lies with determining the shape and extent of the ore body, structural control, and rock competency for mining method selection, and overall mineralogical composition of the ore for selection of beneficiation method. PREVAL has imposed some rigid criteria for mining method selection by asking certain geologic questions that help eliminate mining method choices. If the process does not eliminate all methods based on geologic criteria, then economic criteria are used to select the final method. For example, a steeply dipping, narrow vein ore body may be minable by shrinkage stoping or by cut and fill. The software would select the shrinkage stoping method because it is a more economical mining method. Even though PREVAL selects the mining method, the user may override any selection.

Mining method selection criteria for PREVAL are based on type of ore body (massive or disseminated, flat-bedded or stratiform, or vein), size and shape of ore body,

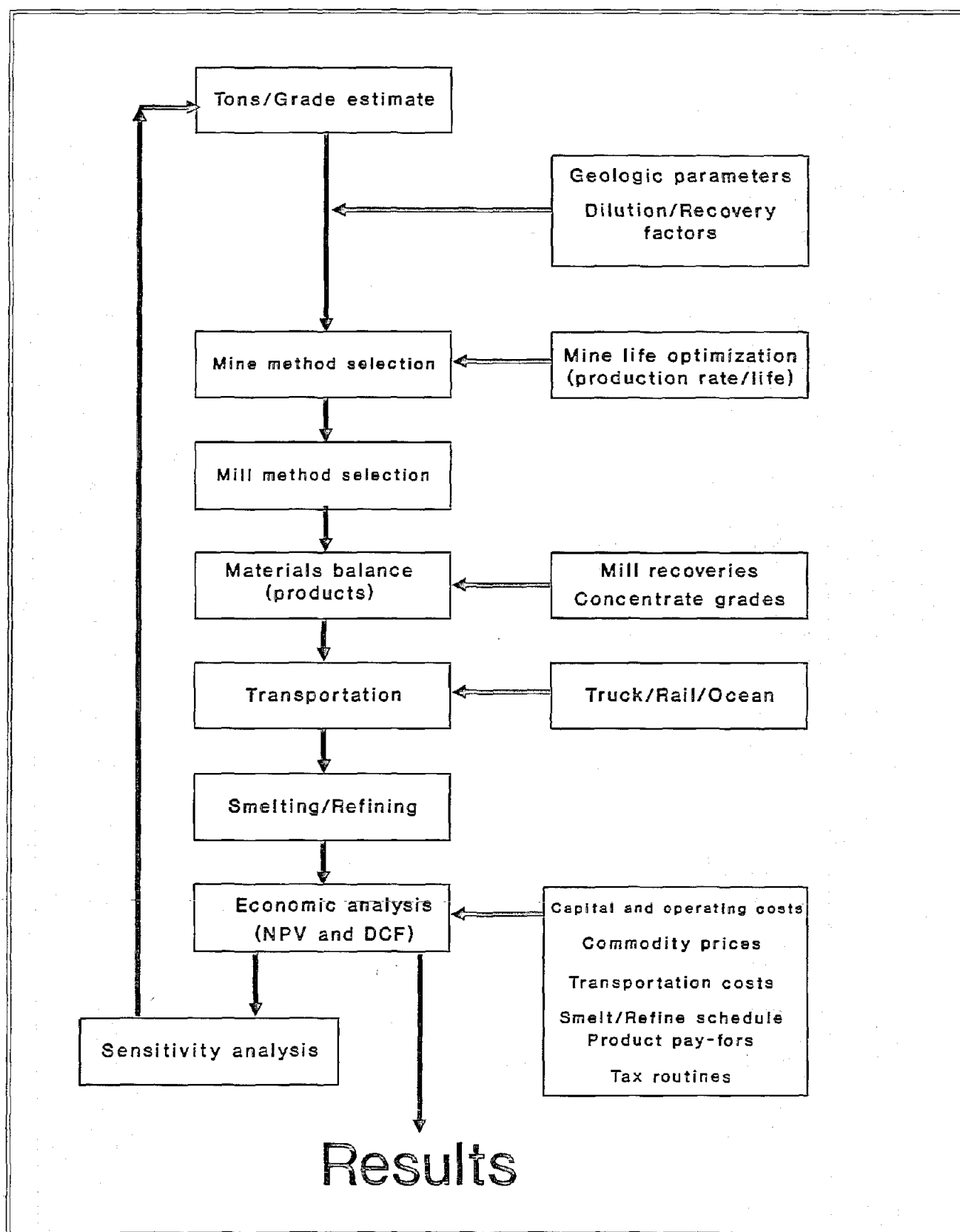


Figure A-1.—Flow diagram for mineral property evaluations using PREVAL.

depth to top and bottom of the ore body, vein width and dip, strength of ore and waste rock (weak, moderate, or strong), and mining rate. Modified or combination mining methods are beyond the scope of the PREVAL system but should be considered after a reserve has been thoroughly delineated. The mining methods included in this software are large open pit (>20,000 tons per day ore plus waste), small open pit (<20,000 tons per day ore plus waste), cut and fill, shrinkage stope, longhole-sublevel stope, vertical crater retreat, room and pillar, and block cave. Although PREVAL selects what it thinks is the best mine method, reevaluating a property with comparable mining methods is recommended to further enhance the decision process.

Mill selection is left entirely to the evaluator by PREVAL, but a "help" screen can be accessed to provide mill selection information. A careful examination of hand specimens or drill cuttings along with assays should provide enough information on ore types to select the probable mill method. For example, if the ore type is a massive sulfide with copper-lead-zinc-silver values, then a three-product flotation mill should be selected. If the ore type is a siliceous, carbonaceous, or complex refractory gold ore, then a carbon-in-pulp (CIP) processing method should be selected. The mill models included in PREVAL are counter-current decantation (CCD), CIP, heap leach, float/roast/leach, free milling (gravity), solvent extraction and electrowinning (SX-EW), and one-, two-, and three-product flotation plants. Short mill summaries are included to help with model selection.

Mine-Life Optimization

Selecting the proper mine life is an important process in property evaluation. Once the mine and mill models have been selected, it is necessary to determine mining and milling rates. Evaluating a property with a high production rate and short mine life may require prohibitive capital costs. Conversely, a medium-size ore body evaluated with a 100-year life may never generate adequate revenue. Neither of these examples takes advantage of optimizing capital and operating costs relative to production rate. Production optimization can be based on several different factors and vary from property to property. An underground mine may be limited by the working space and mechanical constraints of removing ore and waste; whereas a large open pit production rate may be based on the cash-flow analysis. Another property's mine life may be based on market considerations or risk analysis. Whatever the basis, the objective is to maximize profitability within the predetermined constraints.

Some methods used by industry to determine optimum mine life include the 10- and 20-year life plans, the 100 to 125 vertical feet per year plan, and Taylor's Rule. The 10-year plan simply divides the minable reserve by 10 to determine the annual ore production rate. Stripping of

waste for open pits and mining of waste for underground mines must be added to ore production for overall mining rate. This plan is used for medium to small ore bodies, primarily to reduce the risk caused by cyclical price fluctuations. The 20-year plan incorporates the same philosophy, but is applied to large ore bodies. For underground gold mines, Australians and Canadians often use 100 to 125 vertical feet as the optimal mining progress rate per year. Tonnage throughout can therefore be calculated from this rule (1).¹ PREVAL allows for a manual input of the production rate, but if no value is entered, the program default uses Taylor's Rule. The rule is an empirical formula for calculating optimal mine life (2). Taylor essentially incorporated all of the methods and considerations just discussed by developing his formula from actual and planned mining operations. The rule states:

$$\text{Life (years)} \approx 0.2 \times \sqrt[4]{\text{Expected ore tonnage}}$$

Capital and Operating Cost Estimation

Capital and operating cost estimates can be made after selection of mining method, milling method, and production rate. There are several methods of estimation available. Detailed itemized cost estimating is not necessary at this point because of the low level of confidence. A good approach is to use cost information from known and similar mining operations or from literature sources. PREVAL's approach is to use simple and quick mathematical modeling methods. Cost equations have been developed based on many actual operations, usually by mining and milling unit processes, and are normally of the form $Y=A(x)^B$, where x is tonnage, A and B are constants estimated through geometric regression analysis, and Y is the cost. Two of the most notable sources for this type of estimating are T. A. O'Hara (3-4) and the Bureau of Mines (5-7). PREVAL uses the Bureau's latest mathematical cost models (7). The estimation technique is similar to the Bureau's cost estimating system handbooks (CES), but has been vastly simplified by further regression into a few equations that estimate by mine and mill "function." For these capital and operating cost models, the functions are broken down into labor, equipment, fuel/lube, steel, explosives, tires, reagents, electricity, construction materials, and sales tax. One significant advantage of these cost models is that the date of costs can be easily adjusted by using cost indexes. Estimated capital and operating costs can be readily updated to current year dollars or area factors can be applied, such as a labor factor for high or low wage rates. The indexes are updated annually and can be obtained from the Bureau of Mines.

¹Italic numbers in parentheses refer to references at the end of this appendix.

Material Balances, Transportation, Smelting/Refining, Prices

In order to determine the net smelter return, and therefore profitability and cash-flow, the mineral values must be traced from in situ ore through smelting and refining to salable product. Mining of ore always includes dilution, which effectively lowers the grade of mineral values in ore sent to the mill. Beneficiation losses are expected, and can be variable from day to day, but invariably are higher than expected. Smelting and refining losses are minimal (1% to 3%) but must be accounted for.

Determining material balances is extremely subjective at this stage of evaluation. Mine dilution has been roughly approximated for each mining method within PREVAL by averaging hundreds of case studies, but recovery in the beneficiation process is difficult to estimate. Recovery is extremely variable and dependent on grain size, degree of crystal intergrowth, complexity of mineralogy, and processing method. Nevertheless, process recoveries and concentrate grades have also been averaged from case studies and included in the software (table A-1).

At this point in the evaluation, it is presumed that there is a marketable product which can be handled in either of two ways. First, the product is assumed to be salable and may be sold f.o.b. mill, or second, the product is sent to a smelter/refinery for further processing and then sold at

market prices. The first method is not recommended because the sale price of the product would have to be a total guess. The second method, used in PREVAL, provides the evaluation methodology to account for costs, value, and sale of the product, including transportation charges to a smelter and/or refinery, smelter and/or refinery charges, and the payment schedule for finished product.

Transportation distance and mode must be determined by the evaluator and are based on geographic location, proximity to infrastructure, and distance to a treatment facility. For short distances, truck transport is generally the most economical. For long distances, rail haulage is best. Ocean transportation is also available. The software has all three modes available, singly as well as in combination. PREVAL transportation costs also reflect an economy of scale for transportation distance by using variable rates (tables A-2). Ocean transportation was added for European and Asian smelter/refinery destinations and includes European charges based on shipment from the northeast coast to the northern Atlantic coast of Europe. Asian transportation charges are based on shipment from the central Pacific coast to Japan. To assist the user, PREVAL documentation supplies North American smelter/refinery locations and the types of concentration each facility processes.

Table A-1.—Mill recoveries (Percent)

Commodity	Mill ¹ 1	Mill ² 2	Mill ³ 3	Mill ⁴ 4	Mill ⁵ 5	Mill ⁶ 6	Mill ^{7,8} 7	Mill ^{8,9} 8	MVT ¹⁰ ore	Mill ^{8,11} 9	PGM ¹² ore
Gold	92	89	70	88	93	NAp	76	76	NAp	76	NAp
Silver	74	50	40	65	NAp	NAp	80	80	NAp	80	NAp
Lead	NAp	NAp	NAp	NAp	NAp	NAp	90	90	95	90	NAp
Zinc	NAp	NAp	NAp	NAp	NAp	NAp	90	90	76	90	NAp
Copper	NAp	NAp	NAp	NAp	NAp	45	91	91	NAp	91	75
Molybdenum	NAp	NAp	NAp	NAp	NAp	NAp	90	63	NAp	63	NAp
Platinum	NAp	NAp	NAp	NAp	NAp	NAp	91	91	NAp	91	NAp
Palladium	NAp	NAp	NAp	NAp	NAp	NAp	83	83	NAp	83	NAp
Nickel	NAp	NAp	NAp	NAp	NAp	NAp	75	75	NAp	75	NAp

NAp Not applicable.

¹CCD plant.

²CIP plant.

³Au heap leach.

⁴Au float/roast/leach.

⁵Au free milling.

⁶SX/EW (recovery = ore in dump + SX/EW plant).

⁷One-product flotation.

⁸For one-, two-, and three-product flotation mills, recoveries are based on various mineral combinations and do not imply all of the commodities that are present will be recovered.

⁹Two-product flotation.

¹⁰MVT = Mississippi Valley Type ore.

¹¹Three-product flotation.

¹²PGM = Platinum - group metals ore.

Source: U.S. Bureau of Mines Minerals Availability System (MAS) data base.

Table A-2.—Transportation rates

Truck haulage:	Cost (\$)
1 to 100 miles	0.20/mi
101 to 300 miles	.10/mi
> 300 miles	.07/mi
Rail haulage:	
1 to 300 miles	.08/mi
301 to 600 miles	.055/mi
> 600 miles	.04/mi
Ocean transport:	
Atlantic	22.50/st
Pacific	24.00/st

NOTE:—All rates are in average 1989 dollars. Truck rates are based on a one-way haul and no back haul. Rail rates include on- and off-loading charges. PREVAL uses an average value of \$23.25/st for ocean transportation. The user can override any of these values.

Smelting and refining costs often determine whether a property is ultimately economically viable. A small-scale operation may be on a toll schedule that costs more to process than the value of the concentrate plus operating costs. A large operation may be able to guarantee a consistent supply of uniform concentrate and get a much more favorable schedule. Deleterious elements may also add significantly to processing costs. At this prefeasibility stage, deleterious elements usually cannot be properly evaluated so they are not included in the PREVAL evaluation process. Rather, the smelter and refining schedules, presented in table A-3, represent a best case situation. Smelting and refining charges used in PREVAL are applicable for a medium- to large-scale supplier in average 1989 dollars.

Table A-3.—Concentrate smelter/refinery schedules

Concentrate	Pay-for concentrate amount adjusted by:	Smelter charge (dollars)	Refinery charge (dollars)
Gold/silver doré:			
Au	0.997%	NAP	3.50/tr oz
Ag	0.99%	NAP	0.75/tr oz
Lead concentrate:			
Pb	$(-2u/st\ conc^1 + .95\ rem^2)$	155.00/st	NAP
Au	$(-.03\ opt\ conc^3 + .94\ rem^2)$	5.90/tr oz	NAP
Ag	$(-1.25\ opt\ conc^3 + .95\ rem^2)$	0.35/tr oz	NAP
Zinc concentrate:			
Zn	$(-8u/st\ conc^1 + .85\ rem^2)$	165.00/st	NAP
Ag	$(-3.6\ opt\ conc^3 + .95\ rem^2)$	0.40/tr oz	NAP
Copper concentrate: ⁴			
Cu	$(-1u/st\ conc^1 + .97\ rem^2)$	82.00/st	0.10/lb ⁵
Au	$(-.03\ opt\ conc^3 + .94\ rem^2)$	NAP	5.45/tr oz
Ag	$(-1.25\ opt\ conc^3 + .95\ rem^2)$	NAP	0.37/tr oz
Molybdenum concentrate: ⁶			
MoS ₂	NAP	NAP	NAP
PGM concentrate: ⁷			
Pt	0.94%	9.33/tr oz	11.82/tr oz
Pd	0.94%	9.33/tr oz	11.82/tr oz
Nickel concentrate:			
Ni	$(-1.5u/st\ conc^1 + .93\ rem^2)$	145.00/st	0.50/lb ⁸
Cu	$(-1.5u/st\ conc^1 + .95\ rem^2)$	NAP	0.12/lb ⁸

NAP Not applicable.

¹u = 1 st unit = 20 lb of concentrate.

²rem = Remaining amount.

³opt = tr oz/st.

⁴Cathode copper sold f.o.b. mill at \$1.10/lb.

⁵Cu smelter/refinery recovery at 97%.

⁶Molybdenum concentrate sold f.o.b. mill at \$3.05/lb.

⁷Platinum-group metals (PGM) concentrate only accounts for platinum and palladium.

⁸Ni recovery of 93% and Cu at 95%.

Source: Information derived from MAS data base, Mining Cost Service (9), ASARCO Incorporated smelter schedule, and personal contacts.

For more advanced evaluations, it would be more appropriate to tie the price of the commodities to the smelter/refinery charges. In general, smelter and refinery charges rise as commodity prices rise, but do not necessarily decrease at the same rate. Vogel and Grey have demonstrated this correlation and have developed Treatment Charge Factors for lead and zinc (8). The following equations calculate the payment by the smelter to the mine per dry ton of concentrate delivered to the smelter:

Zinc: $NSRZn = [(0.85 \times GRZn) - 0.175] \times PRZn$
 NSRZn = Net smelter return
 GRZn = Amount of metal in the concentrate expressed as a fraction
 PRZn = Price of zinc

Lead: $NSRPb = (GRPb - 0.455) \times PRPb$
 NSRPb = Net smelter return
 GRPb = Amount of metal in the concentrate expressed as a fraction
 PRPb = Price of zinc.

Commodity prices can be extremely variable through time and should therefore be estimated with great caution. One must consider the life of the operation when trying to estimate commodity values. Although 1989 values may be valid for the next 2 years, wide fluctuations may be encountered through the production life. If a particular commodity's price has recently been fluctuating, a historical review of price should probably be made. The best approach when evaluating a property is to use multiple price scenarios that will cover high, low, and a most likely case moderate-price estimate. PREVAL allows the user to input their own commodity price estimates but will default to mid-1989 values if no estimates are entered.

Economic Analysis

Property evaluations cannot be complete without some sort of cash-flow analysis that measures profitability by relating capital and operating costs to revenues generated over the life of the property. The general consensus, within the mining industry, is the use of discounted cash-flow (DCF) analysis (10). The advantage of DCF analysis is that it measures properties, with different mine lives, on a common basis by calculating the present values. Discounting quantitatively adjusts for the time value of money by "present worthing." Discounted cash-flow rate of return (DCFROR) is therefore the rate of return that makes the present worth of cash-flow for an investment equal to the present worth of all after-tax investments. Both DCFROR and net present value (NPV), another economic analysis technique, are included in the PREVAL

software. The NPV is also an after-tax analysis that equals the present worth of cash-flow minus the present worth of after-tax investments calculated at a predetermined rate of return (10).

In order to perform these cash-flow analyses, certain financial assumptions must be made. Mine evaluations are unique compared to nonmineral evaluations because of certain tax considerations. Depletion is the most significant item, but depreciation, acquisition, exploration, and development costs also affect the cash-flow. Depletion allowance essentially allows for recovery of capitalized items such as acquisition, exploration, and some development costs. The method used in the software is "percent depletion." The rates vary by commodity at 15% or 22% of gross revenue, up to the maximum 50% of taxable income plus the deduction for depletion and royalty. Depreciation is handled by the units-of-production method (UOP). This method is not necessarily the most advantageous, but it can easily accommodate very small ore bodies with short life as well as large, long-life ore bodies. This method also avoids counting depletion as a tax preference item and eliminates the need of determining equipment class and depreciation schedules. Acquisition and exploration costs were judged to be too variable to adequately estimate; therefore, they were not included as separate categories in the PREVAL evaluation process. PREVAL accounts for acquisition costs through the royalty rate, and exploration is partially accounted for in the mine capital cost models. Development costs are an estimate extracted from the capital cost models and are handled by expensing 70% of the cost in the proposed year spent and amortizing, over 5 years, the remaining 30%.

Taxes are extremely complex for mining properties (11). There are many factors that affect taxable income, not to mention the variations from State to State. Many different bases and accounting procedures can change the tax rates. Because of these variations and the rapidity of tax law changes with time, it seemed most appropriate to average and standardize as many factors as possible. Most of these are beyond the scope of this software's use. PREVAL makes assumptions, which simplify the accounting, and uses averages for the various rates and bases that should approximate taxes for actual mining operations. One important assumption is that PREVAL considers each property to be a corporate entity so that taxes are valid and applicable only for that property. Because of the dollar amount of tax preference items available to mining operations, it is assumed that every property would be subjected to the Alternative Minimum Tax (AMT). The current rate for AMT is 20%. Most of the economic assumptions in PREVAL are summarized in table A-4. These can easily be changed if an evaluator considers the specific case is too far from these standards.

Table A-4.—Economic evaluation assumptions

Item	Rate	Base
Federal tax rate	20%	Income+preferences.
Tax loss carry (years) . . .	7	NAp.
State tax rate	5%	Net taxable income.
Severance tax rate	2%	Gross revenue.
Depreciation method . . .	UOP	Production.
Amortization (years)	5	NAp.
Depletion rate	15% or 22%	Gross revenue-royalty.
Net proceeds tax rate . . .	2%	Gross profit.
Property tax rate	1.1%	Capital costs.
Debt	60%	Capital costs.
Loan interest rate	10%	Amount financed.
Loan period (years)	5	NAp.
Royalty rate	6%	Net smelter return.
NAp Not applicable.		

SENSITIVITY ANALYSIS

PREVAL produces a complete summary printout of all the mining and milling parameters, capital and operating costs, material balances, transportation charges, smelter and refinery charges and pay-fors, cumulative cash-flow, year-by-year cash-flows, and DCF and NPV summaries. Marginally economic properties may indicate that the production life is too short, i.e., not enough reserve, or the grade is not high enough to produce a profit, or transportation charges are extreme, or even smelting and refining charges reduce the commodity value to an unprofitable condition. At this point, the property can be reevaluated many times by changing the various parameters. After reviewing the results of several scenarios, it is not difficult to determine which areas of the analysis have the most effect on profitability. The results effectively identify and quantify the most crucial parameters that affect profitability. Identification of the most sensitive items allows for early emphasis in the exploration stage to quantify some of the items. For Bureau studies, it allows for better land-use planning by managing agencies.

Price determinations can also be analyzed with PREVAL. This feature allows the user to establish what commodity prices would be required to develop an economical mining operation. After each evaluation is completed, the prices used for each commodity may be changed and the spreadsheet recalculated. By comparing price changes with the NPV, break-even prices and prices for targeted rates of return may be determined.

CONCLUSION

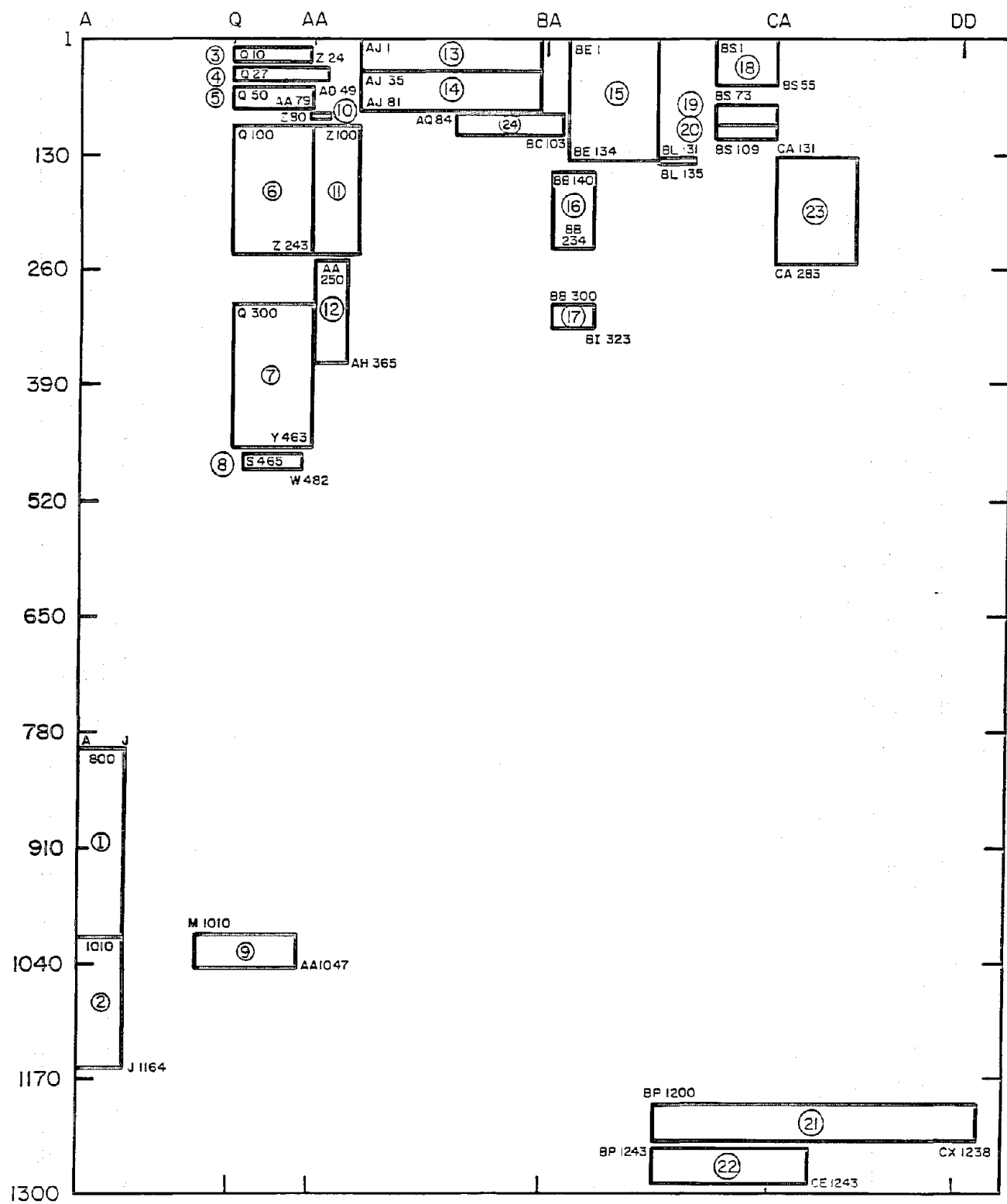
Mineral property evaluations, when not much is known about the mineral potential, do not need to be a "flip of the coin" decision process. Rather, when a systematic appraisal process is used, subjective decisions can be minimized and economical and efficient evaluations and comparisons can be accomplished. This process can save the explorationist time and money and fulfill the goal of evaluating the greatest number of prospects at the least possible cost. It also improves Government agencies' land management and planning capabilities. The Bureau's software (PREVAL) achieves this goal yet allows for more sophisticated analyses as more information becomes available. Thus, the decision and planning processes are improved at every stage of the exploration process.

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APPENDIX B.—SPREADSHEET MAP

(With index of spreadsheet locations)



<u>Number</u>	<u>Description</u>		
1	Summary printout of PREVAL run (file: SUMPRN.WK1)	11	Mine model calculation subroutines
2	Summary cash-flow printout of PREVAL run (files: SUMPRN2.WK1, SUMPRN3.WK1, SUMPRN4.WK1)	12	INTRO macro subroutine
3	Prices/depletion/concentrate grade table	13	Mine method selection table
4	Mill recovery table	14	Mine method selection macro
5	Smelter schedule table	15	PREVAL macro
6	Mine models (capital and operating costs) (file: MMODELS.WK1)	16	Mine model calculation subroutine
7	Mill models (capital and operating costs) (file: MMODELS.WK1)	17	Mine method summary subroutine
8	Transportation schedule (costs)	18	Macro logic subroutine
9	Net present value/rate of return/interest/payment/gross revenue schedules (file: AMT.WK1)	19	Macro subroutine to adjust number of commodities entered
10	Strip ratio modification table (file: MMODELS.WK1)	20	Macro logic subroutine
		21	Alternative Minimum Tax (AMT) schedules (file: AMT.WK1)
		22	Tax-loss-carry calculations (file: AMT.WK1)
		23	PREVAL macro continuation
		24	TONS override screen

NOTE.—The import files for PREVAL are listed in parentheses. Location areas within the import files are the same locations as shown for PREVAL on the map.

APPENDIX C.—SMELTER AND REFINERY LOCATIONS

Table C-1.—Smelter and refinery locations (fig. C-1)

Number	Company	Location	Smelter products	Refinery products
CANADIAN SMELTERS AND REFINERIES				
1	Cominco	Trail, BC	Pb, Zn	Pb, Zn
2	Sherritt Gordon	Ft. Saskatchewan, AB	Ni	Ni
3	Hudson Bay	Flin Flon, MB	Cu, Zn	Cu, Zn
4	Inco	Thompson, MB	Ni	Ni
5	Falconbridge	Timmins, ON	Cu, Zn	Cu, Zn
6	Falconbridge	Falconbridge, ON	Cu, Ni	Cu, Ni
7	Inco	Copper Cliff, ON	Cu, Ni	Cu, Ni
8	Noranda	Rouyn-Noranda, PQ	Cu	Cu
9	Noranda	Valleyfield, PQ	Zn	Zn
10	Noranda	Murdochville, PQ	Cu	Cu
11	Brunswick	Belledune, NB	Pb	Pb
UNITED STATES SMELTERS AND REFINERIES				
12	Copper Range	White Pine, MI	Cu	Cu
13	Zinc Corporation of America	Monaca, PA	Zn	Zn
14	Jersey Miniere	Clarksville, TN	Zn	Zn
15	The Big River Group (formerly AMAX)	Sauget, IL	Zn	Zn
16	Doe Run	Herculaneum, MO	Pb	Pb
17	Doe Run	Buick, MO	Pb	Pb
18	ASARCO, Incorporated	Glover, MO	Pb	Pb
19	ASARCO, Incorporated	Omaha, NE	NAP	Pb
20	Zinc Corporation of America	Bartlesville, OK	Zn	Zn
21	ASARCO, Incorporated	East Helena, MT	Pb	Pb
22	RTZ Corporation	Garfield, UT	Cu	Cu
23	Phelps Dodge	Ajo, AZ	Cu	Cu
24	Cyprus Miami	Inspiration, AZ	Cu	Cu
25	Phelps Dodge	Morenci, AZ	Cu	Cu
26	Phelps Dodge/Mitsubishi	Hurley, NM	Cu	Cu
27	ASARCO, Incorporated	Hayden, AZ	Cu	Cu
28	Magma Copper	San Manuel, AZ	Cu	Cu
29	Phelps Dodge	Playas, NM	Cu	Cu
30	ASARCO, Incorporated	El Paso, TX	Cu, Pb	Cu, Pb
31	ASARCO, Incorporated	Corpus Christi, TX	Zn	Zn
32	Industrial Minera Mexico, SA	Monterrey, Nuevo Leon	NAP	Pb
33	Industrial Minera Mexico, SA	San Luis Potosi, Mexico	Cu, Zn	Cu, Zn
34	Met-Mex Penoles, SA	Torreón, Coahuila	Pb, Cu	Zn
35	Industrial Minera Mexico, SA	Avalos, Chihuahua	Pb	NAP
36	Compania Minera de Cananea, SA	Cananea, Sonora	Pb, Cu	Zn

NAP Not applicable.

NOTE.—Smelters may or may not buy concentrates. The individual is responsible for determining where concentrates can be sent for processing.

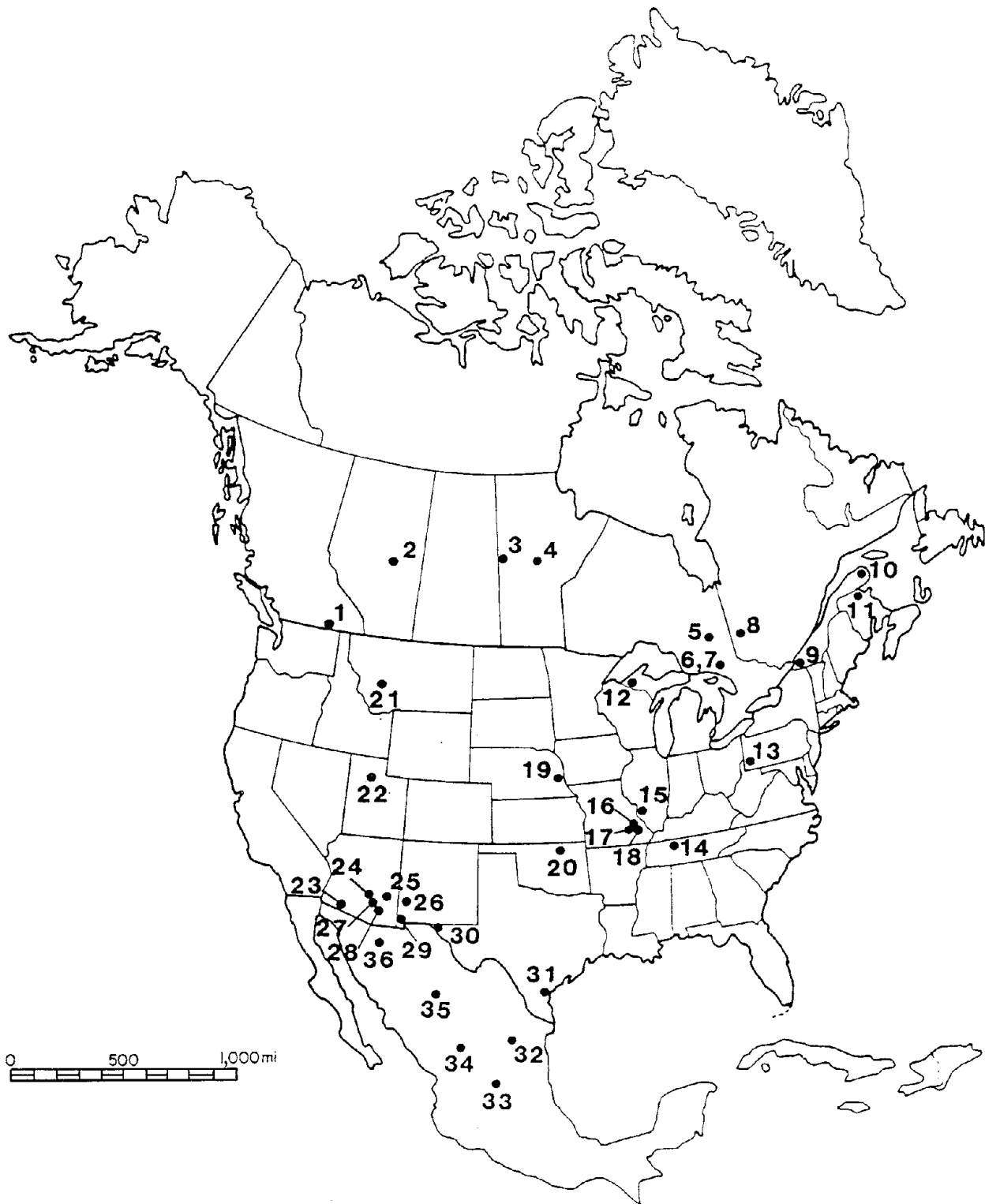
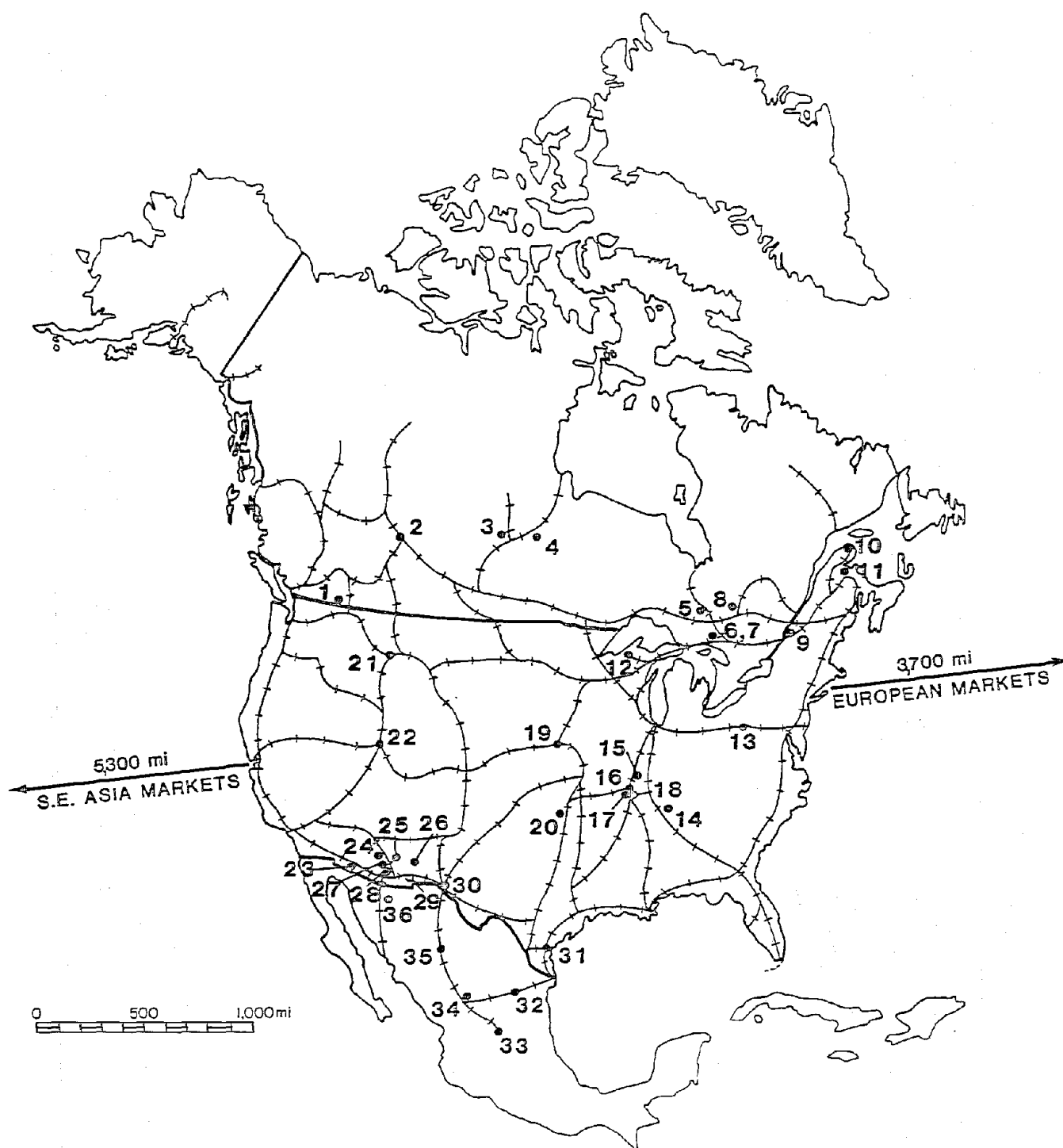


Figure C-1.—North American smelter and refinery complexes.

APPENDIX D.—RAILROAD TRANSPORTATION MAP



NOTE.—Numbers reference smelter-refinery complexes listed in Appendix C.

APPENDIX E.—LIBRARY INFORMATION SCREENS

MAIN MENU

"PRICE"

	Mid - 1989	Depletion	Concentrate	
Commodity	Price (US \$)	(%)	Grade (%)	PGM's

Gold	\$350.00 /tr oz	15%	NA	
Silver	\$4.00 /tr oz	15%	NA	
Lead	\$0.40 /lb	22%	66.00%	
Zinc	\$0.80 /lb HG	22%	56.00%	
Copper	\$1.25 /lb	15%	28.00%	1.80%*
Cathode Cu	\$1.10 /lb	15%	99.50%	
Molybdenum	\$3.05 /lb MoS2	22%	91.00%	
Platinum	\$485.00 /tr oz	22%	NA	
Palladium	\$135.00 /tr oz	22%	NA	
Nickel	\$5.75 /lb	22%	12.00%	2.50%*

COSTS MENU

"SMELT/REF"

Concentrate Smelter/Refinery Schedule				

Concentrate	Pay For	Smelter Charge	Refinery Charge	

Gold/Silver dore				
Au	0.997	NA	\$3.50 /tr oz	
Ag	0.99	NA	\$0.75 /tr oz	
Lead conc.				
Pb	(-2u/st conc + .95 rem)	\$155.00 /st	NA	
Au	(-.03 opt conc + .94 rem)	NA	\$5.90 /tr oz	
Ag	(-1.25 opt conc + .95 rem)	NA	\$0.35 /tr oz	
Zinc conc.				
Zn	(-8u/st conc + .85 rem)	\$165.00 /st	NA	
Ag	(-3.6 opt conc + .95 rem)	NA	\$0.40 /tr oz	
Copper conc.				
Cathode	\$1.10	NA	NA	
Cu	(-1u/st conc + .97 rem)	\$82.00 /st	\$0.10 /lb **	
Au	(-.03 opt conc + .94 rem)	NA	\$5.45 /tr oz	
Ag	(-1.25 opt conc + .95 rem)	NA	\$0.37 /tr oz	
Molybdenum conc.				
MoS2	\$3.05	NA	NA	
PGM conc.				
Pt	0.94	\$9.33 /tr oz	\$11.82 /tr oz	
Pd	0.94	\$9.33 /tr oz	\$11.82 /tr oz	
Nickel conc.				
Ni	(-1.5u/st conc + .93 rem)	\$145.00 /st	\$0.50 /lb ***	
Cu	(-1.5u/st conc + .95 rem)	NA	\$0.12 /lb ***	

u = 1 st unit = 20 lbs of conc.				
rem = remaining amount				
opt = tr oz/st				
** = Cu smelt/ref recovery @ 97%				
*** = Ni recovery of 93% and Cu @ 95%				

COSTS MENU "MINE/MILL"

F967: (H) [W12] 'Return to Menu by pressing "Alt" M

READY

	F	G	H	I	J	K
967						
968		Cost Adjustment/Update Factors				
969		-----				
970		1.000 Mine Operating Cost				
971		1.000 Mill Operating Cost				
972		1.000 Mine Capital Cost				
973		1.000 Mill Capital Cost				
974						
975						
976	*****					
977						
978						
979						
980						
981						
982						
983						
984						
985						
986						
17-Jan-92	02:32 PM			CALC	NUM	

COSTS MENU "TRANSPORT"

S465: (H) 'Return to menu by pressing "alt" M

READY

	S	T	U	V	W	X	Y	Z
465								
466		TRUCK						
467		0 - 100 m	\$0.20	/st mi				
468		101 - 300	\$0.10	/st mi				
469		> 301 mi	\$0.07	/st mi				
470								
471		RAIL						
472		0 - 300 m	\$0.080	/st mi				
473		301 - 600	\$0.055	/st mi				
474		>601 mi	\$0.040	/st mi				
475								
476		OCEAN						
477		Atlantic	\$22.50	/st				
478		Pacific	\$24.00	/st				
479		average	\$23.25	/st	<-----/			
480				/				
481		program uses ave value ---/						
482								
483								
484								
17-Jan-92	02:12 PM				CALC	NUM		

MAIN MENU

"METBAL"

Mill Recovery Table

Commodity	Mill 1	Mill 2	Mill 3	Mill 4	Mill 5	Mill 6	Mill 7	Mill 8	MVT ORE	Mill 9	PGM ORE
Gold	92.00%	89.00%	70.00%	88.00%	93.00%		76.00%	76.00%		76.00%	
Silver	74.00%	50.00%	40.00%	65.00%			80.00%	80.00%		80.00%	
Lead							90.00%	90.00%	95.00%	90.00%	
Zinc							90.00%	90.00%	76.00%	90.00%	
Copper			Table			45.00%	91.00%	91.00%		91.00%	75.00%
Molybdenum			Continued ----->				90.00%	63.00%		63.00%	
Platinum							91.00%	91.00%		91.00%	
Palladium							83.00%	83.00%		83.00%	
Nickel							75.00%	75.00%		75.00%	

MVT = Mississippi Valley Type ores (Pb rec=.95, Zn rec=.76)

PGM = Platinum Group Metals ores (Cu rec=.75)

Mill 1 = CCD plant Mill 6 = SX/EW (recovery = dump + mill)

Mill 2 = CIP plant Mill 7 = 1 Product Flotation

Mill 3 = Au Heap Leach Mill 8 = 2 Product Flotation

Mill 4 = Au Float/Roast/Leach Mill 9 = 3 Product Flotation

Mill 5 = Au Free Milling

MAIN MENU

"TONS"

AF84: (H) 'Return to Menu by pressing "Alt" M

READY

AF AG AH AI AJ AK AL AM AN AO AP

84

85

86

Production rate (short tons of ore/day) may be changed here. Open pit strip ratios (waste rock) should be changed through the MENU. Underground mine waste rock is calculated by PREVAL and cannot be changed.

87

88

89

90

91

92

93

94

Enter production rate:
(short tons of ore/day)

<---- Enter Here
(cell AJ95)

95

96

97

98

99

*** IMPORTANT ***

If you are adjusting the production rate for a

previous run: * You can only increase tonnage

100

101

102

103

* You must press "ALT" T after adjusting

17-Jan-92 02:27 PM

CALC NUM

APPENDIX F.—SAMPLE COMPUTER PRINTOUT

U.S. Bureau of Mines
Prefeasibility Evaluation Summary

Property Name: Test Mine
 Evaluated By: Joe Prospector
 Date: 21-Jan-92 01:21 PM
 * Comments:

GEOLOGIC SUMMARY:

In situ ore reserve:	18,000,000 Short Tons	Equivalent Value
In situ grade:		
Gold	0.065 tr oz/st	2.228 g/mt
Silver	0.4 tr oz/st	13.714 g/mt
Lead	0 % Pb	
Zinc	0 % Zn	
Copper	0 % Cu	
Molybdenum	0 % MoS ₂	
Platinum	0 tr oz/st	0.000 g/mt
Palladium	0 tr oz/st	0.000 g/mt
Nickel	0 % Ni	

Ore dilution: 3 %
 Ore recovery: 90 %

Calculated recoverable ore reserve:	16,686,000 Short Tons	
Calculated diluted ore feed grades:		
Gold	0.063 tr oz/st	2.164 g/mt
Silver	0.388 tr oz/st	13.314 g/mt
Lead	0.000 Pb	
Zinc	0.000 Zn	
Copper	0.000 Cu	
Molybdenum	0.000 MoS ₂	
Platinum	0.000 tr oz/st	0.000 g/mt
Palladium	0.000 tr oz/st	0.000 g/mt
Nickel	0.000 Ni	

METAL PRICES FOR THIS EVALUATION:

(Values in U.S. Dollars)

Gold	350.00 \$/tr oz	
Silver	4.00 \$/tr oz	
Lead	0.40 \$/lb	
Zinc	0.80 \$/lb	
Copper	1.25 \$/lb	(Cathode Cu to b mill @ \$1.10 /lb)
Molybdenum	3.05 \$/lb MoS ₂	(fob mill)
Platinum	485.00 \$/tr oz	
Palladium	135.00 \$/tr oz	
Nickel	5.75 \$/lb	

MINING SUMMARY:

Mining Method:	Small Open Pit
Mining Rate — ore	4937 st/day
Mining Rate — waste	9874 st/day
Operating Days per Year	260 days/yr
Preproduction Development	2 years
Mine Life	13 years
Ore Recovery	90 %

MINERAL PROCESSING SUMMARY:

Processing Method:	Heap Leach Plant (Au, Ag)		tr oz/st of concentrate	
Processing Rate	3,667 st/day		Au	Ag
Operating Days per Year	350 days/yr			
Process Recovery:		Concentrate Grade:		
Gold	76.00%	NA	NA	NA
Silver	40.00%	NA	NA	NA
Lead		73.00% Pb		
Zinc		58.00% Zn		
Copper		28.00% Cu		
Molybdenum		91.00% MoS ₂	NA	NA
Platinum		NA	NA	NA
Palladium		NA	NA	NA
Nickel		12.00% Ni	NA	NA

Recoverable Metal per Year:
(Mill Product Only)

Gold	61,555.8 tr oz/yr
Silver	199,370.9 tr oz/yr
Lead	0.00 st/yr concentrate
Zinc	0.00 st/yr concentrate
Copper	0.00 st/yr concentrate
Molybdenum	0.00 st/yr concentrate
Platinum	0.0 tr oz/yr
Palladium	0.0 tr oz/yr
Nickel	0.00 st/yr concentrate

TRANSPORTATION SUMMARY:

(Concentrates only)
Commodity:

	Truck Distance	Rail Distance	Ocean Transport	Total Cost
Lead	mi	mi		
Zinc	mi	mi		
Copper	mi	mi		
Molybdenum	mi	mi		
Nickel	mi	mi		

Total Annual Charge

\$0

SMELTER AND REFINERY CHARGES:

Commodity:	Smelter Charge	Refinery Charge	Pay For
Gold	NA	\$215,445	0.997
Silver	NA	\$149,528	0.99
Lead		NA	(see smelter schedule)
Zinc		NA	(see smelter schedule)
Copper			(see smelter schedule, Cathode sold fob)
Molybdenum	NA	NA	(sold fob mill)
Platinum			0.94
Palladium			0.94
Nickel			(see smelter schedule)

Total Annual Charge

\$0

\$364,973

MINE COST SUMMARY:

Mining Method	Small Open Pit
Mining Rate - ore	4,937 st/day
Mining Rate - waste	9,874 st/day
Operating Days per Year	260 days/yr

Cost Component:	Annual Operating Cost	Capital Cost
Labor	\$2,343,586	\$2,119,022
Equipment	\$989,448	\$17,171,448
Steel	\$101,282	\$453,340
Fuel/Lube	\$781,676	\$342,484
Explosives	\$579,598	\$249,163
Tires	\$175,978	\$97,206
Construction Materials	\$132,264	\$749,062
Sales Tax	\$118,598	\$1,125,197
Total Cost	\$5,222,430	\$22,306,921

Operating Cost per st Ore
Working Capital

\$4.07 \$/st ore
\$1,807,764

BENEFICIATION COST SUMMARY:

Concentration Method Heap Leach Plant (Au, Ag)
 Concentration Rate 3,667 st/day ore
 Operating Days per Year 350 days/yr

Cost Component:	Annual Operating Cost	Capital Cost
Labor	\$1,720,165	\$5,777,340
Equipment	\$468,074	\$10,491,221
Steel	NA	\$1,014,517
Fuel and Lube	\$518,083	NA
Reagents	\$1,668,485	NA
Construction	--	--
Materials	\$1,386,126	\$1,694,793
Electricity	\$312,624	NA
Sales Tax	\$213,510	\$791,033
Total Cost	\$6,287,067	\$19,768,904

Operating Cost per st Ore \$4.90 \$/st ore
 Working Capital \$1,616,674

FINANCIAL ASSUMPTIONS SUMMARY:

Rate of Return (DCFROR)	15.00%	
Inflation Rate	0.00% (op costs)	0.00% Commodity Inflation
Debt (amount financed)	60.00%	
Loan Interest Rate	10.00%	5 Years
Federal Tax Rate	Alternative Minimum Tax	
Minimum Tax Rate	20.00%	Cost Adjustment/Update Factors
State Tax Rate	5.00%	1.000 Mine Operating Cost
Severance Tax Rate	2.00%	1.000 Mill Operating Cost
Depreciation Method	Units of Production	1.000 Mine Capital Cost
Depletion Rate	15% or 22%	1.000 Mill Capital Cost
Property Tax Rate	1.10%	
Royalty Rate (NSR)	6.00%	

CASH FLOW SUMMARY:

	Cumulative Values
Revenue	289502072
Royalty	-17085445
Operating Costs	-154368106
Loan Payments (P+I)	-36008564
Depreciation/Amortization	0
Depletion	0
Tax Loss Carry Forward	0
Net Proceeds Tax	-1447283
Property Taxes	-5869595
Severance Taxes	-5790041
State Taxes	-695269
Federal Taxes	-11341460
Net Cash Flow	56896308

Net Present Value (NPV) -23031544 at an ROR of 15.00% 15585462 at an ROR of 0.00%
 Internal Rate of Return (DCFROR) 3.08%

PERCENT GROSS REVENUE FROM:

Gold	96.43%
Silver	3.57%
Lead	0.00%
Zinc	0.00%
Copper	0.00%
Molybdenum	0.00%
Platinum	0.00%
Palladium	0.00%
Nickel	0.00%

ANNUAL VALUE @ the MILL

21,544,515
797,483
0
0
0
0
0
0
0
0

TOTAL 22,341,999

ANNUAL CASH FLOW SUMMARY:

Year	1	2	3	4	5	6	7	8
Capital Investment	19,762,948	19,762,948						
Working Capital			3,424,438					
Gross Revenue			22,269,390	22,269,390	22,269,390	22,269,390	22,269,390	22,269,390
- Mine Operating Cost			5,222,430	5,222,430	5,222,430	5,222,430	5,222,430	5,222,430
- Mill Operating Cost			6,287,067	6,287,067	6,287,067	6,287,067	6,287,067	6,287,067
- Transportation			0	0	0	0	0	0
- Smelter/Refinery Charge			364,973	364,973	364,973	364,973	364,973	364,973
- Royalty			1,314,265	1,314,265	1,314,265	1,314,265	1,314,265	1,314,265
- Interest Expense			2,730,016	2,282,846	1,790,959	1,249,884	654,701	0
Gross Profit			6,350,640	6,797,809	7,289,696	7,830,771	8,425,954	9,080,655
- Preproduction (70%)	892,475	892,475						
- Depreciation			2,844,305	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305
- Amortization (30%)			152,996	152,996	152,996	152,996	152,996	
- Net Proceeds Tax			70,127	79,070	88,908	99,729	111,633	124,727
- Severance Tax			445,388	445,388	445,388	445,388	445,388	445,388
- Property Tax		217,392	434,785	434,785	434,785	434,785	434,785	434,785
- Depletion			3,351,300	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300
- Tax Loss Carry Forward			0	0	125,011	655,265	1,238,544	1,135,827
Net Taxable Income	(892,475)	(1,109,868)	(948,260)	(510,034)	(152,996)	(152,996)	(152,996)	744,324
- State Income Tax			0	0	0	0	0	37,216
- Federal Income Tax			480,608	568,253	664,663	670,260	670,260	963,385
- Loan Principal			4,471,697	4,918,867	5,410,753	5,951,829	6,547,012	0
+ Depreciation			2,844,305	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305
+ Amortization			152,996	152,996	152,996	152,996	152,996	0
+ Depletion			3,351,300	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300
- Working Capital			3,424,438					
+ Working Capital Recapture								
+ Income Loss Carry Forward			0	0	125,011	655,265	1,238,544	1,135,827
Annual Cash Flow	(20,655,423)	(20,872,815)	(2,976,403)	351,447	245,199	228,781	216,877	7,075,155

Year	9	10	11	12	13	14	15
Capital Investment							
Working Capital							
Gross Revenue	22,269,390	22,269,390	22,269,390	22,269,390	22,269,390	22,269,390	22,269,390
- Mine Operating Cost	5,222,430	5,222,430	5,222,430	5,222,430	5,222,430	5,222,430	5,222,430
- Mill Operating Cost	6,287,067	6,287,067	6,287,067	6,287,067	6,287,067	6,287,067	6,287,067
- Transportation	0	0	0	0	0	0	0
- Smelter/Refinery Charge	364,973	364,973	364,973	364,973	364,973	364,973	364,973
- Royalty	1,314,265	1,314,265	1,314,265	1,314,265	1,314,265	1,314,265	1,314,265
- Interest Expense	0	0	0	0			
Gross Profit	9,080,655	9,080,655	9,080,655	9,080,655	9,080,655	9,080,655	9,080,655
- Preproduction (70%)							
- Depreciation	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305
- Amortization (30%)							
- Net Proceeds Tax	124,727	124,727	124,727	124,727	124,727	124,727	124,727
- Severance Tax	445,388	445,388	445,388	445,388	445,388	445,388	445,388
- Property Tax	434,785	434,785	434,785	434,785	434,785	434,785	434,785
- Depletion	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300
- Tax Loss Carry Forward	0						
Net Taxable Income	1,880,151	1,880,151	1,880,151	1,880,151	1,880,151	1,880,151	1,880,151
- State Income Tax	94,008	94,008	94,008	94,008	94,008	94,008	94,008
- Federal Income Tax	1,046,290	1,046,290	1,046,290	1,046,290	1,046,290	1,046,290	1,046,290
- Loan Principal	0	0	0	0			
+ Depreciation	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305	2,844,305
+ Amortization	0	0	0	0	0	0	0
+ Depletion	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300	3,351,300
- Working Capital							
+ Working Capital Recapture							3,424,438
+ Income Loss Carry Forward							
Annual Cash Flow	6,935,458	6,935,458	6,935,458	6,935,458	6,935,458	6,935,458	10,359,897

