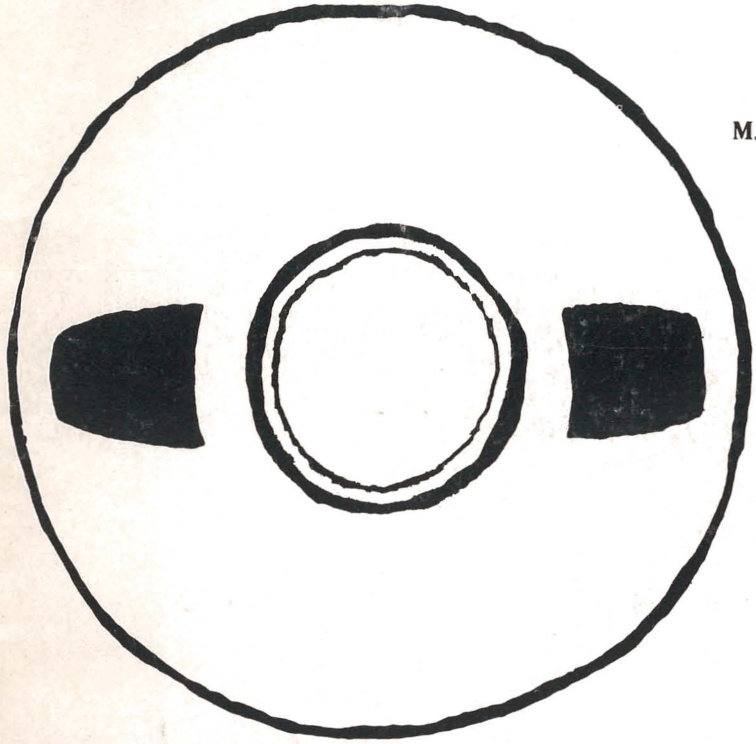

M.I.R.L. Report Number 23

FORTRAN IV PROGRAM FOR PROCESSING GEOCHEMICAL SEDIMENT DATA

By Lawrence E. Heiner

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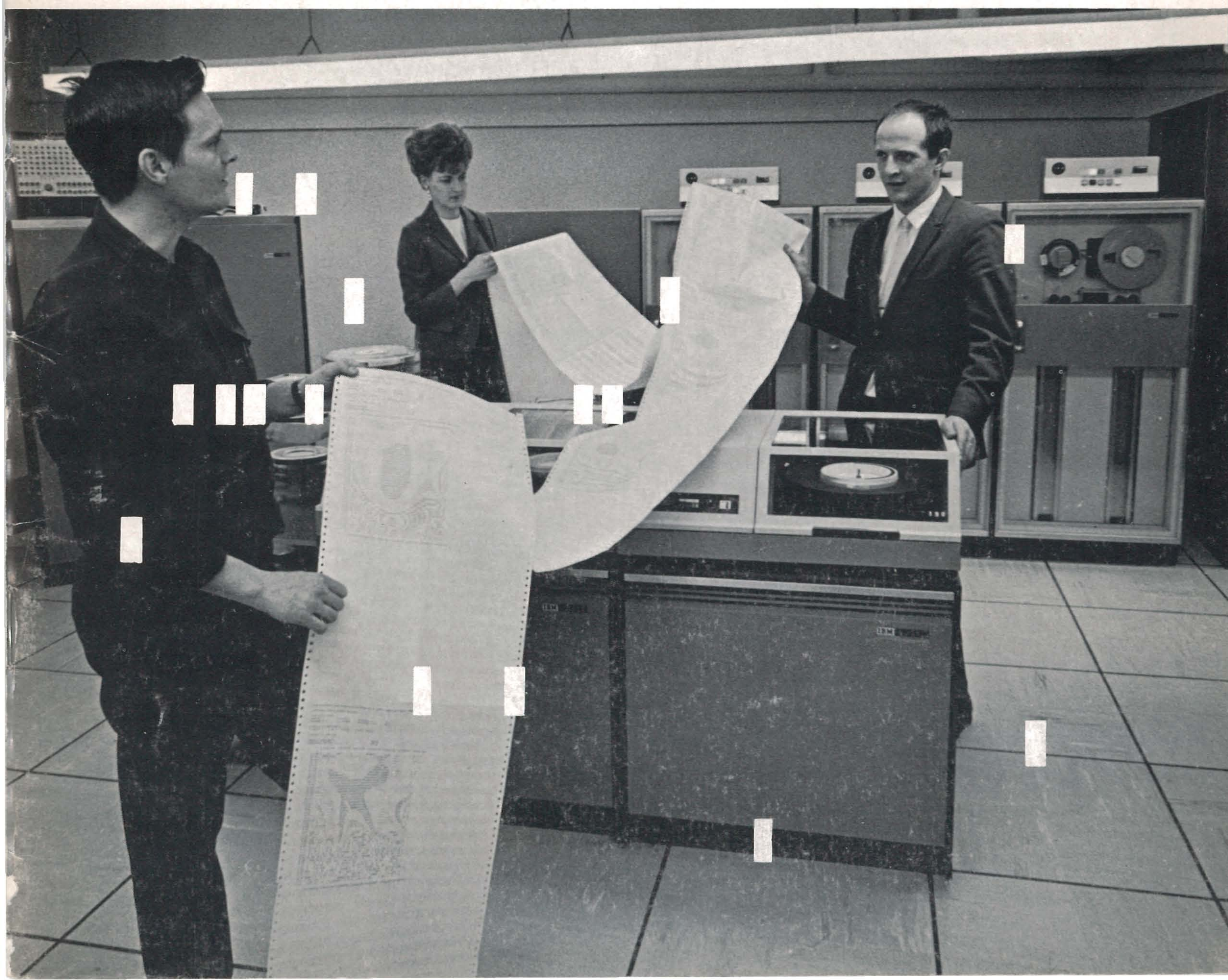

FORTRAN IV PROGRAM FOR PROCESSING GEOCHEMICAL SEDIMENT DATA

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SEPTEMBER 1970

FOREWORD

This report describes the results of a cooperative project between M.I.R.L. and the Division of Mines and Geology. Costs of program development were paid for by M.I.R.L. and subsequent data runs of the program were paid for by the Division of Mines and Geology.

The project represents a first step toward rapid data processing of geochemical information in the State of Alaska. This program should now be expanded to facilitate the study and reporting of this information so that it may reach the exploration fraternity at the earliest possible date with the maximum amount of data analysis.

Earl Beistline
Dean, College of Earth Sciences
and Mineral Industry

ABSTRACT

A general computer program has been written to process geochemical data resulting from the analysis of up to 34 trace elements per sample. This program will:

1. Produce a table for direct inclusion in formal reports. The table contains the map number and field number of the geochemical samples, the corresponding elemental values and a table giving descriptive data about the sample. Prior to printing, the samples are arranged according to map number for easy correspondence between the table of values and to the geochemical map.

2. Compute the average value for each element, normally and lognormally.

3. Compute the standard deviation for each element, normally and lognormally.

4. Compute the threshold value for each element, normally and lognormally.

5. Compute the anomalous concentrations for each element, normally and lognormally.

6. Draw lognormal, or standard histograms for each element.

All geochemical samples taken by the Alaska Division of Mines and Geology during the summer of 1968 and 1969 were processed by this program or a modification of the program. The program can be modified to enable production of automatic maps and tables of anomalous samples.

TABLE OF CONTENTS

FORTRAN IV PROGRAM FOR PROCESSING 34 ELEMENT GEOCHEMICAL SEDIMENT DATA

INTRODUCTION

Rapid analytical techniques for analysis of the trace element composition of soil, stream sediment and rock samples have been developed to the point that it is now economically feasible to measure in excess of 30 elemental concentrations from field samples. During the past few years, the USGS, industry and recently, the Division of Mines and Geology have obtained 30 element analyses from stream sediment, rock and soil samples. These data are, of course, extremely useful in the search for ore and for correlating samples with local geology.

The usefulness of multielement data, however, is limited in that the sheer mass of numbers confronting the geologist and engineer can discourage full utilization of the information which can be gleaned from it. Consider an organization such as the State of Alaska Division of Mines and Geology, which may put five men in the field each summer. If each man were to collect 500 samples and each sample were analyzed for 30 elements a total of 75,000 analyses are generated. The amount of time in manhours to glean rudimentary statistics, or for that matter, to draw histograms of elemental distribution would quite possibly exceed the time available for doing this. Writing, arranging the data sequentially and typing the data is a time consuming task in itself.

There are several questions which can be put forth and hopefully explained by the data. What is an anomalous value? What is the threshold value? What is the variability of the particular element of interest; all elements? Do elements characteristic of certain rock types increase or decrease in content from sample to sample in certain map areas; certain drainages? Does this population appear to be normal; if not, does it compare with populations near other mines; mining districts?

In order to develop techniques for answering the above questions a backlog of geochemical data should be available, preferably on cards or stored on magnetic tape. If this type of data were available, research directed toward answering the above questions and development of new techniques for data analysis could be conducted with a minimum amount of library research and therefore at a much lower cost.

A geochemical data file such as this would have other distinct advantages from a scientific as well as a data processing viewpoint. From a scientific viewpoint one must consider the value of having immediate access to past analyses in an area in which current sampling is taking place. A combination of past plus present analyses gives a better representation of the total population and aids the process of arriving at local, regional, threshold and anomalous values. Perhaps the greatest impact from a scientific viewpoint will occur several years from now when masses of these data are available for regional studies utilizing trend surface, factor analysis, multivariate discriminant analysis and other statistical techniques.

Data processing of geochemical analyses, once they are coded is rapid. Geochemical data are generally collected in the field in order of the direction a particular man traveled. This order, and consequent data point numbering, is seldom used in published lists of analyses which refer the reader to a map number. Geochemical stations are generally plotted on a map and then numbered in a logical sequence in order to provide easy correspondence between the map, published geochemical value and the reader. Reorganization of the geochemical data by automatic sorter or by a computer itself takes but a matter of minutes versus the hours of time that a person would take to manually recopy a list in proper order, which would then have to be retyped. If the geochemical data and field and map numbers were coded prior to any manipulation of the data it would be possible to provide machine printed lists in any logical order without a single typing of the data themselves.

PURPOSE OF THE CURRENT PROJECT

The computer program described represents a first effort to:

1. Start a geochemical data file.

2. Provide for data processing and preliminary statistics for DMG geochemical samples.

All geochemical samples from the summers of 1968 and 1969 taken by the Division of Mines and Geology were processed with the program to be described. Data representing the field number, map number and concentration of 34 elements, 4 elements analyzed by atomic absorption spectrometer and 30 elements analyzed by emission spectrographic techniques, were punched on IBM cards. These cards now represent a storage file. A general computer program was written to:

1. Print map number, field number, geochemical values and descriptive sample data with a format suitable for inclusion in published reports.

2. Compute the average for each element and the average log of each element.

3. Compute the standard deviation of each element and the standard deviation of the logs of each element.

4. Compute the threshold value based upon that described by Hawkes and Webb (1962). Recompute the threshold value based upon an assumed lognormal distribution.

5. Compute the anomalous concentration of each element based upon Hawkes and Webb (1962). Recompute the anomalous value based upon a lognormal distribution.

6. Draw printer histograms of elements selected, both normal and lognormal.

This program must be considered preliminary since the final objectives of the geochemical data file are still being formulated. Modifications to this program will certainly be made.

ALGORITHIMS

Average

The average value computed is the arithmatic average:

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

$\overline{X}$ = average value

X = data value at each station

n = number of non-zero data points

Standard Deviation

The standard deviation is computed by:

$$S = \sqrt{\frac{\sum_{i=1}^{n} X_i - \frac{(\sum X_i)^2}{n}}{n-1}}$$

where:

s = standard deviation

X = data value

n = number of non-zero data points

Threshold Value

The threshold value can be defined as the upper limit of normal background fluctuation (Hawkes and Webb, 1962). Threshold values are sometimes used as guides to areas of further prospecting, since anomalous elemental values quite often occur within areas of local high background. Particular attention should be paid to this value when the data are obtained from reconnaissance surveys, which characteristically have wide sample spacing.

The definition of the threshold value as given by Hawkes and Webb (1962) has been incorporated into this computer program. "For a single population of values that are distributed symmetrically (either normally or lognormally), the threshold for that material may be conventionally taken as the mean plus twice the standard deviation. This is equivalent to saying that only 1 in 40 background samples is likely to exceed the threshold, . . ." (Hawkes and Webb, 1962) therefore:

Threshold = $\overline{X}$ + 2s

Where: $\overline{X}$ = mean

s = standard deviation

Anomalous Value

The anomalous value computed by the program is that given by Hawkes and Webb (1962), i.e., the mean plus three times the standard deviation. Hawkes and Webb (1962) state that " . . . only 1 in 667 background values is likely to exceed the mean plus three times the standard deviation." Therefore:

$$\text{anomalous value} = \bar{X} + 3s$$

Where: X = mean
s = standard deviation

PROGRAM

The program, entitled GEOSTAT, is written with a mainline, and four subroutines: LOGNOR, WRITE, XFREQ and HIST. The mainline program causes data input, data listing and computation of the mean, standard deviation, threshold value and anomalous value for each of the 34 elements. It also controls treatment of the data prior to computing histograms, and calls appropriate subroutines.

The mainline will accept a trace element matrix composed of 34 elements and a maximum of 800 samples. Notes on data handling procedures are:

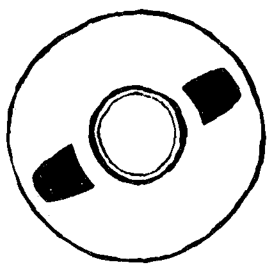
1. If there are four or less data points, the standard deviation, threshold and anomalous values are not computed, nor are any subroutines other than "WRITE" called.

2. If a geochemical sample contains a zero or a blank it is assumed that this sample was not analyzed for the element in question and this point is not considered in computation of any statistics or in any subroutines. If the sample was analyzed but an element not detected a (–) minus is left justified in the columns reserved for the element in question and a specific value is inserted automatically by the program. These values are:

*Au = .1	Co = 5.	Sr = 25.	Y = 5.
*Cu = .1	Cr = 2.5	B = 5.	V = 5.
*Pb = .1	Ni = 2.5	Be = 3.5	As = 1.8
*Zn = .1	Mn = 10.	Sn = 2.	Sb = .2
Cu = 1.	Ti = .57	W = 1.5	Bi = .17
Pb = 5.	Fe = .006	Zr = 10.	Cd = .2
Zn = 70.	Mg = .0002	La = 10.	Au = .004
Mo = 1.5	Ca = .004	Nb = 5.	
Ag = .07	Ba = 10.	Sc = 2.5	

*Analyses by atomic absorption.

These values represent the crustal averages or one-half the detection limit of the emission spectrograph.



Subroutine LOGNOR

This subroutine will cause the geochemical data to be converted to the normal log value prior to producing histograms. Provision is provided to include the addition of a constant. To utilize this subroutine, see data preparation.

$$X_i = \log_{10} (X_i + C)$$

Where: X_i = data value

C = constant

Subroutine XFREQ

Subroutine XFREQ generates a vector of frequencies for use by subroutine HIST. The subroutine has an optional class length of from 1 to 20 classes. The class interval is automatically selected if the user does not specify it. If the class interval is not specified the interval becomes:

$$\text{Interval} = \frac{\text{Max. Value} - \text{Min. Value}}{\text{No. of Intervals}}$$

and: the first class is equal to the minimum elemental value.

When the class interval is selected the minimum value is zero.

Values which fall on a boundary between class intervals are credited 50% to the higher class and 50% to the lower class. Values which fall below the minimum class are credited to the first class. Values which exceed the last class are credited to the last class.

A vector of class intervals in percent is transferred to the mainline and hence to subroutine HIST for plotting. These values are rounded to the nearest percent. A listing of:

1. class interval
2. percent in each class
3. number of samples in each class

is printed just prior to automatic printing of each histogram.

Subroutine HIST

This subroutine was written by IBM and is documented on pages 285-286 of "System/360 Scientific Subroutine Package (360A-CM-03X) Version II

Programmer's Manual." Copies of this and other IBM publications can be obtained through IBM branch offices or, Technical Publications Department, 112 East Post Road, White Plains, New York, 10601.

This subroutine will print a histogram when given a set of classes and will give either number of data in each class or percent data in each class. As used in this program, it prints a histogram based upon percent of total data points in each class.

Subroutine WRITE

This subroutine generates three types of printed pages suitable for reproduction in formal reports. Page one lists the map number, field number, and analytical results for the first 21 elements. In addition, a plus (+) is written in the extreme left hand column opposite each map number if the sample is a soil sample; an asterisk (*) for a rock sample or a blank ( ) to indicate a stream sediment sample are also used in a like manner.

The remaining 13 elements are tabulated on page two of the output. The map number is repeated on the right of this output for clarity. Page three output is composed of the descriptive data output. From left to right these data are: sample depth, field test, stream width, sample location, organic content of the sample, size of stream sediment, rock type, remarks and the sample map number. The codes for organic content have been revised to HI, MD and LO which mean high, medium and low respectively. Codes for size of stream sediment have been revised to F, M and C which mean fine, medium and coarse respectively.

INPUT DATA PREPARATION

Control Cards

A total of four control cards are needed for a single computer run.

CARD NUMBER ONE

Col 1-80 — Identification (any alphabetic or numeric characters).

CARD NUMBER TWO

Col 1-3 — Number of data points, not total number of data cards. Number must be right justified.

Col 4-5 – Number of classes in the histograms, 5 to 20. Number must be right justified.

Col 6-7 – Constant for lognormal distributions. The value 1. (one decimal) has been used extensively.

Col 8-41 – Represents one column for each element (1-34). If a histogram is desired a one must be punched in the appropriate column. Example: histogram is desired for elements 1, 2, 3, 4 and 34. Must punch a one in columns 9, 10, 11, 12, 42.

CARD NUMBER THREE

This is the first of two class interval cards. Both must be in the data deck, even if one or both are entirely blank. The Format is 7F3.0, and the decimal point is therefore assumed to be after each set of three columns. Fill in columns in which histograms are desired, or for those histograms which the user desires to specify the class interval.

Col 1-3 – Class interval for 1st element

Col 4-6 – Class interval for 2nd element

Col 7-9 – Class interval for 3rd element

––––

Col 49-51 – Class interval for 17th element

CARD NUMBER FOUR

This is the second of two class interval cards.

Col 1-3 – Class interval for the 18th element

Col 4-6 – Class interval for the 19th element

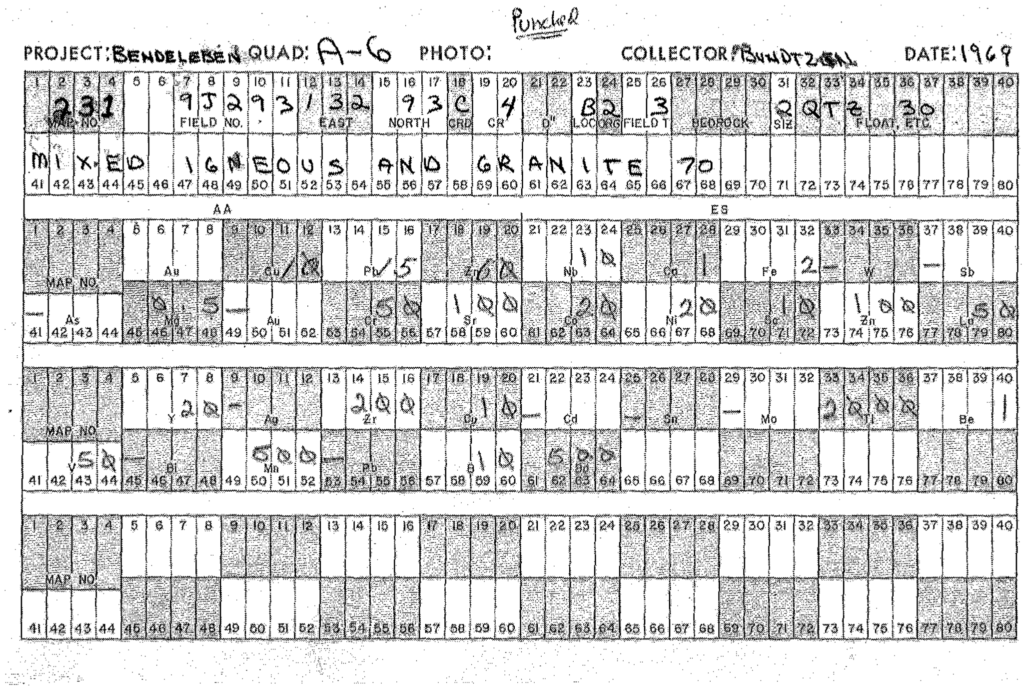
Col 7-9 – Class interval for the 20th element

––––

Col 49-51 – Class interval for the 34th element

Data

Input data to the program are obtained from the standard preprinted field-lab form shown in figure 1.



Card one, top two rows of figure 1, contains descriptive information pertinent to the sample and its location.

Col 1-4, Map No. — Contains sample map number. Must be right justified and should not contain leading zeros.

Col 5-11, Field No. — Sample field number. May contain alphanumeric data. Should be right justified.

Col 12-14, East — Contains the x-coordinate of sample location. It is described in inches from the lower left margin of the quadrangle map used. A decimal is assumed between col. 13 and 14.

Col 15-17, North — Contains the y-coordinate value for sample location. This location is described as the vertical distance from the lower left margin to the sample location. A decimal is assumed between col. 16 and 17.

Col 18, CRD — Type of sample: C = creek, R = rock, D = soil (dirt).

Col 19-20, CR — Creek width in feet; DR = dry creek.

Col 21-22, D — Depth of soil sample below base of moss or soil surface.

Col 23, LOC — Sample location; A = below water, B = active sediment at water edge, C = sediment sample above current water level but below high water level, D = sediment sample above high water level.

Col 24, ORG — Organic content of sample; 1 = low, 2 = medium, 3 = high.

Col 25-26, FIELD T — Citrate soluble field test in milliliters of dithizone. Must be right justified.

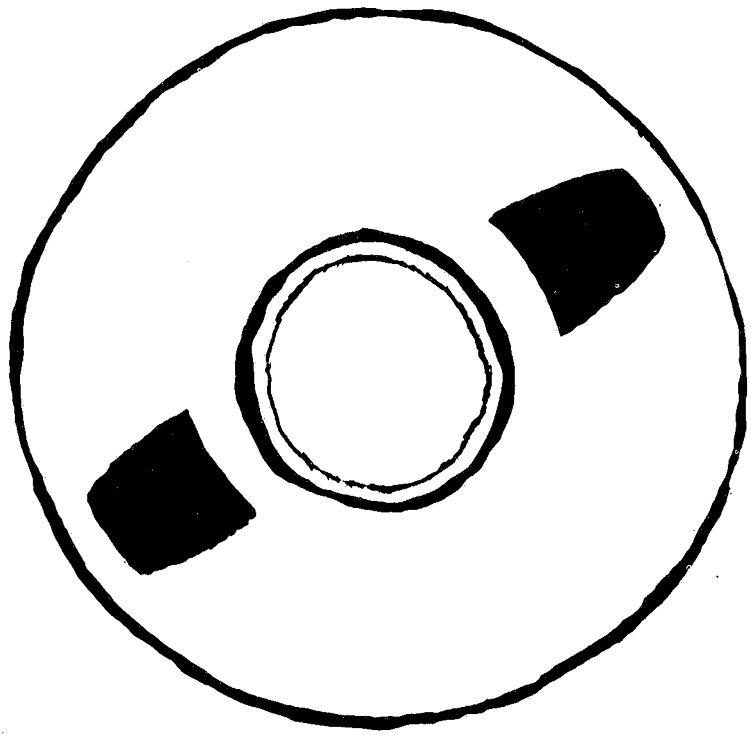
Col 27-30, BEDROCK — Four letter rock code

Col 31, SIZ — Maximum particle size of sampled material; 1 = larger or equal in size to gravel, 2 = sand size, 3 = silt, mud.

Col 32-80, FLOAT, ETC — Remarks or other information. Alphanumeric characters allowed. Enter in readable fashion as this information will be printed just as it appears on the form.

Cards two and three contain spaces for analytical results. In each case the first four columns are reserved for keypunch duplication of the map number. Card one of this set contains spaces for the analysis of Au, Cu, Pb and Zn by atomic absorbtion as well as spaces for spectrographic analyses. All numbers must be right justified and decimals are assumed after each four column block for each element. If the analysis is less than 1 ppm or less than 1 percent, the decimal must be entered on the coding form. If the element is not analyzed the spaces are left blank and "NA" is printed on the output tables; the sample is not included in any of the statistics computed by the program. If the sample is analyzed but not detected, a minus (—) is left justified and the crustal average or one-half the detection limit, whichever is lower, for that element is assumed by the program. Final printout in this case would be "ND" (not detected). The coding forms contain only four spaces per element thus providing for a maximum of 9999 ppm to be entered. The spectrographic method used has reporting intervals including 10,000 and 20,000 ppm. In the case of an analysis of 10,000 ppm, 9,000 is entered on the form and 10,000 is assumed by the program; if 9,100 is entered, 20,000 ppm is assumed. On output these data are converted to percent and written *1.0 and *2.0 respectively.

APPENDIX I



```
              C DIVISION OF MINES AND GEOLOGY GEOCHEMICAL PROCESSING PROGRAM 2
              C  WRITTEN BY LAWRENCE E HEINER FEB 1970
              C  PURPOSES
              C
0001                DIMENSION NSPLE(7),RMKS(49),D(34),IWRIT(34),SD(34),SUM(34),AV(34)
0002                DIMENSION THRES(34),ANOM(34),Z(20),XN(34),X(800),VECT(20),NV(34)
0003                DIMENSION XINTER(34),DL(34),DSPEC(34),SUML(34),SDL(34),AVL(34)
0004                DATA IDASH/'-   '/
0005                NELM=34
0006                NORM=0
0007                DO 6 I=1,NELM
0008                THRES(I)=0.
0009                ANOM(I)=0.
0010                XN(I)=0.
0011                SD(I)=0.
0012                SUM(I)=0.
0013                SUML(I)=0.
0014                SDL(I)=0.
0015                AVL(I)=0.
0016                D(I)=0.
0017                AV(I)=0.
0018                XN(I)=0.
0019              6 XINTER(I)=0.
0020                REWIND 4
0021                REWIND 5
              C READ REPORT TITLE AND HEADER CARDS
0022                READ(1,97) (Z(I),I=1,20)
0023             97 FORMAT(20A4)
0024                READ(1,96) NC,NINT,CONST,(NV(I),I=1,34)
0025             96 FORMAT(I3,I2,F2.0,34I1)
0026                READ(1,401) (XINTER(I),I=1,34)
0027            401 FORMAT(17F3.0/17F3.0)
0028                WRITE(3,93) (Z(N),N=1,20),NC,NELM
0029             93 FORMAT('1',20A4,10X,2I3,//)
0030                DL( 1)  =  .1
0031                DL( 2)  =  .1
0032                DL( 3)  =  .1
0033                DL( 4)  =  .1
0034                DL( 5)=1.
0035                DL( 6)=5.
0036                DL( 7)=70.
0037                DL( 8)=1.5
0038                DL( 9)=.07
0039                DL(10)=5.
0040                DL(11)=2.5
0041                DL(12)=2.5
0042                DL(13)=10.
0043                DL(14)=.57
0044                DL(15)=.006
0045                DL(16)=.0002
0046                DL(17)=.004
0047                DL(18)=10.
0048                DL(19)=25.
0049                DL(20)=5.
0050                DL(21)=3.5
0051                DL(22)=2.
0052                DL(23)=1.5
0053                DL(24)=10.
0054                DL(25)=10.
0055                DL(26)=5.
0056                DL(27)=2.5
0057                DL(28)=5.
0058                DL(29)=5.
0059                DL(30)=1.8
0060                DL(31)=.2
0061                DL(32)=.17
0062                DL(33)=.2
0063                DL(34)=.004
0064                DO 55 NCAR=1,NC
0065                READ(1,99) MAP,(NSPLE(I),I=1,7),P,Y,NCRD,NCR,NDEP,NLOC,NORG,NTEST,
                   1ROCK,NSIZ,(RMKS(I),I=1,49)
0066             99 FORMAT(A4,7A1,2F3.1,A1,2A2,2A1,A2,A4,A1,49A1)
0067                READ(1,250) (DSPEC(I),I=1,19),(IWRIT(I),I=1,19)
0068            250 FORMAT(4X,19F4.0,T5,19A4)
0069                READ(1,255) (DSPEC(I),I=20,34),(IWRIT(I),I=20,34)
0070            255 FORMAT(4X,15F4.0,T5,15A4)
0071                DO 260 I=1,34
0072                IF(IWRIT(I).EQ.IDASH) GO TO 261
0073                GO TO 260
0074            261 DSPEC(I)=-1.
0075            260 CONTINUE
0076                WRITE(5) MAP,(NSPLE(I),I=1,7),P,Y,NCRD,NCR,NDEP,NLOC,NORG,NTEST,
                   1ROCK,NSIZ,(RMKS(I),I=1,49),(IWRIT(I),I=1,NELM)
0077                D( 1) = DSPEC( 1)
0078                D( 2) = DSPEC( 2)
0079                D( 3) = DSPEC( 3)
0080                D( 4) = DSPEC( 4)
0081                D( 5) = DSPEC(23)
```

```
      D( 6) = DSPEC(32)
      D( 7) = DSPEC(18)
      D( 8) = DSPEC(26)
      D( 9) = DSPEC(21)
      D(10) = DSPEC(15)
      D(11) = DSPEC(13)
      D(12) = DSPEC(16)
      D(13) = DSPEC(31)
      D(14) = DSPEC(27)
      D(15) = DSPEC( 7)
      D(16) = DSPEC(11)
      D(17) = DSPEC( 6)
      D(18) = DSPEC(34)
      D(19) = DSPEC(14)
      D(20) = DSPEC(33)
      D(21) = DSPEC(28)
      D(22) = DSPEC(25)
      D(23) = DSPEC( 8)
      D(24) = DSPEC(22)
      D(25) = DSPEC(19)
      D(26) = DSPEC( 5)
      D(27) = DSPEC(17)
      D(28) = DSPEC(20)
      D(29) = DSPEC(29)
      D(30) = DSPEC(10)
      D(31) = DSPEC( 9)
      D(32) = DSPEC(30)
      D(33) = DSPEC(24)
      D(34) = DSPEC(12)
      DO 5001 I=1,34
      IF(D(I))251,5001,5
    5 IF(D(I)-9000.)3,252,253
  252 D(I)=10000.
      GO TO 3
  253 IF(D(I)-9100.)3,254,3
  254 D(I)=20000.
      GO TO 3
  251 D(I)=DL(I)
    3 XN(I)=XN(I)+1.
      SUM(I)=SUM(I)+D(I)
      SUML(I)=SUML(I)+ALOG10(D(I)+CONST)
      SDL(I)=SDL(I)+ALOG10(D(I)+CONST)*ALOG10(D(I)+CONST)
      SD(I)=SD(I)+D(I)*D(I)
 5001 CONTINUE
      WRITE(4) MAP,(D(K),K=1,34)
   55 CONTINUE
      DO 8 I=1,NELM
      IF(XN(I)-4.)8,8,7
    7 AV(I)=SUM(I)/XN(I)
      AVL(I)=SUML(I)/XN(I)
    8 CONTINUE
      DO 9 I=1,NELM
      IF(XN(I)-4.)14,14,12
   12 SD(I)=SQRT(ABS((SD(I)-SUM(I)*SUM(I)/XN(I))/(XN(I)-1.)))
      SDL(I)=SQRT(ABS((SDL(I)-SUML(I)*SUML(I)/XN(I))/(XN(I)-1.)))
      GO TO 9
   14 SD(I)=0.
    9 CONTINUE
      DO 11 I=1,NELM
      IF(XN(I)-4.)11,11,13
   13 THRES(I)=AV(I)+SD(I)*2.
      ANOM(I)=AV(I)+SD(I)*3.
   11 CONTINUE
      WRITE(3,262)
  262 FORMAT(' ',3X,'AL',7X,'CU',7X,'PB',7X,'ZN',7X,'CU',7X,'PB',7X,'ZN'
     1,7X,'MO',7X,'AG',7X,'CO',7X,'CR',7X,'NI',7X,'MN',7X,'TI',/8X,
     2'FE',7X,'MG',
     37X,'CA',7X,'BA',7X,'SR',7X,'B',8X,'BE',7X,'SN',7X,'W',8X,'ZR',7X,
     4'LA',7X,'NB',7X,'SC',7X,'Y',/8X,'V',8X,'AS',7X,'SB',7X,'BI',7X,
     5'CD',7X,'AU')
      WRITE(3,201)
  201 FORMAT('0','AVERAGE '//)
      WRITE(3,200) (AV(I),I=1,NELM)
  200 FORMAT(' ',14F9.2/1X,14F9.2/1X,6F9.2)
      WRITE(3,202)
  202 FORMAT('0','STANDARD DEVIATION'//)
      WRITE(3,200) (SD(I),I=1,NELM)
      WRITE(3,203)
  203 FORMAT('0','THRESHOLD AS DEFINED BY HAWKES AND WEBB')
      WRITE(3,200) (THRES(I),I=1,NELM)
      WRITE(3,204)
  204 FORMAT('0','ANOMALY AS DEFINED BY HAWKES AND WEBB'//)
      WRITE(3,200) (ANOM(I),I=1,NELM)
      DO 257 I=1,34
      IF(XN(I)-4.)257,257,258
  258 THRES(I)=AVL(I)+SDL(I)*2.
      ANOM(I)=AVL(I)+SDL(I)*3.
  257 CONTINUE
      WRITE(3,256)
  256 FORMAT(' ',20X,'********************LOGNORMAL CALCULATIONS*****')
      WRITE(3,201)
```

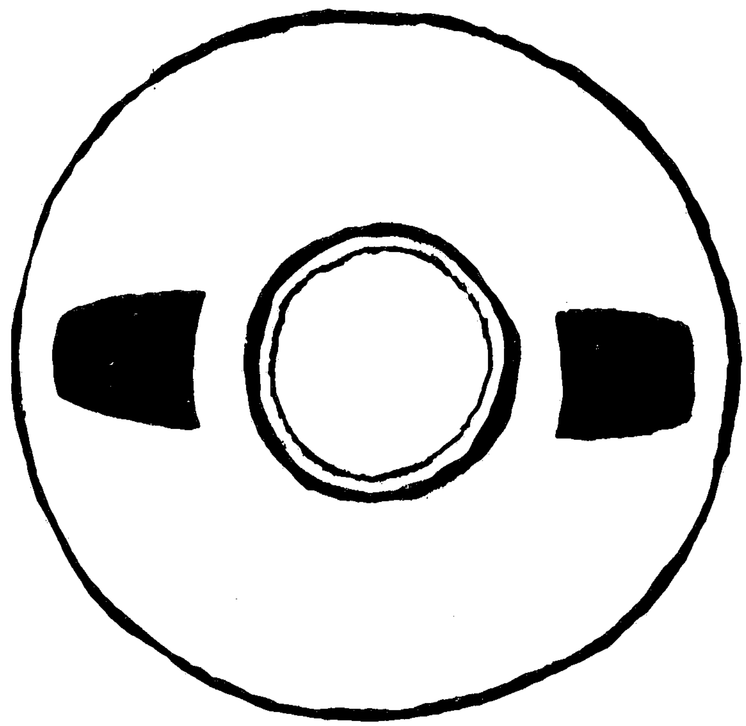
```
      WRITE(3,200) (AVL(I),I=1,34)
      WRITE(3,202)
      WRITE(3,200) (SDL(I),I=1,34)
      WRITE(3,203)
      WRITE(3,200) (THRES(I),I=1,34)
      WRITE(3,204)
      WRITE(3,200) (ANOM(I),I=1,34)
      NU=0
      REWIND 4
      DO 41 I=1,NELM
      IF(NV(I))41,41,42
   42 KKK=0
      IF(XN(I)-4.)49,49,501
   49 WRITE(3,500) I
  500 FORMAT('1','EL ='I4,'HISTOGRAM IGNORED--LESS THAN 4 DATA VALUES')
      GO TO 41
  501 NU=I
      REWIND 4
      DO 43 J=1,NO
      READ(4) MAP,(D(K),K=1,NELM)
      IF(D(I))43,43,44
   44 KKK=KKK+1
      X(KKK)=D(I)
      NX2=KKK
   43 CONTINUE
      REWIND 4
      YSPACE=0.
      IF(XINTER(I))405,405,406
  406 YSPACE=XINTER(I)
  405 CONTINUE
      CALL XFREQ(X,NX2,VECT,NINT,NORM,NU,YSPACE)
      CALL HIST(NU,VECT,NINT)
      REWIND 4
      YSPACE = 0.
      CALL LOGNOR(X,NX2,CONST)
      CALL XFREQ(X,NX2,VECT,NINT,NORM,NU,YSPACE)
      WRITE(3,407)
  407 FORMAT('0','FOLLOWING HISTOGRAM VALUES CONVERTED TO LOGS')
      CALL HIST(NU,VECT,NINT)
   41 CONTINUE
      CALL WRITE(NO,Z)
      CALL EXIT
      END
      SUBROUTINE LOGNOR(X,NO,Y)
       DIMENSION X(800)
       DO 1    I = 1,NO
    1 X(I)=ALOG10(X(I)+Y)
       RETURN
       END
      SUBROUTINE XFREQ(X,NO,VECT,NINT,NORM,NU,XINTER)
      DIMENSION X(800),VECT(20),XINT(20),NBRS(20)
C     FIND MIN AND MAX  VALUES
       VMIN = 1.0E75
       VMAX = -1.0E75
       DO 30    J = 1,NO
       IF(X(J)) 10,30,10
   10    IF(X(J) - VMIN) 15,20,20
   15    VMIN = X(J)
   20 IF(X(J)-VMAX)30,30,25
   25    VMAX = X(J)
   30 CONTINUE
C     COMPUTE INTERVAL SIZE
      IF(VMAX-VMIN)53,52,53
   53 FN=NO
      DO 45 I=1,NINT
      XINT(I)=0.
   45    VECT(I) = 0.0
      FINT = NINT
      IF(XINTER)32,32,31
   31 SINT = XINTER
      GO TO 33
   32 SINT =ABS((VMAX-VMIN)/FINT)
   33 CONTINUE
      DO 100     J = 1,NINT
      FK=J
      IF(NORM)300,300,301
  301 AK=SINT*FK
      GO TO 302
  300 AK=(SINT*FK)+VMIN
      IF(XINTER)302,302,303
  303 AK=SINT*FK
  302 BK=AK-SINT
       SUM = 0.
       DO 50    I = 1,NO
      IF(X(I)-AK)44,46,51
   51 IF(J-NINT)50,48,50
   46 SUM=SUM+0.5
      GO TO 50
   44 IF(X(I)-BK)49,47,48
   49 IF(J-1)50,48,50
   47 SUM=SUM+0.5
      GO TO 50
```

```
   48 SUM=SUM+1.0
   50 CONTINUE
      NBRS(J)=SUM+.5
      VECT(J)=((SUM/FN)*100.)
  100 CONTINUE
      DO 400 K=1,NINT
      FKK=K
      IF(NORM)304,304,305
  305 XINT(K)=SINT*FKK
      GO TO 400
  304 IF(XINTER)307,307,306
  307 XINT(K)=(SINT*FKK)+VMIN
      GO TO 400
  306 XINT(K)=SINT*FKK
  400 CONTINUE
      WRITE(3,402) NU,VMIN,VMAX
      WRITE(3,406) NO
  406 FORMAT('0',' NUMBER OF DATA POINTS = ',I6)
      WRITE(3,407)
  407 FORMAT('0','PERCENT SAMPLES IN CLASS INTERVALS')
      WRITE(3,401) (VECT(K),K=1,NINT)
      IF(XINTER)601,602,601
  601 WRITE(3,409)
  409 FORMAT('0',5X,'  INTERVAL '6X,'    NUMBER')
      DO 600 II=1,NINT
      INTE=SINT
      NHIGH=II*INTE
      NLOW=NHIGH-INTE
  600 WRITE(3,408) NLOW,NHIGH,NBRS(II)
  408 FORMAT(I6,'  -  ',I6,5X,I6)
  602 WRITE(3,403)
      WRITE(3,401) (XINT(K),K=1,NINT)
  401 FORMAT(' ',12F9.3/1X,12F9.3/1X,12F9.3)
  402 FORMAT('1','ELEMENT =',I3,'  MINIMUM = ',F8.2,'  MAXIMUM =',F9.2)
  403 FORMAT('0','INTERVALS')
      GO TO 405
   52 WRITE(3,404) NU
  404 FORMAT('1',I4,2X,'HISTOGRAM IGNORED---DATA VALUES ALL EQUAL')
  405 CONTINUE
       RETURN
       END
C                                                                       HIST  10
C     ..................................................................HIST  20
C                                                                       HIST  30
C        SUBROUTINE HIST                                                HIST  40
C                                                                       HIST  50
C        PURPOSE                                                        HIST  60
C           PRINT A HISTOGRAM OF FREQUENCIES VERSUS INTERVALS           HIST  70
C                                                                       HIST  80
C        USAGE                                                          HIST  90
C           CALL HIST(NU,FREQ,IN)                                       HIST 100
C                                                                       HIST 110
C        DESCRIPTION OF PARAMETERS                                      HIST 120
C           NU   - HISTOGRAM NUMBER (3 DIGITS MAXIMUM)                  HIST 130
C           FREQ - VECTOR OF FREQUENCIES                                HIST 140
C           IN   - NUMBER OF INTERVALS AND LENGTH OF FREQ (MAX IS 20)   HIST 150
C                  NORMALLY, FREQ(1) CONTAINS THE FREQUENCY SMALLER THANHIST 160
C                  THE LOWER BOUND AND FREQ(IN) CONTAINS THE FREQUENCY  HIST 170
C                  LARGER THAN THE UPPER BOUND                          HIST 180
C                                                                       HIST 190
C        REMARKS                                                        HIST 200
C           FREQUENCIES MUST BE POSITIVE NUMBERS                        HIST 210
C                                                                       HIST 220
C        SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                  HIST 230
C           NONE                                                        HIST 240
C                                                                       HIST 250
C        METHOD                                                         HIST 260
C           THE LARGEST FREQUENCY IS DETERMINED AND SCALING IS USED     HIST 270
C           IF REQUIRED                                                 HIST 280
C                                                                       HIST 290
C     ..................................................................HIST 300
C                                                                       HIST 310
      SUBROUTINE HIST(NU,FREQ,IN)                                       HIST 320
      DIMENSION JOUT(20),FREQ(20)                                       HIST 330
C                                                                       HIST 340
    1 FORMAT(6H EACH ,A1,8H EQUALS ,I2,7H POINTS,/)                     HIST 350
    2 FORMAT(I6,4X,20(4X,A1))                                           HIST 360
    3 FORMAT(9H0INTERVAL,4X,19(I2,3X),I2)                               HIST 370
    4 FORMAT(1H1,47X,'ELEMENT ',I3)                                     HIST 410
    5 FORMAT(10H0FREQUENCY,20I5)                                        HIST 390
    6 FORMAT(6H CLASS)                                                  HIST 400
    7 FORMAT(113H    -------------------------------------------------HIST 410
     1---------------------------------------------------------)        HIST 420
    8 FORMAT(1H )                                                       HIST 430
    9 FORMAT(A1)                                                        HIST 440
   10 FORMAT(1H*)                                                       HIST 450
C                                                                       HIST 460
      REWIND 6
      WRITE(6,10)
      REWIND 6
      READ(6,9) K
```

```
      REWIND 6
      WRITE(6,8)
      REWIND 6
      READ(6,9) NOTH
      REWIND 6
C
C        PRINT TITLE AND FREQUENCY VECTOR
C
      WRITE(3,4) NU
      DO 12 I=1,IN
   12 JOUT(I)=FREQ(I)
      WRITE(3,5) (JOUT(I),I=1,IN)
      WRITE(3,7)
C
C        FIND LARGEST FREQUENCY
C
      FMAX=0.0
      DO 20 I=1,IN
      IF(FREQ(I)-FMAX) 20,20,15
   15 FMAX=FREQ(I)
   20 CONTINUE
C
C        SCALE IF NECESSARY
C
      JSCAL=1
      IF(FMAX-50.0) 40,40,30
   30 JSCAL=(FMAX+49.0)/50.0
      WRITE(3,1) K,JSCAL
C
C        CLEAR OUTPUT AREA TO BLANKS
C
   40 DO 50 I=1,IN
   50 JOUT(I)=NOTH
C
C        LOCATE FREQUENCIES IN EACH INTERVAL
C
      MAX=FMAX/FLOAT(JSCAL)
      DO 80 I=1,MAX
      X=MAX-(I-1)
      DO 70 J=1,IN
      IF(FREQ(J)/FLOAT(JSCAL)-X) 70,60,60
   60 JOUT(J)=K
   70 CONTINUE
      IX=X*FLOAT(JSCAL)
C
C        PRINT LINE OF FREQUENCIES
C
   80 WRITE(3,2)IX,(JOUT(J),J=1,IN)
C
C        GENERATE CONSTANTS
C
      DO 90 I=1,IN
   90 JOUT(I)=I
C
C        PRINT INTERVAL NUMBERS
C
      WRITE(3,7)
      WRITE(3,3)(JOUT(J),J=1,IN)
      WRITE(3,6)
      RETURN
      END
      SUBROUTINE WRITE(NO,Z)
C  PRINT GEOCHEM PROGRAM
      DIMENSION NS(7),IWT(34),RM(49),Z(20)
      INTEGER OUT(34)
      DATA IBLK/'    '/,IDASH/'-    '/,I9000/'9000'/,I9100/'9100'/,
     1IPL/'+'/,IASTR/'*'/,IB/' '/,IED/'MD'/,ILC/'LC'/,IHI/'HI'/,
     2IFINE/'F'/,MEQ/'M'/,ICOR/'C'/,KR/ 'R'/,KD/'D'/,KC/'C'/,
     3AC/'A'/,BC/'B'/,I1/'1'/,I2/'2'/,I3/'3'/,IDEC/'  ND'/,IAN/'  NA'/,
     4I10/'*1.0'/,I20/'*2.0'/
      REWIND 5
      DO 2 K=1,NO
      READ(5)    M,(NS(I),I=1,7),X,Y,NC,NCR,NDE,NLO,MOR,NT,R,NSI,
     1(RM(I),I=1,49),(IWT(I),I=1,34)
      DO 19 N=1,34
   19 OUT(N)=IBLK
      OUT( 1)  =  IWT( 1)
      OUT( 2)  =  IWT( 2)
      OUT( 3)  =  IWT( 3)
      OUT( 4)  =  IWT( 4)
      OUT( 5)  =  IWT(23)
      OUT( 6)  =  IWT(32)
      OUT( 7)  =  IWT(18)
      OUT( 8)  =  IWT(26)
      OUT( 9)  =  IWT(21)
      OUT(10)  =  IWT(15)
      OUT(11)  =  IWT(13)
      OUT(12)  =  IWT(16)
      OUT(13)  =  IWT(31)
      OUT(14)  =  IWT(27)
      OUT(15)  =  IWT( 7)
      OUT(16)  =  IWT(11)
```

```
      OUT(17)  =  IWT( 6)
      OUT(18)  =  IWT(34)
      OUT(19)  =  IWT(14)
      OUT(20)  =  IWT(33)
      OUT(21)  =  IWT(28)
      OUT(22)  =  IWT(25)
      OUT(23)  =  IWT( 8)
      OUT(24)  =  IWT(22)
      OUT(25)  =  IWT(19)
      OUT(26)  =  IWT( 5)
      OUT(27)  =  IWT(17)
      OUT(28)  =  IWT(20)
      OUT(29)  =  IWT(29)
      OUT(30)  =  IWT(10)
      OUT(31)  =  IWT( 9)
      OUT(22)  =  IWT(30)
      OUT(23)  =  IWT(24)
      OUT(24)  =  IWT(12)
      ITYPE=IB
      IF(MCR.EQ.I1) GO TO 3
      IF(MCR.EQ.I2) GO TO 4
      IF(MCR.EQ.I3) GO TO 5
      GO TO 6
    3 MOR = ILO
      GO TO 6
    4 MOR = IEQ
      GO TO 6
    5 MOR = IHI
    6 CONTINUE
   10 IF(NSI.EQ.I1) GO TO 11
      IF(NSI.EQ.I2) GO TO 12
      IF(NSI.EQ.I3) GO TO 13
      GO TO 14
   11 NSI = IFINE
      GO TO 14
   12 NSI = MED
      GO TO 14
   13 NSI = ICOR
   14 CONTINUE
      DO 15 J=1,34
      IF(OUT(J).EQ.IDASH) GO TO 16
      IF(OUT(J).EQ.I9000) GO TO 17
      IF(OUT(J).EQ.I9100) GO TO 18
      IF(OUT(J).EQ.IBLK) GO TO 24
      GO TO 15
   16 OUT(J)=IDEC
      GO TO 15
   17 OUT(J) = I10
      GO TO 15
   18 OUT(J) = I20
   24 OUT(J)=IAN
   15 CONTINUE
      WRITE(6) M,(NS(I),I=1,7),X,Y,NC,NCR,NDE,NLO,MOR,NT,R,NSI,
     1(RM(I),I=1,49)
    2 WRITE(6) (OUT(I),I=1,34)
      REWIND 6
      WRITE(3,25) (Z(I),I=1,20)
   25 FORMAT('1','PAGE 1',20A4)
      WRITE(3,95)
   95 FORMAT(' ',' MAP  FIELD   AU   CU   FE   ZN   CU   PB   ZN   MO',
     1'   AG   CO   CR   NI   MN   TI   FE   MG   CA   BA   SR   B    ',
     2'BE')
      DO 20 KJ=1,NC
      READ(6) M,(NS(I),I=1,7),X,Y,NC,NCR,NDE,NLO,MOR,NT,R,NSI,
     1(RM(I),I=1,49)
      READ(6) (OUT(I),I=1,34)
C     WRITE PAGE ONE OF OUTPUT
      IF(NC.EQ.KR) GO TO 7
      IF(NC.EQ.KC) GO TO 8
      IF(NC.EQ.KO) GO TO 9
      GO TO 20
    7 ITYPE = IASTR
      GO TO 20
    8 ITYPE = IB
      GO TO 20
    9 ITYPE = IPL
   20 WRITE(3,98) ITYPE,M,(NS(I),I=1,7),(OUT(I),I=1,21)
   98 FORMAT(' ',A1,A4,7A1,1X,A4,1X,20(A4,1X))
      REWIND 6
      WRITE(3,26) (Z(I),I=1,20)
   26 FORMAT('1','PAGE 2',20A4)
      WRITE(3,94)
   94 FORMAT(' ','  SN   W    ZR   LA   NB   SC   Y    V    AS   SB   BI
     1   CD   AU')
      DO 22 J=1,NC
      READ(6) M,(NS(I),I=1,7),X,Y,NC,NCR,NDE,NLO,MOR,NT,R,NSI,
     1(RM(I),I=1,49)
      READ(6) (OUT(I),I=1,34)
   22 WRITE(3,97) (OUT(I),I=22,34),M
   97 FORMAT(' ',13(A4,1X),A4)
      REWIND 6
      WRITE(3,27) (Z(I),I=1,20)
   27 FORMAT('1','PAGE 3',20A4)
      WRITE(3,93)
   93 FORMAT(' ','D T  WD L OR S ROCK'16X,'REMARKS',29X,'MAP')
      DO 23 J=1,NC
      READ(6) M,(NS(I),I=1,7),X,Y,NC,NCR,NDE,NLO,MCR,NT,R,NSI,
     1(RM(I),I=1,49)
      READ(6) (OUT(I),I=1,34)
   23 WRITE(3,96) NDE,NT,NCR,NLO,MOR,NSI,R,(RM(I),I=1,49),M
   96 FORMAT(' ',2A2,1X,A2,1X,A1,1X,A2,1X,A1,1X,A4,1X,49A1,1X,A4)
      RETURN
      END
```

APPENDIX II



EXAMPLE PRINTOUT
46201. 1111
10. 5.20.

```
135  69P77 31125C15  A120     1ARGL50,FELS50
135      750  25 250  20   2  10-                     5-     200 200  20   20   20 200-
135  20-     1001000-             105000    1 100-    2000   20  10 500
136  69P78 31125C15  A1 6     1ARGL50,FELS50
136      600  20 215  20   2  10-       50            2-     500 200  20   50   20 200-
136  20    1 2001000-             205000-      100    2000   20  20 500
137  69P79 31125D    2 1 6    2ARGL50,FELS50
137      830  25 260  20   2  10                      2-     200 200  20   20   20 200-
137  20    1 1001000-             205000-      100-   2000   20  20 500
138  69P80 31125D    1 220    1ARGL50,FELS50
138      800  30 300  20   2   5       100-           2-     200 200  20   20   20 200
138  20    1 1001000-             102000-      100    1000   20  20 500
139  69P73 29123C15  A110-    3ARGL50,FELS49,HEM1
139      500  25 230  20   2   5        50-           2      500 200  50   20   20 200-
139  20    1 2001000-             205000-      100-   2000   20  20 500
140  69P74 29123C15  A2 4     2ARGL50,FELS49,HEM1
140      700  20 240  20   2   5-                     2-     200 200  50   20   20 500-
140  20    1 1001000-             205000-      100-   2000   20  20 500
141  69P75 29123D    2 220    1ARGL50,FELS49,HEM1
141      675  30 300  20   2   5                      2      200 200  20   20   20 200
141  20      200 500-             205000    1 100    52000   20  10 500
142  69P76 29123D    2 120    1ARGL50,FELS49,HEM1
142      920  25 320  20   2   5-       50-           2-     500 200  20   50   20 200
142  50    1 2001000-             205000-      100-   2000   20  20 500
143  69P69 28122C 1  A1 6     2SCH100
143      400  25 155  10   2   2-                     1-     200 100  20   20   10 100
143  20-     100 500-              52000-      100-   2000   10  10 500
144  69P70 28122C15  A125     3ARGL50,FELS50
144      575  25 260  20   2   5-       50            2-     500 200  20   20   20 200-
144  20-     100 500-             205000-      100    2000   20  20 500
145  69P71 28122D    1 1 8    2ARGL50,FELS50
145      525  20 220  20   2   5-                     2-     500 200  50   50   20 200-
145  20-     200 500-             205000-      100-   2000   20  20 500
146  69P72 28122D    1 210    1ARGL50,FELS50
146      725  30 275  20   2  10-       50            2-     500 100  50   20   20 200
146  20    1 2001000-             205000       100    2000   20  20 500
147  69P65 27121C15  A125     3SCH50,FELS50
147      620  25 250  20   2   5-                     2-     200 200  20   20   20 200-
147  50-     1001000-             205000-      100-   2000   20  10 500
148  69P66 27121C15  A2 8     1SCH50,FELS50
148      480  25 200  20   2   5-                     2-     200 200  20   20   20 200-
148  20-     200 500-             105000       100-   2000   20  20 500
149  69P67 27121D    1 1 8    2SCH50,FELS50
149      580  20 255  20   2   5-       50            2-     500 200  20   20   20 100-
149  20    1 200 500-             105000-      100-   2000   20  20 500
150  69P68 27121D    2 212    1SCH50,FELS50
150     1000  30 300  20   2  10-                     2-     200 200  50   20   20 500-
150  20    1 2001000-             205000-      200    2000   20  20 500
155  69P57 26118C 1  A225     2ARGL50,FELS50
155     1650  25 300  20   5  10-                     2-     500 200  50   20   20 500-
155  50    2 1002000-             505000-      100   55000   50  20 500
156  69P58 26118C 1  A225     2ARGL50,FELS50
156     1275  30 275  20   2   5-       50-           2-     500 200  20   50   10 200-
156  20    1 1001000-             205000    1 100     2000   20  20 500
157  69P59 26118D    2 225    1ARGL50,FELS50
157     1705  35 460  20   5  10-                     2-       2   2   5    2    2  5 -
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157  50   2 1002000-  -     202000-     100-   5000   50  20 500
158  69P60 26118D   2 225    1ARGL50,FELS50
158    1500  35 375  20   5  10-     50        5    500 200  50  50  20 500-
158  50   2 1002000-  -     205000-     100-   2000   50  20 500
159  69P53 26118C15  A125    2FELS50,ARGL30,LS20
159    730  40 260  20   2   5-     50-       2-    500 200  50  50  20 200  20
159  20-   2001000-  -     205000-     100-   2000   20  10 500
160  69P54 26118C15  A216    1FELS50,ARGL30,LS20
160    620  25 275  20   2  10-  -   -        2-    200 200  20  20  20 500-
160  50   1 2001000-  -     205000-     100-   2000   50  20 500
161  69P55 26118D   2 216    1FELS50,ARGL30,LS20
161    400  30 110  20   2   5-  -   -        2-    200 200  20  20  20 100  20
161  50-    200 500-   -     105000-     100-   2000   20  10 500
162  69P56 26118D   2 1 5    1FELS50,ARGL30,LS20
162    350  25 135  20   2   5-  -            2-    200 200  20  20  20 100-
162  20-    200 500-   -     109000-     100-   2000   20  10 500
163  69P51 27116C15  A125    2ARGL50,LS30,HEM20
163   1940  45 620  20   5  10-  -   -        5-    500 200 100  50  201000-
163  50-    1005000-   -     505000-     100   55000   50  20 500
164  69P52 27116D   2 125    1ARGL50,LS30,HEM20
164   1750  45 680  20   2  10-  -   -        5-    200 200  50  20  201000-
164  50   2 1001000-   -     205000-     100-   5000   50  20 500
165  69P47 27115C10  A125    1ARGL50,LS30,HEM20
165   1250  35 430  20   5  10-  -   -        5-    200 200 100  20  201000-
165  50-    1005000-   -     205000-     100   55000   50  201000
166  69P48 27115C10  A125    1ARGL50,LS30,HEM20
166    670  20 210
166
167  69P49 27115D   2 125    1ARGL50,LS30,HEM20
167   1350  40 260  20  10  10-  -            5-    200 200  50  20  20 500-
167  20   2  502000-   -     202000-     100-   5000   50  10 500
168  69P50 27115D   2 125    1ARGL50,LS30,HEM20
168   1650  55 700  20   2  10-               2-    500 200  50  50  201000  20
168  50   2 1001000-   -     505000      100   55000   50  20 500
169  69P43 26112C 1  A120    ARGL89,HEM10,VQTZ1
169   1700  40 420  20   2   5-     50-       2-    500 200  50  50  20 500-
169  50   2 1002000-         505000-     100   55000   50  20 500
170  69P44 26112D   2 218    1ARGL89,HEM10,VQTZ1
170   1400  55 550  20   2  10-               2     500 200  50  50  20 500  20
170  50   2 1002000-         505000-     100   52000   50  50 500
171  69P45 26112C15  A120    1ARGL89,HEM10,VQTZ1
171   1950  55 850  20   2  10-               2-    200 200  50  20  201000-
171  20   5 1002000-         505000-     100    5000   50  20 500
172  69P46 26112D   2 225    1ARGL89,HEM10,VQTZ1
172   1700  50 830  20   2  10-     -         5-    200 200  50  20  201000-
172  50   2 1002000          205000      100    5000   50  20 500
173  69P39 26112C15  A125    1ARGL89,HEM10,VQTZ1
173   2500  50 900  20   2  10-  -   -        5-    200 200  50  20  201000  20
173  50   5 1002000-   -     505000-     100-   5000   50  20 500
174  69P40 26112C15  A125    1ARGL89,HEM10,VQTZ1
174    850  25 290
174
175  69P41 26112D   2 325    1ARGL89,HEM10,VQTZ1
175   1450  70 680  20   2  10-  -            5     200 200  50  20  201000  20
175  50   2 1002000-   -     205000-     100-   5000  100  20 500
176  69P42 26112D   2 125    1ARGL89,HEM10,VQTZ1
176   1750  55 750  20   5  10-  -            2-    500 100  50  50  201000-
176  50   2 1002000-   -     205000-     100-   2000   50  20 500
177  69P35 26112C15  A125ARGL2ARGL89,HEM10,VQTZ1
177    825  35 375  20   2   5-     50-       2-    500 200  50  50  50 500-
```
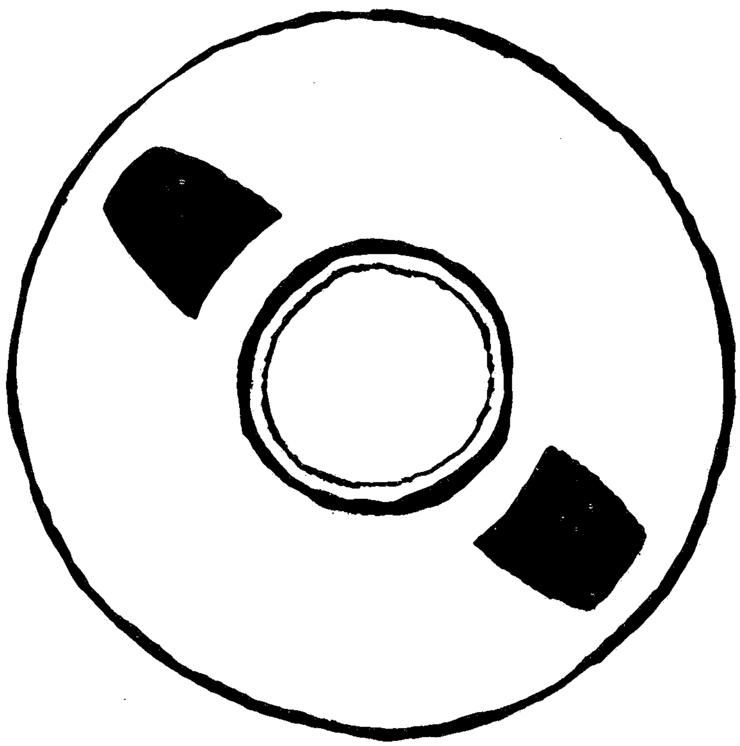

```
177   50    1 1001000-    -       505000-      100-    2000   50   20 500
178   69P36 26112C15   A125ARGL2ARGL89,HEM10,VQ1Z1
178      1450   50 730   20    2   10-     -     -          2-       200 200   50   20   201000   20
178   50    2 1001000-    -       505000-      100-    5000   50   20 500
179   69P37 26112D     1 114ARGL1ARGL89,HEM10,VQ1Z1
179       650   50 250   20    5    5-     -     -          2-       200 100   50   50   20 200   20
179   50    1 1001000-    -       502000-      100-    2000   50   20 500
180   69P38 26112D     1 125ARGL1ARGL89,HEM10,VQ1Z1
180       950   40 550   20    5   10-        50-           5-       200 200   50   20   20 500-
180   50    1 1001000-    -       205000-      100-    2000   50   20 500
181   69P31 26111C20   A125ARGL2ARGL89,HEM10,VQ1Z1
181      2500   35 470   20    2   10-     -     -          5-       200 200 100   20   20 500-
181   50    2 1002000-    -       502000-      100    55000   50   50 500
182   69P32 26111C20   A125ARGL1ARGL89,HEM10,VQ1Z1
182      1750   35 500
182
183   69P33 26111D     2 125ARGL1ARGL89,HEM10,VQ1Z1
183       605   701200   20    5   10-        50 500      2-       200 200   50   50   501000-
183   50    1 100 500-    -      -205000-      200     52000 100   50 500
184   69P34 26111D     2 125ARGL1ARGL89,HEM10,VQ1Z1
184      2810  150 620   20    5   10-        50-           5-       500 200 100   20   201000-
184   50    5 2002000-    -       505000-      100-    5000 100   20 500
/*
/*
```

APPENDIX III



EXAMPLE PRINTOUT

AU	CU	PB	ZN	CU	PB	ZN	MO	AG	CO	CR	NI	MN	TI
FE	MG	CA	BA	SR	B	BE	SN	W	ZR	LA	NB	SC	Y
V	AS	SB	BI	CO	AU								
AVERAGE													
0.0	1138.26	38.04	415.76	1383.72	39.30	497.67	26.63	1.32	44.19	325.58	29.77	3023.26	4697.67
7.84	2.81	2.88	511.63	190.70	20.23	3.33	2.00	1.50	131.40	13.72	19.77	20.93	36.74
104.65	13.39	18.73	1.18	0.20	0.00								
STANDARD DEVIATION													
0.0	621.60	21.36	239.28	987.04	22.51	344.68	15.23	1.26	22.91	149.75	14.22	1471.77	1336.91
2.62	1.38	1.69	76.25	29.39	9.13	0.64	0.0	0.0	48.82	7.25	1.52	6.84	15.07
21.31	75.97	26.69	1.99	0.00	0.00								
THRESHOLD AS DEFINED BY HAWKES AND WEBB													
0.0	2381.46	80.76	894.32	3357.81	84.32	1187.03	57.08	3.85	90.01	625.08	58.22	5966.79	7371.50
13.07	5.58	6.27	664.13	249.48	38.48	4.61	2.00	1.50	229.04	28.21	22.82	34.60	66.89
147.27	165.34	72.11	5.16	0.20	0.00								
ANOMALY AS DEFINED BY HAWKES AND WEBB													
0.0	3003.06	102.11	1133.61	4344.84	106.83	1531.71	72.30	5.11	112.92	774.83	72.44	7438.56	8708.41
15.69	6.97	7.96	740.38	278.87	47.61	5.26	2.00	1.50	277.87	35.46	24.34	41.44	81.97
168.58	241.31	98.79	7.15	0.20	0.00								
******************LOGNORMAL CALCULATIONS*****													
AVERAGE													
0.0	2.99	1.55	2.56	3.06	1.54	2.58	1.38	0.31	1.60	2.47	1.45	3.43	3.65
0.92	0.56	0.56	2.71	2.28	1.30	0.63	0.48	0.40	2.09	1.14	1.32	1.33	1.54
2.02	0.50	0.65	0.22	0.08	0.00								
STANDARD DEVIATION													
0.0	0.24	0.17	0.23	0.26	0.24	0.34	0.24	0.22	0.22	0.20	0.18	0.20	0.15
0.15	0.14	0.15	0.05	0.09	0.16	0.09	0.00	0.00	0.15	0.16	0.04	0.10	0.19
0.06	0.34	0.80	0.29	0.00	0.00								
THRESHOLD AS DEFINED BY HAWKES AND WEBB													
0.0	3.47	1.90	3.02	3.58	2.02	3.25	1.86	0.74	2.05	2.87	1.81	3.84	3.95
1.22	0.84	0.86	2.80	2.45	1.61	0.81	0.48	0.40	2.40	1.45	1.40	1.54	1.92
2.15	1.19	2.25	0.80	0.08	0.00								
ANOMALY AS DEFINED BY HAWKES AND WEBB													
0.0	3.71	2.08	3.26	3.84	2.25	3.59	2.10	0.96	2.27	3.06	2.00	4.04	4.10
1.36	0.98	1.01	2.85	2.54	1.77	0.90	0.48	0.40	2.55	1.60	1.45	1.64	2.12
2.21	1.53	3.04	1.09	0.08	0.00								

PAGE 1EXAMPLE PRINTOUT

MAP	FIELD	AU	CU	PB	ZN	CU	PB	ZN	MO	AG	CO	CR	NI	MN	TI	FE	MG	CA	BA	SR	B	BE
135	69P77	NA	750	25	250	1000	20	200	10	ND	20	200	20	2000	5000	10	5	2	500	200	10	1
136	69P78	NA	600	20	215	1000	20	200	20	1	20	500	50	2000	5000	10	2	2	500	200	20	ND
+ 137	69P79	NA	830	25	260	1000	20	200	20	1	20	200	20	2000	5000	10	2	2	500	200	20	ND
+ 138	69P80	NA	800	30	300	1000	20	200	10	1	20	200	20	1000	2000	5	2	2	500	200	20	ND
139	69P73	NA	500	25	230	1000	20	200	20	1	50	500	20	2000	5000	5	2	2	500	200	20	ND
140	69P74	NA	700	20	240	1000	20	500	20	1	50	200	20	2000	5000	5	2	2	500	200	20	ND
+ 141	69P75	NA	675	30	300	500	20	200	20	ND	20	200	20	2000	5000	5	2	2	500	200	10	1
+ 142	69P76	NA	920	25	320	1000	20	200	20	1	20	500	50	2000	5000	5	2	2	500	200	20	ND
143	69P69	NA	400	25	155	500	10	100	5	ND	20	200	20	2000	2000	2	1	2	500	100	10	ND
144	69P70	NA	575	25	260	500	20	200	20	ND	20	500	20	2000	5000	5	2	2	500	200	20	ND
+ 145	69P71	NA	525	20	220	500	20	200	20	ND	50	500	50	2000	5000	5	2	2	500	200	20	ND
+ 146	69P72	NA	725	30	275	1000	20	200	20	1	50	500	20	2000	5000	10	2	2	500	100	20	ND
147	69P65	NA	620	25	250	1000	20	200	20	ND	20	200	20	2000	5000	5	2	2	500	200	10	ND
148	69P66	NA	480	25	240	500	20	200	10	ND	20	200	20	2000	5000	5	2	2	500	200	20	ND
+ 149	69P67	NA	580	20	255	500	20	100	10	1	20	500	20	2000	5000	5	2	2	500	200	20	ND
+ 150	69P68	NA	1000	30	300	1000	20	500	20	1	50	200	20	2000	5000	10	2	2	500	200	20	ND
155	69P57	NA	1650	25	300	2000	50	500	50	2	50	500	20	5000	5000	10	2	5	500	200	20	ND
156	69P58	NA	1275	30	275	1000	20	200	20	1	20	500	50	2000	5000	5	2	2	500	200	20	1
+ 157	69P59	NA	1705	35	460	2000	50	500	20	2	50	200	20	5000	2000	10	2	5	500	200	20	ND
+ 158	69P60	NA	1500	35	375	2000	50	500	20	2	50	500	50	2000	5000	10	5	5	500	200	20	ND
159	69P53	NA	730	40	260	1000	20	200	20	ND	50	500	50	2000	5000	5	2	2	500	200	10	ND
160	69P54	NA	620	25	275	1000	50	500	20	1	20	200	20	2000	5000	10	2	2	500	200	20	ND
+ 161	69P55	NA	400	30	110	500	20	100	10	ND	20	200	20	2000	5000	5	2	2	500	200	10	ND
+ 162	69P56	NA	350	25	135	500	20	100	10	ND	20	200	20	2000	+1.0	5	2	2	500	200	10	ND
163	69P51	NA	1940	45	620	5000	50	1000	50	ND	100	500	50	5000	5000	10	5	5	500	200	20	ND
+ 164	69P52	NA	1750	45	680	1000	50	1000	20	2	50	200	20	5000	5000	10	5	2	500	200	20	ND
165	69P47	NA	1250	35	430	5000	50	1000	20	ND	100	200	20	5000	5000	10	5	5	1000	200	20	ND
166	69P48	NA	670	20	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
+ 167	69P49	NA	1350	40	260	2000	50	500	20	2	50	200	20	5000	2000	10	5	10	500	200	10	ND
+ 168	69P50	NA	1650	55	700	1000	50	1000	50	2	50	500	50	5000	5000	10	2	2	500	200	20	ND
169	69P43	NA	1700	40	420	2000	50	500	50	2	50	500	50	5000	5000	5	2	2	500	200	20	ND
+ 170	69P44	NA	1400	55	550	2000	50	500	50	2	50	500	50	2000	5000	10	2	2	500	200	50	ND
171	69P45	NA	1950	55	850	2000	50	1000	50	5	50	200	20	5000	5000	10	2	2	500	200	20	ND
+ 172	69P46	NA	1700	50	830	2000	50	1000	20	2	50	200	20	5000	5000	10	5	2	500	200	20	ND
173	69P39	NA	2500	50	900	2000	50	1000	50	5	50	200	20	5000	5000	10	5	2	500	200	20	ND
174	69P40	NA	850	25	290	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
+ 175	69P41	NA	1450	70	680	2000	100	1000	20	2	50	200	20	5000	5000	10	5	2	500	200	20	ND
+ 176	69P42	NA	1750	55	750	2000	50	1000	20	2	50	500	50	2000	5000	10	2	5	500	100	20	ND
177	69P35	NA	825	35	375	1000	50	500	50	1	50	500	50	2000	5000	5	2	2	500	200	20	ND
178	69P36	NA	1450	50	730	1000	50	1000	50	2	50	200	20	5000	5000	10	2	2	500	200	20	ND
+ 179	69P37	NA	650	50	250	1000	50	200	50	1	50	200	50	2000	2000	5	2	5	500	100	20	ND
+ 180	69P38	NA	950	40	550	1000	50	500	20	1	50	200	20	2000	5000	10	5	5	500	200	20	ND
181	69P31	NA	2500	35	470	2000	50	500	50	2	100	200	20	5000	2000	10	5	2	500	200	50	ND
182	69P32	NA	1750	35	500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
+ 183	69P33	NA	605	70	1200	500	100	1000	20	1	50	200	50	2000	5000	10	2	5	500	200	50	ND
+ 184	69P34	NA	2810	150	620	2000	100	1000	50	5	100	500	20	5000	5000	10	5	5	500	200	20	ND

PAGE 2EXAMPLE PRINTOUT

SN	W	ZR	LA	NB	SC	Y	V	AS	SB	BI	CD	AU	
ND	ND	100	ND	20	20	20	100	ND	ND	ND	ND	ND	135
ND	ND	200	ND	20	20	20	100	ND	50	ND	ND	ND	136
ND	ND	100	ND	20	20	20	100	ND	ND	ND	ND	ND	137
ND	ND	100	20	20	20	20	100	ND	100	ND	ND	ND	138
ND	ND	200	ND	20	20	20	100	ND	50	ND	ND	ND	139
ND	ND	100	ND	20	20	20	100	ND	ND	ND	ND	ND	140
ND	ND	200	20	20	20	20	100	ND	ND	5	ND	ND	141
ND	ND	200	20	20	20	50	100	ND	50	ND	ND	ND	142
ND	ND	100	50	10	10	20	100	ND	ND	ND	ND	ND	143
ND	ND	100	ND	20	20	20	100	ND	50	ND	ND	ND	144
ND	ND	200	ND	20	20	20	100	ND	ND	ND	ND	ND	145
ND	ND	200	20	20	20	20	100	ND	50	ND	ND	ND	146
ND	ND	100	ND	20	20	50	100	ND	ND	ND	ND	ND	147
ND	ND	200	ND	20	20	20	100	ND	ND	ND	ND	ND	148
ND	ND	200	ND	20	20	20	100	ND	50	ND	ND	ND	149
ND	ND	200	ND	20	20	20	200	ND	ND	ND	ND	ND	150
ND	ND	100	ND	20	20	50	100	ND	ND	5	ND	ND	155
ND	ND	100	ND	20	10	20	100	ND	50	ND	ND	ND	156
ND	ND	100	ND	20	20	50	100	ND	ND	ND	ND	ND	157
ND	ND	100	ND	20	20	50	100	ND	50	ND	ND	ND	158
ND	ND	200	20	20	20	20	100	ND	50	ND	ND	ND	159
ND	ND	200	ND	20	20	50	100	ND	ND	ND	ND	ND	160
ND	ND	200	20	20	20	50	100	ND	ND	ND	ND	ND	161
ND	ND	200	ND	20	20	20	100	ND	ND	ND	ND	ND	162
ND	ND	100	ND	20	20	50	100	ND	ND	5	ND	ND	163
ND	ND	100	ND	20	20	50	100	ND	ND	ND	ND	ND	164
ND	ND	100	ND	20	20	50	100	ND	ND	5	ND	ND	165
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	166
ND	ND	50	ND	20	20	20	100	ND	ND	ND	ND	ND	167
ND	ND	100	20	20	20	50	100	ND	ND	5	ND	ND	168
ND	ND	100	ND	20	20	50	100	ND	50	5	ND	ND	169
ND	ND	100	20	20	20	50	100	ND	ND	5	ND	ND	170
ND	ND	100	ND	20	20	20	100	ND	ND	ND	ND	ND	171
ND	ND	100	ND	20	20	50	100	ND	ND	ND	ND	ND	172
ND	ND	100	20	20	20	50	100	ND	ND	ND	ND	ND	173
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	174
ND	ND	100	20	20	20	50	100	ND	ND	ND	ND	ND	175
ND	ND	100	ND	20	20	50	100	ND	ND	ND	ND	ND	176
ND	ND	100	ND	20	50	50	100	ND	50	ND	ND	ND	177
ND	ND	100	20	20	20	50	100	ND	ND	ND	ND	ND	178
ND	ND	100	20	20	20	50	100	ND	ND	ND	ND	ND	179
ND	ND	100	ND	20	20	50	100	ND	50	ND	ND	ND	180
ND	ND	100	ND	20	20	50	100	ND	ND	5	ND	ND	181
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	182
ND	ND	100	ND	20	50	50	200	500	50	5	ND	ND	183
ND	ND	200	ND	20	20	50	100	ND	50	ND	ND	ND	184

PAGE 3EXAMPLE PRINTOUT

D	T	WD	L	OR	S	ROCK	REMARKS	MAP
	20	15	A	LO	F		ARGL50,FELS50	135
	6	15	A	LO	F		ARGL50,FELS50	136
2	6			LO	M		ARGL50,FELS50	137
1	20			MD	F		ARGL50,FELS50	138
	10	15	A	LO	C		ARGL50,FELS49,HEM1	139
	4	15	A	MD	M		ARGL50,FELS49,HEM1	140
2	20			MD	F		ARGL50,FELS49,HEM1	141
2	20			LO	F		ARGL50,FELS49,HEM1	142
	6	1	A	LO	M		SCH100	143
	25	15	A	LO	C		ARGL50,FELS50	144
1	8			LO	M		ARGL50,FELS50	145
1	10			MD	F		ARGL50,FELS50	146
	25	15	A	LO	C		SCH50,FELS50	147
	8	15	A	MD	F		SCH50,FELS50	148
1	8			LO	M		SCH50,FELS50	149
2	12			MD	F		SCH50,FELS50	150
	25	1	A	MD	M		ARGL50,FELS50	155
	25	1	A	MD	M		ARGL50,FELS50	156
2	25			MD	F		ARGL50,FELS50	157
2	25			MD	F		ARGL50,FELS50	158
	25	15	A	LO	M		FELS50,ARGL30,LS20	159
	16	15	A	MD	F		FELS50,ARGL30,LS20	160
2	16			MD	F		FELS50,ARGL30,LS20	161
2	5			LO	F		FELS50,ARGL30,LS20	162
	25	15	A	LO	M		ARGL50,LS30,HEM20	163
2	25			LO	F		ARGL50,LS30,HEM20	164
	25	10	A	LO	F		ARGL50,LS30,HEM20	165
	25	10	A	LO	F		ARGL50,LS30,HEM20	166
2	25			LO	F		ARGL50,LS30,HEM20	167
2	25			LO	F		ARGL50,LS30,HEM20	168
	20	1	A	LO			ARGL89,HEM10,VQTZ1	169
2	16			MD	F		ARGL89,HEM10,VQTZ1	170
	20	15	A	LO	F		ARGL89,HEM10,VQTZ1	171
2	25			MD	F		ARGL89,HEM10,VQTZ1	172
	25	15	A	LO	F		ARGL89,HEM10,VQTZ1	173
	25	15	A	LO	F		ARGL89,HEM10,VQTZ1	174
2	25			HI	F		ARGL89,HEM10,VQTZ1	175
2	25			LO	F		ARGL89,HEM10,VQTZ1	176
	25	15	A	LO	M	ARGL	ARGL89,HEM10,VQTZ1	177
	25	15	A	LO	M	ARGL	ARGL89,HEM10,VQTZ1	178
1	14			LO	F	ARGL	ARGL89,HEM10,VQTZ1	179
1	25			LO	F	ARGL	ARGL89,HEM10,VQTZ1	180
	25	20	A	LO	M	ARGL	ARGL89,HEM10,VQTZ1	181
	25	20	A	LO	F	ARGL	ARGL89,HEM10,VQTZ1	182
2	25			LO	F	ARGL	ARGL89,HEM10,VQTZ1	183
2	25			LO	F	ARGL	ARGL89,HEM10,VQTZ1	184

```
ELEMENT =  3  MINIMUM =      1.32  MAXIMUM =      2.18

 NUMBER OF DATA POINTS =      46

PERCENT SAMPLES IN CLASS INTERVALS
   10.870     0.0     26.087   13.043     0.0      13.043     8.696     4.348     8.696     8.696     0.0       0.0
    4.348     0.0      0.0      0.0       0.0       0.0       0.0       2.174

INTERVALS
    1.365     1.408    1.451    1.494     1.536     1.579     1.622     1.665     1.708     1.751     1.793     1.836
    1.879     1.922    1.965    2.008     2.050     2.093     2.136     2.179

FOLLOWING HISTOGRAM VALUES CONVERTED TO LOGS



                                         ELEMENT   3

FREQUENCY     10   0  26  13   0  13   8   4   8   8   0   0   4   0   0   0   0   0   0   2
--------------------------------------------------------------------------------------------
     26                *
     25                *
     24                *
     23                *
     22                *
     21                *
     20                *
     19                *
     18                *
     17                *
     16                *
     15                *
     14                *
     13                *   *       *
     12                *   *       *
     11                *   *       *
     10        *       *   *       *
      9        *       *   *       *
      8        *       *   *       *   *       *   *
      7        *       *   *       *   *       *   *
      6        *       *   *       *   *       *   *
      5        *       *   *       *   *       *   *
      4        *       *   *       *   *   *   *   *           *
      3        *       *   *       *   *   *   *   *           *
      2        *       *   *       *   *   *   *   *           *                           *
      1        *       *   *       *   *   *   *   *           *                           *
--------------------------------------------------------------------------------------------

INTERVAL       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
CLASS
```

ELEMENT = 3 MINIMUM = 20.00 MAXIMUM = 150.00

NUMBER OF DATA POINTS = 46

PERCENT SAMPLES IN CLASS INTERVALS

0.0	0.0	0.0	5.435	18.478	19.565	13.043	10.870	6.522	6.522	8.696	4.348
0.0	2.174	2.174	0.0	0.0	0.0	0.0	2.174				

INTERVAL	NUMBER
0 - 5	0
5 - 10	0
10 - 15	0
15 - 20	3
20 - 25	9
25 - 30	9
30 - 35	6
35 - 40	5
40 - 45	3
45 - 50	3
50 - 55	4
55 - 60	2
60 - 65	0
65 - 70	1
70 - 75	1
75 - 80	0
80 - 85	0
85 - 90	0
90 - 95	0
95 - 100	1

INTERVALS

5.000	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000	55.000	60.000
65.000	70.000	75.000	80.000	85.000	90.000	95.000	100.000				

```
                                         ELEMENT  3

FREQUENCY   0   0   0   5  18  19  13  10   6   6   8   4   0   2   2   0   0   0   0   2
-------------------------------------------------------------------------------------------
   19                           *
   18                       *   *
   17                       *   *
   16                       *   *
   15                       *   *
   14                       *   *
   13                       *   *   *
   12                       *   *   *
   11                       *   *   *
   10                       *   *   *   *
    9                       *   *   *   *
    8                       *   *   *   *           *
    7                       *   *   *   *           *
    6                       *   *   *   *   *   *   *
    5                   *   *   *   *   *   *   *   *
    4                   *   *   *   *   *   *   *   *   *
    3                   *   *   *   *   *   *   *   *   *
    2                   *   *   *   *   *   *   *   *   *       *   *                   *
    1                   *   *   *   *   *   *   *   *   *       *   *                   *
-------------------------------------------------------------------------------------------

INTERVAL    1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
CLASS
```