UNITED STATES DEPARTMENT OF THE INTERIOR

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The MIRA (Mineral Resource Analysis) System Users Manual: A microcomputer-based geochemical data analysis system

by

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I. System Overview

A. Introduction

The MIneral Resource Analysis (MIRA) System is a computer software system designed to help exploration geologists enter, retrieve, and analyze geochemical data. It is based on a microcomputer with 2 floppy-disk drives, a digitizing tablet, a television monitor, and a printer.

The MIRA System is capable of performing the following tasks:

- Entry and editing of field information;
- Entry and editing of geochemical information;
- Retrieval of information based upon given conditions and logic;
- calculation of basic summary statistics;
- creation of histograms;
- production of scatter diagrams and location plots.

The underlying reason for the development of this system is that it be used to aid in initial evaluation of the data while in the field. Other systems such as STATPAC (VanTrump and Miesch, 1977) and Q'GAS (Lavin and Nichol, 1981) are powerful analytical systems but they are based on a mainframe computer and a minicomputer, respectively. Therefore, a geologist must rely upon telephone lines (not always available or reliable) to use these systems. MIRA, being microcomputer-based, is self-sufficient. If certain analytical techniques are needed that are unavailable in MIRA, the geologist can use the microcomputer as a terminal to communicate with a mainframe where the programs reside. Even so, most of the needs of an exploration geologist can be met by MIRA either now or in the near future.

Eventually, MIRA will have data-transfer capabilities, more statistical methods, and enhanced graphics techniques.

B. Background

The MIRA System has its roots in an experiment conducted during the summer of 1980 (Hanley, 1981). This experiment involved remote-site entry of field and geochemical data and transmission of that data to the Honeywell MULTICS computer in Denver, Colorado. There the data were combined and both RASS (Rock Analysis Storage System) and STATPAC data sets were created. This experiment was successfully conducted from Elk City, Idaho, using data gathered from the nearby Gospel-Hump Wilderness Area.

The MIRA System was created to eliminate the vagaries of the telephone lines and the expense of MULTICS. It was designed to allow geologists to be completely self-sufficient in computing power and allow them to look at their geochemical data rapidly, find anomalous areas and resample those areas all in a single field season, assuming samples have been analyzed with a spectrograph.

C. Hardware

The MIRA System has been implemented on the Apple II Plus microcomputer. This system requires at least 64K RAM (kilobytes of random-access memory), which includes 48K RAM on-board and 16K RAM on an expansion card. Storage is handled by two 5 1/4-inch floppy-disk drives. Drive 1 stores the MIRA System programs and Drive 2 handles the data disk. A television monitor is needed to view the computer's output. A dot-matrix printer with graphics capability is needed for making hard-copies of graphs, etc. The MIRA software has been written to use a Grappler printer interface card. This card allows single-command printouts of high-resolution graphics. If another printer card is used, the programs must be modified to accommodate your card's specific needs. The printer should use standard, tractor-feed computer paper (132 columns). A digitizing tablet is necessary to encode sample locations. Communication capability is important so that the microcomputer can be used as a terminal to transmit data to a larger host. This can be accomplished by either an acoustic modem and card or direct-connect modems. Summarizing, the equipment necessary for the MIRA System is as follows:

- Apple II Plus with 64K RAM (48K on-board and 16K RAM card),
- DOS 3.3 (Disk Operating System)
- Two 5 1/4 inch, floppy disk drives,
- A monitor,
- A tractor-feed, dot-matrix printer with 132-character bed and graphics capability,
- Grappler printer interface card,
- A digitizing tablet, and
- A modem for communications.

D. Future Capabilities

The MIRA System performs the tasks listed in the Introduction. Tasks that are presently under development include printout of an archival RASS II form and transmission of data to MULTICS. Planned future capabilities include: factor analysis, multiple regression, block diagram, contour maps, gray-level maps and shaded relief maps.

There are other useful capabilities that could be incorporated into an analytical system such as MIRA. We encourage and welcome all suggestions as to techniques, graphs or capabilities that any user would like to have added to MIRA.

II. Start-up Procedures

A. Cold Start (computer is turned off)

1. Place the "MIRA System Disk" in Drive 1.
2. Place your data disk in Drive 2.
3. Turn the computer on.
4. If you have not initialized your data disk then go to the "DATA ENTRY AND EDITING" section by entering a "1" and run the disk initialization program by entering a "1" again.
5. You are now in the MIRA System.

B. Warm Start (computer is already on)

1. Make sure that the "MIRA System Disk" is in Drive 1.
2. Make sure that your data disk is in Drive 2.
3. Type in "RUN DRIVER, D1" and return.
4. If you have not initialized your data disk then go to the "DATA ENTRY AND EDITING" section by entering a "1" and run the disk initialization program by entering a "1" again.
5. You are now in the MIRA System.

III. Data Entry and Editing

A. Pre-field season programs

Three tasks must be completed before the field season begins:

- o Initialize data disks and create back-up copies of MIRA System disk
- o Run the field-data-initialization program
- o Determine control points for quadrangles and run quadrangle control-points program

1) Initialize data disks and copy MIRA System disk

Every disk must be initialized before it is used in the MIRA System. Explicit instructions for this can be found on pages 13-14 in The Apple II DOS Manual (Apple Computer, Inc., 1981). We recommend that on the data disks the HELLO programs, mentioned in this section, consist of REM (remark) statements that contain your name, the field area, and the date the disk was initialized. For instance, after entering "NEW" to clear memory, type in the following program:

```
100  REM   your name
110  REM   your field area
120  REM   the date
130  END
```

This leaves a permanent record on the disk of necessary identification information. Back-up copies of the MIRA System can be made by following the instructions on pages 38-40 in DOS manual.

2) Field Data Initialization

This program will allow you to enter state and county codes that remain constant, ask you whether you are using latitude/longitude or UTM coordinates, and allow you to enter your free-coding questions, if you have any. The program creates a text file (designated by a "T" in the CATALOG listing) named SAMCTL on your data disk. This file contains the answers to all the questions asked and will be called-up when you are entering your field data.

The procedure is as follows:

1. Enter the MIRA System (see Chapter II: Start-up Procedures).
2. Enter a "1" for the category "ENTRY AND EDITING OF RASS DATA."
3. Enter a "1" for the task "INITIALIZE FIELD DATA."
4. The program now begins.

The following format will be used throughout the rest of the manual to indicate questions that you will be asked and an explanation of possible responses:

Q = Question
R = Response

Q (A1): ARE YOU COLLECTING SAMPLES FROM ONLY ONE STATE ?

R: Enter a Y for yes or N for no.

R = Y, then

Q (A2): ENTER 2 LETTER STATE CODE :

R: Use post office-authorized 2 letter state abbreviation

R = N, then Q(A3).

Q (A3): DO YOU WANT TO ENTER A COUNTY CODE ?

R: Enter Y for yes or N for no.

R = Y, then

Q (A4): ENTER 3 OR LESS LETTER CODE FOR THE COUNTY :

R: An appropriate county code of your own design made up of 3 or less letters should be used.

Q (A5): HOW MANY FREE-CODING QUESTIONS DO YOU WANT TO USE ?

R: Enter the number of free-coding questions you want asked up to 14. Enter a 0 for none. (These free-coding questions are the 14 optional spaces for information of your choice allowed in the RASS field data entry system.)

R>0, then

Q (A6): ENTER FREE-CODING QUESTION 1 WITH LESS THAN 255 CHARACTERS.

R: Enter the question as you want it asked in the field entry program. It must be less than 255 characters.

This Q and R sequence will repeat the number of times indicated in question A5.

Q (A7): DO YOU WANT TO USE LATITUDE/LONGITUDE (ENTER A 1) OR UTM COORDINATES (ENTER A 2) :

R: Enter a 1 if you want latitude/longitude or a 2 if you want to use UTM coordinates when entering the quadrangle-control points and calculating the sample locations.

After answering question A7, the main menu will appear again and ask you for a category. This is standard procedure after each program is finished.

3) Quadrangle control-points program

The physical dimensions of the Apple graphics tablet restrict the size of the map that can be used to a quarter of a 7 1/2-minute quadrangle. There must be 2 control points on each quarter-quadrangle. These points should be in the upper-left and lower-right of the sheet. They can be in the corners but that is not necessary. The easiest way to determine the control points is to use points which already have the coordinates calculated for them. Use the corner and the "cross" (located 2 1/2-minutes in both directions away from the corner) for latitude and longitude control points. Similar "crosses" can be found for UTM coordinates, although those will have to be drawn on the map. We suggest placing a dot enclosed by a circle at each point using a red marker pen.

You will need to assign a 4-character quadrangle identifier to each quarter-quadrangle. We suggest that the following scheme be used. The quadrangles that are to be used should each be assigned a character and number in a particular order. For instance, the most northwest quadrangle could be given the identifier, A1; east of A1 is A2 and south of A1 is B1 (See figure 1).

The second 2 characters should refer to which quarter-quadrangle is identified (e.g. NE = northeast, NW = northwest, SW = southwest, SE = southeast).

The program will create a text file called QUADCTL on the MIRA System disk. We suggest that you write-protect the MIRA System disk after you have created the QUADCTL file. Write-protection means that a tab has been placed over the notch on the side of the disk. This prevents the disk from being written on accidentally.

The procedure to run this program is:

1. Enter the MIRA System (See Chapter II: Start-up Procedures)
2. Enter a "1" for the category "ENTRY AND EDITING OF RASS DATA."
3. Enter a "2" for the task "ENTER QUADRANGLE CONTROL PTS."
4. The program now begins.

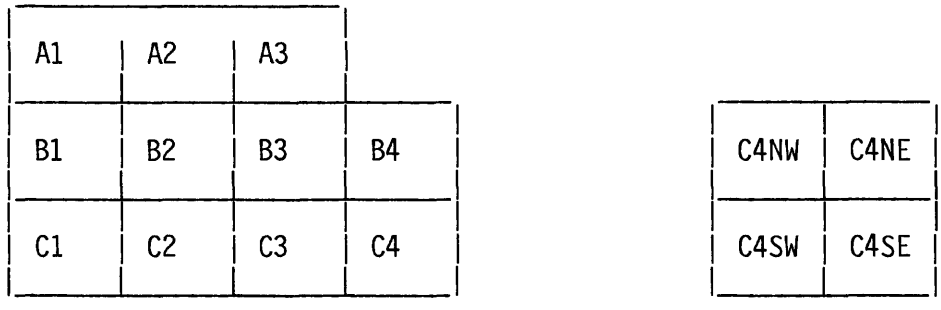


Figure 1.--Suggestions for labeling quadrangles and quarter-quadrangles.

If you are using latitude/longitude then you will be asked the following questions:

Q (B1): ENTER 4-CHARACTER QUADRANGLE IDENTIFIER :

R: Refer to Figure 1 and text for our suggestions on labeling quads. Use only 4 characters.

Q (B2): ENTER LATITUDE OF UPPER LEFT CONTROL POINT IN DEGREES, MINUTES AND SECONDS

ENTER DEGREES ONLY :

R: Enter the degree part of latitude of the upper left control point. It must be $\leq$ 90.

Q (B3): ENTER MINUTES :

R: Enter the minutes part of latitude of the upper left control point. It must be $\leq$ 60.

Q (B4): ENTER SECONDS :

R: Enter the seconds part of the latitude of the upper left control point. It must be $\leq$ 60.

Q (B5): ENTER LONGITUDE OF UPPER LEFT CONTROL POINT

ENTER DEGREES ONLY :

R: Enter the degrees part of the longitude of the upper left control point. It must be $\leq$ 180.

Q (B6): ENTER MINUTES :

R: Enter the minutes part of the longitude of the upper left control point. It must be $\leq$ 60.

Q (B7): ENTER SECONDS :

R: Enter the seconds part of the longitude of the upper left control point. It must be $\leq$ 60.

Q (B8): ENTER LATITUDE OF THE LOWER RIGHT CONTROL POINT

ENTER DEGREES ONLY :

R: Enter the degrees part of the latitude of the lower right control point. It must be $\leq$ 90.

Q (B9): ENTER MINUTES :

R: Enter the minutes part of the latitude of the lower right control point. It must be $\leq$ 60.

Q (B10): ENTER SECONDS :

R: Enter the seconds part of the latitude of the lower right control point. It must be $\leq$ 60.

Q (B11): ENTER LONGITUDE OF THE LOWER RIGHT CONTROL POINT.

ENTER DEGREES :

R: Enter the degrees part of the longitude of the lower right control point. It must be $\leq$ 180.

Q (B12): ENTER MINUTES :

R: Enter the minutes part of the longitude of the lower right control point. It must be $\leq$ 60.

Q (B13): ENTER SECONDS :

R: Enter the seconds part of the longitude of the lower right control point. It must be $\leq$ 60.

Q (B14): DO YOU HAVE ANY MORE QUADS ?

R: Enter Y if you have more quarter-quads to be entered or N if you do not. Please be sure to enter <u>all</u> of the quarter-quads now. If you must add more, you will have to unlock and delete QUADCTL and re-enter all of the previously entered quads plus the new ones. Y will repeat the question sequence B1-B14 until an N is entered. Then you will return to the MIRA menu.

If you are using <u>UTM coordinates</u> then you will be asked the following questions.

Q (B15): ENTER 4 CHARACTER QUADRANGLE IDENTIFIER:

R: Refer to Figure 1 and text for our suggestions on labeling quads. Use only 4 characters.

Q (B16): ENTER NORTHING UTM COORDINATE OF THE UPPER LEFT CONTROL POINT :

R: Enter 7 or 8 digit UTM coordinate. Use only numbers.

Q (B17): ENTER EASTING UTM COORDINATE OF THE UPPER LEFT CONTROL POINT :

R: Enter 7 or 8 digit UTM coordinate. Use only numbers.

Q (B18): ENTER NORTHING UTM COORDINATE OF THE LOWER RIGHT CONTROL POINT :

R: Enter 7 or 8 digit UTM coordinate. Use only numbers.

Q (B19): ENTER EASTING UTM COORDINATE OF THE LOWER RIGHT CONTROL POINT :

R: Enter 7 or 8 digit UTM coordinate. Use only numbers.

Q (B14): DO YOU HAVE ANY MORE QUADS ?

R: Refer to the response to question B14 on page 11.

B. Field Information

1) Field Data Entry

This program helps you enter field information in RASS II format. You will be asked all the questions that are found on the RASS II coding sheet. Each question is asked and a list of all possible answers is displayed below it. You can enter only one of these choices. The program handles any other response as an error. The following questions are exceptions: formation name (C17), geologic age (C15), all free-coding fields and comments. The answers to these questions will be checked for length (see the question-response section for length restrictions). The tag number (or lab number) is not required for this program. It will be entered in the geochemistry-entry program.

The program will allow you to digitize the locations of your samples. It has already been given information on whether you are using latitude/longitude or UTM coordinates because of your answer in the field-data-initialization program. You will be asked for the 4-character quadrangle identifier that was entered in the quadrangle control-points program. It should be located somewhere on the quarter-quadrangle where your sample is located. For more information on these prerequisite programs, see previous section entitled "Pre-field season programs."

The actual digitizing of the location involves placing the quarter-quadrangle on the digitizing tablet and fastening it lightly with 2 pieces of masking tape. After the quadrangle identifier has been entered, you will be instructed to place the pen on the upper left control point, then the lower right control point, and finally on the sample location. If the next sample is on the same quarter-quadrangle, you will only have to place the pen on the sample location. Thus, we recommend entering the information on all the samples on one quarter-quadrangle before proceeding to another one.

Since your knowledge of each sample is best recalled on the day the sample is collected, we recommend that sample information be entered that same day if possible. Additionally, you should create separate data sets for each type of sample you take. For instance, if you are taking rock, soil, and stream sediment samples, you should create 3 different data sets and use different names such as: ROCK1, SOIL1, and STREAM1. The maximum number of characters possible for a data set name is 30 characters.

The procedure to run this program is as follows:

1. Enter the MIRA System (see Chapter II: Start-up Procedures).
2. Enter a "1" for the category "ENTRY AND EDITING OF RASS DATA".
3. Enter a "3" for the task "ENTER FIELD INFORMATION."

4. The program now begins.

Q (C1): ENTER DATA FILE NAME:

R: Enter the name of the data file you want to work on.

Q (C2): IS THIS A NEW FILE (Y OR N)?

R: Enter Y for yes or N for no.

If you answer Y and the file exists then you will get the error statement "FILE LOCKED" and will go to Apple Systems level, evidenced by a "]". Type "RUN" to restart the program. If you answer N and the file is new (does not exist), then you will get the error statement "END OF DATA" and will go to Apple Systems level. Type "RUN" to restart the program.

Q (C3): ENTER FIELD NUMBER (< = 8 CHAR.):

R: The field number of your sample must be less than or equal to

8 characters.

For the responses to questions C4 through C17, we refer you to "RASS II Sample Submittal Manual" for any problems you may have. This manual can be obtained from the Branch of Exploration Research (BOER), U.S. Geological Survey, Box 25046, Denver Federal Center, Mail Stop 973, Lakewood, Colorado 80225.

You must enter one of the possible responses listed after questions C4-C6 and C8-C14. These responses are omitted here for brevity. For questions C7, C15-C17, you should refer to the "RASS II Sample Submitted Manual" to determine the proper response. A period (.) should be entered to leave the question blank.

Q (C4): ENTER SAMPLE TYPE:

Q (C5): ENTER METHOD COLLECTED:

Q (C6): ENTER SAMPLE SOURCE:

Q (C7): ENTER ROCK TYPE (ENTER A PERIOD (.) IF BLANK):

Q (C8): ENTER IGNEOUS FORM:

Q (C9): ENTER STRUCTURAL SETTING:

Q (C10): ENTER PREDOMINATE MATRIX:

Q (C11): ENTER OXIDATION STATE:

Q (C12): ENTER ALTERATION STATE:

Q (C13): ENTER ORE MINERALS:

Q (C14): ENTER MINERAL DEPOSIT FORM:

Q (C15): ENTER METAMORPHIC FACIES:

Q (C16): ENTER GEOLOGIC AGE (ENTER A PERIOD (.) IF BLANK):

Q (C17): ENTER SAMPLE DESCRIPTION CODE (USE NO MORE THAN 3 CHARACTERS.
ENTER A PERIOD (.) IF BLANK):

Q (C18): ENTER FORMATION CODE (ENTER A PERIOD (.) IF BLANK):

R: Formation code must not be more than 20 characters.
Enter a period (.) for a blank formation code.

If you have any free-coding questions to answer then

Q (C19): ENTER FREE-CODING SPACES (ENTER A PERIOD (.) IF BLANK):

R: Enter 1 character per question asked.

Q (C20): DO YOU HAVE ANY COMMENTS TO ENTER?

R: Enter Y for yes or N for no.

R=Y then Q (C21): ENTER COMMENTS (< or = 70 CHARACTERS):

If you are entering data from more than one state then

Q (C22): ENTER 2 LETTER STATE CODE:

R: Use standard post office authorized abbreviations.

If you are entering data from more than one county then Q (22):

Q (C23): DO YOU WANT TO ENTER A COUNTY CODE?

R: Enter Y for yes or N for no.

R = Y then Q (C24): ENTER COUNTY CODE (USE 3 OR LESS CHARACTERS):

R: County code must be no more than 3 characters.

Q (C25): DIGITIZE LATITUDE AND LONGITUDE OF SAMPLE:

R: Use the quadrangle identifier that is on the quarter-quadrangle.
The identifier must be 4 characters.

Q (C26): PLACE PEN ON UPPER LEFT CONTROL POINT:

R: Place graphics tablet pen on the upper left control
point and press down to enter the location.

Q (C27): PLACE PEN ON LOWER RIGHT CONTROL POINT:

R: Place graphics tablet pen on the lower right control point and press down to enter the location.

Q (C28): PLACE PEN SAMPLE LOCATION:

R: Place graphics tablet pen on the sample location and press down to enter the location.

For the subsequent samples you enter this session you will be asked:

Q (C29): IS THIS SAMPLE ON THE SAME QUADRANGLE SECTION AS THE LAST ONE?

R: Enter Y for yes or N for no.

Q (C30): DO YOU WANT ANY MORE INPUTING NOW (Y OR N)?

R: Enter Y for yes or N for no.

2) Editing Field Information

This program allows you to edit the field information that you have entered. You will be asked if you want to page through the data set or if you have a specific record that you want to edit. The record number must be known, which is simply the sequence number for the sample.

Editing is done by entering the number beside the item you wish to change. You will be asked the appropriate question for the item you want to change. The editing program does not check your answers to determine whether or not they are suitable, except for the proper length. If you want to change the free-coding space, you must enter all 14 spaces.

A warning must be made here. After making a change to an item, you will be asked if you have any other changes to make. If you answer yes (Y), the corrected record will be displayed. If you enter a zero for no change at this time, the record will <u>not</u> be updated on the disk with the changes you have just made. If you feel that you may have made an error in correcting the information and want to display the record again, then re-enter one of the single-character data items and answer the question about more changes with no

(N). This will update the record to disk.

The procedure to enter the editing program is as follows:

1. Enter the MIRA System (see Chapter II): Start-Up Procedures).'
2. Enter a "1" for the category "ENTRY AND EDITING OF RASS DATA."
3. Enter a "4" for the task "EDIT FIELD INFORMATION."
4. The program now begins.

Q (D1): ENTER NAME OF DATA FILE TO BE EDITED:

R: Enter the data file name. If you enter a nonexistent file the program will return the error statement "END OF FILE." This will result in that file name being written on your data disk. Type CATALOG to determine the correct name, if you have forgotten it. It should be the one without an asterisk and have 001 (1 sector) in front of the name. We suggest that you delete files in which there are no data. Type DELETE, followed by the file name. Then type RUN to reenter the editing program.

Q (D2): DO YOU HAVE A PARTICULAR RECORD YOU WANT TO EDIT?

R: Enter Y for yes or N for no.

R = Y then Q (D3): ENTER THE RECORD NUMBER:

R: Use the sequential number of the rcord.

R = N then Q (D4): DO YOU WANT TO EDIT ANOTHER FILE?

R: Enter Y for yes or N for no.

R = N then returns to MIRA menu.

R = Y then Q (D1) above.

If the response to questions D3 or D4 is yes, then your data will be displayed, one sample (record) at a time. All data items for that sample will be displayed beside its item-name and a corresponding item-number. If you want to change an item, then enter the item number and you will be asked to re-enter the data tor that item.

There are several problem areas that presently exist that will be corrected in future versions. These are:

Sample Number: Enter all 8 characters. A blank is a character. If your sample number is less than 8 characters, fill in the remainder with blanks.

County Code: This must be 3 characters long. Enter blanks for any extra characters required.

Free-coding spaces: You must enter all 14 characters, each in its proper position for the free-coding questions you are asked. Use blanks to fill unanswered or unasked questions-spaces.

Latitude/Longitude: Degrees must have 2 (latitude) and 3 (longitude) characters.

Minutes and seconds must have 2 characters each.

Use blanks to fill in unneeded spaces.

Any more changes?: If this question is answered Y for yes, then the sample data will be re-displayed, including the changes you have made. There is a temptation to answer Y to make sure that your changes are correct. If you answer Y and then enter 0 for no changes, the record will not be updated on disk. Therefore, if you want to check what you've done, answer Y, then enter the number of a blank item and a period (.) for a blank, and finally an N for no more changes.

If you are paging through the data set, the program will continue to display samples until it reaches the end of the data. You will then be asked question D5 (above).

If you are looking at individual records, the program will ask you:

Q (D6): DO YOU WANT TO EDIT ANOTHER SAMPLE?

R: Enter Y for yes or N for no.

R = Y then Q (D3) above.

R = N then Q (D5) above.

3) Location Calculation

This program allows you to determine only the latitude/longitude or UTM coordinates for a sample. This is convenient for calculating incorrect or misplaced locations. The program prints out the coordinates of your sample on the screen. You would then write the location down, enter the field-data-editor and change the location coordinates.

The procedure to run this program is as follows:

1. Enter the MIRA System (see Chapter II: Start-up Procedures).
2. Enter a "1" for the category "ENTRY AND EDITING OF RASS DATA."
3. Enter a "4" for the task "LOCATION CALCULATION ONLY."
4. The program now begins.

Q (E1): ENTER 4-CHARACTER QUAD IDENTIFIER:

R: Enter the quadrangle identifier that is on the quarter-quadrangle where the sample is located.

Q (E2): PLACE PEN ON UPPER LEFT CONTROL POINT:

R: Place graphics tablet pen on the upper left control point and press down to enter the location.

Q (E3): PLACE PEN ON LOWER RIGHT CONTROL POINT:

R: Place graphic tablet pen on the upper right control point and press down to enter the location.

Q (E4): PLACE PEN ON SAMPLE LOCATION:

R: Place graphics tablet pen on the sample location and press down to enter the location.

Q (E5): DO YOU WANT TO ENTER MORE?

R: Enter Y for yes or N for no.

R = Y then Q (E6): IS THIS ON THE SAME QUAD SECTION?

R: Enter Y for yes or N for no.

R = Y then Q (E2) above.

R = N then Q (E1) above.

R = N then returns to MIRA menu.

C. Geochemical Analyses

1) Qualified values

Semiquantitative emission spectrographic data usually contain some variables with qualified values. These are values that are beyond the detection limits of the spectrometer. There are five qualifiers that are used, N, L, G, B, and H. These qualifiers are explained in Table 1. A qualified value consists of the associated value (see Table 1) followed by the qualifier.

Qualified data may be entered using only the qualifier, i.e., N, L, G, B, and H (see Table 1). The program has the current upper and lower detection limits of each element in it and automatically appends those numbers onto the front of the qualifier. Additionally, if all of the samples of an element are the same qualifier, as is usually the case with Au, for example, you have the opportunity to enter only one qualifier for all the samples.

Table 1.--Associated values and meanings of the qualifiers used in semiquantitative emission spectrographic data.

Qualifier	Meaning	Associated values
N	not detected	lower detection limit
L	less than lower detection limit	lower detection limit
G	greater than upper detection limit	upper detection limit
B	Blank	0.0
H	interference, and unreadable	0.0

2) Entry of geochemical analyses

This program allows you to enter semiquantitative emission-spectrographic data from the Branch of Exploration Research's spectrographic data forms. Data is entered by column for each of the 31 elements that are analyzed, as well as the field and tag (or lab) numbers. Any additional data to be entered, such as atomic absorption data, require program modification.

The procedure to run the program is as follows:

1. Enter the MIRA System (see Chapter II: Start-up Procedures).
2. Enter a "1" for the category "ENTRY AND EDITING OF RASS DATA."
3. Enter a "6" for "ENTER GEOCHEMICAL DATA."
4. The program now begins.

Q (F1): ENTER DATA SET NAME:

R: Enter the name of the data set on disk drive 2.

Q (F2): IS THIS A NEW DATA SET (Y OR N):

R: Enter Y for yes or N for no.

Q (F3): HOW MANY SAMPLES DO YOU WANT TO ENTER NOW?

R: Enter the number of samples that you want to enter geochemical data for at this time. If you have only 5 samples on one spec. sheet, you would enter a "5." You can enter more into the same data set from another spec. sheet later. You can enter a maximum of 23 samples into any one data set.

You will now be asked to enter the field and tag numbers and the data for each element. The program will ask for values for each sample. You will enter values down one column, then proceed to the next.

Q (F4): ENTER "x" FIELD NUMBERS

```
1 :
?
```

R: Enter "x" field numbers, one at a time. The field numbers must be less than or equal to 8 characters. If you use more than 8 characters, you will have to truncate them.

Q (F5): ARE THE TAG NUMBERS ALL SEQUENTIAL?

R: Enter Y for yes or N for no. Check your spec. sheet to make sure that the tag numbers are listed sequentially.

R = Y then Q(F6): ENTER STARTING TAG NUMBER:

R: The tag number must be 6 characters.

R = N then ENTER "x" NUMBER OF TAG NUMBERS. THEY MUST BE 6 CHARACTERS.

For each chemical variable you will be asked the following question:

ARE ALL ENTRIES ONE QUALIFIER?

Enter Y for yes or N for no. If you enter yes you will be asked:

ENTER QUALIFIER:

The qualifier can be only one of the following characters "N", "L", "B", "G", or "H." All samples will be given the value of the detection limit associated with the qualifier you entered.

If the data for the element you are working on is not all one qualifier, you will be asked to enter each value. You need enter only the qualifier if you have one. The program will add the value of the detection limit associated with the qualifier you entered.

Q (F7): DO YOU WANT TO ENTER MORE DATA?

R: Enter Y for yes or N for no.

R = Y then Q (1)

R = N then returns to MIRA menu.

3) Editing geochemical analyses

This program allows you to edit semiquantitative emission-spectrographic data that was entered by the previous program. Data for the 31 elements that are analyzed and the field and tag numbers may be edited. Any additional data, such as atomic absorption, that were entered by changing the chemistry-entry program, require that this program also be changed. Qualified data may be edited by entering the qualifier only. The program has the current upper and lower detection limits of each element in it.

The procedure to run the program is as follows:

1. Enter the MIRA SYSTEM (see Chapter II: Start-up Procedures).
2. Enter a "1" for the category "ENTRY AND EDITING OF RASS DATA."
3. Enter a "7" for the task "EDIT GEOCHEMICAL DATA."
4. The program now begins.

Q (G1): ENTER DATA SET NAME:

R: Enter the name of the data set on drive 2.

The program will tell you at this point how many samples are in this data set.

Q (G2): DO YOU WANT TO EDIT FIELD NUMBERS?

R: Enter Y for yes or N for no.

R = Y then the program will display the field numbers, each one beside an index number that has been assigned by the program.

Q (G3): ENTER INDEX NUMBER (0 = NO CHANGE):

R: Enter the number beside the field number that you wish to change. Enter a 0 (zero) if you wish no change.

Q (G4): ENTER NEW FIELD NUMBER:

R: The field number entered must be less than or equal to 8 characters.

Q (G5): ANYMORE CHANGES?

R: Enter a Y for yes or N for no.

WARNING: For changes to field numbers, tag numbers, and elemental values, if you make changes and want to review them (i.e. enter a Y for question G5), then you must reenter a field number for the file to be updated. If you enter a 0 (zero) for no more changes, after making some changes, the disk file will not be updated.

Q (G6): DO YOU WANT TO EDIT TAG NUMBERS?

R: Enter Y for yes or N for no.

R = Y then the program will display the tag numbers, each one beside an index number that has been assigned by the program.

Q (G8): ENTER NEW TAG NUMBER:

R: The tag number must be 6 characters.

Q (G9): ANYMORE CHANGES?

R: Enter Y for yes or N for no.

WARNING: See Warning above.

Q (G10): DO YOU WANT TO EDIT ANY DATA VALUES?

R: Enter Y for yes or N for no.

R = N then return to MIRA.

R = Y then Q (G11): ENTER CHEMICAL SYMBOL OF DATA TO BE EDITED:

R: Enter the 2-character chemical symbol of the element you want to edit. The program will display the values of the element, each beside an index number.

Q (G12): ENTER INDEX NUMBER (0 = NO CHANGE):

R: Enter the number beside the value you wish to change.

Q (G13): ENTER QUALIFIER OR VALUE:

R: Enter either the qualifier only or the unqualified value of the value to be changed.

Q (G14): ANY MORE CHANGES TO THIS ELEMENT:

R: Enter Y for yes or N for no.

WARNING: See WARNING on page 19.

R = Y then Q (G12).

R = N then Q (G15): DO YOU WANT TO CHANGE VALUES OF ANOTHER ELEMENT?

R: Enter Y for yes or N for no.

R = Y then Q (11).

R = N then return to MIRA.

IV. Data Retrieval

A. Apple-GRASP

Apple-GRASP (Geologic Retrieval And Synopsis Program) is a version of micro-GRASP (Bowen, written communication) that has been adapted and enhanced to run on the Apple II. GRASP was originally written in FORTRAN (Bowen and Botbol, 1975) and was translated into BASIC for the Tektronix 4054 by R.W. Bowen. This code formed the basis for translation into Applesoft, Apple's floating-point BASIC. This program allows you to make retrievals of your data based upon relational conditions and logical operators. Output of these retrievals may be routed to either the printer or to another disk file.

1) Data Structure

The structure of a GRASP data file consists of two main parts, the data definitions file (dd file) and the data itself. The dd file consists of two parts. The first part is made up of 3 variables, each occupying one record: N1 equals the number of data items; R9 is the number of characters in a data record; and NR is the number of data records. The second part is made up of one record for each variable. Each record consists of the variable name, the type of variable and the beginning and ending character number in the data records. The variable name must be 8 or less characters, either alphabetic or numeric. There are three types of variables: character, numeric and qualified. Qualified variables are discussed on page 21. The data follow the dd file. The GRASP-file-creation program discussed in the previous section creates this file structure for the user given a standard set of RASS data.

Table 2 summarizes the information in this Section. This data structure is used not only by GRASP but by all the programs in the exploratory data analysis package (See Chapter V).

B. Creation of a GRASP file

This program provides you with the ability to create an Apple-GRASP file. The GRASP file-creation program combines field and geochemical data into a data file according to user-selected criteria. These criteria are the data items to be used and the order in which they are to be found in the GRASP file. Future improvements of this program will include the ability to change the existing data definitions file and create a GRASP file from data transmitted from MULTICS.

The procedure to run the program is as follows:

1. Enter the MIRA System (see Chapter II: Start-up Procedures).
2. Enter a "3" for the category "Retrieval Of Data."
3. Enter a "1" for the task "Create A GRASP File."

Table 2.--Apple-GRASP data file structure

Record 1:	number of variables (N1)
Record 2:	length of data record (R9)
Record 3:	number of data records (NR)
Records 4 thru 3+N1:	each record contains the following information about one variable
columns 1-8 :	variable name
column 10 :	variable type (C, N, or Q)
columns 11-14:	starting position in data record
columns 15-18:	ending position in data record
Records 3+N1+1 thru 3+N1+NR:	data records, NR in number, each containing one record that consists of the value of each variable for one data item, structured according to the above mentioned format.

Q (H1): GRASP DATA SET CREATION PROGRAM

1: CREATE A NEW DATA SET

2: RETURN TO MIRA

R: Enter either a 1 or 2.

Q (H2):

```
ITEMS POSSIBLE FOR STANDARD DATA SET.
          1) FLD     20) CD
          2) TAC     21) CO
          3) LAT     22) CR
          4) LONG    23) CU
          5) UTME    24) LA
          6) UTMN    25) MO
          7) RKTP    26) NB
          8) FE      27) NI
          9) MG      28) PB
          10) CA     29) SB
          11) TI     30) SC
          12) MN     31) SN
          13) AG     32) SR
          14) AS     33) V
          15) AU     34) W
          16) B      35) Y
          17) BA     36) ZN
          18) BE     37) ZR
          19) BI     38) TH
ENTER DATA ITEM NUMBERS WANTED
(I.E. 4-10/15/20/25-) :
```

R: Enter either single numbers or a range of numbers that corresponds to the variables wanted. Single numbers must be separated by a slash (/). A range of numbers consists of the beginning and ending number separated by a hyphen (-). If you want from one number through the end, enter the beginning number followed by a hyphen with no ending number. Each single number and range of numbers must be separated by a slash (/).

If your numbers are entered in ascending order, the program will list them with the corresponding variable name and ask the question:

Q (H3): IS THIS ALL RIGHT?

R : Enter Y for yes or N for no.

R = Y then Q (H5)

R = N then Q (H2)

If your numbers have not been entered in ascending order, the program will ask the following question:

Q (H4): YOU HAVE ENTERED SOME VARIABLE IN NON-ASCENDING ORDER.

IS THAT O.K.?

R: Enter Y for yes or N for no.

R = Y then Q (H3)

R = N then Q (H3) after the variables have been placed in ascending order.

Q (H5): ENTER GRASP FILE NAME:

R : Enter the name that you want to call the GRASP file you are creating. You cannot overwrite an existing file. If the file name you entered is an existing file, you will be asked to re-enter the GRASP file name.

After answering question H5, the computer will ask you to:

Q (H6): PLACE THE GRASP DISK IN DRIVE 2

HIT RETURN KEY AFTERWARDS.

R : After placing the disk you want your GRASP file on in Drive 2, hit the return key.

Q (H7): ENTER CHEMISTRY DATA SET NAME:

R : Enter the name of the data set containing the chemistry results.

If the data set name does not exist on the disk, the program will ask you to re-enter the file name.

After answering question H7, the program will ask you:

Q (H8): PLACE CHEMISTRY DISK IN DRIVE 2

HIT RETURN KEY AFTERWARDS.

R : After placing the disk that has the chemistry data set on it in Drive 2, hit the return key.

Q (H9): ENTER FIELD DATA SET NAME:

R : Enter the name of the data set containing the field information.

If the data set name does not exist on the disk, the program will ask you to re-enter the file name.

After answering question H9, the program will ask you:

Q (H10): PLACE FIELD DISK IN DRIVE 2

HIT RETURN KEY AFTERWARDS:

R : After placing the disk that has the field information data set on it in Drive 2, hit the return key.

At this point, the program will check to make sure that the number of samples in the field and chemistry data sets are the same. If they are not, the program will display the number of records in each data set and their respective names. It will allow you to re-enter each data set or go back to the MIRA command level and rectify the situation.

Additionally, the program checks each field number for consistancy between the field and chemistry data sets. If a field number is not the same in each data set, the program will alert you to that fact and allow you to rectify the situation by returning to MIRA command level and editing whichever sample is necessary.

Q (H11): PLACE GRASP DISK IN DRIVE 2

HIT RETURN KEY AFTERWARDS.

R : Place in Drive 2 the disk that you earlier had in the drive to write the GRASP data definitions file on and hit the return key.

Q (H12): DO YOU HAVE ANY MORE DATA TO ADD TO THIS GRASP FILE?

R : Enter Y for yes and N for no.

R = Y then Q (H7). This allows you to concatenate several data sets together.

R = N then returns to MIRA menu.

C. Apple-GRASP retrievals

This section will depart from our previous structure because GRASP requires you to issue commands rather than simply answering questions. Each of the 12 commands will be discussed individually. Parts of this discussion have been drawn from the user's manual for micro-GRASP (Bowen, personal communication).

The procedure to run GRASP is as follows:

1. Enter the MIRA System (see Chapter II: Start-up Procedures).
2. Enter a "3" for the category "RETRIEVAL OF DATA."
3. Enter a "2" for the task "GRASP RETRIEVALS."
4. The program now begins.
5. You must enter a GRASP data file name after you begin the program.

3) COND Command

The COND (conditions) command allows you to enter a set of conditions for any variable. Each condition is entered using the syntax "variable-name relation value" and each is labeled with a letter that you will use in the LOGI (logic) command to refer to that condition. The name used in a condition must be either a valid variable or defined-variable (see DEFI command) name. The relation can be any of the following:

RELATION	EXPLANATION	USE WITH VARIABLE TYPE[1]
GT	greater than	N,Q
LT	less than	N,Q
GE	greater than or equal to	N,Q
LE	less than or equal to	N,Q
EQ	equal to	N,Q
NE	not equal to	N,Q
CS	contains string	C,Q

[1] N = numeric
Q = qualified
C = character

With the exception of "CS", all relations can only be used with variable values that are numbers (0, 1, ..., 9). If you want to enter a condition using alphanumeric characters use the relation "CS." Since the value of each particular qualifier of qualified variables is the same for each variable, there is no need to use any numeric values. In other words, the condition "variable-name CS N" will retrieve all samples with an N (not detected) qualifier.

If conditions have already been entered into the system, you can either add to the existing list of conditions or create a totally new set. After you have entered all the conditions, press the RETURN key to exit this command.

4) LOGI Command

The LOGI (logic) command is used to complete the formation of the selection criteria by entering a logical expression. This is accomplished by entering the letter-label for each condition you want to include, combined with the appropriate logical operator. The three possible logical operators are: "+" (or), "*" (and), and "-" (not). Logic is entered using an expression containing letters standing for conditions and +, *, and - for their respective logical operation. The - operator will be applied before the * operator, which will be applied before the + operator. This order may be superceded by using parentheses.

A single condition may be entered with no logical operator, setting the criteria for your retrieval to be that single condition. If you have previously entered a logical expression and wish not to have any criteria set for your next retrieval, then press the RETURN key when asked to enter a logic expression. You may then review the current status of your conditions and logic by using the REVI (review) command.

5) LIST Command

The LIST command allows you to display the values of specified variables that satisfy your condition and logic selections. You may display the data in row-type or column-type format. Row-type format displays the value of each selected variable on a separate line. Each record is separated by rows of asterisks ("*"). Column-type format displays all the values of selected variables in a single row. Wrap-around will occur if the number of characters exceeds the width of the printer or the monitor, depending on where the output is directed. The number of characters can be calculated by multiplying the number of variables selected by 8. The LIST command will ask you to enter the type of listing you want. You will enter a "C" for column-type or "R" for row-type listing.

You may select to output your listing to a printer by answering the next question with "Y" for yes. Next you will be asked to enter the list of variable names that you wish to output. You should enter the variable names, each followed by a carriage return, in the order you wish them printed. If you have already entered a list of variables that list may be used instead. After you have finished entering all the variable names you want, enter a carriage return without a variable name to begin the listing. If you want all the variables to be listed, enter ".ALL" for the first variable name.

6) DISK Command

The DISK command provides you with the means of creating another GRASP file based upon your selected conditions and logic, or selected variables, or both. For example, you may want to create a GRASP file from a rock sample file that contains samples taken from a quartz vein with only 5 variables that you consider important. You would then be able to use the exploratory data analysis package to examine characteristics of the quartz vein samples retrieved.

You will be asked to enter the new data set name to be created and the drive number (either 1 or 2 as labeled) where the disk to be written on is. The data set name cannot be an already existing file. If you want to use the same name as an existing file, delete the file before entering GRASP. The data file that you will be making a retrieval from must be on drive 2. If you do not want your new data set to be written on the same disk, you may take out the "MIRA System Disk" in Drive 1 and replace it with the initialized disk that you want the new file written on. After the new file has been written, be sure to replace the "MIRA System Disk" in Drive 1.

You will be asked to enter a list of variables that you want copied into the new file. If a list has already been entered previously, you may use that list or enter a new list. If you want all the variables copied into the new file, type in ".ALL" for the first variable name.

7) DEFI Command

The DEFI (Define) command is used to create new variables based upon a user-supplied equation. You will be prompted with a number prior to each new definition. The maximum number of variables that may be created in any session is 5. Defined variables are transient with the session. If you do not create a new GRASP file, using the DISK command, the variables you define will have to be re-entered in the next session, provided you want to use them.

The defining equation consists of the new variable name, followed by an equal sign (=), followed by the arithmetic expression. Variable names that already exist may not be re-defined. At this time, only numeric variables (variable type = "N") may be used to define a new variable. We hope to be able to use qualified variables (variable type = "Q") in the near future but must decide how to handle qualifiers in any mathematical expression.

The arithmetic expression may consist of numeric constants, variable names, the arithmetic operators add (+), subtract, (-), multiply (*), divide (/) or exponential (**) and the functions absolute value (ABS), square root (SQR), natural log (LOG), exponential of e (EXP), negative (NEG), integer truncation (INT), sine (SIN) and cosine (COS). Trigonometric function arguments must be in degrees.

The maximum number of names, constants, operators and functions in one arithmetic expression is 16. The expression is evaluated from left to right in this order: parenthetical expressions and function arguments first, followed by exponentiation, then multiplication and division, then addition and subtraction. The process of defining new variables is ended by pressing the RETURN key with no definition entered or whenever 5 definitions have been entered.

8) STAT Command

The STAT (statistics) command displays summary statistics for each variable selected. The maximum number of variables that can be displayed at one time on the screen is 3. You can display more by calling the STAT command recursively. If you want to have a printout of statistics or use more than 3 variables at a time, we recommend using the Basic Statistic program (Chapter V, Section A) in the Exploratory Data Analysis package.

The summary statistics calculated are number of values, minimum, maximum, sum of values, mean, variance and standard deviation. Statistics may be calculated for both numeric and qualified variable types. For variables that include qualified values, the statistics are calculated using only unqualified values. The number of qualified values is printed out for each qualifier. The list of defined-variable names is entered the same in the LIST and DISK commands as other variable name.

9) REVI Command

The REVI (review) command allows you to review the name of the current file, the set of conditions, the current logic, the current list of variable names, and the currently defined-variable names.

10) NAME Command

The NAME command outputs the data definitions file to the screen. If any new variables have been defined, their names are displayed on the screen.

11) FILE Command

The FILE command allows you to change the data file you are currently working on to another one. The new file must be on the disk in Drive 2. Any defined variables, conditions, logic and output lists are reset by invoking this command.

12) HELP Command

The HELP command provides you with a list of the available commands with a one line description.

13) CATA Command

The CATA (catalog) command displays a list of all files on the disk in Drive 2.

14) QUIT Command

The QUIT command is used to exist GRASP. This will bring you back to the MIRA command level.

V. EXPLORATORY DATA ANALYSIS

A. Basic Statistics

The basic statistics program (BASTAT) computes statistics for a data set, displays them on the monitor and prints them out. The following statistics are computed:

- minimum - includes samples qualified with N, L or G ordered such that N < L < unqualified < G.
- maximum - same as above.
- median - middle value (50th percentile) of all data items considered in minimum and maximum.
- arithmetic mean - all qualified values are ignored.
- arithmetic deviation - all qualified values are ignored.
- geometric mean - mean of logarithmically transformed data. All qualified values are ignored.
- geometric deviation - antilogarithm of deviation of logarithmically transformed data. All qualified values are ignored.
- tallies for qualifier codes - unqualified, B, N, L, G, other.

See Figure 2 for a sample printout. The statistics for each variable can be previewed on the screen and individually considered for printing.

BASIC STATISTICS PROGRAM

Q(I1): DATA DISK MUST BE IN DRIVE 2

DO YOU WISH TO SEE A CATALOG LISTING?

OF FILES IN DRIVE 2? (Y OR RETURN):

R: Y) Type "Y" to list a catalog of files on disk drive # 2. It may be necessary to type "RETURN" several times to reach the end of catalog listing.

RETURN) Hit the "RETURN" key to go to next prompt.

Q(I2): ENTER DATA SET NAME

R: Enter the name of the data set for BASTAT to read and compute statistics on.

DATA SET NAME

NUMBER OF VARIABLES

NUMBER OF RECORDS

Q(I3) TYPE:

1: SELECT A NEW DATA SET

2: RETURN TO MIRA MENU

RETURN: DISPLAY STATISTICS

R: Hit the "RETURN" key to display statistics:

VARIABLE NO.) NAME

MINIMUM

MAXIMUM

MEAN: ARITH GEOM

DEVIATION: ARITH GEOM

UNQUALIFIED (VALID)

QUALIFIED 'B'

QUALIFIED 'N'

QUALIFIED 'L'

QUALIFIED 'G'

QUALIFIED 'OTHER'

Q(I4): PRINT MENU VAR SELECT RETURN NEXT VAR

R: P) Type "P" to print the displayed variable on the printer. If it hasn't done so already, the program will print a header.

M) Type "M" to return to main menu at the beginning of the program.

V) Type "V" to select one or more variables as a group for display or printing.

FILE NAME GOSPEL HUMP — BASIC STATISTICS — N/C = NOT CALCULATED

VARIABLE NO	NAME	MINIMUM	MAXIMUM	MEDIAN	ARITHMETIC MEAN	ARITHMETIC DEVIATION	GEOMETRIC MEAN	GEOMETRIC DEVIATION	UNQUALIFIED (VALID)	QUALIFIED B	QUALIFIED N	QUALIFIED L	QUALIFIED G	QUALIFIED OTHER
1	FLD	CHARACTER DATA												
2	TAG	CHARACTER DATA												
3	TYPE	CHARACTER DATA												
4	LAT	45.5	45.583	45.583	45.539	.024	45.539	1.000	46					
5	LONG	115.75	115.83	115.83	115.781	.025	115.781	1.000	46					
6	FE	07	10	1.5	2.383	2.686	1.150	3.920	46	0	0	0	0	0
7	MG	02	5	.5	1.048	1.376	.428	4.517	46	0	0	0	0	0
8	CA	05	20	1	2.578	3.968	.781	5.827	46	0	0	0	0	0
9	TI	01	1	.15	.255	.288	.133	3.386	46	0	0	0	0	0
10	MN	30	3000	300	558.478	732.138	281.975	3.303	46	0	0	0	0	0
11	AG	5N	15	.5N	10	7.071	8.660	2.174	2	0	44	0	0	0
12	AS	200N	200N	200N	N/C	N/C	N/C	N/C	0	0	46	0	0	0
13	AU	10N	10N	10N	N/C	N/C	N/C	N/C	0	0	46	0	0	0
14	B	10N	50	10	16.379	12.599	13.688	1.718	29	0	2	15	0	0
15	BA	20	2000	500	681.956	538.832	406.173	3.599	46	0	0	0	0	0
16	BE	1N	10	2	2.769	2.154	2.246	1.832	39	0	7	0	0	0
17	BI	10N	10N	10N	N/C	N/C	N/C	N/C	0	0	46	0	0	0
18	CD	20N	20N	20N	N/C	N/C	N/C	N/C	0	0	46	0	0	0
19	CO	5N	50	5N	14.105	13.366	10.824	1.958	19	0	27	0	0	0
20	CR	10N	500	10	92.826	109.511	53.981	3.059	23	0	23	0	0	0
21	CU	5N	150	5N	31.833	45.490	16.150	3.101	12	0	26	8	0	0
22	LA	20N	100	20	50.4	28.207	42.901	1.809	25	0	21	0	0	0
23	MO	5N	5N	5N	N/C	N/C	N/C	N/C	0	0	46	0	0	0
24	NB	20N	20	20N	20	0	20	0	1	0	40	5	0	0
25	NI	5	150	5	16.434	26.266	9.619	2.424	46	0	0	0	0	0
26	PB	10N	30	10	20.192	8.059	18.556	1.537	26	0	10	10	0	0

Figure 2. Basic Statistics

RETURN) Hit the "RETURN" key to display statistics for the next variable in the data set.

Q(I5) VARIABLE SELECTION

ENTER VARIABLES (IE. 3-7/9/18-):

R: "1-" selects all variables in the data set. Use dashes to select a range of variables (i.e., 3-6) and slashes to separate items (i.e., 3-6/12-16).

Q(I6): TYPE: P PRINT RETURN SCREEN DISPLAY

R: The variables can be printed selectively by hitting the "RETURN" key and then typing "P" as desired. When the preselected list of variables is exhausted the program returns to the main menu.

B. Histogram

The histogram program generates bar graphs of class tally information. The horizontal axis represents the measured value divided into classes (i.e., parts per million Cu). The vertical axis (bar height) represents the frequency of occurrence of the samples in each class. Up to 37 classes can be depicted in a single plot. Data values may range from -10E10 to +10E10. Class divisions are established according to several linear or log scale options, including a six step log scale for geochemical emmission spectroscopy data. Two class labeling options exist. In "continuous" mode the boundaries between classes are labeled. In "discrete" mode the classes themselves are labeled, not the boundaries.

The histogram program handles both numeric and qualified-numeric data. For a discussion of qualified data see section III.C.1. The program will not accept character data at this time.

HISTOGRAM PROGRAM

FOR CONTINUOUS OR DISCRETE DATA

Q(J1) TYPE:

1: SELECT NEW DATA SET

2: VIEW PREVIOUS PLOTS

3: RETURN TO MIRA MENU

4: REPLOT OLD DATA AND VARIABLE

RETURN: REPLOT OLD DATA, NEW VARIABLE

R: 1) Type "1" to select a data set.

2) Type "2" to display plots that have been generated previously and stored on disk.

3) Type "3" to return to MIRA command level.

4) Type "4" to replot the current variable from the same data set chosen with option # 1.

RETURN: Hit "RETURN" key to select a new variable from the current data set chosen with option # 1.

Q(J2): DATA DISK MUST BE IN DRIVE 2

DO YOU WISH TO SEE A CATALOG LISTING

OF FILES IN DRIVE 2? (Y OR RETURN):

R: Y) Type "Y" to list a catalog of files on disk drive # 2. It may be necessary to hit the "RETURN" key several times to reach the end of the catalog listing.

RETURN: Hit the "RETURN" key if you know the name of your data set and do not need to see a catalog listing.

Q(J3): ENTER DATA SET NAME:

R: Enter the name of the data set to be plotted.

Q(J4): HOW DO YOU WANT BLANK DATA ITEMS AND ITEMS QUALIFIED WITH

"B" HANDLED?

TYPE:

1: CONVERT TO ZEROS

2: NOT PLOTTED

RETURN: PLOTTED IN "OTHER" CLASS

R: 1) Type "1" to plot blank data items as Ø's. Caution is advised when using this option with qualified data as B's would also be plotted as Ø's. For most applications, B's should be either ignored (option # 2) or plotted in "OTHER" class (option # 3, "RETURN").

2) Type "2" to avoid plotting blanks and B's. They will not be tallied in any class nor in the data set total.

RETURN) Hit the "RETURN" key to tally blank data items and B's in "OTHER" class.

Q(J5): VARIABLE SELECTION

ENTER VARIABLE NO. TO BE PLOTTED:

R: Enter the variable number to be plotted.

PLOT TYPE SELECTION

Q(J6): ENTER:

C: FOR "CONTINUOUS" DATA PLOT

RETURN: FOR "DISCRETE" DATA PLOT

H: FOR HELP

R: C) Type "C" to create a "continuous" plot in which horizontal axis values occupy a continuous spectrum. Classes are established continuously such that:

boundary1 < = class 1 data values < boundary2 < = class 2 data values < boundary3 ..... < = class (n-1) data values < boundary n < = class n data values < = boundary (n+1)

The boundaries between classes are labeled, not the classes themselves.

RETURN) Hit the "RETURN" key to create a "discrete" plot. The horizontal axis is divided into classes such that:

data values in class n = class n value (label)

All data items in a given class have the same value, only the tally can change. Since the horizontal axis varies in a discrete manner, the classes themselves are labeled, not the boundaries between classes.

H) Type "H" for a brief summary of the above information.

Q(J7): CLASS BOUNDARIES WILL BE:

1) APPLE CALCULATED LINEAR

2) USER INPUTED LINEAR

3) USER INPUTED LOGARITHMIC

RETURN) SIX STEP LOG (1,1.5,2,3,5,7)

R: 1) Type "1" to divide the horizontal axis into evenly spaced classes on a linear scale. Then enter the number of desired classes.

2) Type "2" to enter your own class boundaries or class values. The following prompt will appear if "discrete" plot option was chosen in Q(J6):

ENTER 1 TO 33 CLASSES

(10 -9) <= CLASS BOUNDARY < (10 10)

FLOATING POINT (1.5E-6) IS ACCEPTABLE

TYPE RETURN TO QUIT INPUT STREAM

ENTER CLASS NO. 1

If "continuous" plot option was chosen in Q(J6) the following prompt will appear:

ENTER 2 TO 33 CLASS BOUNDARIES

(10 -9) <= CLASS BOUNDARY < (10 10)

EACH CLASS INCLUDES ITS LOWER BOUNDARY

EXCEPT THE HIGHEST CLASS WHICH INCLUDES

BOTH UPPER AND LOWER BOUNDARIES

FLOATING POINT (1.5E-6) IS ACCEPTABLE

TYPE RETURN TO QUIT INPUT STREAM

ENTER CLASS BOUNDARY NO. 1

3) Type "3" to enter logarithmic classes. The following prompt will appear for "discrete" plots:

ENTER 1 TO 8 POSITIVE CLASSES

1 <= CLASS BOUNDARY <10

TYPE RETURN TO QUIT INPUT STREAM

ENTER CLASS NO. 1

The following prompt will appear for "continuous" plots:

ENTER 2 TO 8 POSITIVE CLASS BOUNDARIES

1 <= CLASS BOUNDARY <10

EACH CLASS INCLUDES ITS LOWER BOUNDARY

EXCEPT THE HIGHEST CLASS WHICH INCLUDES

BOTH UPPER AND LOWER BOUNDARIES

TYPE RETURN TO QUIT INPUT STREAM

ENTER CLASS BOUNDARY NO. 1

Enter boundaries or class values for one decade, $1 <= x < 10$. The program automatically repeats the series throughout the range of the data.

RETURN) Hit the "RETURN" key to use the standard six step logarithmic scale for semiquantitative emission spectroscopy.

Q(J8): DO YOU WANT BAR HEIGHT EXPRESSED IN PERCENT? (Y OR RETURN):

R: Y) Type "Y" to express frequency on the vertical axis in percent of total samples in data set.

RETURN) Hit the "RETURN" key to express frequency on the vertical axis in raw class totals.

Q(J9): ENTER MAX VALUE OR RETURN FOR SELF-SCALING:

R: X) Type any number to be used as the maximum value on the frequency axis.

RETURN) Type "RETURN" to accept the default value - the largest class total rounded up to one significant digit. If the most populated class in the data set has 136 samples, then 200 becomes the full scale reading on the frequency axis.

Q(J10) P) Print S store or RETURN

R: P) Type "P" to output plot to printer. Then type "D" for double size or "RETURN" for normal size. The plot in figure 2 is double size.

S) Type "S" to store plot on disk.

RETURN) Hit the "RETURN" key to see the main menu at the beginning of the program.

The horizontal axis in figure 2 is numbered with an abbreviated version of exponential notation.

```
+
5
.
0    =  +5.00E+2 = 500
0
+
2
```

The values are truncated to 3 significant digits.

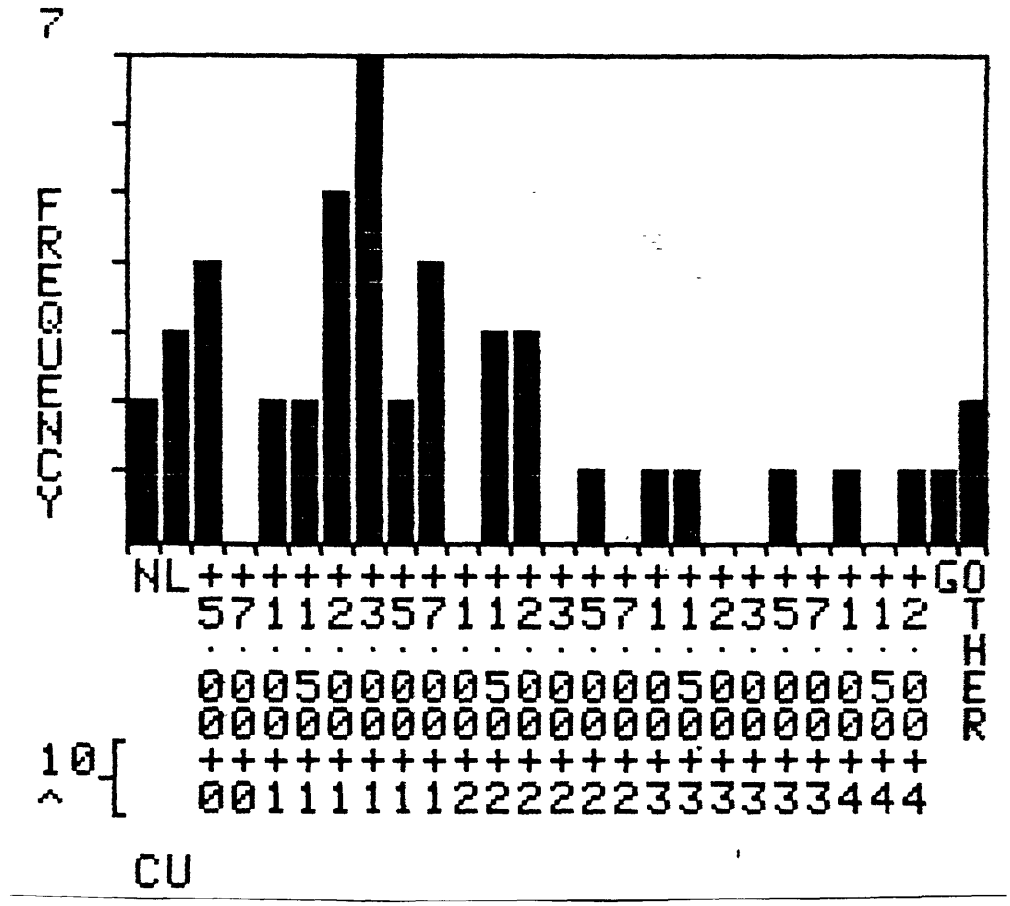


Figure 3. Sample Histogram

C. Scatter Diagram

The scatter diagram program produces two displays on the monitor screen. The first display is the scatter diagram. The program plots two chosen variables against each other and draws the correlation line for the resulting distribution. The user can easily see the dispersion of the data around the correlation line.

The second display presents the following statistics:

- minimum value
- maximum value
- mean (arithmetic). This is the first moment of the distribution.
- standard deviation. This is the second moment of the distribution.
- beta 1. This is the third moment of the distribution. B1 is a measure of the asymmetry or skewness of the distribution. The square root of B1 is actually displayed. The expected value is 0.0.
- beta 2. This is the fourth moment of the distribution. B2 is a measure of the kurtosis or peakedness of the distribution. Its expected value is 3.0.
- correlation coefficient. The Pearson r coefficient is calculated by the mean deviation method. It measures the tendency of one variable to predict the other. The coefficient is always between -1 and +1. A high r means there exists a linear relationship between the two variables such that when x increases, y increases in a similar manner.
- slope of correlation line
- y-axis intercept of the correlation line

Qualified values are ignored in all calculations.

The scatter diagrams and statistics can be directed to the monitor screen or printer.

SCATTER DIAGRAM PROGRAM

Q(K1): DATA DISK MUST BE IN DRIVE 2

DO YOU WISH TO SEE A CATALOG LISTING?

OF FILES IN DRIVE 2? (Y OR RETURN):

R: Y) Type "Y" to list a catalog of files on disk drive # 2. It may be necessary to type "RETURN" several times to reach the end of the catalog.

RETURN) Type "RETURN" if you know the name of your data set and do not need to see a catalog listing.

Q(K2): ENTER DATA SET NAME:

R: Enter name of data set to be plotted.

Q(K3) TYPE:

1: SELECT NEW DATA SET

2: RETURN TO MIRA

3: REPLOT OLD DATA AND VARIABLES

RETURN: REPLOT OLD DATA, NEW VARIABLES

R: 1) Type "1" to select a data set for plotting. This step is mandatory upon entering the program.

2) Type "2" to leave the program and return to MIRA command level.

3) Type "3" to replot the same two variables from the same data set chosen in option # 1.

RETURN) Hit the "RETURN" key to select new variables from the data set.

Q(K4): VARIABLE SELECTION

ENTER X-AXIS VARIABLE NO.

ENTER Y-AXIS VARIABLE NO.

R: Enter variable numbers for horizontal (x) and vertical (y) axes.

DATA ITEMS WITH NON-BLANK QUALIFIERS

WILL BE IGNORED UNLESS TRANSFORMED

ACCORDING TO THE FOLLOWING SCHEDULE:

'N' = .5 N

'L' = .7 L

'G' = G/.7

Q(K5): ENTER Y TO TRANSFORM OR RETURN:

For an explanation of qualified data see section IIIC1.

Q(K6): Hit the "RETURN" key to continue.

Q(K7): TYPE:

P: PRINT SCATTER DIAGRAM

S: DISPLAY SCATTER DIAGRAM ON SCREEN WITH BOTH AXES SAME SCALE

I: DISPLAY SCATTER DIAGRAM ON SCREEN WITH INDEPENDENTLY SELF-SCALING AXES

M: RETURN TO MAIN MENU

RETURN: DISPLAY STATISTICS

R: P) Type "P" to print scatter diagram and statistics on printer.

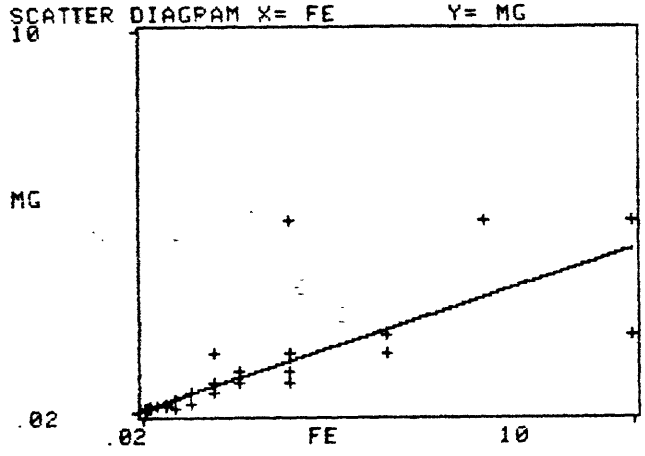
S) Type "S" to plot scatter points with X and Y axes the same scale.

This is the default option if "P" print option is chosen first.

I) Type "I" to plot scatter diagram with axis scales which reflect the range of the individual variables.

M) Type "M" to return to main menu.

RETURN) Hit the "RETURN" key to display statistics on screen.



	FE	MG
MINIMUM	.07	.02
MAXIMUM	10	5
MEAN	2.38304348	1.04869565
STD DEV	2.68681213	1.3761825
B1	1.57938897	2.01005129
B2	4.87383046	6.29139535
CORRELATION COEF.		.824280412
SLOPE		.422195606
INTERCEPT		.0425851663
NUMBER OF POINTS		46

Figure 4. Sample scatter diagram and statistics.

D. Location Plots

The location plot program generates x-y plots of spatial information. Decimal degrees or UTM coordinates are acceptable as input. The following information can be plotted at each point:

- a plus "+" symbol
- class numbers (1-9) of data divided into classes
- number of standard deviations above or below the mean

Output can be directed to the monitor screen or printer.

X - Y PLOTTING PROGRAM

DATA DISK MUST BE IN DRIVE 2

Q(L1): DO YOU WISH TO SEE A CATALOG LISTING?

OF FILES IN DRIVE 2? (Y OR RETURN):

R: Y) Type "Y" to list a catalog of files on disk drive # 2. It may be necessary to type "RETURN" several times to reach the end of the catalog.

RETURN) Type "RETURN" if you know the name of your data set and do not need to see a catalog listing.

Q(L2): ENTER DATA SET NAME:

R: Enter name of data set to be plotted.

Q(L3): TYPE:

1: PLOT NEW DATA SET

2: RETURN TO MIRA

3: REPLOT OLD DATA AND VARIABLE

RETURN: REPLOT OLD DATA, NEW VARIABLE

R: 1) Type "1" to select a data set. This step is manadatory upon entering the program.

2) Type "2" to return to MIRA command level.

3) Type "3" to make another plot of the same variable in the same data set chosen in option # 1.

RETURN) Hit the "RETURN" key to select a new variable for plotting from the data set chosen in option # 1.

Q(L4): COORDINATE SELECTION

ENTER X-COORDINATE VARIABLE NUMBER

ENTER Y-COORDINATE VARIABLE NUMBER

R: Enter variable numbers for horizontal (x) and vertical (y) axes. Usually, longitude or UTM easting is chosen for x and latitude or UTM northing is chosen for y.

Q(L5): VARIABLE SELECTION

ENTER VARIABLE NO. TO BE PLOTTED

R: Enter the variable number to be plotted. This decision is inconsequential if plus "+" symbols only will be plotted.

Q(L6): IS THIS WINDOW ACCEPTABLE?

TYPE:

1: TO REVERSE X-AXIS

2: TO INPUT NEW VALUES

RETURN: TO CONTINUE

R: 1) Type "1" to reverse horizontal axis. Degrees of longitude increase to the left in the western hemisphere. UTM coordinates increase to the right.

2) Type "2" to input new window coordinates. Caution is advised when exercising this option because points out of bounds will not be plotted. Furthermore, if an out of bounds condition exists, no indication will be given.

RETURN) Hit the "RETURN" key to use the coordinates as displayed on the screen.

Q(L7): TYPE:

1: PLOT DATA IN CLASSES

2: PLOT STANDARD DEVIATIONS FROM MEAN

RETURN: PLOT '+' SYMBOL

R: 1) Type "1" to plot class numbers. Data values can be placed in 2-9 evenly spaced classes or 2-9 user defined classes. The qualifier code will be plotted for each qualified value.

2) Type "2" to plot the number of standard deviations above or below the mean at each point. The qualifier code will be plotted for qualified values.

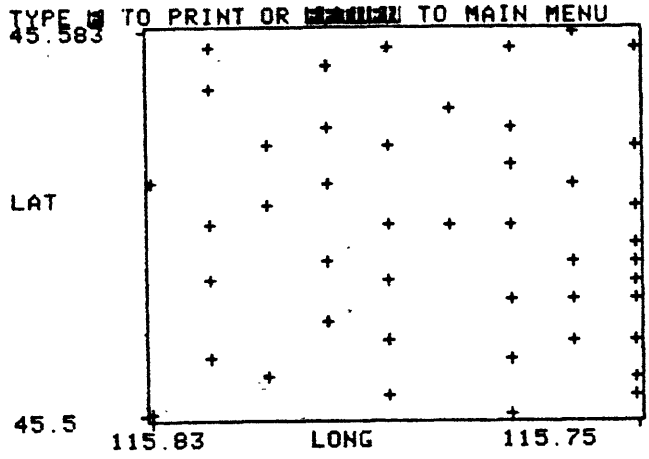
RETURN) Type "RETURN" to plot plus "+" symbols.

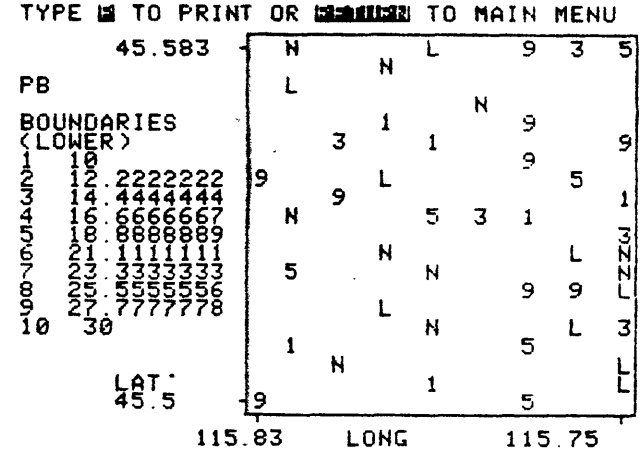
Q(L8): P to PRINT or RETURN to main menu.

R: After each plot enter one of the following responses:

P) Type "P" to print the plot.

RETURN) Hit the "RETURN" key to return to the main menu at the beginning of the program.





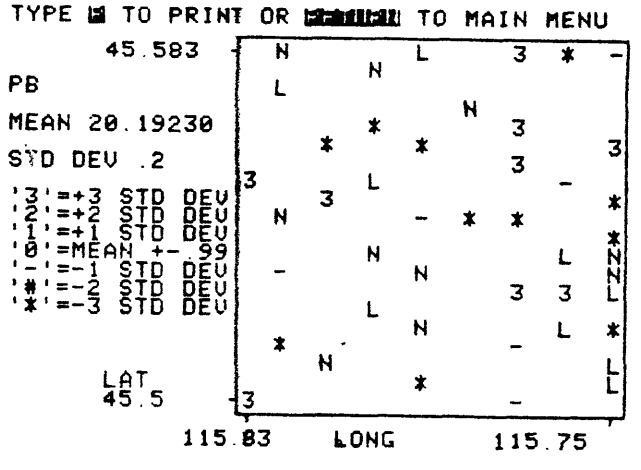


Figure 5. Sample location plots.

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