United States Department of the Interior

Geological Survey

$ANBA - a rapid, combined data acquisition and correction program for the SEMQ electron microprobe

by

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CONTENTS

Figures

Appendices

Abstract

$ANBA is a program developed for rapid data acquisition and correction on an automated SEMQ electron microprobe. The program provides increased analytical speed and reduced disk read/write operations compared with the manufacturer's software, resulting in a doubling of analytical throughput. In addition, the program provides enhanced analytical features such as averaging, rapid and compact data storage, and on-line plotting. The program is described with design philosophy, flow charts, variable names, a complete program listing, and system requirements. A complete operating example and notes to assist in running the program are included.

Introduction

Microprobe analysis is a rapid, non-destructive X-ray spectrometric technique which allows operators to visually select and analyze small surfaces ($\sim 4 \mu m^2$) of polished materials (typically petrographic thin sections for geologic applications). The electron microprobe has the added capability of measuring and displaying other signals such as secondary and backscattered electrons and cathodoluminescence. However, the primary application of the U.S. Geological Survey's Reston, Virginia, SEMQ (Scanning Electron Microprobe Quantometer) microprobe is fully automated wavelength dispersive X-ray microanalysis.

The necessity for rapid acquisition of numerous quantitative chemical analyses of the common rock-forming minerals by a large number (35-60) of operators led to the development of an analytical program that provides extremely fast throughput on the U.S.G.S.-Reston electron microprobe. The electron microprobe has automation software provided by the manufacturer. However, that portion of the software which performs quantitative X-ray intensity measurements and reduces the data was quite general in nature, slow in operation, and lacking in some features considered desirable for multiple analyses of geological materials. The program described in this report, $ANBA, was developed to replace two of the manufacturer's programs ($ANLZ and $B-AL) which were loaded and run alternately for each analysis and required access to several data files on disk in order to transfer information from one program to the next. $ANBA also provides several optional features not present in the original programs.

This report is intended to provide information on $ANBA both for current users of the program at the U.S.G.S.'s Reston microprobe facility and for potential users who have access to the SEMQ microprobe automation system provided by Bausch and Lomb (1979) for use on the Applied Research Laboratories' SEMQ microprobe. For this reason, a description of the program development is included so that users of the manufacturer's original automation programs will understand the particular applications for which this program was developed.

Microprobe Automation System

The operating system for the SEMQ automation package (Bausch and Lomb, 1979) is called ARLEB (Applied Research Laboratories Extended Basic) and is supplied by the microprobe manufacturer (Applied Research Laboratories, 1981). The ARLEB operating system is implemented on Digital Equipment Corporation (DEC) PDP-11 series computers. The U.S.G.S. Reston SEMQ is equipped with the LSI-11/23 microprocessor with 32K words of memory, a DEC DLV11-J interface board, and RX-02 double density floppy disk media. The DLV11-J board provides 4 asychronous serial interfaces which are assigned as follows: 0=plotter, 1=unassigned, 2=printing terminal, 3=video terminal. A Houston Instruments DMP-7 HIPLOT digital plotter is interfaced to the microprobe automation system, providing the ability to perform on-line plotting of results if the necessary software to drive the plotter is incorporated into the analytical programs. The U.S.G.S. Reston SEMQ microprobe is configured for simultaneous quantitative analyses of 9 elements. This is achieved through a combination of 6 spectrometers with fixed wavelength positions (for the elements Si, Ca, Mg, Fe, Na, Mn) and 3 variable wavelength scanning spectrometers (Fig. 1).

Use of floppy disk media rather than hard disk media has the advantages that the initial cost is low and that each of the many U.S.G.S. microprobe operators has a set of disks, each set up for the particular configuration that the operator needs (particularly with respect to choice of elements and plotting components). The disadvantage of floppy disks lies in the relatively long time needed to write or read files. Elimination of the lengthy disk read/write operations by combining the data acquisition and analysis programs into a single program resident in computer memory was thus a high priority task for the U.S.G.S. Reston microprobe project. This task was successfully accomplished by implementation of $ANBA, thus making the floppy disk medium advantageous with respect to cost, convenience, and speed.

$ANBA is fully integrated into the SEMQ's ARLEB operating system and thus should be capable of running on any SEMQ microprobe with Bausch and Lomb automation. Configurational changes, as described in the SEMQ automation manual, are minimal and are identical to those necessary for adapting one laboratory's versions of $ANLZ and $B-AL to another's instrument configuration. The $ANBA program is available on ARLEB formatted floppy disks for those who have ARLEB (Applied Research Laboratories, 1981) operating systems available. Copies may be obtained by sending a blank, ARLEB formatted disk (specifying RX-02 or RX-01 format) to the author.

Program Applications

$ANBA was primarily developed to reduce the analysis time and repetitive disk accessing of the microprobe manufacturer's $ANLZ and $B-AL program cycle (Bausch and Lomb, 1979). The $ANLZ and $B-AL programs function sequentially as follows:

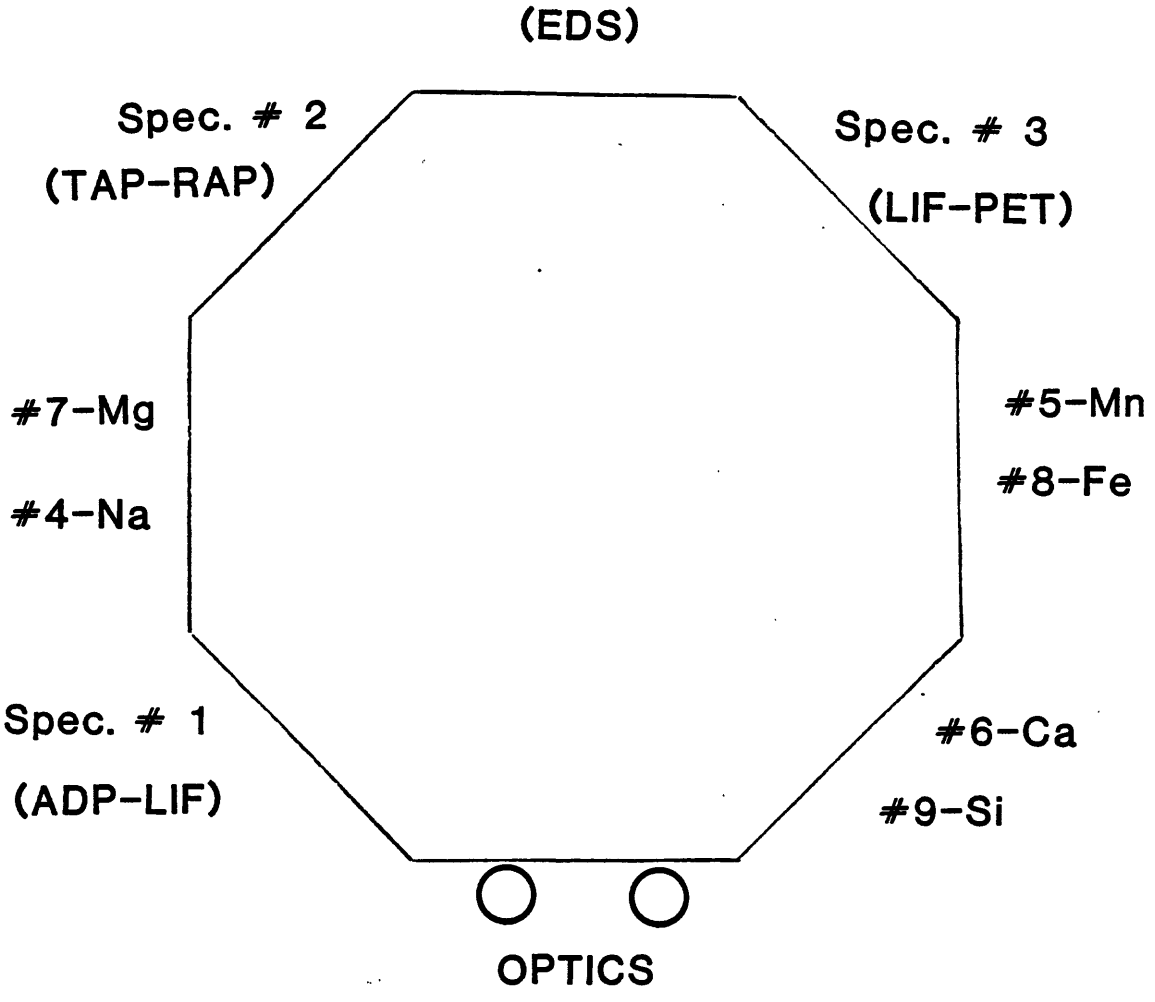

Figure 1 - U.S.G.S Reston SEMQ Spectrometer Configuration.

$ANLZ - open and read analysis parameters from 3 disk data files (#UDTA, #PDTA, QDATA);
- open and read standardization data from #STDZ file;
- update analytical parameters;
- collect data;
- open and write new data into disk output file (#ODTA) for transferral to the $B-AL program;
- open and write updated analytical parameters into #UDTA file;
- load and run $B-AL program.

$B-AL - loaded from disk and run by $ANLZ program;
- open and read raw data file (#ODTA);
- open and read alpha factor file (AFILE);
- perform corrections;
- open and read X-ray data file (#XDTA);
- print out results;
- open and write results to output file (optional);
- load and run $ANLZ program.

For a single analysis, these two programs perform 12 floppy disk access operations. This is not only very slow (~ 60 seconds for disk accessing and file loading) but these frequent disk operations increase the rate of wear on the disk drives, thus increasing the likelihood of maintenance for the drives and damage to the floppy disks.

With the development of $ANBA, the need for two of the data files (#UDTA and #ODTA) was totally eliminated. The other files are accessed only once, during the first analysis, and subsequent analyses can be obtained with the disks removed, unless data storage is desired (1 disk writing operation per analysis). In a laboratory where instrument time is fully utilized, this reduction in disk access and analysis time results in a substantial increase in the number of analytical results. For example, to obtain 100 9-element analyses using $ANLZ and $B-AL, the disks would be accessed 1200 times (with data filing) and a period of approximately 3 hours would be needed in addition to time needed for standardization (assuming speedy and efficient operator control). Under the same conditions, $ANBA would obtain the 100 analyses in approximately 1.5 hours and would access the disk only 105 times (with data filing). This increased operating efficiency has enabled the microprobe facility to function with two 4.5 hour daytime operating shifts. During this shift the operator can standardize and routinely obtain 100 or more quantitative analyses, depending only on the amount of time needed by the individual operator to select an analytical point and respond to program prompts and analysis results. The increased analytical speed and availability of two prime daytime shifts has reduced the waiting period for normal daytime microprobe access by a half.

In addition to the increased operating speed and reduced disk access, $ANBA was designed to provide the following major enhancements over the original two programs:

a) Ability to average a series of individual analyses;
b) Ability to plot analytical results as they are obtained;
c) Ability to store data in a rapid and compact manner.

Data stored on disk can subsequently be accessed off-line for plotting and mineralogical or statistical analysis with a program such as RDARL4 (Huebner, 1983), which was developed to retrieve and reformat stored SEMQ data for use with other DEC computer operating systems.

The two primary limitations of $ANBA are:

1- A maximum of 14 elements (oxides) can be analyzed (this limit could be increased if the data storage option were eliminated);
2- Only Bence-Albee (Ziebold-Olgilvie) type corrections are applied (this has proven to work quite well for silicate, oxide, and many sulfide minerals).

The 14 element analysis limit in $ANBA is due to limitations imposed by the desire for a compact data storage format, as well as by computer memory (program size) constraints encountered when all of the features such as averaging, plotting, and data storage are incorporated. Analyses of 14 elements (or oxides) in most cases, however, is more than adequate for mineralogical applications. An ideal set-up for maximum analytical speed is one element per channel, which on the U.S.G.S. microprobe would be 9 elements. This accomodates the major and most minor elements of interest in geologic materials.

The Bence-Albee correction routine (Bence and Albee, 1968) is the same as that used in the $B-AL program (ARLEB subfunction 20) and uses the alpha-factor arrays supplied with the SEMQ automation package (Bausch and Lomb, 1979). Since the Bence-Albee correction is automatic in $ANBA, the operator must be sure to select it as the correction type when setting up the element analysis file in $QSET. This will ensure that the proper standard and alpha factor information are available for the correction routine. The built in correction routine eliminates the need for the constant swapping of programs and analytical data - thus providing the two important enhancements of minimized disk access and accelerated analysis results.

The sequence of events and prior programs needed to run the $ANBA program are similar to those needed to run the $ANLZ and $SST analysis programs (Fig. 2). $ANBA is essentially an additional analysis program, like $ANLZ and $SST, which is selected as an option in the $PSET program.

Program Development

Development of the $ANBA program involved several major steps:

1) The existing $ANLZ analytical program was modified to streamline the analytical sequence. Options for correction routines other than the Bence-Albee method were deleted. Read/write operations were minimized. Use of data files for swapping various analytical parameters and uncorrected data were eliminated. The lengthy data filing routine was eliminated.

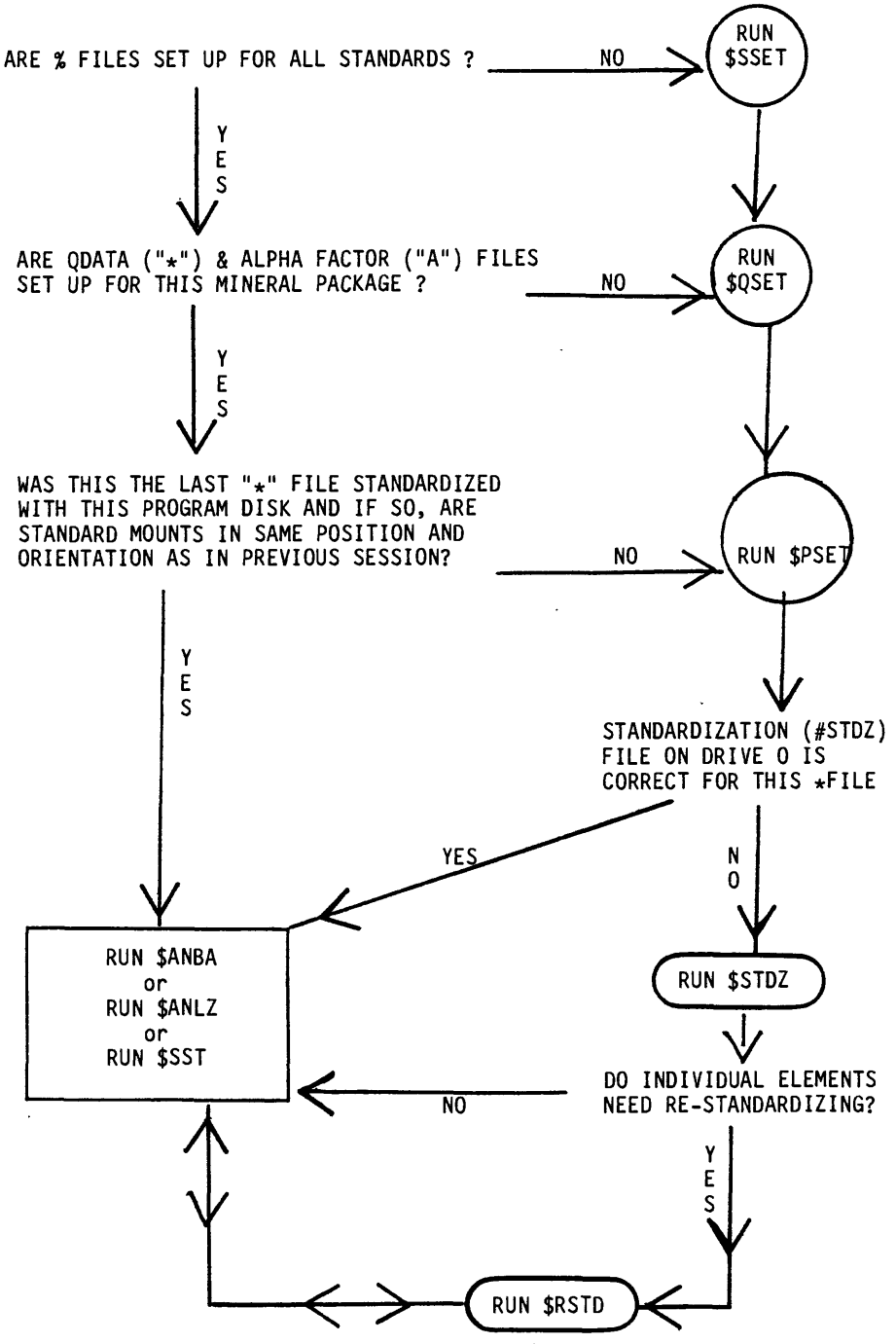

Figure 2 - Flow structure of SEMQ microprobe automation programs, showing variable entry points.

2) The original $B-AL program was consolidated, and the entire program was re-numbered in order to blend it into a logical sequence of the modified $ANLZ program. The lengthy data filing routine, also present in this program, was deleted.

3) The re-structured $ANLZ and $B-AL programs were blended into a single combined analysis/correction program. Numerous variable names were changed and/or re-defined. This was necessary because of the use of several names for the same variable or the use of the same name for two different variables in the original unblended programs. Some variables were re-defined in the program in order to allow values to be restored as the program loops back to the beginning of the analysis sequence. This allows standard, unknown, and correction data to be read from disk files only once. Thus, after completion of the first analysis, there is no repetitive disk reading and writing of analytical variables. The need for disk operations during the execution of $ANBA only occurs if the operator chooses to store the analytical results. Memory constraints also forced some dual-use of variables. Multiple use of some of the large arrays helped shrink the combined program's memory usage so that it would fit into available program memory of the 32K word system. Reduction of the maximum number of elements that can be analyzed to 14 provided the dual advantages of reducing memory usage and facilitating a compact data storage procedure.

4) The basic analysis/correction program was enhanced with the addition of several important optional features: the ability to average multiple analyses; a compact, single record per analysis data storage routine (Appendix C); on-line digital plotting (Appendix D). Additionally, numerous minor but significant features were included, such as options to change the oxygen basis for the formula calculation, to examine the beam spot or beam current prior to each analysis, and to automatically drive the sample stage to a specified X,Y location. Several "user friendly" features were added, such as increased use of straightforward dialogue and operator prompting for ease of program operation, automatic loading of the standardization ($STDZ) and restandardization ($RSTD) programs, plus checking of, and non-fatal recovery from, spectrometer or stage drive errors.

The final version of the program is listed in Appendix A. A list of variable names and their assignments is given in Appendix B.

Program Description

$ANBA can be viewed as consisting of 10 segments that perform the major functions of the program. Interaction of these routines is graphically demonstrated in the $ANBA flow diagram (Fig. 3). A brief description of the functions of the 10 major segments follows:

1. ENTRY (lines 1-269) - initial dimensioning and defining of variables and set-up of optional auxiliary routines (data filing and plotting).

2. SET-UP ANALYSIS (lines 270-350) - new parameters entered for the next anaylsis (this is the re-entry point after each analysis is completed).

3. COLLECT (lines 5000-8111) - this is the main data collection routine and basically has not been changed from that which was originally in $ANLZ. A few minor "bugs" were corrected and some spectrometer and stage drive error checking was added. Two small routines for automatic PHA setting (lines 5330-5370) and 4-channel crystal flipping (lines 7200-7250) were deleted.

4. HEADER (lines 399-1525) - calculates background counts and prints header information for each analysis.

5. CORRECTION (lines 3020-3504) - calculates corrected analysis and mineral formula.

6. PRINTOUT (lines 3505-3660) - prints analysis results on terminal in one of two possible formats.

7. FILING (lines 4000-4300) - stores analysis results (element symbol, weight %, cation proportion) in 1 record of the data storage file (see Appendix C).

8. PLOT (lines 4500-4699) - if desired, the data can be plotted in a variety of formats. $ANBA currently has routines to plot either 2-axis plots or ternary (and quadrilateral) plots (see Appendix D).

9. AVERAGE (lines 2000-2635) - stores uncorrected count data in an array and, when signalled, calculates the average and standard deviation of the data array.

10. EXIT (lines 375-395) - routine to exit program. Links to standardization or restandardization programs, if desired.

Program Operation

The only configurational changes that should be necessary to allow $ANBA to run on any 32K word SEMQ automation system are in those lines pertaining to the instrument's wiring order, DAC's (Digital to Analogue Converters) for PHA's (Pulse Height Analyzers) and 4-crystal spectrometers (lines 8000, 8020, 8060, and 8080). $ANBA assumes no PHA DAC's or 4 crystal spectrometers are present. A discussion of the changes necessary for various instrument configurations appears in the SEMQ Floppy Disk Automation Software Instruction Manual (Bausch and Lomb, 1979). With the configurational changes made, $ANBA should operate properly, as long as the QDATA file generated in $QSET is limited to a maximum of 14 elements.

$ANBA will operate from the video terminal and print just the analyses on the printing terminal, or the entire program can be run from the printing

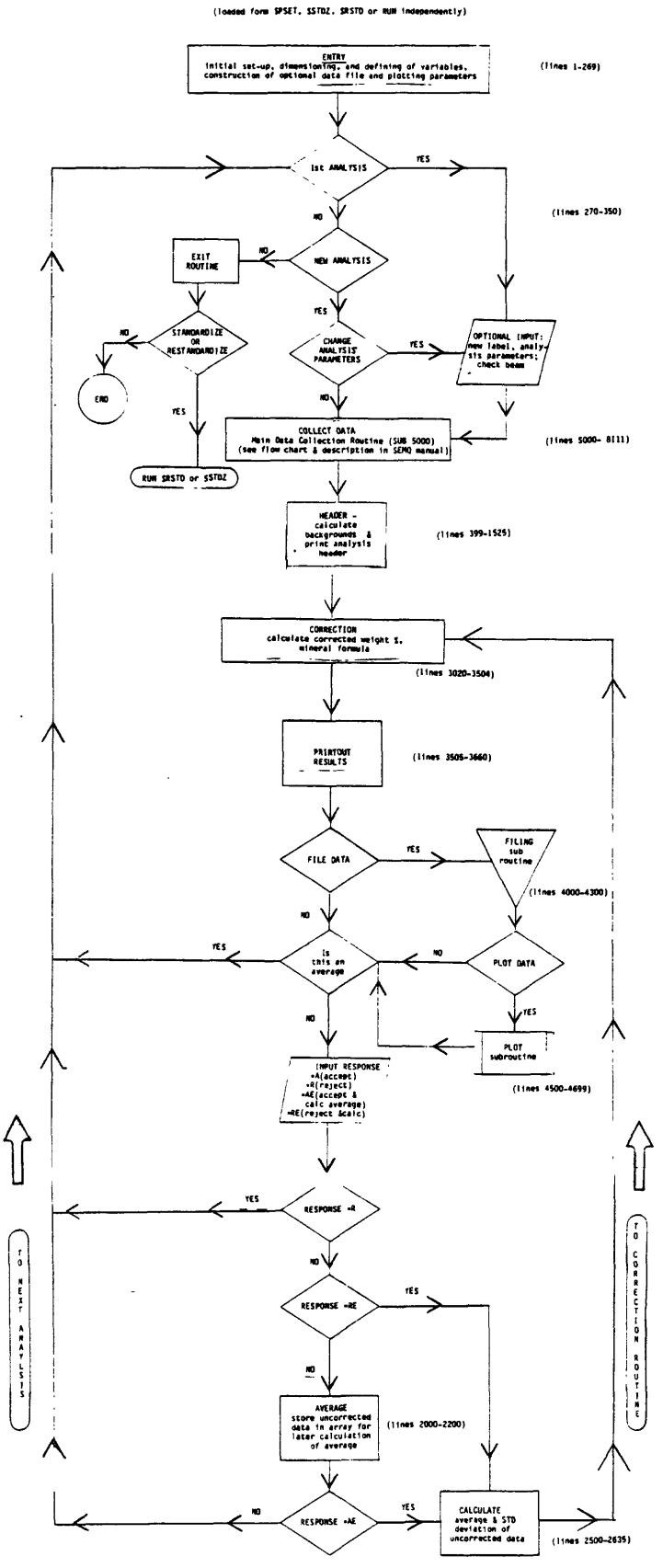

Figure 3 - $ANBA flow diagram (simplified).

terminal. The program is configured so that the video terminal, printing terminal, and plotter correspond to ARLEB devices 0, 4, and 5, respectively.

The $ANBA program is loaded automatically following $STDZ, or $PSET (if standardization was previously stored), assuming "$ANBA" is one of the allowable choices to the prompt "Which Analysis Program?" in the $PSET program (Fig. 2).

The program can be terminated and re-run at any time after standardization. However, the analysis number is reset to 1 each time the program is started. At the beginning of the program, the option to set up a new data file for storage of analyses is given. As long as the same QDATA file is used, the operator may continue to store data in a file used in a previous analytical session (the previously stored data will not be over-written). The data file holds 100 analyses. When this file is filled to capacity, the program will prompt the operator for the name of a new data file.

The following six pages contain printout of the program in operation, showing both the computer/operator dialogue and the results printed by the program. Operator input is designated by a box, [ ]. Circled numbers in the right-hand column refer to explanatory notes that follow the operating example.

Operating Example

```
*ANBA -- ANALYSIS PROGRAM WITH BENCE-ALBEE CORRECTIONS, MULTI-POINT AVERAGING,
        DATA FILING, AND PLOTTING ROUTINES.  DEVELOPED FOR THE U.S.G.S.-RESTON
        SEM@ MICROPROBE FACILITY BY J.J. MCGEE  (OCTOBER, 1983 VERSION).


** ANALYZING FOR -- J.J. MCGEE - PROGRAM DEVELOPMENT      10  7  83

 USING: *GABT - GARNET-BIOTITE 9 ELMT SET WITH FIXED BKGDS  6-JAN-83

**NOTE - USE THE 'N' OPTION AFTER AN ANALYSIS TO EXIT PROGRAM OR RESTANDARDIZE

'CTRL P' WILL HALT EXECUTION BUT IS FOR EMERGENCY ONLY

ENTER # OF OXYGENS FOR FORMULA CALC.? 24

CHOOSE PRINTOUT FORMAT (1 = REGULAR, 2=LONG) - ? 1

DO YOU WANT TO FILE DATA? YES
ENTER FILENAME FOR DATA STORAGE ? D1011
'D1011' ALREADY EXISTS ON DRIVE 1
'W' TO WRITE OVER THIS FILE
'N' TO CREATE FILE WITH NEW NAME
'C' TO CONTINUE FILING IN 'D1011' (IF USING SAME *QDATA FILE)

 W, N, OR C -? C

DO YOU WANT ON-LINE PLOTTING ? YES
TERNARY - ENTER SEQUENCE # FOR TOP, LEFT, RIGHT ELEMENTS (ADD 15 IF OXIDE INSTEAD OF CATION PLOT) ? 3,2,6
CA  ,MG  ,FE   -ARE THESE CORRECT ? YES
INPUT COUNTING TIMES (SEC) FOR UNKNOWNS:
    (ON STANDARDS, PEAK= 20 SEC, BKGD= 10 SEC.) ? 20,10

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? KAKANUI HORNBLENDE

ENTER X,Y STAGE POSITIONS TO DRIVE TO (5 DIGITS -- ENTER 0,0 FOR NO MOTION)
? 7100,24000

DO YOU WANT TO CHECK THE BEAM? YES

SELECT ANALYSIS POSITION AND PUSH BUTTON WHEN READY


  ****** BENCE-ALBEE DATA REDUCTION METHOD ******


 ** SAMPLE:  KAKANUI HORNBLENDE   X= 7570.5  Y= 21414.5   B.C./SEC=  9779.65

        WEIGHT%  ST.DEV.  FORMULA  K-RAT   UNKN PK   UNKN BKG   TIME    STD PEAK   STD BKG  ST TIME  STANDARD  LIN
                  ( % )                    COUNTS     COUNTS   (SEC)    COUNTS     COUNTS   (SEC)   FILENAME

SIO2      40.71     1.32    6.285   0.696   9789.3      27.0    20.0   14043.5      27.0    20.0    %PXAD    KA
MGO       12.74     1.09    2.931   0.652  16386.8     978.0    20.0   24618.9     978.0    20.0    %PXAD    KA
CAO       10.13     1.49    1.676   0.400   6417.9      40.0    20.0   15990.1      40.0    20.0    %PXAD    KA
NA2O       2.78     1.57    0.832   0.202   5610.8     278.0    20.0   26708.3     278.0    20.0    %FSTA    KA
K2O        1.96     2.84    0.386   0.127   1769.2     146.0    20.0   12954.4     146.0    20.0    %FSBO    KA
FEO       10.37     1.56    1.338   0.138   5225.8     198.0    20.0   36601.2     198.0    20.0    %OLSF    KA
AL2O3     14.04     0.60    2.554   0.658  47772.6     844.0    20.0   72180.6     844.0    20.0    %FSTA    KA
MNO        0.02   152.89    0.002   0.000    238.1     224.0    20.0   68401.1     224.0    20.0    %OLST    KA
TIO2       4.49     2.42    0.521   0.087   2020.1      60.0    20.0   22595.2      60.0    20.0    %OXIL    KA

TOTAL     97.23            16.526 CATIONS              ITERATIONS= 3
                           ( 24.0 OXYGENS)

12-OCT-83 09:24:26

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? S
(ANALYSIS # 15 FILED IN 'D1011')

PLOT THIS POINT ? Y
COMPONENTS ARE (TOP,LEFT,RIGHT):  0.28   0.49   0.23

(RESPONSES ARE: 'A'=INCLUDE IN AVG, 'AE'=INCLUDE AND CALCULATE AVG,
          'R'=REJECT, 'RE'=REJECT AND CALCULATE AVERAGE)
RESPONSE- (A, AE, R, RE) ? A
RESPONSE- A  ( 1 ANALYSES ACCEPTED IN THIS AVERAGING LOOP)

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ?


ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ?
```

1

2

3

** SAMPLE: KAKANUI HORNBLENDE X= 7214 Y= 20940 B.C./SEC= 9764.45

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	39.45	1.33	6.168	0.674	9471.9	27.0	20.0
MGO	12.51	1.10	2.915	0.640	16096.8	978.0	20.0
CAO	10.20	1.49	1.708	0.403	6460.8	40.0	20.0
NA2O	2.77	1.57	0.838	0.200	5575.9	278.0	20.0
K2O	2.03	2.79	0.405	0.132	1831.6	146.0	20.0
FEO	10.25	1.56	1.340	0.137	5171.8	198.0	20.0
AL2O3	14.33	0.60	2.640	0.672	48746.7	844.0	20.0
MNO	0.04	67.06	0.005	0.000	256.7	224.0	20.0
TIO2	4.73	2.36	0.556	0.092	2125.6	60.0	20.0
TOTAL	96.30		16.577 CATIONS (24.0 OXYGENS)			ITERATIONS= 3	

12-OCT-83 09:26:52

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [ ]
RESPONSE- (A, AE, R, RE) ? [A]
RESPONSE- A (2 ANALYSES ACCEPTED IN THIS AVERAGING LOOP)

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? [ ]

ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [B]

BEAM IS NOW ON

ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [ ]

4

** SAMPLE: KAKANUI HORNBLENDE X= 7592.5 Y= 21409.5 B.C./SEC= 9743.95

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	40.59	1.32	6.253	0.694	9759.4	27.0	20.0
MGO	12.64	1.09	2.903	0.646	16242.9	978.0	20.0
CAO	10.30	1.48	1.699	0.407	6523.7	40.0	20.0
NA2O	2.71	1.59	0.810	0.196	5462.6	278.0	20.0
K2O	1.96	2.84	0.385	0.127	1770.7	146.0	20.0
FEO	10.65	1.54	1.372	0.142	5365.3	198.0	20.0
AL2O3	14.07	0.60	2.555	0.659	47868.0	844.0	20.0
MNO	0.01	180.49	0.002	0.000	235.9	224.0	20.0
TIO2	4.70	2.37	0.544	0.091	2111.8	60.0	20.0
TOTAL	97.62		16.523 CATIONS (24.0 OXYGENS)			ITERATIONS= 3	

12-OCT-83 09:28:26

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [S]
(ANALYSIS # 16 FILED IN 'D1011')

PLOT THIS POINT ? [Y]
COMPONENTS ARE (TOP,LEFT,RIGHT): 0.28 0.49 0.23
RESPONSE- (A, AE, R, RE) ? [AE]
RESPONSE- AE

5

********** 3 POINT AVERAGE **********

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	40.25	1.82	6.236	0.688	9673.5	27.0	20.0
MGO	12.63	0.95	2.916	0.646	16242.2	978.0	20.0
CAO	10.21	0.83	1.695	0.403	6467.5	40.0	20.0
NA2O	2.75	1.47	0.827	0.199	5549.7	278.0	20.0
K2O	1.98	2.17	0.392	0.128	1790.5	146.0	20.0
FEO	10.42	1.97	1.350	0.139	5254.3	198.0	20.0
AL2O3	14.15	1.14	2.583	0.663	48129.1	844.0	20.0
MNO	0.02	58.53	0.003	0.000	243.5	224.0	20.0
TIO2	4.64	2.83	0.541	0.090	2085.8	60.0	20.0
TOTAL	97.05		16.542 CATIONS (24.0 OXYGENS)			ITERATIONS= 3	

12-OCT-83 09:29:01

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [S]
ENTER NEW TITLE FOR AVERAGE (OPTIONAL)? [HORNBLENDE STD- 3 PTS]
(ANALYSIS # 17 FILED IN 'D1011')

PLOT THIS POINT ? [ ]

6

7

8

```
SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? KAKANUI GARNET

ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? N

EXIT PROGRAM ?
CHANGE COUNTING TIMES ? NO

ENTER NEW # OXYGENS FOR CATION CALC. ('RETURN' FOR NO CHANGE) ? 12

ENTER X,Y STAGE POSITIONS TO DRIVE TO (5 DIGITS - ENTER 0,0 FOR NO MOTION)
? 12000,15000

DO YOU WANT TO CHECK THE BEAM? N

SELECT ANALYSIS POSITION AND PUSH BUTTON WHEN READY

 ** SAMPLE:  KAKANUI GARNET   X= 18711.5  Y= 13196   B.C./SEC=  9922.35

        WEIGHT%  ST.DEV.  FORMULA  K-RAT   UNKN PK  UNKN BKG   TIME
                  ( % )                    COUNTS   COUNTS   (SEC)

SIO2     41.63     1.33    2.973   0.685   9626.3     27.0    20.0
MGO      18.56     0.96    1.975   0.996  24528.8    978.0    20.0
CAO       5.04     1.97    0.385   0.197   3185.5     40.0    20.0
NA2O      0.01   102.97    0.002   0.001    301.4    278.0    20.0
K2O       0.00    49.29    0.000   0.000    113.3    146.0    20.0
FEO      10.53     1.55    0.629   0.140   5294.8    198.0    20.0
AL2O3    23.87     0.52    2.009   1.118  80582.9    844.0    20.0
MNO       0.25    11.44    0.015   0.003    451.3    224.0    20.0
TIO2      0.31    11.70    0.017   0.006    197.4     60.0    20.0

TOTAL   100.20             8.006 CATIONS            ITERATIONS= 3
                          ( 12.0 OXYGENS)

12-OCT-83 09:32:39

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? Y
(ANALYSIS # 18 FILED IN 'D1011')

PLOT THIS POINT ?  A\A\
Y
COMPONENTS ARE (TOP,LEFT,RIGHT):  0.13   0.66   0.21
RESPONSE- (A, AE, R, RE) ? A
RESPONSE- A  ( 1 ANALYSES ACCEPTED IN THIS AVERAGING LOOP)

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ?

ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ?

 ** SAMPLE:  KAKANUI GARNET   X= 18656  Y= 13055.5   B.C./SEC=  9915.45

        WEIGHT%  ST.DEV.  FORMULA  K-RAT   UNKN PK  UNKN BKG   TIME
                  ( % )                    COUNTS   COUNTS   (SEC)

SIO2     42.56     1.32    3.008   0.702   9863.6     27.0    20.0
MGO      18.37     0.96    1.935   0.984  24288.7    978.0    20.0
CAO       5.32     1.93    0.403   0.208   3361.6     40.0    20.0
NA2O      0.01   153.29    0.001   0.001    293.6    278.0    20.0
K2O       0.00   295.01    0.000   0.000    140.3    146.0    20.0
FEO      10.50     1.55    0.620   0.140   5277.5    198.0    20.0
AL2O3    23.80     0.52    1.983   1.117  80505.1    844.0    20.0
MNO       0.25    11.55    0.015   0.003    448.6    224.0    20.0
TIO2      0.35    10.74    0.019   0.007    214.5     60.0    20.0

TOTAL   101.15             7.983 CATIONS            ITERATIONS= 3
                          ( 12.0 OXYGENS)

12-OCT-83 09:34:17

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ?
RESPONSE- (A, AE, R, RE) ? AE



RESPONSE- AE
```

********** 2 POINT AVERAGE **********

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	42.09	1.73	2.990	0.693	9745.0	27.0	20.0
MGO	18.46	0.72	1.955	0.991	24408.7	978.0	20.0
CAO	5.18	3.85	0.394	0.203	3273.6	40.0	20.0
NA2O	0.01	28.23	0.001	0.001	297.5	278.0	20.0
K2O	0.00	0.00	0.000	0.000	126.8	146.0	20.0
FEO	10.51	0.24	0.625	0.140	5206.1	198.0	20.0
AL2O3	23.84	0.07	1.996	1.117	80544.0	844.0	20.0
MNO	0.25	0.84	0.015	0.003	450.0	224.0	20.0
TIO2	0.33	8.28	0.018	0.004	205.9	60.0	20.0
TOTAL	100.68		7.994 CATIONS (12.0 OXYGENS)			ITERATIONS= 3	

12-OCT-83 09:34:59

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [S]
ENTER NEW TITLE FOR AVERAGE (OPTIONAL)? [GARNET STD (KAKANUI)]
(ANALYSIS # 19 FILED IN 'B1011')

PLOT THIS POINT ? [Y]
COMPONENTS ARE (TOP,LEFT,RIGHT): 0.13 0.66 0.21

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? [LAKE CNTY PLAGIOCLASE]

ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [N]

EXIT PROGRAM ? [NO]
CHANGE COUNTING TIMES ? [YES]
INPUT COUNTING TIMES (SEC) FOR UNKNOWNS:
? [10,10]

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? [ ]

ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [N]

EXIT PROGRAM ? [ ]
CHANGE COUNTING TIMES ? [ ]

ENTER NEW # OXYGENS FOR CATION CALC. ('RETURN' FOR NO CHANGE) ? [8]

ENTER X,Y STAGE POSITIONS TO DRIVE TO (5 DIGITS - ENTER 0,0 FOR NO MOTION)
? [7000,7000]

DO YOU WANT TO CHECK THE BEAM? [Y]

SELECT ANALYSIS POSITION AND PUSH BUTTON WHEN READY

** SAMPLE: LAKE CNTY PLAGIOCLASE X= 3289.5 Y= 3328 B.C./SEC= 9900.60

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	49.69	1.55	2.332	0.854	5999.1	13.5	10.0
MGO	0.00	26.63	0.000	0.000	378.4	489.0	10.0
CAO	13.28	1.76	0.668	0.516	4133.6	20.0	10.0
NA2O	4.02	1.69	0.366	0.324	4426.5	139.0	10.0
K2O	0.11	29.82	0.007	0.007	119.6	73.0	10.0
FEO	0.29	23.24	0.012	0.004	169.5	99.0	10.0
AL2O3	29.77	0.57	1.647	1.565	56247.6	422.0	10.0
MNO	0.00	21.36	0.000	0.000	52.0	112.0	10.0
TIO2	0.00	376.07	0.000	0.000	28.0	30.0	10.0
TOTAL	97.17		5.031 CATIONS (8.0 OXYGENS)			ITERATIONS= 3	

12-OCT-83 09:38:52

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [ ]
RESPONSE- (A, AE, R, RE) ? [R]
RESPONSE- R
SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? [ ]

9

10

```
ENTER 'L' FOR NEW LABEL, 'R' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [ ]
```

** SAMPLE: LAKE CNTY PLAGIOCLASE X= 3038 Y= 3372 B.C./SEC= 9898.90

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	50.96	1.53	2.345	0.877	6160.2	13.5	10.0
MGO	0.00	23.43	0.000	0.000	364.3	489.0	10.0
CAO	13.63	1.74	0.672	0.529	4241.7	20.0	10.0
NA2O	3.94	1.71	0.352	0.318	4340.2	139.0	10.0
K2O	0.09	36.92	0.005	0.006	109.6	73.0	10.0
FEO	0.21	30.67	0.008	0.003	150.5	99.0	10.0
AL2O3	30.16	0.57	1.635	1.587	57030.2	422.0	10.0
MNO	0.00	68.10	0.000	0.000	91.1	112.0	10.0
TIO2	0.00	44.69	0.000	0.000	15.0	30.0	10.0
TOTAL	99.00		5.016 CATIONS (8.0 OXYGENS)			ITERATIONS= 3	

```
12-OCT-83 09:40:19

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [Y]
(ANALYSIS # 20 FILED IN 'D1011')

PLOT THIS POINT ? [Y]
COMPONENTS ARE (TOP,LEFT,RIGHT):  0.99   0.00   0.01
RESPONSE- (A, AE, R, RE) ? [A]
RESPONSE- A  ( 1 ANALYSES ACCEPTED IN THIS AVERAGING LOOP)

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? [ ]

ENTER 'L' FOR NEW LABEL, 'R' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [ ]
```

** SAMPLE: LAKE CNTY PLAGIOCLASE X= 3368 Y= 3153.5 B.C./SEC= 9894.40

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	52.07	1.52	2.372	0.898	6309.0	13.5	10.0
MGO	0.00	32.30	0.000	0.000	396.9	489.0	10.0
CAO	13.58	1.74	0.663	0.527	4224.4	20.0	10.0
NA2O	3.88	1.72	0.343	0.313	4273.0	139.0	10.0
K2O	0.07	44.66	0.004	0.005	102.7	73.0	10.0
FEO	0.20	32.34	0.008	0.003	147.6	99.0	10.0
AL2O3	29.96	0.57	1.608	1.577	56687.7	422.0	10.0
MNO	0.00	25.84	0.000	0.000	61.1	112.0	10.0
TIO2	0.00	787.18	0.000	0.000	31.0	30.0	10.0
TOTAL	99.76		4.997 CATIONS (8.0 OXYGENS)			ITERATIONS= 2	

```
12-OCT-83 09:42:11

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [ ]
RESPONSE- (A, AE, R, RE) ? [A]
RESPONSE- A  ( 2 ANALYSES ACCEPTED IN THIS AVERAGING LOOP)

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? [ ]

ENTER 'L' FOR NEW LABEL, 'R' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [ ]
```

** SAMPLE: LAKE CNTY PLAGIOCLASE X= 3466.5 Y= 3167 B.C./SEC= 9894.60

	WEIGHT%	ST.DEV. (%)	FORMULA	K-RAT	UNKN PK COUNTS	UNKN BKG COUNTS	TIME (SEC)
SIO2	50.12	1.54	2.334	0.862	6054.4	13.5	10.0
MGO	0.00	31.22	0.000	0.000	393.8	489.0	10.0
CAO	13.67	1.74	0.682	0.531	4254.7	20.0	10.0
NA2O	3.80	1.74	0.343	0.306	4180.8	139.0	10.0
K2O	0.05	62.36	0.003	0.003	93.7	73.0	10.0
FEO	0.14	44.19	0.006	0.002	133.5	99.0	10.0
AL2O3	30.03	0.57	1.648	1.581	56830.3	422.0	10.0
MNO	0.00	32.20	0.000	0.000	70.1	112.0	10.0
TIO2	0.00	52.72	0.000	0.000	17.0	30.0	10.0
TOTAL	97.81		5.015 CATIONS (8.0 OXYGENS)			ITERATIONS= 3	

```
12-OCT-83 09:43:46

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [ ]
RESPONSE- (A, AE, R, RE) ? [RE]
RESPONSE- RE
```

11

```
********** 2 POINT AVERAGE **********

         WEIGHT%  ST.DEV.  FORMULA  K-RAT   UNKN PK   UNKN BKG   TIME
                  ( % )                     COUNTS    COUNTS    (SEC)

SIO2       51.53    1.69    2.358   0.888   6234.6      13.5     10.0
MGO         0.00    0.00    0.000   0.000    380.6     489.0     10.0
CAO        13.60    0.29    0.667   0.528   4233.0      20.0     10.0
NA2O        3.91    1.14    0.347   0.315   4306.6     139.0     10.0
K2O         0.08   14.78    0.005   0.005    106.1      73.0     10.0
FEO         0.21    4.16    0.008   0.003    149.0      99.0     10.0
AL2O3      30.06    0.43    1.621   1.582  56859.0     422.0     10.0
MNO         0.00    0.00    0.000   0.000     76.1     112.0     10.0
TIO2        0.00    0.00    0.000   0.000     23.0      30.0     10.0

TOTAL      99.39            5.007 CATIONS              ITERATIONS= 3
                          (  8.0 OXYGENS)

12-OCT-83 09:44:10

ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ? [S]
ENTER NEW TITLE FOR AVERAGE (OPTIONAL)? [ ]
(ANALYSIS # 21 FILED IN 'M101')

PLOT THIS POINT ? [ ]

SAMPLE LABEL ('RETURN' FOR NO CHANGE) ? [N]

ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT
- OR 'RETURN' TO START ANALYSIS ? [N]

EXIT PROGRAM ? [YES]

****  9  **** ANALYSES OBTAINED   (EXCLUDING AVERAGES)

ENTER 'R' TO RESTANDARDIZE 1 TO  8  ELEMENTS-
   OR 'S' TO REMEASURE BACKGROUNDS OR STANDARDIZE ENTIRE FILE -
(HIT 'RETURN' FOR NEITHER OF THESE) - ? [ ]
IF YOU ARE DONE FOR THE DAY -

RUN THE 'SDATA' PROGRAM TO GENERATE STANDARDIZATION TABLE

PUT PRINTOUT OF STANDARDIZATION TABLE IN LOGBOOK
AND FOLLOW SHUTDOWN PROCEDURES IN MANUAL

--ENJOY THE DATA--

READY

[RUN SDATA]

ADVANCE PAPER TO TOP OF PAGE-  PUSH ANY KEY WHEN READY


STANDARDIZATION DATA FOR FILE #GABT     12-OCT-83

EL.  CH.   PEAK   COUNTS SEC.   BKGD SEC.   BC/SEC   STNDRD    BG STD

SI    9    FIX    14044  20      27  20    10017    %PXAD     %OXCO
MG    7    FIX    24619  20     489  10    10017    %PXAD     %PXWO
CA    6    FIX    15990  20      40  20    10017    %PXAD     %OXCO
NA    4    FIX    26708  20     139  10     9902    %FSTA     %PXWO
K     1  14193    12954  20      73  10     9864    %FSBO     %PXWO
FE    8    FIX    36601  20      99  10     9933    %OLSF     %PXWO
AL    2  13109    72181  20     422  10     9902    %FSTA     %PXWO
MN    5    FIX    68401  20     112  10     9907    %OLST     %PXWO
TI    3  27471    22595  20      30  10     9892    %OXIL     %PXWO
```

12

13

Operating Notes (see numbers in examples):

1. The data filing and plotting routines are set-up at this point. In the example, filing is "continued" in a pre-existing file which was set up in a previous run when the same QDATA file was used. If filing is not chosen, plotting will not be allowed. If neither filing nor plotting options are chosen, the queries to file or plot will be skipped after each analysis.

The "long" printout format is automatically used for the first analysis. This format includes count data for the standards. If a "regular" format is chosen, the second and all subsequent analysis printouts will skip the printing of redundant standard information (see the printout examples). The standardization data can be printed out at the end of the operating shift by running the program "SDATA", which generates a compact table of standard count data (see note 13 and Appendix E).

2. The beam is "blanked" unless the operator responds with a "yes" to the "Check the beam" question. To start an analysis after checking the beam, the joystick button is pressed.

3. These are the various options after an analysis is printed out. This analysis was stored as a standard ("S"). If filing was not desired, the "Return" would have been depressed instead of "Y" or "S". If the analysis is stored, and if on-line plotting was selected in the set-up, the operator is given the option to plot the preselected components.

The echoing of the "RESPONSE" message in the example is due to the fact that this entire operating example was generated on a printing terminal. Normal operation would be to operate the program from a video terminal. If a video terminal is used, the dialogue and program prompts are displayed on the video terminal and the analysis, storage counter, and averaging response are transmitted to the printing terminal.

The blank box signifies that a "Return" was depressed to start the next analysis.

4. Note that since the analysis was not stored, the plotting option was skipped.

The "B" option is chosen to turn the beam on. The operator can then identify the material and enter a new label, if desired, prior to starting the next analysis.

5. The "AE" response signals the program to calculate the average of all of the accepted analyses. The average is calculated by summing and averaging the uncorrected count data for each accepted analysis and then re-running the correction routine on the uncorrected average. In this case, a 3 point average is calculated and printed. The "ST. DEV." column in an average analysis gives the standard deviation, in percent, of the average analysis. Thus, the standard deviation of the SiO_2 value in this average is 40.25 $\pm$ 1.82% of 40.25, or 40.25 $\pm$ .73.

6. The blank box signifies that a "RETURN" has been depressed. In

the program, the "NO" response can be signalled by "No", "N", or "RETURN". The "YES" response is signalled by "YES" or "Y".

7. A new label is entered here. After an average is calculated, any previous label is erased. Otherwise, the previous label is carried over unless a new label is entered.

8. "New Options" are chosen and displayed here. Any or all of the analysis parameters can be changed. If a new label is desired, it should be entered first and then the choice for other "New Options" can be made when the analysis option prompt is repeated.

9. A new title is entered to be stored with the average analysis.

10. New counting times are entered and the "New Options" choice is repeated so as to modify other analysis parameters.

11. The "RE" response excludes the last analysis from the averaging array and then calculates the average of the previously accepted analyses.

12. Program is exited at this point. If desired, the $STDZ or $RSTD programs can be automatically loaded and run here.

13. The "SDATA" program is separate from $ANBA (see Appendix E). It is used at the U.S.G.S. Reston facility to print out the standardization data, which can then be referred to in the operator's log. This is the data that is omitted from the analysis printout if a "regular" printout format is chosen at the beginning of the program.

Preparing to Use $ANBA

If a system is equipped with the SEMQ automation package and 32K of memory, the $ANBA program should be operable once the following steps are taken:

1) The $ANBA program is resident on the program disk (drive 0) with the other SEMQ analytical programs ($QSET, $PSET, $ANLZ, etc.);

2) The $QSET program has been used to generate a 14-element maximum QDATA file and corresponding alpha-factor file for Bence-Albee correction procedures;

3) A formatted "data" disk with at least 101 free records is available in drive 1 (this can be the same disk that contains the QDATA and alpha files);

4) The $ANBA program can be latched automatically after $PSET and $STDZ are run if it is an analysis program choice in $PSET (the program name is stored in #PDTA). To include $ANBA as a program choice, insert it as a valid name in the $PSET program, lines 590-700;

5) Instrument configuration is entered into $ANBA by modifying lines 8000 (digital drives for stage and scanners), 8020 (4-crystal data), 8060 (# DACS for PHA'S), and 8080 (scaler/timer wiring order);

6) Check that the ARLEB device assignments are compatible (see p. 9-10). If they are not, change the device assignments to those of your system by changing the "SEND" commands in lines 115, 170, 2190, 3131, 3756, 4260, and 4670 in the $ANBA program.

The routines to file data and produce plots have been found to be extremely valuable at the U.S.G.S.-Reston microprobe facility. However, they could be deleted from the program if they are not applicable to another microprobe facility. The plotting code is of course dependent on the type of plotter used and other laboratories may prefer a different data storage format. Thus, it is important to note that both the filing and plotting routines can be regarded as auxiliary to the main program. The speed of operation and averaging ability make $ANBA a valuable alternative to the original data acquisition programs even without these two routines. If the filing and plotting routines are not needed the following lines can be deleted from the program:

Filing - lines 213-230, 3670-3685, 4000-4300.
Plotting (See Appendix D) - lines 232-248, 4500-4699.

Deletion of these routines will allow analysis of more than 14 elements, if desired (line 20 defines maximum number of elements, N). Each additional element requires approximately 1K word of data memory. The deletion of the filing and plotting routines would leave enough memory to allow analysis of 18, or possibly 19, elements.

Acknowledgments - L.B. Wiggins and J.S. Huebner of the U.S.G.S. (Reston) and W.J. Hamilton, Jr. of ARL are credited for proposing the feasibility of condensing the analytical programs so that they would be resident in computer memory and thus reduce disk access. They provided valuable advice during the author's introduction to the ARLEB operating system. Suggestions by J.S. Huebner and numerous microprobe operators at the U.S.G.S. in Reston greatly aided the process of debugging and improving the program during its development.

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Bausch and Lomb (1979) SEMQ Floppy Disk Automation Software Instruction Manual, published by Applied Research Laboratories Division of Bausch & Lomb.

Bence, A.E. and Albee, A.L. (1968) Empirical correction factors for the electron microanalysis of silicates and oxides. Jour. Geology, 76, p. 382-403.

Huebner, J.S. (1983) RDARL4, a FORTRAN interface for transferring chemical analytical data from an Applied Research Laboratories electron microprobe to a PDP-11 computing system. U.S.G.S. Open-File Report, 83-713.

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PAGE  01    10:49:28 12-OCT-83

1COMPRESS
5REM *$ANBA- COMBINED ANALYSIS/BENCE-ALBEE PROGRAM WITH AVERAGING AND DATA FILING -- J.J. MCGEE  U.S.G.S.-RESTON**
6REM* DEVELOPED IN 1982 BY JIM MCGEE (959 NATIONAL CENTER - U.S. GEOLOGICAL SURVEY - RESTON, VA  22092  (703) 860-7294)
7REM* FOR RAPID DATA ACQUISITION, CORRECTION, AND STORAGE OF ANALYSES OF UP TO  14 ELEMENTS*
8REM *LINES 3000-3999 FOR B-A CORRECTION - LINES 4000-4300 FOR DATA FILING**
10REM **LINES 2000-2900 FOR MULTIPLE POINT AVERAGING ROUTINE**
17CALL(7,0,0,1):REM *BLANK BEAM*
20LET N=14:LET F=N-1:LET M2=10:REM *MAX FOR DIMENSIONS*
21REM **N=#ELEMS MAX: M2=#STDS MAX**
30LET N8=3:LET N9=6
31LETN7=N8+N9:REM *N8=#SCNRS: N9=#FIXED CHS*
40LETT7=2:REM *PK SK CT TIME*
45DIM B(N,4),B0(N,4),B1(N,4),C(N,7),M(N,3),P(N,4),P0(N,4),P2(N,N),S(N,2),S6(N,N)
50DIM E(N),E0(N),K(N),L(N),L3(N),S1(N),S4(N),S5(N),S7(N),V5(N)
55DIM A2(F),B2(F),B3(F),D2(F),D3(F),K1(F),P3(F),S2(F),S3(F),T5(F),U2(F),U3(F),W1(F)
60DIM H(F,15),L2(N8),V(N8),V3(N8),V4(N7)
65DIM D(50),D1(2),T(21),T1(13),T3(10),T4(17),U(N+2),U1(N+2),V0(16),V1(8),V2(16),W(N+2),W2(N+2)
80LET S9=19:LET S0=5:REM*MOTOR SPEEDS*
85LET E=0:LET A=0:LET X2=0:LET G1=0:LET G2=1:REM *DEFAULTS FOR CONDITIONALS*
95PRINT:PRINT"$ANBA -- ANALYSIS PROGRAM WITH BENCE-ALBEE CORRECTIONS, MULTI-POINT AVERAGING,"
96PRINT"        DATA FILING, AND PLOTTING ROUTINES.  DEVELOPED FOR THE U.S.G.S.-RESTON"
97PRINT"        SEMQ MICROPROBE FACILITY BY J.J. MCGEE  (OCTOBER, 1983 VERSION)."':PRINT
100OPEN#PDTA
110FETCH(1)X,D,F4,F5,F1,F2,(2)D(1),(2)U,B(0,2):FETCH(2)(17)T4
115SEND(0,3):PRINT:PRINT:PRINT"** ANALYZING FOR -- "@T4,T4(14);T4(15);T4(16):BACK
125OPEN@F4,F5:REM FETCH INFO FROM *FILE **
130FETCH(1,F5)E0,S,B1,(2)D(0),R1,D(2),F7,F8,(3)D(3):FETCH(2,F5)X,Y,(19)T
132IFE0<1THEN135
133IFE0>NTHEN135
134GOTO138
135PRINT"SORRY - "E0"ELEMENTS ARE OUT OF ALLOWABLE RANGE IN $ANBA":STOP *CHECK YOUR QDATA FILE OR RE-RUN $PSET*
138DIMA1(E0-1,E0-1):REM *ALPHA ARRAY DIM (MUST BE FOR EXACT # ELMTS)*
140FORI=1TOE0
145FETCH(I+2,F5)E0(I),E(I),L(I),(2)P(I,0),(2)D,P(I,4),P(I,2),(3)B(I,0),(2)S(I,1)
148LET B0(I,0)=B(I,0):LET B0(I,1)=B(I,1):LET B0(I,2)=B(I,2)
150NEXTI
155FORI=1TOS:LET K=E0+3*I:FETCH(K,F5)V5(I),Y,S5(I),S1(I):FETCH(K+1,F5)(S5(I))S6(I,1):FETCH(K+2,F5)(S5(I))P2(I,1):NEXTI
170SEND(0,3):PRINT:PRINT" USING: "@F4" - "@T:BACK
173PRINT:PRINT"**NOTE - USE THE 'N' OPTION AFTER AN ANALYSIS TO EXIT PROGRAM OR RESTANDARDIZE":PRINT
174PRINT"'CTRL P' WILL HALT EXECUTION BUT IS FOR EMERGENCY ONLY":PRINT:DELAY150
175PRINT:PRINT"ENTER # OF OXYGENS FOR FORMULA CALC.";:INPUTX0
177PRINT:PRINT"CHOOSE PRINTOUT FORMAT (1 = REGULAR, 2=LONG) - ";:INPUTP1:IFP1<>2THENLET P1=1
180FORJ=1TOS:LETS4(J)=0:REM *FIND #EL ANLZ EA STD*
185FORI=1TOE0:IFS(I,1)=JTHENLET S7(I)=V5(J):LET S4(J)=S4(J)+1
190NEXTI:NEXTJ
195OPEN#XDTA,0:REM FETCH PHYSICAL DATA FOR B-A ROUTINE*
198FORI=0TOE0-1:FETCH(E0(I+1))B1(I,0),B1(I,1),(16)D,B1(I,2),B1(I,3),B1(I,4):NEXTI
200FETCH(8)B1(E0,0),B1(E0,1):REM *OXY SYMBOL AND ATOM. WT*
205OPEN@F1,F2:REM *FETCH STD DATA FROM #STDZ*
207FORI=1TOE0:FETCH(I,F2)P(I,1),C(I,6),C(I,7),B(I,3),B(I,4),P(I,3)
209LET P0(I,1)=P(I,1):LET P0(I,3)=P(I,3):LET B0(I,3)=B(I,3):NEXTI
211ZEROD:REM *FOR INITIALIZING DATA FILES*
213PRINT:PRINT"DO YOU WANT TO FILE DATA";:INPUT@X:GOSUB4900:IFX=1THEN215
214LET @G1=0:GOTO250:REM *NO FILING OR PLOTTING*
215PRINT"ENTER FILENAME FOR DATA STORAGE ";:INPUT@G1:LET G2=1
216OPEN@G1,G2,Y:IFY=0THEN228
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217FETCH(1,G2)(14)D(1):IFD(14)>YTHENPRINT@G1' IS FULL, USE A NEW FILENAME,':GOTO215
218PRINT''@G1'' ALREADY EXISTS ON DRIVE'G2
219PRINT''W' TO WRITE OVER THIS FILE'
220PRINT''N' TO CREATE FILE WITH NEW NAME'
221PRINT''C' TO CONTINUE FILING IN ''@G1'' (IF USING SAME *QDATA FILE)'
222PRINT:PRINT' W, N, OR C -';:INPUT@X:IF@X='W'THEN228
223IF@X='N'THEN215
224IF@X='C'THENIF@D(8)=@F4THEN232
225PRINT:PRINT'YOU CANNOT STORE DATA IN '@G1' USING '@F4'.  '@G1' USES '@D(8)'!'
226PRINT:GOTO219
228LET X=101:IFY<>XTHENBUILDX,@G1,G2
230ZEROD:FORI=1TOX:FILE(I,G2)(42)D:NEXTI
232PRINT:PRINT'DO YOU WANT ON-LINE PLOTTING ';:INPUT@X:GOSUB4900:IFX<1THENLET F0=0:GOTO250
233REM **TERNARY PLOT ROUTINE - J. MCGEE  7-MAR-83**
234PRINT'TERNARY - ENTER SEQUENCE # FOR TOP, LEFT, RIGHT ELEMENTS (ADD 15 IF OXIDE INSTEAD OF CATION PLOT) ';:INPUTA0,L0,R0
235REMFILLER
236IFA0>E0THEN242
237REM
238PRINT@B1(A0-1,0)',@B1(L0-1,0)',@B1(R0-1,0)' -ARE THESE CORRECT ';:INPUT@X:GOSUB4900:IFX<1THEN234
239REM FILLER
240LET F0=2:GOTO247:REM *CATION PLOT FLAG*
241REM
242PRINT@B1(A0-16,0)',@B1(L0-16,0)',@B1(R0-16,0)' -ARE THESE CORRECT ';:INPUT@X:GOSUB4900:IFX<1THEN234
243REM FILLER
244LET F0=3:REM *ON-LINE PLOT FLAG FOR OXIDES*
247LET D(47)=CHR(100):LET D(48)=CHR(073):LET D(49)=CHR(072):REM  ' @;: ' FOR PLOTTER SELECT **
248LET @A5=@D(47)+@D(48)+@D(49):REM *PLOTTER SELECT CODE*
250PRINT'INPUT COUNTING TIMES (SEC) FOR UNKNOWNS:'
260IFE=0THENPRINT'    (ON STANDARDS, PEAK='U'SEC, BKGD='U(1)'SEC.) ';
262INPUTT8,T9
264IFT8>0THENIFT9>0THENIFT8<201THENIFT9<201THEN280
265PRINT' MAX. COUNTING TIMES = 200 SEC. - REENTER';:GOTO262
269REM *PROGRAM LOOPS BACK TO 270 AFTER ANALYSIS *
270FORI=1TOE0:LET P(I,1)=P0(I,1):LET P(I,3)=P0(I,3):LET B(I,3)=B0(I,3)
275LET B(I,0)=B0(I,0):LET B(I,1)=B0(I,1):LET B(I,2)=B0(I,2):NEXTI
280ZEROT,T1:CALL(9,CCX)
281IFEXF(8)=-1THENCALL(9,XXX):PRINT:PRINT'SCANNER AT LIMIT - BACK OFF & RECALIBRATE.  'RETURN' WHEN READY':WAIT:GOTO280
282CALL(9,XXX)
283PRINT:PRINT'SAMPLE LABEL ('RETURN' FOR NO CHANGE) ';:INPUT@T:IF@T=''THENLET @T1=@T3:GOTO286
284FORI=0TO9:LET T1(I)=T(I):NEXTI:LET @T3=@T1:REM *RESTORE TITLE AFTER AVG*
286IFE=0THEN314
287PRINT:PRINT'ENTER 'L' FOR NEW LABEL, 'B' FOR BEAM ON, 'N' FOR NEW OPTIONS OR PROGRAM EXIT'
288PRINT'- OR 'RETURN' TO START ANALYSIS ';:INPUT@X:IF@X<>'L'THENLET @T1=@T3
289IF@X='L'THEN283
290IF@X='B'THENCALL(7,0,0,0):PRINT:PRINT'BEAM IS NOW ON':GOTO287
291IF@X='N'THEN295
292IF@X=''THEN343
293PRINT'NOT A VALID RESPONSE !':GOTO287
295PRINT:PRINT'EXIT PROGRAM ';:INPUT@X:GOSUB4900:IFX=1THEN375
296PRINT'CHANGE COUNTING TIMES ';:INPUT@X:GOSUB4900:IFX=1THEN250
310PRINT:PRINT'ENTER NEW # OXYGENS FOR CATION CALC. ('RETURN' FOR NO CHANGE) ';:INPUTY0:IFY0>0THENLET X0=Y0
314PRINT:PRINT'ENTER X,Y STAGE POSITIONS TO DRIVE TO (5 DIGITS - ENTER 0,0 FOR NO MOTION)':INPUTV0(1),V0(2)
316IFV0(1)=0THENIFV0(2)=0THEN330
318IFV0(1)>500THENIFV0(1)<63600THEN321
319PRINT:PRINT'X VALUE IS OUT OF RANGE  (00500< X < 63600)':GOTO314
321IFV0(2)>700THENIFV0(2)<56000THEN326
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322PRINT:PRINT"Y VALUE IS OUT OF RANGE  (00700< Y < 56000)":GOTO314
326CALL (1,XXC):CALL(4,V1(1)):CALL(1,CCX)
327FORQ=1TO2:LET X=Q:IFV0(Q)<=0THENLET V2(X)=0:GOTO329
328LET V2(X)=V0(Q)-V1(X)/10
329NEXTQ:CALL(2,V2(1),S9):CALL(1,CCC):IFEXF(0)=-1THENCALL(1,XXX):PRINT"STAGE AT LIMIT - RESET AND 'RETURN' WHEN READY":WAIT:GOTO329
330CALL(1,XXX):CALL(12,J):PRINT:PRINT"DO YOU WANT TO CHECK THE BEAM";:INPUT@X:GOSUB4900:IFX=1THENCALL(7,0,0,0)
340PRINT:PRINT"SELECT ANALYSIS POSITION AND PUSH BUTTON WHEN READY":ZEROV0:CALL(1,XXX):CALL(13):GOTO344
343ZEROV0
344RESTORE8000:READU,U1,(3)U(1)
346CALL(1,XXC):CALL(4,V1(1)):CALL(1,XXX)
348FORQ=1TO3:LETX=U(Q):LETD(Q)=V1(U(Q)):NEXTQ:REM *NOW D IS X,Y,Z POSNS*
350CALL(7,0,0,1):LET D1(2)=0:REM *D1(2) FOR BEAM CURRENT*
360LET K=0:GOTO5000:REM *COLLECT DATA FOR UNKNOWNS (K=0)*
375LET A=0:SEND(0,3):PRINT:PRINT:PRINT"**** 'E' **** ANALYSES OBTAINED   (EXCLUDING AVERAGES)":PRINT:BACK
380PRINT:PRINT"ENTER 'R' TO RESTANDARDIZE 1 TO 'E0-1' ELEMENTS-"
382PRINT"   OR 'S' TO REMEASURE BACKGROUNDS OR STANDARDIZE ENTIRE FILE - "
384PRINT"(HIT 'RETURN' FOR NEITHER OF THESE) - ";:INPUT@X:IF@X="R"THENLOAD$RSTD
386IF@X="S"THENLOAD$STDZ
390CALL(1,XXX):CALL(9,XXX):CALL(7,0,0,0):PRINT:PRINT"IF YOU ARE DONE FOR THE DAY -":PRINT
392PRINT:PRINT"RUN THE 'SDATA' PROGRAM TO GENERATE STANDARDIZATION TABLE"
393PRINT:PRINT"PUT PRINTOUT OF STANDARDIZATION TABLE IN LOGBOOK"
394PRINT"AND FOLLOW SHUTDOWN PROCEDURES IN MANUAL"
395STOP--ENJOY THE DATA--
399FORJ=1TOE0:REM *ENTER HERE AFTER DATA COLL. (FROM SUB 5000)*
400IFB(J,0)<0THENLETB(J,0)=B(J,3)*C(J,3)/B(J,4):LETB(J,3)=B(J,3)*C(J,7)/B(J,4):GOTO440:REM *BKGD STDS-NORM TO PK CTS*
410IFB(J,1)=0THENIFB(J,2)=0THENLETB(J,0)=B(J,0)*B(0,2)*C(J,3):LETB(J,3)=B(J,3)*C(J,7):GOTO440:REM *BKGD INPT-NORM NAMP & PK CTS*
420LETB(J,0)=B(J,0)*C(J,3)/T9:LETB(J,3)=B(J,3)*C(J,7)/B(J,4):REM *NORM TO TM ON PK*
440LET D1(2)=D1(2)+C(J,4)/C(J,3):NEXTJ:REM *D1(2)=BEAM CURRENT/SEC*
445REM *ABOVE LOOP ASSIGNS BACKGROUNDS*
690SEND(0):IFE>0THEN790
700FORI=1TOE0:LET J=S(I,1):REM *GET WT%/BETA*
710FORK=1TOS5(J):IF E0(I)=S6(J,K)GOTO730
720NEXTK
730LET W2(I-1)=P2(J,K):NEXTI:REM *W2=CONC./BETA OF STD FOR B-A CORR.*
787PRINT:PRINT:PRINT"  ****** BENCE-ALBEE DATA REDUCTION METHOD ******"
790PRINT:PRINT:PRINT:PRINT" ** SAMPLE:  "@T1";:PRINT"   X="D(1)/10" Y="D(2)/10;
791PRINT"  B.C./SEC=";:USE9.2:PRINTD1(2)/E0
792BACK
1525LET E=INT(E+1):GOTO3020:REM *GOES TO CORRECTION ROUTINE*
2000REM **FILE UNKN DATA FOR AVERAGING***
2001LET A=A+1:REM *INCREMENT AVERAGE COUNTER*
2130FORI=0TOE0-1:LET H(I,A)=U1(I)-U2(I)
2140LET P3(I)=P3(I)+U1(I):LET B3(I)=B3(I)+U2(I):LET T5(I)=T5(I)+U3(I):NEXTI
2180IF@R="AE"THEN2501
2185IFA=15THEN2501
2190SEND(0,3):PRINT"  ("A"ANALYSES ACCEPTED IN THIS AVERAGING LOOP)":BACK
2200GOTO270
2500REM**SUB TO AVERAGE AND EXIT TO B-AL ROUTINE**
2501IFA=15THENPRINT"YOU HAVE REACHED MAX. # OF AVERAGEABLE POINTS (15). ENOUGH'S ENOUGH!!"
2505IFA=1THENLET A=0:ZEROP3,B3,T5,H:GOTO270
2535SEND(0)
2538PRINT:PRINT:PRINT:PRINT
2540PRINT:PRINT"**********"A"POINT AVERAGE **********"
2590ZEROU1,U2,U3,B2,D3
2592FORI=0TOE0-1:LET U1(I)=P3(I)/A:LET U2(I)=B3(I)/A:LET U3(I)=T5(I)/A
2596LET A2(I)=U1(I)-U2(I):NEXTI:REM *A2 FOR SD CALC*
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2600FORI=0TOE0-1:FORJ=1TOA
2604LET D3(I)=D3(I)+(H(I,J)-A2(I))*(H(I,J)-A2(I))
2605NEXTJ:NEXTI:REM SUM SQUARES
2606FORI=0TOE0-1:IFA2(I)<=0THENLET B2(I)=0:GOTO2610
2608LET B2(I)=100*(SQR(D3(I)/(A-1)))/A2(I):REM **B2=SIGMA %**
2610NEXTI
2630LET X2=1:ZEROP3,B3,T5,H:BACK:REM *ZERO ARRAYS FOR NEXT CYCLE*
2631REM *X2 IS AVERAGE FLAG (=1 IF AVERAGE)*
2635GOTO3022:REM *SKIPS ZEROING OF TITLE FOR AVERAGE FILING AT 4000*
2995REM ** BENCE-ALBEE CORRECTION + PRINTOUT ROUTINE (USES EXF 20- LINE 3105)*
3020ZEROT3:LET @T3=@T1:IFE=1THENLET L=S1(1)
3021REM *L NOW ASSIGNED OXIDE FLAG (1=OX, 0=ELEM)*
3022LET D1(0)=D(1):LET D1(1)=D(2):REM *X-Y POSITIONS*
3023KILLK:DIMK(E0-1)
3024IFX2=1THEN3055:REM *SKIP RE-ASSIGNMENT FOR AVERAGE CALC.*
3025FORI=0TOE0-1
3050LET U1(I)=C(I+1,0):LET U2(I)=B(I+1,0):LET U3(I)=C(I+1,3)
3052LET S1(I)=C(I+1,6):LET S2(I)=B(I+1,3):LET S3(I)=C(I+1,7)
3054NEXTI
3055FORI=0TOE0-1
3057LET U=U1(I)-U2(I):LET C1=S1(I)-S2(I)
3058IFU<0THENLET U=0
3059IFC1<=0THENLET C1=1
3060LET K(I)=U/C1*S3(I)/U3(I)*W2(I)
3061LET K1(I)=U/C1*S3(I)/U3(I):NEXTI
3065IFE>1THEN3100
3070OPEN@F7,F8
3080FORI=1TOE0:FETCH(I,F8)(E0)A1(I-1,0):NEXTI
3095REM *ALPHA FACTOR ARRAY*
3098REM *A AND K RE-DIM IN 3023 FOR A-FACTOR ARRAY CALC. IN EXF 20*
3099REM **TOO LARGE AN ARRAY GENERATES 0 FOR W'S**
3100LET T=1:REM **T=ITERATION COUNTER**
3102LET R=.005:REM *CONVERGENCE LIMIT*
3105LET C1=EXF(20,T,E0,A1,K,W):REM **B-A CORRECTION**
3110FORI=0TOE0-1:IFW(I)=0GOTO3115
3111IFT=1THENLET W1(I)=K(I)
3112IFABS(W1(I)-W(I))/W1(I)>RTHENIFT<10GOTO3117
3115NEXTI
3116GOTO3131
3117LET T=T+1
3118FORI=0TOE0-1:LET W1(I)=W(I):NEXTI:GOTO3105
3131SEND(0,3,4)
3135PRINT:REM *PRINT HEADINGS*
3138IFE=1THENLET Y1=P1:LET P1=2
3140PRINT"         WEIGHT%  ST.DEV. ";
3144IFL=1THENPRINT"FORMULA ";:GOTO3150
3146PRINT"ATOMIC% ";
3150PRINT" K-RAT   UNKN PK  UNKN BKG   TIME   ";
3152IFP1=1THEN3158
3154PRINT"STD PEAK  STD BKG  ST TIME  STANDARD";
3157IFL=1THENPRINT"  LINE";
3158PRINT
3170TAB18:PRINT"( % )";
3172SPACE20:PRINT"COUNTS   COUNTS   (SEC)";
3173IFP1=1THEN3177
3174PRINT"    COUNTS    COUNTS   (SEC)   FILENAME";
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3177PRINT:PRINT
3180ZEROD:LET T0=0:LET H1=0:LET T2=0:REM *WT & CAT SUMS*
3190IFL=0THEN3250
3199REM *CALC WT% EL INTO D IF OXIDES*
3200FORI=0TOE0-1:LET X=B1(I,2)*B1(I,1)
3205LET D(I)=W(I)*X/(X+B1(I,3)*B1(E0,1)):REM *CALC WT. FRAC. ELEM*
3210LET D(E0)=D(E0)+(W(I)-D(I)):REM *SUM OXY WT. FRACT.*
3215LET T0=T0+D(I):NEXTI
3220LET T0=(T0+D(E0))*100:REM *T0=TOTAL WT%*
3225GOTO3300
3250FOR I=0TOE0-1:LET D(I)=W(I):LET T0=T0+D(I):NEXTI:LET T0=T0*100:REM *D=WT FRACS - T0=TOTAL WT%*
3299REM *CONVERT WT FR IN D TO ATOM FR IN D**
3300LET X=E0:IFL=0THENLET X=E0-1
3305FORI=0TOX:LET D(I)=D(I)/B1(I,1):LET T2=T2+D(I):NEXTI:REM *WT FR/AT WT INTO D*
3310FORI=0TOX:LET D(I)=D(I)/T2:NEXTI:REM *CALC ATOM FRACT*
3315IFL=0THEN3390
3349REM *CALC FORMULA*
3355FORI=0TOE0-1:LET D(I)=D(I)*X0/D(E0):LET H1=H1+D(I):NEXTI:REM *CALC FMLA AND TOTAL*
3390IFX2=1THENFORI=0TOE0-1:LET K(I)=B2(I):NEXTI:REM *SD FROM AVG CALC*
3391IFX2=0THEN3490:REM *CALC. SD*
3410GOTO3505:REM *SKIP K CALC- SD FROM AVG ROUTINE*
3490ZEROK
3499REM *PRINT RESULTS*
3500FORI=0TOE0-1
3502LET X=U1(I)-U2(I):LET M=S1(I)-S2(I)
3503LET K(I)=100*SQR((U1(I)+U2(I))/(X*X)+(S1(I)+S2(I))/(M*M))
3504NEXTI
3505FORI=0TOE0-1:IFL=1THENUSE7:PRINT@B1(I,4);:GOTO3510
3507USE5:PRINT@B1(I,0);:PRINT@L(I+1);
3510USE7.2:PRINTW(I)*100;
3525USE9.2:PRINTK(I);
3530IFL=0THENLET D(I)=D(I)*100
3535USE8.3:PRINTD(I);
3540USE8.3:PRINTK1(I);:REM *K-RATIO*
3545USE10.1:PRINTU1(I);:USE9.1:PRINTU2(I);
3550USE8.1:PRINTU3(I);
3552IFP1=1THEN3573
3555USE11.1:PRINTS1(I);
3560USE9.1:PRINTS2(I);
3565USE8.1:PRINTS3(I);
3570PRINT"    "@S7(I+1)"    ";
3572IFL=1THENPRINT@L(I+1);
3573PRINT
3575NEXTI
3600PRINT:PRINT"TOTAL";
3605USE9.2:PRINT T0;
3606IFL=1THENUSE17.3:PRINTH1;" CATIONS";
3615PRINT"               ITERATIONS="T
3616IFL=1THENSPACE25:PRINT"(";:USE5.1:PRINTX0;" OXYGENS)"
3620PRINT
3650DATE,:TIME:PRINT
3654BACK
3660IFE=1THENLET P1=Y1:REM *RESTORE PRINT FORMAT*
3670IF@G1="O"THEN3740
3680PRINT"ENTER 'Y' ('S' IF STANDARD) TO STORE ANALYSIS AND/OR PLOT ";:INPUT@X1
3683LET X3=0:IF@X1="S"THENLET X3=80:GOSUB4000:REM *FILE DATA AS STANDARD*
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3685IF@X1="Y"THENGOSUB4000:REM *FILE THIS ANALYSIS*
3740IFX2=1THENLET A=0:LET X2=0:LET @T3=(NO LABEL ENTERED AFTER AVERAGE) :GOTO270:REM *EXIT FROM AVG- NO RESPONSE ALLOWED*
3745IFE>1THEN3754
3750PRINT:PRINT"(RESPONSES ARE: 'A'=INCLUDE IN AVG, 'AE'=INCLUDE AND CALCULATE AVG,"
3752PRINT"          'R'=REJECT, 'RE'=REJECT AND CALCULATE AVERAGE) "
3754PRINT"RESPONSE- (A, AE, R, RE) ";:INPUT@R
3756SEND(0):PRINT"RESPONSE- ";:BACK:TRANSMIT R,0
3758IF@R="A"THEN2001
3760IF@R="AE"THEN2001
3762IF@R="R"THEN270
3764IF@R="RE"THENIFA=0THEN270
3768IF@R="RE"THEN2501
3770GOTO3754:REM *NEED A RESPONSE!*
3998REM **DATA FILING ROUTINE - JJ MCGEE 1-JUL-82**
4000IFX2=0THEN4014
4004PRINT"ENTER NEW TITLE FOR AVERAGE (OPTIONAL)";:ZEROT:INPUT@T:IF@T=""THEN4014
4006ZEROT3:FORI=0TO8:LET @T3(I)=@T(I):NEXTI
4014IFE0<14THENFORI=E0TO13:LET W(I)=0:LET D(I)=0:NEXTI
4020OPEN@G1,G2,R:IFR=0THENPRINT"FILE "@G1" IS NOT ON DRIVE"G2"--REPLACE DISK - ANY KEY WHEN READY":WAIT:GOTO4020
4025FETCH(1,G2)(12)T(1),E1,E2
4027IFX2>0THENLET D1(0)=0:LET D1(1)=0:GOTO4040:REM *X,Y = 0 FOR AVG*
4030LET D1(0)=D1(0)/10:LET D1(1)=D1(1)/10
4040IFE1=0THENLET E2=2
4045FORI=0TOE0-1:LET W(I)=W(I)*100
4047LET @D2(I)=@B1(I,0)[1]+@B1(I,0)[2]+@B1(I,0)[3]+@L(I+1):NEXTI
4050IFX2>0THENLET A=A+X3:FILE(E2,G2)(8)T3,(2)D1(0),A,(14)W(0),T0,(14)D(0),H1,X0:GOTO4070
4060FILE(E2,G2)(8)T3,(2)D1(0),X3,(14)W(0),T0,(14)D(0),H1,X0:REM *X3=80 IF STD, 0 OTHERWISE*
4070LET E1=E1+1:LET E2=E2+1
4080GOTO4250
4090PRINT:PRINT"FILE ""@G1"" IS FULL."
4091PRINT"ENTER NEW FILENAME FOR DATA STORAGE - ";:INPUT@G1
4092IF@G1=""THENLET @G1="0"
4094OPEN@G1,G2,R:IFR=0THEN4120
4098PRINT""@G1"" ALREADY EXISTS ON DRIVE"G2
4100PRINT"'W' TO WRITE OVER THIS FILE"
4102PRINT"'N' TO CREATE FILE WITH NEW NAME"
4106PRINT:PRINT" W OR N -";:INPUT@X:IF@X="W"THEN4120
4108IF@X="N"THEN4091
4110GOTO4098
4120LET R=101:BUILDR,@G1,G2
4125ZEROD
4130FORI=1TOR:FILE(I,G2)(42)D:NEXTI
4140LET E1=0:GOTO4300
4250FILE(1,G2)(4)T4,(3)T4(14),F4,G1,R1,E0,L,E1,E2,(14)D2(0),(14)S7(1)
4255REM**FILED NAME,DATE,*FILE,DFILE,REDUCTION,#ELMTS,OXIDE FLAG,STORAGE COUNTER,RECORD,EL+LINE,STD FILE**
4260SEND(0,3):PRINT"(ANALYSIS #"E1"FILED IN ""@G1"")":PRINT:BACK
4280IFF0<1THEN4295:REM *PLOT OPTION NOT CHOSEN*
4290PRINT"PLOT THIS POINT ";:INPUT@X:GOSUB4900:IFX=1THENGOSUB4500:REM **PLOT**
4295IFE2>RTHEN4090
4300RETURN
4499REM *PLOTTING SUBROUTINE STARTS AT 4500*
4500IFF0=3THEN4600:REM *3=OXIDES, SKIP TO 4600*
4510LET T0=D(L0-1)+D(R0-1)+D(A0-1):REM *CATION NORMALIZED*
4515REM FILLER
4520LET A4=D(A0-1)/T0:LET L4=D(L0-1)/T0:LET R4=D(R0-1)/T0
4530GOTO4640
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4540REM
4550REM
4554REM
4560REM
4570REM FILLER
4600LET T0=W(L0-16)+W(R0-16)+W(A0-16):REM *TOTAL FOR OXIDE NORM*
4610LET A4=W(A0-16)/T0:LET L4=W(L0-16)/T0:LET R4=W(R0-16)/T0
4620REM
4640SEND(0,3)
4645PRINT'COMPONENTS ARE (TOP,LEFT,RIGHT): ';:USE5.2:PRINTA4'  'L4'  'R4
4652BACK
4656LET L4=200*(10-L4*10)-.5774*1733.4*A4+200:LET A4=1733.4*A4+200
4660LET A4=INT(A4):LET L4=INT(L4)
4670SEND(5)
4680PRINT@A5;'A U '#L4#A4;' M23 D H'
4686BACK
4699RETURN
4900IF@X=''THENLETX=0
4901IF@X='YES'THENLETX=1
4902IF@X='Y'THENLETX=1
4904IF@X='NO'THENLETX=-1
4906IF@X='N'THENLETX=-1
4908RETURN
4999REM **MAIN DATA COLLECTION LOOP*
5000IFN8=0GOTO5290:REM *NO SCNRS*
5005ZEROV5
5010REM *M7 DELETED THIS VERSION- NO MANUAL PEAKING*
5050FORC=1TOE0:LETX=INT(P(C,0)+.05)
5055LETL3(C)=INT(10*(P(C,0)-X)+.05):REM *XTAL #1-4 *
5060LETP(C,0)=X:NEXTC:REM *SCNR # *
5070REM GET MAX # OF ELEMS ON ONE SCANNER INTO V3
5080ZEROV3:ZEROV4
5090FORC=1TOE0:IFK=1THENIFS(C,K)<>IGOTO5160:REM *ENTER W/ K=0 UNKNS; =1 PK STDS: =2 BKGD STDS*
5095IFK=2THENIFS(C,K)<>I-SGOTO5160
5100LETX=P(C,0):IFX>N7THEN5120
5110IFX>=1GOTO5130
5120STOP ERROR LINE 5120--BAD CH # IN P(N,0)
5130LETC(C,5)=-1:REM *SET FLAG FOR ELEM C*
5135FORB=0TO4:LETC(C,B)=0:NEXTB
5140IFX<=N8THENLETV3(X)=V3(X)+1:IFV3(X)>V3THENLETV3=V3(X)
5150IFX>N8THENLETV4(X)=C:REM V4'S=0, EXCEPT FIXED CHANNELS
5160NEXTC
5165LETV4=V3
5170IFV3=0THEN5290:REM *NO SCNRS ASSIGNED*
5180REM **ASSIGN ELEMENTS TO SCANNERS FOR FIRST LOOP**
5190FORB=1TON8:LETV1(B)=0
5200FORC=1TOE0:IFP(C,0)>N8THEN5260
5210IFK=1THENIFS(C,K)<>IGOTO5260
5215IFK=2THENIFS(C,K)<>I-SGOTO5260
5220IFC(C,5)<>-1THEN5260
5230IFV1(B)<>0THEN5260
5240IFP(C,0)<>BTHEN5260
5250LETV3(B)=C:LETV1(B)=1:LETC(C,5)=0
5260NEXTC
5270NEXTB
5280GOTO5320
```

```
5290GOSUB6600:REM *NO SCNRS-JUST MEAS FIXED CHS & EXIT*
5300GOTO6400
5310REM **SET PULSE HEIGHT ANALYZERS**
5320GOTO5400
5330REM * PHA ROUTINE DELETED THIS VERSION (5330-5370) *
5398REM **PEAK SEEK ROUTINE**
5400LETP=0
5410FORB=1TON8:LETX=V3(B):IFX=0THEN5460
5415IFP(X,4)=P(X,1)THENLETP(X,2)=0:REM *PK FND IN PREV LOOP*
5420IFK=1THENIFP(X,4)<2THENLETP(X,2)=0:REM *STDS BUT NO PK SK*
5425IFK=2THENLETP(X,2)=0
5430IFK=0THENIFP(X,4)<>1THENIFP(X,4)<>3THENLETP(X,2)=0:REM *UNKNS: NO PK SK*
5440LETV(B)=P(X,1)+2*P(X,2):REM *WHERE PK SK, GO UP TWO STEPS*
5450LETP=P+P(X,2)
5460NEXTB
5465IFV3=V4THENCALL(7,0,0,0):DELAY320:REM *BM ON*
5470GOSUB7500:REM *MOVE SCNRS*
5475ZEROV
5480IFP=0GOTO5970
5490IFU=U1THENCALL(1,XXC):CALL(4,V2(1)):CALL(1,XXX):GOTO5500
5495CALL(9,XXC):CALL(11,V2(1)):CALL(9,XXX)
5500FORB=1TON8:LETX=U1(B):LETV1(B)=V2(X)/10:NEXTB
5520FORC=0TO2:LETX=T7:GOSUB7350:REM *CT AT 3 SCNR POSNS EA ELEM*
5530FORB=1TON8:LETX=V3(B):IFX=0THEN5570
5532IFP(X,2)=0GOTO5570
5535LETM(B,C)=V2(B)
5540IFC<2THENLETV(B)=-P(X,2):LETV1(B)=V1(B)+V(B)
5550IFC=0THENLETP(X,4)=V1(B):REM *P(X,4)MARKS CNTR POSN OF 3*
5560LETM(B,3)=0:REM *FLAG=-1 PK FOUND, =2 SEEKING DN SCAN, =0 SEEKING UP SCAN*
5570NEXT B
5580GOSUB7800:REM *MOVED SCNRS 1 STEP DN*
5585ZEROV
5590NEXTC
5600FORB=1TON8:LETX=V3(B):IFX=0THEN5780
5605IFP(X,2)=0THENLETV5(X)=-1
5610IFV5(X)=-1GOTO5780
5620IFM(B,3)<0THEN5780
5630LETM0=M(B,1)-M(B,0):LETM1=M(B,1)-M(B,2):LETM2=3*SQR(M(B,1))
5640IFABS(M0)>M2THEN5700:REM *CHECK 3 SIGMA SIGNF OF PK*
5650IFABS(M1)>M2THEN5700
5660IFABS(P(X,1)-P(X,4))/P(X,2)<8GOTO5730
5670LETV5(X)=-1:REM *EXIT IF >11 STEPS FROM START*
5680PRINT"PEAK NOT FOUND FOR "@E(X)" ON SCANNER"B" - USING NOMINAL PEAK POSITION":REM *5690 SETS TO PRESET VALUE*
5690LETV(B)=0:LETP(X,4)=P(X,1):GOTO5780
5700IFM0>0THENIFM1<0THEN5730:REM *GOING UP?*
5710IFM0<0THENIFM1>0GOTO5750:REM *GOING DN?*
5720IFM0>0THENIFM1>0THENLETM(B,3)=-1:LETV(B)=0:GOTO5780:REM *PK FOUND*
5730LETV(B)=-P(X,2):LETV1(B)=V1(B)+V(B):LETP(X,4)=P(X,4)+V(B):REM *STEP DN 1*
5740LETM(B,0)=M(B,1):LETM(B,1)=M(B,2):LETM(B,3)=2:GOTO5780:REM *SHIFT CTS TOO*
5750LETV(B)=P(X,4)+2*P(X,2)-V1(B):LETV1(B)=V1(B)+V(B):REM *STEP UP 1*
5760LETP(X,4)=P(X,4)+P(X,2)
5770LETM(B,2)=M(B,1):LETM(B,1)=M(B,0):LETM(B,3)=0:REM *SHIFT CTS*
5780NEXTB
5790LETV(0)=0
5800FORB=1TON8:LETV=V+V(B):NEXTB
5810IFV=0THEN5895:REM *IF ALL PKS FOUND JMP OUT TO EXIT CALC*
```

```
5820GOSUB7800:REM *MOVED SCNRS*
5830LETX=T7:GOSUB7350:REM *CT T7 SEC*
5840FORB=1TON8:LETX=V3(B):IFX=0THEN5870
5850IFM(B,3)<0THEN5870
5860LETM(B,M(B,3))=V2(B)
5870NEXTB
5880GOTO5600
5888REM **CALC PEAK CENTER & MOVE**
5895FORB=1TON8:LETX=V3(B):IFX=0THEN5950
5900IFV5(X)=-1THENLETV(B)=P(X,1)-V1(B):GOTO5950
5910FORC=0TO2:IFM(B,C)=0THENLETM(B,C)=1:NEXTC
5920LETV(B)=(1/M(B,0)-1/M(B,2))/(2/M(B,2)-4/M(B,1)+2/M(B,0))
5930LETV(B)=INT(-P(X,2)*V(B)+P(X,4)-V1(B)+.5):LETV1(B)=V1(B)+V(B)
5940LETP(X,4)=V1(B):LETP(X,1)=V1(B)
5950NEXTB
5958REM **MOVE TO PKS & TAKE DATA**
5960GOSUB7800
5970LETX=T8:IFK=2THENLETX=T9
5975GOSUB7350:REM *COUNT X SEC, SUM SCNRS & FX CHS*
5980IFN9>0THENGOSUB6620:REM *SUMS FIXED CH*
5990FORB=1TON8:LETX=V3(B):IFX=0THEN6020
6000GOSUB6720
6020NEXTB
6048REM **MEAS BKGDS**
6050IFK=2THEN6360:REM *ON BKGD STDS-NO OFFSET*
6060REM **MEAS HI SIDE BKGDS**
6070LETB(0,1)=0
6080FORB=1TON8:LETX=V3(B):LETV(B)=0:IFX=0THEN6110
6090IFB(X,1)<>0THENLETV(B)=P(X,1)+B(X,1):LETB(0,1)=1:GOTO6110
6100LETV(B)=P(X,1)
6110NEXTB
6120IFB(0,1)=0THEN6210:REM *NO HI BKGDS TO MEAS*
6130GOSUB7500:REM *MOVED TO HI BKGD POSN*
6140LETX=T9:GOSUB7350
6145LETT9=X:REM *NOW T9=TIME FOR PRESET*
6150FORB=1TON8:LETX=V3(B):IFX=0THEN6190
6160IFB(X,1)<>0THENLETB(X,0)=V2(B)/V2(7):GOTO6190
6170GOSUB6720:REM *SUM CTS, TM, CURR*
6190NEXTB
6200GOSUB6620:REM *SUM FX CHS*
6208REM **DRIVE TO LO SIDE BKGDS, IF SPECIF., OTHERS TO PKS**
6210LETB(0,1)=0
6220FORB=1TON8:LETX=V3(B):LETV(B)=0:IFX=0THEN6250
6230IFB(X,2)<>0THENLETV(B)=P(X,1)+B(X,2):LETB(0,1)=1:GOTO6250
6240LETV(B)=P(X,1)
6250NEXTB
6260IFB(0,1)=0THEN6360:REM *NO LO SIDE BKGDS*
6270GOSUB7500
6280LETX=T9:GOSUB7350
6288REM THAT MOVED SCANNERS AND COUNTED
6290FORB=1TON8:LETX=V3(B):IFX=0THEN6340
6300IFB(X,2)=0GOTO6330:REM *SUMS PK FOR CHS NOT MEAS*
6310IFB(X,1)<>0THENLETB(X,0)=(B(X,0)+V2(B)/V2(7))/2:GOTO6340
6320LETB(X,0)=V2(B):GOTO6340
6330GOSUB6720
6340NEXTB
```

```
6350GOSUB6620
6360LETV3=V3-1:IFV3>0GOTO5190:REM *BACK TO START*
6365CALL(7,0,0,1)
6370REM **END OF MAIN LOOP**
6380REM **EXIT ROUTINE**
6395PRINT
6400FORC=1TOE0:IFK=1THENIFS(C,K)<>IGOTO6480
6405IFK=2THENIFS(C,K)<>I-SGOTO6480
6410LETX=P(C,0):RESTORE8110:READ(X)V2(1)
6420LETV=C(C,2)/C(C,3):LETC(C,0)=V/(1-V*V2(X))*C(C,3):REM *DT CORR*
6440IFP(C,3)=0THENLETP(C,3)=C(C,4)/C(C,3)
6450LETC(C,0)=C(C,0)*P(C,3)*C(C,3)/C(C,4):REM *CTS CORR DT/DRIFT*
6460IFB(C,1)=0THENIFB(C,2)=0THEN6480
6470LETB(C,0)=B(C,0)*P(C,3)*T9
6480LETP(C,0)=P(C,0)+L3(C)/10
6485NEXTC
6490GOTO399:REM ***RETURN TO MAIN PROGRAM***
6597REM **ENTER AT 6600 TO MEAS FIXED CHS ONLY; AT 6620 TO SUM FIXED CHS**
6600ZEROV:GOSUB7500
6605CALL(7,0,0,0):DELAY360
6610LETX=T8:GOSUB7350:REM *THAT COUNTS*
6615CALL(7,0,0,1)
6620FORB=N8+1TON7:LETX=V4(B):IFX=0THEN6690
6630IFB>6GOTO6660
6640GOSUB6720
6650GOTO6690
6660LETC(X,2)=C(X,2)+V2(B+2)
6670LETC(X,3)=C(X,3)+V2(8)
6680LETC(X,4)=C(X,4)+V2(7)
6690NEXTB
6700RETURN
6710REM SUM COUNTS IN CHS 1-6
6720LETC(X,2)=C(X,2)+V2(B)
6730LETC(X,3)=C(X,3)+V2(0)
6740LETC(X,4)=C(X,4)+V2(7)
6750RETURN
6999REM *MANUALLY ALIGN SPECTROMETER*
7000REM **MANUAL ALIGNMENT SUBROUTINE DELETED FROM THIS VERSION*
7199REM **ROUTINE TO FLIP XTALS ON 4-CHNL SPECTR**
7200REM *7200-7250 (4 XTL ROUTINE) DELETED FROM THIS VERSION*
7274REM *SUBR TO DELAY FOR XTL FLIPPER*
7275LETL2=0:LETL3=0
7278FORQ=1TON8:LETX=L3(V3(Q)):IFX<=0THEN7290:REM *NOT 4 XTL*
7280IFL2(Q)=0THEN7290:REM * =0 1ST TIME*
7285LETY=ABS(X-L2(Q)):IFY>L2THENLETL2=Y:REM *MAX # STEPS FLPPD*
7290LETL2(Q)=X:NEXTQ:REM *L2=LAST XTL # *
7295LETL3=L2*100:CLOCKY:IFY<L3THEN7295:REM *DLAY= #STEPS*1.67SEC*
7296RETURN
7347REM **SUBR--COUNT FOR X SEC & PUT CTS IN V2 ARRAY**
7348REM **SET UP P4,P5,P6 FOR EXF 3*
7350LETY=1:IFX>10THENLETY=INT(X/10):LETX=10
7355LETP6=INT(LOG(X*100)/LOG(10)):IFP6<2THENLETP6=2:LETP4=1:GOTO7410
7360LETP4=INT((100*X)/(10^P6)+.5)
7370IFP4>4THENLETP4=1:LETP6=P6+1:GOTO7400
7380IFP4>2THENLETP4=4:GOTO7400
7385IFP4>1THENLETP4=2
```

```
7390IFP4<1THENLETP4=1
7400IFP6>6THENLETP6=6
7410LETP5=0
7420ZEROU:ZEROV2:RESTORE8080:READU1:READ(8*U1)U:REM *READ SC/TM WIRING ORDER*
7425FORX=1TOY
7430IFU1=1THENCALL(3,V0,P4,P5,P6):GOTO7450
7440CALL(3,V0,P4,P5,P6,P4,P5,P6)
7450FORQ=0TO8*U1-1:LETV2(Q)=V2(Q)+V0(U(Q)):NEXTQ
7455NEXTX
7460LETV2(0)=V2(0)/100:IFU1=2THENLETV2(8)=V2(8)/100:REM *100THS TO SECS*
7465ZEROV0
7470LETX=INT(P4*10^P6/100+.5)*Y:RETURN
7499REM **SUBR TO MOVE STAGE/SCNRS TO FINAL POSNS V0(I) AND V(I)**
7500RESTORE8000:ZEROU:ZEROU1:ZEROV1:ZEROV2
7510READU,U1,(3)U(1),(N8)U1(1):REM *GET WIRING ORDER*
7520IFU=U1GOTO7540:REM *ONE MOD DRIVE ONLY*
7530GOTO7660:REM *2 MODS*
7540CALL(1,XXC):CALL(4,V1(1)):REM *READ MOTOR POSITIONS*
7550FORQ=1TO2:LETX=U(Q):IFV0(Q)<=0THENLETV2(X)=0:GOTO7570:REM *ASSIGN X,Y*
7560LETV2(X)=V0(Q)-V1(X)/10:REM *COMP MOVE INCR*
7570NEXTQ
7580FORQ=1TON8:LETX=U1(Q):IFV(Q)<=0THENLETV2(X)=0:GOTO7600:REM *ASSIGN SCNRS*
7590LETV2(X)=V(Q)-V1(X)/10
7600NEXTQ
7610CALL(2,V2(1),S9):IFEXF(0)=-1THENCALL(1,XXX):STOPDRIVE ERROR LINE 7610
7611REM **THAT MOVED**
7620IFV0(3)<=0THEN7785
7630ZEROV2:LETX=U(3):LETV2(X)=V0(3)-V1(X)/10:REM *ASSIGN Z*
7640CALL(2,V2(1),S0):CALL(1,XXX):IFEXF(0)=-1THENSTOPDRIVE ERROR LINE 7640
7641REM **MOVE Z**
7650GOTO7785
7660CALL(1,XXC):CALL(4,V1(1)):REM *2 MODULE DRIVE*
7670FORQ=1TO2:LETX=U(Q):IFV0(Q)<=0THENLETV2(X)=0:GOTO7690
7680LETV2(X)=V0(Q)-V1(X)/10
7690NEXTQ
7700CALL(2,V2(1),S9):IFEXF(0)=-1THENCALL(1,XXX):STOPDRIVE ERROR LINE 7700
7710IFV0(3)<=0GOTO7740
7720ZEROV2:LETX=U(3):LETV2(X)=V0(3)-V1(X)/10
7730CALL(2,V2(1),S0):CALL(1,XXX):IFEXF(0)=-1THENSTOPDRIVE ERROR LINE 7730
7731REM **STG MOVED**
7740CALL(9,XXC):CALL(11,V1(1)):CALL(9,CCX):REM *READ SCNR POSNS*
7745CALL(9,CCX):IFEXF(8)=-1THENPRINT'SCANNER AT LIMIT- MANUALLY RESET, RECALIBRATE - 'RETURN' WHEN READY':CALL(9,XXX):WAIT:GOTO7745
7746REM *7745 CHECKS FOR DRIVE ERRORS BEFORE DRIVING- J.MCGEE*
7750FORQ=1TON8:LETX=U1(Q):IFV(Q)<=0THENLETV2(X)=0:GOTO7770:REM *ASSN SCNRS*
7760LETV2(X)=V(Q)-V1(X)/10
7770NEXTQ
7780CALL(10,V2(1),S9):CALL(9,XXX):IFEXF(8)=-1THENSTOPDRIVE ERROR LINE 7780
7781REM **MOVED SCNRS**
7785CALL(1,XXX):CALL(12,J)
7790GOSUB7275:REM *DELAY*
7795RETURN
7799REM **SUBR TO DRIVE STG V0 STEPS OR SCNRS V STEPS**
7800RESTORE8000:ZEROU:ZEROU1:ZEROV2
7810READU,U1,(3)U(1),(N8)U1(1)
7820IFU=U1GOTO7840:REM *ONE MOD*
7830GOTO7900:REM *2 MODS*
```

```
7840FORQ=1TO2:LETX=U(Q):LETV2(X)=V0(Q):NEXTQ
7850FORQ=1TON8:LETX=U1(Q):LETV2(X)=V(Q):NEXTQ
7860CALL(1,XXX)
7865CALL(2,V2(1),S9):IFEXF(0)=-1THENCALL(1,XXX):STOPDRIVE ERROR LINE 7865
7870IFV0(3)=0GOTO7965
7880ZEROV2:LETX=U(3):LETV2(X)=V0(3)
7890CALL(2,V2(1),S0):CALL(1,XXX):IFEXF(0)=-1THENSTOPDRIVE ERROR LINE 7890
7895GOTO7965
7900FORQ=1TO2:LETX=U(Q):LETV2(X)=V0(Q):NEXTQ:REM *TWO MODS*
7910CALL(2,V2(1),S9):IFEXF(0)=-1THENCALL(1,XXX):STOPDRIVE ERROR LINE 7910
7920IFV0(3)=0GOTO7950
7930ZEROV2:LETX=U(3):LETV2(X)=V0(3)
7940CALL(2,V2(1),S0):CALL(1,XXX):IFEXF(0)=-1THENSTOPDRIVE ERROR LINE 7940
7950ZEROV2
7955FORQ=1TON8:LETX=U1(Q):LETV2(X)=V(Q):NEXTQ
7958CALL(9,CCX)
7960CALL(10,V2(1),S9):CALL(9,XXX):IFEXF(8)=-1THENSTOPDRIVE ERROR LINE 7960
7965CALL(1,XXX):CALL(12,J)
7970GOSUB7275:REM *DELAY*
7975RETURN
7998REM **DATA LINE 8000-STAGE & SCNR WIRING ORDER**
7999REM **MODULE # FOR STG, MOD # FOR SCNRS, X, Y, Z, SC#1, SC#2,...,SC#N8 **
8000DATA1,2,1,2,3,1,2,3
8018REM **DATA LINE 8020-4 XTAL ORDER**
8019REM ** # OF 4 XTAL SCNRS, SCNR #, MUX GROUP #, SCNR #, MUX GROUP #, ETC.
8020DATA0
8058REM **DATA LINE #8060-PHA WIRING ORDER**
8059REM ** #DACS(PHA), LL CH#1, WIND CH#1,ETC.**
8060DATA0
8077REM **DATA LINE #8080-SC/TM WIRING ORDER**
8078REM  ** #MODS,TM#1,CH#1,CH#2,...,CH#6,BM CR,TM#2,CH#7,CH#8,CH#9,3 DUMMIES,SC CR**
8079REM  *9 OR 17 #'S:  USE CHS NOT ASSND AS DUMMIES**
8080DATA2,0,1,2,3,4,5,6,7,8,9,10,11
8109REM **DEF DEADTIME ALL CHS**
8110DATA1.0E-6,1.0E-6,1.0E-6,1.0E-6,1.0E-6,1.0E-6
8111DATA1.0E-6,1.0E-6,1.0E-6,1.0E-6,1.0E-6,1.0E-6
```

Appendix B - $ANBA variables

```
A       = counter for averaging loop
A0      = plotting variable (element #)
A1      = alpha factor arrray
A2      = average counts (for "A" analyses)
A4      = plotting component
A5      = plotter select code

B       = arrays (4X #EL) for background measurement parameters and for
          #XDTA file parameters
B0      = temporary storage for B arrays (from acquisition routine to
          correction routine)
B1      = # of background standards
B1(I,1)= atomic weight
B1(I,2)= number of cations in formula
B1(I,3)= number of anions in formula

B1(I,4)= oxide formula
B2      = standard deviation (percent) of average analysis
B3      = accumulated background counts for averaging (= sum of U2's)

C       = arrays for count data on peaks for unknowns and standards
C1      = background-corrected standard counts

D       = working variable- various assignments (x,y positions, cations)
D1      = X (0), Y (1) positions and beam current (2) readout
D2      = element symbol + X-ray line for data storage
D3      = variable for average's STD deviation calculation

E       = atomic symbol (@E)
E       = loop counter for total # of analyses
E0      = array for atomic # of elements
E0      = # of elements analyzed
E1      = # of analyses stored in data file
E2      = counter for storage location of analysis

F       = size variable for dimensioning
F0      = variable for plot type
F1      = filename for standardization data (#STDZ)
F2      = drive for standard file
F4      = QDATA (*file) filename
F5      = drive for *file
F7      = alpha factor filename
F8      = drive for alpha factor file

G1      = data output filename
G2      = drive for file G1

H       = storage array for averaging (counts for "A" unknowns)
H1      = cation total
```

```
I       = loop counter

J       = loop counter

K       = counter
K       = K-ratio X wt. frction/beta in correction routine
K       = STD. deviation of counts (for single analysis)
K       = flag for analyzing unknowns for sub 5000 (set in line 360)
K1      = K-ratio

L       = oxide flag (1=oxide, 0=element)
L       = X-ray lines (@L)
L0      = plotting variable (element #)
L2      = 4-crystal spectrometer parameter
L3      = 4-crystal spectrometer parameter
L4      = plotting component

M       = standard background-corrected counts (LN 3502, 3503)
M       = array for peak-seek parameters in sub 5000
M0      = peak-seek data
M1      = peak-seek data
M2      = peak-seek data

N       = max. # of elements (for variable dimensioning)
N       = name of analysis program (@N)
N7      = # of spectrometers (total)
N8      = # of scanning spectrometers
N9      = # of fixed spectrometers

P(I,1)  = peak position array
P(I,2)  = peak-seek increment
P(I,3)  = digitized beam current
P(I,4)  = peak-seek flag  (0=no seek, 1= unknown, 2=standard, 3=both)
P0      = temporary storage for equivlent "P" array (see above)
P1      = printout format (1= unknown data, 2=unknown + standard data)
P2      = wt. fraction/beta array for elements in standards
P3      = sum of peak accounts array for averaging
P4      = scaler counting variable for subfunction 3
P5      = timer device # (for subfunction 3)
P6      = exponent for count time (for subfunction 3)

Q       = stage & spectrometer motor #'s

R       = response for average option (@R)
R       = convergence limit for correction routine
R       = # of records for data file (sub 4000)
R0      = plotting variable (element #)
R1      = data reduction method (=2 for B-A correction)
R4      = plotting component (sub 4500)

S       = # of standards for peak count data
S(I,1)  = standard # for peak data
S(I,2)  = standard # for background data
S0      = motor speed (slow)
```

```
S1      = oxide flag (1=oxide, 0=element)
S1(I)   = array for standard peak data in correction routine
S2      = array for standard background counts in correction routine
S3      = array for standards counting time
S4      = # of elements analyzed from each standard
S5      = # of elements in standard
S6      = atomic # of elements in standards
S7      = filename for standards (swapped from V5, LN 185)
S9      = motor speed (fast)

T       = *file name description (@T)
T       = sample label (@T)
T       = iteration counter for correction routine
T0      = sum of wt. %
T1      = new sample label (@T1)
T2      = sum of wt. fraction/ atomic wt. (for formula calc.)
T3      = sample label used for average title and data source
T4      = operator's name and mineral type (header) (@T4)
T5      = counting time summation for averaging
T7      = peak-seek counting time
T8      = peak counting time
T9      = background counting time

U       = wiring order & scaler for readout assignments
U       = peak count array in correction routine
U(0)    = peak count time
U(1)    = background count time
U1      = wiring order
U1      = unknown peak count array for correction routine (from C(I,0))
U1      = # of scalers
U2      = unknown background counts array in correction routine (from
          B(I,0))
U3      = unknown counting time in correction routine (from C(I,3))

V       = scanner motor positions / steps
V0      = stage motor positions / steps
V1      = storage of motor positions read by subfunctions 4 & 11
V2      = scaler count data output
V2      = motor steps for input to subfunctions 2 & 10
V3      = element scanner assignments
V4      = element fixed-channel assignments
V5      = %file array in set up (later assigned to S7)
V5      = peak-seek flag in sub 5000

W       = wt. fraction array (output from subfunction 20)
W1      = K-ratio input for correction iteration (uses previous wt. fraction
          output)
W2      = concentration/beta of standard

X       = numerous temporary counters, input variables and test variables,
          usually for reponses input by operator
X0      = # of oxygens for formula calculation
X1      = data filing flag (@X1+"y" to file, ="S" to file standard
          analysis)
```

X2 = flag for average calculation (1=average, 0=single analyis)
X3 = storage flag (=80 for standards, =0 for unknowns)

Y = various temporary test variables (drive #'s, record lengths, count time exponent)
Y0 = new # of oxygens input for formula calcualtion (assigned to X0)
Y1 = temporary print format storage (swapped after first analysis)

Appendix C - Format of Data File for Storage of Analyses Generated in $ANBA

If the option to file data is chosen, $ANBA builds a 101 record data file with a 5 character (maximum) name chosen by the operator (this file is automatically built on the disk in drive 1). The first record of the data file contains general information pertaining to the analysis session. Records 2 thru 101 are used for storage of selected analyses (1 per record). If 100 analyses are not stored in one session, the operator may continue to store data in the same file during the next session, as long as the same QDATA file is used for obtaining the analyses (this ensures correspondence of element symbols and standards to the stored analyses). The storage format of information in the data file is as follows:

RECORD	ENTRY	VARIABLE	DESCRIPTION
1	1-4	T4(0-3)	Operator name & mineral type
	5-7	T4(14-16)	Date
	8	F4	QDATA (*FILE) Filename
	9	G1	Datafile name
	10	R1	Data reduction method (=2 for B-A)
	11	E0	# of elements analyzed
	12	L	Oxide flag (1=oxide, 0=element)
	13	E1	# of analyses in this file
	14	E2	Counter for storage location
	15-28	D2	Element symbol & measured X-Ray line (up to 14 elements)
	29-42	S7	Standard (%File) filename for each element
2 thru 101	1-8	T3(0-7)	Sample label
	9	D1(0)	X stage position
	10	D1(1)	Y stage position
	11	A+X3	Combined flag equalling # of analyses in average + standard/ unknown anaysis indcator
	12-25	W(0-13)	Corrected weight %
	26	T0	Total weight %
	27-40	D(0-13)	Formula (cations)
	41	H1	Total cations
	42	X0	# of oxygens for formula calculation

Appendix D - Plotting Routines

This appendix contains listings of three programs used for on-line plotting. The first program, called "IPLOT", must be run prior to running the $ANBA program. Its purpose is to initialize the plotter and to draw and label the axes for the desired plot. The other two programs, called "PLOT 2" and "PLOT 3", are built into the $ANBA program (through ARLEB's "blend" utility). These programs allow various combinations of either oxide weight percent values or "molecular" formula values to be plotted in x-y or ternary format. Only one of them is resident in $ANBA at a given time. The alternate can be "blended" into $ANBA and will completely overwrite it's predecessor. All of these programs are provided on disk with $ANBA. The default version of $ANBA contains the "PLOT 3" routine for generating ternary plots. An example of the ternary plot output, generated during the operation example (p. 11-16) is included on page 44.

PAGE 01 10:27:26 02-AUG-83

```
100PRINT'IPLOT- PROGRAM TO INITIALIZE PLOTTER FOR X-Y, TERNARY, QUAD, OR SINGLE ELEMENT PLOTS'
110REM *WRITTEN BY J.J. MCGEE FOR THE RESTON MICROPROBE LABORATORY*
115REM  *AFTER THE FORMAT OF J.S. HUEBNER'S QUAD.BAS EXAMPLE PROGRAM*
120 REM PLOTTER COORDINATES SEPARATED BY SPACES RATHER THAN BY COMMAS
130 REM THIS IS A DISTINCTION BETWEEN MINC-BASIC AND ARLEB
900 DIM W(5),E(5),B(2),A(4),A1(1),A2(1),A3(1)
905DIML(20),L2(20),L3(20),L4(20),L5(20),L6(20)
910LET A1=CHR(100)!LET A2=CHR(073)!LET A3=CHR(072)
915 LET @B=H A LO
920 LET @D=D!LET @H=H!LET @U=U
930 LET S=CHR(040)!LET C=CHR(054)
940 LET @A=@A1+@A2+@A3
954LET C=5!REM *DEVICE 5 ON SEMQ= CH #0 ON MINC*
960LET @H2=_ H!LET @R=R
1000PRINT'CHOOSE ! SINGLE ELEMENT TRAVERSE=1,  X-Y PLOT=2,  TERNARY=3,  QUAD=4 '!!INPUTT4
1325 LET X9=1 ! LET Y9=1
1350LET F=1.0!REM *NO INPUT OF SCALING FACTOR*
1370LET S=200*F
1400LET X1=S*(0+X9)!LET Y1=S*(0+Y9)
1420LET X2=S*(10+X9)!LET Y2=S*(0+Y9)
1450IFT4=1THEN1500
1460IFT4=2THEN1500
1470IFT4=3THEN1600
1480IFT4=4THEN1700
1490PRINT' 'T4' IS NOT A VALID OPTION'!GOTO1000
1500LET X3=S*(0+X9)!LET Y3=S*(8+Y9)
1505LET X2=S*(12+X9)!LET X4=X2!LET Y4=S*(8+Y9)
1510SEND(C)
1520PRINT@A;@B;@U;@S
1530PRINTX1;Y1;@D;X2;Y2;X4;Y4;X3;Y3;X1;Y1;@H
1532BACK
1535PRINT!PRINT'ENTER LABEL FOR X AXIS - '!!INPUT@L
1540PRINT'ENTER LABEL FOR Y AXIS - '!!INPUT@L2
1545PRINT'X,Y DIMENSIONS ARE 12,8 INCHES'
1550GOSUB3000
1555GOSUB4000
1560GOTO2000
1600LET X3=S*(5+X9)!LET Y3=S*(8.66+Y9)
1610SEND(C)
1620PRINT@A;@B;@U;@S
1630PRINTX1;Y1;@D;X2;Y2;X3;Y3;X1;Y1;@H
1640BACK
1642PRINT!PRINT'ENTER LABEL FOR LEFT - '!!INPUT@L
1644PRINT'LABEL FOR RIGHT - '!!INPUT@L2
1646PRINT'LABEL FOR TOP - '!!INPUT@L3
1650GOSUB3200
1660PRINT'TERNARY HAS 10 INCH SIDES AND HEIGHT OF 8.66 INCHES'
1665GOSUB4500
1670GOTO2000
1700 LET X3=S*(7.5+X9)
1750 LET Y3=S*(4.33+Y9)
1800 LET X4=S*(2.5+X9)
1850 LET Y4=S*(4.33+Y9)
1925SEND(C)
1929 PRINT@A;@B;@U;@S
1930 PRINT X1;Y1;@D;X2;Y2;@S;X3;Y3;@S;X4;Y4;@S;X1;Y1
```

```
1931 PRINT @U;@H
1935 BACK
1945PRINT"QUAD HAS 10 INCH BASE AND 4.33 INCH HEIGHT"
1950PRINT"ENTER LABEL FOR LEFT - "!!INPUT@L
1955PRINT"LABEL FOR RIGHT - "!!INPUT@L2
1960PRINT"LABEL FOR TOP - "!!INPUT@L3
1970GOSUB3200
1975GOSUB4500
2000PRINT!PRINT"PLOTTER INITIALIZED - DO NOT RESET!"
2100END
3000LET @L5=H A U 1200,100 S03
3020LET @L6=H A U 100,750 S43
3050SEND(C)
3060PRINT@A;@L5;@L
3065PRINT@H2
3070PRINT@A;@L6;@L2
3075PRINT@H2
3080BACK
3100RETURN
3200LET @L4=H A U 125,125 S03 !REM *LEFT*
3210LET @L5=H A U 2200,125 S03 !REM *RIGHT*
3215IFT4=4THENLET @L6=H A U 1150,1200 S03 !GOTO3230!REM *QUAD TOP*
3220LET @L6=H A U 1150,1940 S03 !REM *TERNARY TOP*
3230SEND(C)
3240PRINT@A;@L4;@L
3245PRINT@H2
3250PRINT@A;@L5;@L2;@H2!REM *RIGHT LABEL*
3255PRINT@H2
3260PRINT@A;@L6;@L3;@H2!REM *TOP LABEL*
3265PRINT@H2
3270BACK
3290RETURN
4000IFT4=1THENLET @R5=0!LET @R6=60!GOTO4040
4010PRINT"ENTER MIN,MAX RANGE FOR "@L;!!INPUT@R5,@R6
4040PRINT"ENTER MIN,MAX RANGE FOR "@L2;!!INPUT@R3,@R4
4060LET @L5=H A U 175,150 S02 !REM X MIN
4070LET @L6=H A U 2575,150 S02 !REM X MAX
4080LET @L3=H A U 125,200 S02 !REM Y MIN
4090LET @L4=H A U 125,1800 S02 !REM Y MAX
4099SEND(C)
4100PRINT@A;@L5;@R5;@H2
4110PRINT@A;@L6;@R6;@H2
4120PRINT@A;@L3;@R3;@H2
4130PRINT@A;@L4;@R4;@H2
4190PRINT@A;@B
4195FORX=400TO2400STEP200
4200PRINTX;175;@D;X;200;@U
4205NEXTX
4210FORX=400TO2400STEP200
4220PRINTX;1800;@D;X;1825;@U
4230NEXTX
4240PRINT@A;@B
4250FORY=400TO1700STEP200
4255PRINT175;Y;@D;200;Y;@U
4260NEXTY
4265FORY=400TO1700STEP200
```

```
4270PRINT2600;Y;@D;2625;Y;@U
4280NEXTY
4285PRINT@H
4290BACK
4299RETURN
4500SEND(C)
4510PRINT@A;@B
4520FORX=400TO2000STEP200:REM TICKS FOR BASE
4540PRINTX;175;@D;X;200;@U
4560NEXTX
4590PRINT@A;@B
4600FORZ=400TO2000STEP200
4620LET X=200+((Z-200)*.5)
4630LET Y=200+((Z-200)*.866)
4640LET X2=2200-((Z-200)*.5)
4650PRINTX-25;Y;@D;X;Y;@U;X2;Y;@D;X2+25;Y;@U
4655IFZ>=1000THENIFT4=4THEN4680
4670NEXTZ
4680PRINT@H
4690BACK
4695RETURN

READY
```

```
PAGE  01    10:26:00 02-AUG-83

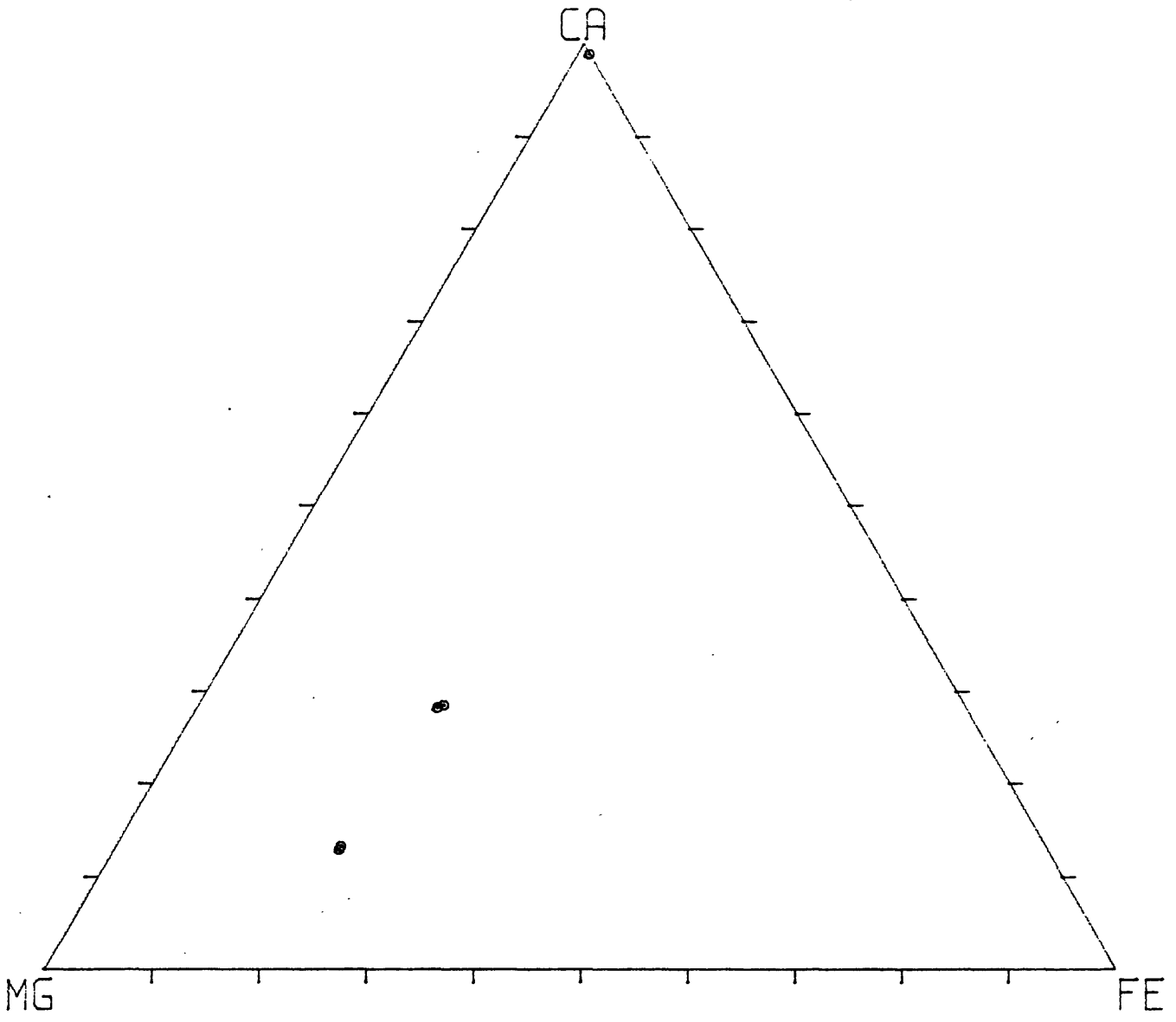
233PRINT"2 AXIS PLOT- X-AXIS ELMT # (0 IF ANALYSIS #, +15 IF OXIDE) "!:INPUTX4:IFX4>E0THEN238
234IFX4=0THENLET F0=4:LET R0=0:LET R2=60:GOTO240:REM *FLAG & RANGE FOR ANALYSIS #
235PRINT"INPUT 2ND ELEMENT FOR FRACTION "!:INPUTX5:IFX5>0THENLET F0=5:PRINT@B1(X4-1,0)"/"@B1(X4-1,0)"+"@B1(X5-1,0):GOTO240
236PRINT" X = "@B1(X4-1,0) ", CORRECT "!:INPUT@X:GOSUB4900:IFX !!!
237LET F0=2:PRINT"ENTER MIN,MAX RANGE FOR "@B1(X4-1,0)!:INPUTR0,R2:GOTO240:REM *X AXIS=CATION*
238PRINT" X = "@B1(X4-16,0)", CORRECT "!:INPUT@X:GOSUB4900:IFX<1THEN234
239LET F0=3:PRINT"ENTER MIN,MAX RANGE FOR "@B1(X4-16,0)!:INPUTR0,R2:REM *X AXIS = OXIDE*
240PRINT"  -ENTER Y-AXIS ELEMENT # (ADD 15 FOR OXIDE) "!:INPUTY4:IFY4>E0THEN244
241PRINT" Y = "@B1(Y4-1,0) ", CORRECT "!:INPUT@X:GOSUB4900:IFX<1THEN240
242LET Y2=2:PRINT"ENTER MIN,MAX RANGE FOR "@B1(Y4-1,0)!:INPUTR3,R4:GOTO247:REM *Y AXIS =CATION*
243PRINT" Y = "@B1(Y4-16,0) ", CORRECT "!:INPUT@X:GOSUB4900:IFX<1THEN240
244LET Y2=3:PRINT"ENTER MIN,MAX RANGE FOR "@B1(Y4-16,0)!:INPUTR3,R4:REM *Y AXIS = OXIDE*
247LET D(47)=CHR(100):LET D(48)=CHR(073):LET D(49)=CHR(072):REM  " @!! " FOR PLOTTER SELECT **
248LET @A5=@D(47)+@D(48)+@D(49):REM *PLOTTER SELECT CODE*
4499REM *PLOTTING SUBROUTINE STARTS AT 4500*
4500IFF0=2THENLET P7=D(X4-1)/(R2-R0):REM *CATION PROP ON X*
4510IFF0=3THENLET P7=W(X4-16)/(R2-R0):REM *OXIDE PROP ON X*
4515IFF0=5THENLET P7=D(X4-1)/(D(X4-1)+D(X5-1)):REM *CATION FRACTION*
4520IFF0=4THENLET P7=E1/(R2-R0):REM *ANALYSIS # ON X*
4530IFY2=2THENLET P8=D(Y4-1)/(R4-R3):REM *CATION PROP ON Y*
4540IFY2=3THENLET P8=W(Y4-16)/(R4-R3):REM *OXIDE PROP ON Y*
4550SEND(0,3)
4554IFF0=5THENPRINT"X= "!:USE5.2:PRINTP7!:PRINT"  Y= "!:USE5.2:PRINTP8*(R4-R3):GOTO4570
4560PRINT"X= "!:USE5.2:PRINTP7*(R2-R0)!:PRINT"  Y= "!:USE5.2:PRINTP8*(R4-R3)
4570BACK
4600LET P7=INT(200+2400*P7):REM *X POSITION IN STEPS*
4610REM BLEND FILLER
4620LET P8=INT(200+1600*P8):REM *Y POSITION IN STEPS*
4630REM
4640REM BLEND FILLER
4645REM FILLER
4652REM FILLER
4656REM FILLER
4660REM BLEND FILLER
4670SEND(5)
4680PRINT@A5!"A  0 U "!P7!","!P8!" M23 D H"
4686BACK
4699RETURN

READY
```

```
PAGE  01    10:26:48 02-AUG-83

233REM **TERNARY PLOT ROUTINE - J. MCGEE  7-MAR-83**
234PRINT"TERNARY - ENTER SEQUENCE # FOR TOP, LEFT, RIGHT ELEMENTS (ADD 15 IF OXIDE INSTEAD OF CATION PLOT) "#:INPUTA0,L0,R0
235REMFILLER
236IFA0>E0THEN242
237REM
238PRINT@B1(A0-1,0)",@B1(L0-1,0)",@B1(R0-1,0)" -ARE THESE CORRECT "#:INPUT@X:GOSUB4900:IFX<1THEN234
239REM FILLER
240LET F0=2:GOTO247:REM *CATION PLOT FLAG*
241REM
242PRINT@B1(A0-16,0)",@B1(L0-16,0)",@B1(R0-16,0)" -ARE THESE CORRECT "#:INPUT@X:GOSUB4900:IFX<1THEN234
243REM FILLER
244LET F0=3:REM *ON-LINE PLOT FLAG FOR OXIDES*
247LET D(47)=CHR(100):LET D(48)=CHR(073):LET D(49)=CHR(072):REM  " @#: " FOR PLOTTER SELECT **
248LET @A5=@D(47)+@D(48)+@D(49):REM *PLOTTER SELECT CODE*
4499REM *PLOTTING SUBROUTINE STARTS AT 4500*
4500IFF0=3THEN4600:REM *3=OXIDES, SKIP TO 4600*
4510LET T0=D(L0-1)+D(R0-1)+D(A0-1):REM *CATION NORMALIZED*
4515REM FILLER
4520LET A4=D(A0-1)/T0:LET L4=D(L0-1)/T0:LET R4=D(R0-1)/T0
4530GOTO4640
4540REM
4550REM
4554REM
4560REM
4570REM FILLER
4600LET T0=W(L0-16)+W(R0-16)+W(A0-16):REM *TOTAL FOR OXIDE NORM*
4610LET A4=W(A0-16)/T0:LET L4=W(L0-16)/T0:LET R4=W(R0-16)/T0
4620REM
4630REM
4640SEND(0,3)
4645PRINT"COMPONENTS ARE (TOP,LEFT,RIGHT): "#:USE5.2:PRINTA4"  "L4"  "R4
4652BACK
4656LET L4=200*(10-L4*10)-.5774*1733.4*A4+200:LET A4=1733.4*A4+200
4660LET A4=INT(A4):LET L4=INT(L4)
4670SEND(5)
4680PRINT@A5;"A U "#L4#A4#" M23 D H"
4686BACK
4699RETURN

READY
```


CA
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Appendix E - SDATA Program listing

This program prints out a table of the standardization data used in the most recent operating shift. The $ANBA program refers to it in the exit routine. It is used at the U.S.G.S. Reston facility for log-entry of operating conditions, providing a neat tabular listing of the elements analyzed, the standards used and the count data obtained. This is the information that is ommitted from the printout of each analysis if the "regular" printout format is selected.

```
        SDATA


PAGE  01    10:28:26 02-AUG-83

10REM* PROGRAM SDATA- STANDARDIZATION PRINTOUT - J.MCGEE 15-APR-82 *
20PRINT:PRINT"ADVANCE PAPER TO TOP OF PAGE-  PUSH ANY KEY WHEN READY"
22WAIT
40SENDS(0,4)
50PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
100OPEN#STDZ,0,R
110DIMP(R),C(R),T(R),B(R),T1(R),D(R),H(R),Y(12)
115DIMN(R),Y1(R)
120DIME0(R),E(R),Z(R),Z1(R)
150FORI=1TOR:FETCH(I)P(I),C(I),T(I),B(I),T1(I),D(I)
160NEXTI
200OPEN#PDTA,0
220FETCH(1)(2)H,Q,F
300OPEN@Q,F
320FETCH(1,F)X,S
340FORI=1TOX:FETCH(I+2,F)E0(I),E(I),N(I),Y1(I),(10)Y(2)
360FETCH(X+2+(Y(10)*3-2),F)Z(I)
380IFY(11)=0THEN450
400FETCH(X+(3*S)+Y(11)+2,F)Z1(I)
450NEXTI
500PRINT:PRINT:PRINT"STANDARDIZATION DATA FOR FILE "@Q"     "#:DATE
520PRINT:PRINT"EL. CH.  PEAK  COUNTS SEC.  BKGD SEC.  BC/SEC  STNDRD  BG STD"
525PRINT
530FORJ=1TOX
540USE4:PRINT@E(J)#:PRINTY1(J)#
545IFP(J)<100THENPRINT"  FIX "#:GOTO560
550USE6:PRINTP(J)#
560USE8:PRINTC(J)#:PRINT" "T(J)#
570USE6:PRINTB(J)#:PRINT" "T1(J)#:USE7:PRINTD(J)#
580PRINT"    "#:USE6:PRINT@Z(J)#:PRINT"    "@Z1(J)
590NEXTJ
600PRINT:PRINT:PRINT

READY
```