FORTAN IV PROGRAMS TO
DEVELOP CONTOUR MAPS
OF 3-DIMENSIONAL DATA

MAY 1968

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Highway
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PURDUE UNIVERSITY
LAFAYETTE INDIANA

by

A K TURNER

Progress Report
PORTMAN IV PROGRAMS TO DEVELOP CONTOUR
MAPS OF 3-DIMENSIONAL DATA

To: G. A. Leonards, Director
Joint Highway Research Project

May 9, 1968

File No: 1-6-1

From: E. L. Michael, Associate Director
Joint Highway Research Project

Project No: C-36-12A

The attached Progress Report "Portman IV Programs to Develop Contour Maps of 3-Dimensional Data" has been prepared by Mr. A. Keith Turner, Graduate Instructor in Research, under the direction of Professor R. D. Miles.

The material in the report was developed from the current HPR-1 (5) research on "Evaluation of Numerical Surface Techniques Applied to Highway Location Analysis." This research is concerned with the graphical representation of various conceptual surfaces so that man-machine information interchanges between design engineers and electronic computers may be developed.

The need for graphical display of 3-Dimensional data exists for a wide variety of highway engineering applications, yet this capability has not been available at Purdue until the current research. It is anticipated that further refinement of these programs will become desirable, in the light of experience with their application. Further routines are still under development. Thus it is anticipated that additional reports in this area will be made.

The report is presented to the Board for the record and for review and comment. It will also be presented to the ISHC and the EPR for their review, comment and approval as partial fulfillment of the objectives of the research.

Respectfully submitted,

Harold L. Michael
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Progress Report

FORTRAN IV PROGRAMS TO DEVELOP CONTOUR
MAPS OF 3-DIMENSIONAL DATA

by

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Joint Highway Research Project

Project No. C-36-72A

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Progress Report

FORTRAN IV PROGRAMS TO DEVELOP CONTOUR

MAPS OF 3-DIMENSIONAL DATA

This report describes a series of FORTRAN-IV subroutines used to prepare graphical displays of three-dimensional data.

Considerable work has been expended to make these programs as flexible as possible. Many are based on routines obtained from the University of Michigan Department of Geography or the Harvard University Laboratory for Computer Graphics, and are believed to be among the best routines available.

It is hoped to produce a revised version of this report during the summer of 1968 which will contain additional programs now in the developmental stage. Comments from users regarding corrections or modifications to the routines are welcome.

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FORTRAN IV PROGRAMS TO DEVELOP CONTOUR

MAPS OF 3-DIMENSIONAL DATA

Joint Highway Research Project

Progress Report

PART I

INTRODUCTION

INTRODUCTION

The graphical display of three-dimensional data is important in many scientific and engineering studies. Such data form surfaces which may be of many types ranging from real surfaces such as the surface of the earth to various mathematical and functional relationships.

This manual describes an integrated series of routines which can be combined to produce various types of graphical displays of three-dimensional surfaces using either the printer or the CALCOMP plotter. Use of the printer has several advantages over the CALCOMP plotter, particularly in the early stages of a project, since the output is produced as part of the regular job output, the printer is cheap and fast (allowing many more plots to be produced), and its use does not require extra tape mounts. Due to the limited resolution of the printer which is controlled by the line and character spacing, printer displays may be distorted, although under favorable conditions distortion can be eliminated. Since the CALCOMP routines are designed to be easily compatible with the printer routines, the plotter can be used for final drafting of selected displays.

PROGRAM LANGUAGE

These routines are written in FORTRAN-IV. Most of these routines can be run on either the IBM 7094 or the CDC 6500 with only minor changes to accommodate the different word lengths on the two machines.

PROGRAM AVAILABILITY

FORTRAN-IV source decks are available for copying in the Airphoto Interpretation and Photogrammetry Laboratory, Room B-24, Civil Engineering Building and in Room G-150, Math. Sciences Building.

METHODS OF SURFACE REPRESENTATION

The three most common methods of graphically displaying three-dimensional data are:

- (1) perspective or isometric views of the surface
- (2) three-dimensional histograms
- (3) contour maps.

Routines presently under development will provide the capability of preparing perspective and isometric views, and three-dimensional histograms. It is hoped that these new routines will be available this summer.

This first edition of the manual describes a series of main programs and associated subroutines to perform the following functions -

- a) Production of contour maps utilizing polynomial equations.
- b) Interpolation of irregularly spaced to gridded data.
- c) Production of contour maps of the printer.
- d) Production of contour maps on the Calcomp plotter.

BENEFITS AND LIMITATIONS OF MACHINE-COMPUTED CONTOUR MAPS

Contouring can be extremely literal, extremely interpretative, or a compromise between the two. The routines developed here give literal contours. As such, the maps produced are not "unbiased," as is often claimed, but are in fact strongly and consistently biased toward literal interpretation of the data.

As a consequence, computer-generated contour maps developed by these routines may not be equally suitable for all applications. They are extremely useful as "quick-look" maps to give the user a general idea of his data, or to check the general validity of the data.

Furthermore, since all maps are made consistently, they can also be used for comparison purposes. Contouring several data sets by humans inevitably involves some learning processes which introduce an uncertain and subtle bias into the results rendering comparison of maps difficult. In contrast, the computer will not "learn" from one problem to the other, but will handle each data set uniformly.

PROCEDURE

Computer contouring of data involves two steps

- 1) determination of regularly spaced (gridded) values of the dependent variable (elevation)
 - 2) linear interpolation to locate contour lines within the grid squares.
- (Obviously, if data is already in grid form, step 1 may be omitted.)

Determination of Gridded Values

1) By Regression Analysis

The determination of regularly spaced values can be accomplished by first developing an analytic equation to describe the data, and then evaluating this equation at a series of grid coordinates. Least squares regression procedures based on the polynomial expansion are commonly used, although double Fourier series expansion procedures have also been

developed (2). Statistical procedures allow the research to determine the ability of the various surfaces to conform to his data (1, 3). These techniques, termed Trend Surface Analysis, have long been used by geologists and geographers (3, 4, 5, 7). They have found residual maps, contour maps showing the lack of fit to the regression equations, useful in locating anomalous areas (6).

Program POLYFIT and its associated subroutines will fit polynomials up to the fifth power and produce trend surface maps. Program RESMAP will produce residual maps.

2) By Weighted Moving-Average Procedures

Weighted moving-averages or the fitting of local polynomials are two other techniques for interpolating irregularly spaced data to a uniform grid. Weighted moving averages are generally computationally easier, and therefore faster, than the fitting of local polynomials.

Subroutine GRID, based on an algorithm developed by Professor W. R. Tobler at the University of Michigan, uses a weighted moving average to determine grid values. As in all interpolation procedures some smoothing of the data results from its use. A limited amount of testing suggests that the smoothing is normally less than 2% of the data range, rising to nearly 10% of the range with extremely erratic data.

Linear Interpolation Within Grid Squares

Subroutines PATCON1 and PATCON2 perform this step on the printer; program CONTUR, performs a similar operation on the CALCOMP plotter.

PATCON1 and PATCON2 differ only in the type of output produced. PATCON1 produces maps with various characters representing different contour intervals. Options allow for the printing of contour lines only, alternate contour bands, or all print positions within the map. PATCON2 produces maps with contour intervals delineated by combinations of overprinted characters to give a graded density from light (low areas) to dark (high areas). Since the overprint carriage control is only available on the CDC 6500, this program is restricted to that machine.

The CALCOMP plotting routines are much more efficient on the IBM 7094; plotting speeds are at least twice as great, and plot tapes are written at a higher density. Under these circumstances program CONTUR has not been converted to run on the CDC 6500, although no unusual difficulties are anticipated for such a conversion.

SUMMARY

A series of integrated routines are available to perform machine contouring of three-dimensional data on either the printer or the CALCOMP plotter.

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- 3) Krumbein, W. C., and Graybill, F. A.; - "An Introduction to Statistical Models in Geology," McGraw-Hill, 1965, 475 pp.
- 4) Merriam, D. F., and Lippert, R. H.; - "Pattern Recognition Studies of Geologic Structure, Using Trend Surface Analysis," Colorado School of Mines Quarterly, Vol. 59, 1964, p. 237-246.
- 5) Merriam, D. F., and Cooke, W. C. (editors); - "Computer Applications in the Earth Sciences: Colloquium on Trend Analysis," Computer Contrib. 12, Kansas Geol. Survey, 1967.
- 6) Thomas, E. N.; - "Maps of Residuals from Regression: Their Characteristics and Uses in Geographic Research," Iowa State Univ. Studies in Geog., No. 2, Dept. of Geog., State Univ. of Iowa, Iowa City, 1960.
- 7) IBM Corp.; - "Numerical Surface Techniques and Contour Map Plotting," Publication E20-0117-0, undated.

PART II

PROCEDURES FOR MAP CONTOURING UTILIZING REGRESSION EQUATIONS

NOTE - Program POLYFIT (and associated subroutines) should be used if polynomial regression surfaces are to be fitted to regularly or irregularly spaced data.

Program RESMAP (and associated subroutines) should be used in conjunction with program POLYFIT to analyze residual and original data.

CONTENTS OF THIS SECTION

- 1) Program POLYFIT - including subroutines
 READ1, INVER, INVCK, POLY, EVALU,
 and PLOT
- 2) Program RESMAP

PURPOSE --

TO PERFORM TREND SURFACE ANALYSIS USING POWER SERIES EXPANSION. POLYNOMIALS UP TO FIFTH DEGREE CAN BE REQUESTED. THIS PROGRAM HAS EVOLVED FROM AN EARLIER PROGRAM OBTAINED FROM PROFESSOR R.B. JOHNSON, FORMERLY HEAD OF THE DEPARTMENT OF GEOSCIENCES, PURDUE UNIVERSITY.

PURDUE UNIVERSITY VERSION 4.2

A KEITH TURNER,
CIVIL ENGINEERING,
FEBRUARY, 1968.

THIS VERSION CAN FIT A SURFACE TO 1000 DATA POINTS. UP TO FOUR DIFFERENT VARIABLES CAN BE ANALYZED AT EACH POINT. DATA CARDS (ONE PER POINT) SHOULD INCLUDE IDENTIFICATION, X-COORDINATE, Y-COORDINATE, AND VARIABLES 1-4 (Z1, Z2, Z3, Z4). AN UNLIMITED NUMBER OF DATA SETS, EACH CONTAINING UP TO 1000 POINTS, CAN BE PROCESSED.

THE PROGRAM WILL (1) FIT THOSE POLYNOMIAL SURFACES REQUESTED, (2) LIST THE MATRICES USED TO DETERMINE THE COEFFICIENTS, (3) LIST THE COEFFICIENTS, (4) ESTIMATE THE ERROR IN EACH COEFFICIENT, (5) PERFORM ANALYSIS OF VARIANCE, AND (6) LIST THE ORIGINAL DATA, COMPUTED VALUES, AND RESIDUALS FOR ALL POINTS.

SUBROUTINES EVALU AND PLOT GENERATE AND MACHINE-PUNCH GRIDDED VALUES FOR SELECTED TREND SURFACES AND PRODUCE PRINTER-CONTOUR MAPS OF THESE SURFACES. A VARIETY OF CONTOUR MAPS CAN BE SPECIFIED, MULTIPLE MAPS OF ANY SURFACE MAY BE PRODUCED. THE GRIDDED VALUES MAY PRODUCE CALCOMP CONTOUR MAPS USING PROGRAM CONTOUR.

ALL ORIGINAL AND COMPUTED VALUES, AND RESIDUALS, FOR THE DATA CAN BE STORED ON A USER-DESIGNATED TAPE (TAPE8) FOR LATER ANALYSIS.

TAPE REQUIREMENTS --

TAPE1 IS A SCRATCH TAPE USED TO STORE AND REGENERATE DATA DESTROYED DURING THE OPERATION OF SUBROUTINES EVALU AND PLOT. NO REQUEST CARD IS NECESSARY SINCE A DISK FILE WILL AUTOMATICALLY BE GENERATED.

TAPE8 IS USED TO STORE THE ORIGINAL INPUT VALUES, COMPUTED VALUES AND RESIDUALS FOR ALL POINTS. THE TAPE SHOULD BE WRITTEN IN BINARY AT 556 BPI. THE REQUEST CARD FORM IS --

REQUEST (TAPE8,41) PLEASE MOUNT USERTAPENAME, FILE XXX

THE FIRST TAPE RECORD WILL CONTAIN THE NUMBER OF DATA POINTS (N) BEING ANALYZED, THERE THEN FOLLOW N RECORDS CONTAINING THE DATA ID, X, Y, Z, 1ST DEGREE ESTIMATE, 1ST DEGREE RESIDUAL, ---, 5TH DEGREE RESIDUAL.

THIS SEQUENCE WILL BE REPEATED FOR EACH VARIABLE (ONE UP TO FOUR TIMES) FOR EACH DATA SET OF 1000 POINTS OR LESS. AN END-OF-FILE IS WRITTEN AFTER THE LAST DATA SET.

IF IT IS DESIRED TO IMMEDIATELY ANALYZE THE RESIDUALS, PROGRAM RESMAP MAY BE INCLUDED UNDER THE SAME JOB CARD. IN THIS CASE NO TAPE REQUEST CARD IS REQUIRED.

ROUTINES REQUIRED

A) MAIN PROGRAM (POLYFIT)

B) SUBROUTINES

- 1) READ1 - READS THE DATA CARDS.
- 2) INVER - DETERMINES INVERSE MATRIX.
- 3) INVCH - PRINTS OUT X-PRIME-X MATRIX.
- 4) POLY - DETERMINES (ESTIMATED VALUES AND RESIDUALS.
- 5) EVALU - EVALUATES SURFACES AT GRID POINTS.
- 6) PLOT - PRODUCES PRINTER CONTOUR MAPS.
- 7) STATS - CALCULATES STATISTICAL MEASURES.

DESCRIPTION OF CONTROL CARDS - (REPEAT ALL CARDS FOR EACH DATA SET)

1) LABEL CARD -

POLYFIT (COLS 1-6) CODE WORD INDICATING START OF DATA

2) MASTER CONTROL CARD -

POLYFIT (COLS 1-6)

LIMIT(1-5) (COLS 11-15) IF LIMIT(K)=1, SURFACE OF DEGREE K FITTED.

ISURF(1-5) (COLS 16-20) IF ISURF(K)=1, GRID VALUES FOR SURFACE K ARE CALCULATED (THESE WILL BE PUNCHED IF SPECIFIED ON CARD 9). HOWEVER NO MAP WILL BE PRINTED.

IF ISURF(K)=2, GRID VALUES WILL BE DETERMINED AND MAP(S) OF SURFACE K WILL BE PRINTED.

INCK (COL 25) IF INCK=1, X-PRIME-X MATRICES PRINTED.

NLINE5 (COL 30) NUMBER OF GENERAL TITLE CARDS TO FOLLOW, MAXIMUM=5

NZ(1-4) (COLS 37-40) IF NZ(K)=1, VARIABLE K WILL BE ANALYZED.

NRES (COL 50) IF NRES=1, RESIDUAL VALUES LISTED.

IOUT1 (COL 60) IF IOUT1=1, DATA WRITTEN ON TAPE 8.

3) GENERAL TITLE CARD(S) -

1-5 CARDS (NUMBER EQUALS NLINE5), EACH CARD CONTAINS ANY ALPHANUMERIC TITLE IN COLS 1-72

4) VARIABLE IDENTIFICATION CARD -

FOUR SETS OF ALPHANUMERIC TITLES (COLS 1-20, 21-40, 41-60, 61-80)

WHICH WILL IDENTIFY VARIABLES Z1-Z4.

NOTE-IF NO FURTHER IDENTIFICATION REQUIRED, INSERT BLANK CARD

5) FORMAT CARD -

FORMAT OF DATA (COLS 7-78), SHOULD BE IN FORM (A10,5FLOATING POINT FIELDS(X,Y,Z1,Z2,Z3,Z4))

6) DATA CARDS -

(ONE CARD FOR EACH POINT.)

7) BLANK CARD -

BLANK CARD USED TO DISTINGUISH END OF DATA SET.

7
IF THE GRIDDING OR GRIDDING AND MAPPING OPTIONS ARE REQUESTED
(IF ISURF(K)=1 OR 2) , THE FOLLOWING CARDS MUST BE REPEATED FOR EACH
REQUEST --

8) AREA DEFINITION CARD -

MAXIMUM AND MINIMUM VALUES OF X AND Y COORDINATES (XMAX,XMIN,
YMAX,YMIN) WITH DECIMALS PUNCHED(COLS 1-10,11-20,21-30,31-40)

9) GRID SPECIFICATION CARD -

ROWS(COLS 1-3) INTEGER NUMBER OF ROWS IN GRID(MAXIMUM=100).
COLS(COLS 4-6) INTEGER NUMBER OF COLUMNS IN GRID(MAXIMUM=100).
NMAP(COLS 7-9) NUMBER OF DIFFERENT MAPS OF THIS SURFACE TO BE
PRINTED.

IPUN(COL 10) IF IPUN=1,GRID VALUES PUNCHED (EACH SURFACE IDENT-
IFIED BY PUNCHED TITLE CARDS)

NOTE-A) FOR 1 INCH GRID COLS=MAP WIDTH (INCHES) + 1
ROWS=MAP LENGTH (INCHES) + 1

B) IF COLS.GT.42,PRODUCTION OF PRINTER MAPS IS IMPOSSIBLE
DUE TO LIMITED WIDTH OF PAPER (HOWEVER
CALCOMP PLOTS ALLOW UP TO 100X100 ARRAYS).

REPEAT THE FOLLOWING CARD(S) FOR EACH MAP REQUESTED BY NMAP -

10) PLOT CONTROL CARD -

CON (COLS 1-2) NUMBER OF CONTOUR INTERVALS,MAXIMUM = 19
IF CON = 0, CON SET TO 6.

TOUR(COL 3) IF TOUR=0,MAX. AND MIN. DATA ELEVATIONS USED AS
CONTOUR LIMITS.

IF TOUR=1,DESIRED TOP AND BOTTOM CONTOURS READ IN
FROM SPECIAL CARD (SEE BELOW)

IF TOUR=2,VARIABLE CONTOURS READ IN (LOW TO HIGH).
IN THIS CASE SET CON EQUAL TO THE NUMBER OF VALUES
TO BE READ IN.

IF TOUR=3,CONTOUR INTERVAL BECOMES 1/2 STANDARD
DEVIATION INCREMENTS.(MAX=+3 SIGMA, MIN=-3 SIGMA)

LINES(COL4) IF LINES=0, CONTOUR LINES ARE PRINTED.

IF LINES=1,ALTERNATE(EVEN-VALUED) BANDS ARE PRINTED
IF LINES=2, COMPLETE BANDS ARE PRINTED.

INCHES(COLS5-9) WIDTH OF MAP IN INCHES,MAXIMUM=12.7

11) SPECIAL CARD(S) (REQUIRED ONLY IF TOUR = 1 OR 2)

IF TOUR=1, THIS CARD SPECIFIES MINIMUM AND MAXIMUM ELEVATION
VALUES. ZMIN(COLS 1-10),ZMAX(COLS 11-20) DECIMALS PUNCHED.

IF TOUR=2, THIS CARD SPECIFIES A FORMAT (INCON) USED IN READING
A SERIES OF IRREGULARLY SPACED CONTOUR VALUES. THE VALUES ARE
ARRANGED FROM LOWEST TO HIGHEST ON SUBSEQUENT CARDS. SET CON=
NUMBER OF LINES.

PROGRAM POLYFIT MAIN PROGRAM

PROGRAM POLYFIT(INPUT,OUTPUT,PUNCH,TAPE1,TAPE8, APE5=INPUT,TAPE6=1
OUTPUT)

DIMENSION XX(21,21), R(21), A(21,5), XINV(21,21,5), PAR(21), ZR(10
1), SSR(5), BB(21,4), SSQZ(4), X(1000), Y(1000), Z(1000,4), ID(1000
2), LIMIT(5), NZ(4), ERR(21), SSE(5), DFREE(5)
DIMENSION ISURF(5), TITL(8,5), ORDIN(4,2)
DIMENSION DUM1(3000)
COMMON X,Y,Z,ID,DUM1,XINV,A,KSOR
DATA NDOG/6HPOLYFT/
XD=0.0
YD=0.0
ZD=0.0

SEARCH THE INPUT TAPE FOR THE PARAMETER CARD WITH THE CODE POLYFT

READ (5,370) LABLE

IF (EOF,5) 310,10

IF (LABLE-NDOG) 5,15,5

READ (5,375) LABLE,LIMIT,ISURF,INCK,NLINES,NZ,NRES,IOUT1

WRITE OUT HEADING

WRITE (6,455)

DO 20 I=1,NLINES

READ (5,320) (TITL(II,I),II=1,8)

WRITE (6,460) (TITL(II,I),II=1,8)

WRITE (6,380)

READ (5,465) (ORDIN(I,1),ORDIN(I,2),I=1,4)

SSQZ(1)=0.0

SSQZ(2)=0.0

SSQZ(3)=0.0

SSQZ(4)=0.0

DO 30 I=1,5

J=6-I

IF (LIMIT(J)) 25,30,25

N=((J+1)*(J+2))/2

JUMP=I

GO TO 35

CONTINUE

GO TO 305

READ THE DATA POINTS

CALL READ1 (NCARDS)

```

C      COMPUTE THE COEFFICIENT MATRIX
C
      PAR(1)=1.0
      DO 45 I=1,N
        DO 40 J=I,N
40          XX(I,J)=0.0
            BB(I,1)=0.0
            BB(I,2)=0.0
            BB(I,3)=0.0
45          BB(I,4)=0.0
            DO 95 K=1,NCARDS
              XD=X(K)
              YD=Y(K)
              PAR(2)=XD
              PAR(3)=YD
              GO TO (50,50,50,50,70), JUMP
50          PAR(4)=XD*XD
              PAR(5)=XD*YD
              PAR(6)=YD*YD
              GO TO (55,55,55,70,70), JUMP
55          PAR(7)=PAR(4)*XD
              PAR(8)=PAR(4)*YD
              PAR(9)=PAR(6)*XD
              PAR(10)=PAR(6)*YD
              GO TO (60,60,70,70,70), JUMP
60          PAR(11)=PAR(7)*XD
              PAR(12)=PAR(7)*YD
              PAR(13)=PAR(4)*PAR(6)
              PAR(14)=PAR(10)*XD
              PAR(15)=PAR(10)*YD
              GO TO (65,70,70,70,70), JUMP
65          PAR(16)=PAR(11)*XD
              PAR(17)=PAR(11)*YD
              PAR(18)=PAR(7)*PAR(6)
              PAR(19)=PAR(10)*PAR(4)
              PAR(20)=PAR(15)*XD
              PAR(21)=PAR(15)*YD
70          DO 75 I=1,N
              DO 75 J=I,N
75          XX(I,J)=XX(I,J)+PAR(I)*PAR(J)
C
C      COMPUTE THE B VECTORS FOR EACH Z TO BE FITTED.
C
      DO 90 JIM=1,4
        IF (NZ(JIM)) 80,90,80
80        ZD=Z(K,JIM)
        DO 85 I=1,N
85        BB(I,JIM)=BB(I,JIM)+ZD*PAR(I)
            SSQZ(JIM)=SSQZ(JIM)+ZD*ZD
90        CONTINUE
95        CONTINUE

```

```

WRITE (6,325)
DO 100 I=1,N
  WRITE (6,330) I,(XX(I,J),J=1,N)
100  CONTINUE
  WRITE (6,335)
  DO 105 JIM=1,4
    IF (NZ(JIM).EQ.0) GO TO 105
  DO 105 I=1,N
    WRITE (6,340) I,BB(I,JIM)
105  CONTINUE
  NM1=N-1
  DO 110 I=1,NM1
    IP1=I+1
    DO 110 J=IP1,N
110  XX(J,I)=XX(I,J)
    WRITE (6,345)
    DO 115 I=1,N
      WRITE (6,330) I,(XX(I,J),J=1,N)
115  CONTINUE
    DO 140 K=1,5
      IF (LIMIT(K)) 120,140,120
120  NTERMS=((K+1)*(K+2))/2
      KSOR=0
      CALL INVER (XX,XINV,NTERMS,K)
      IF (KSOB) 125,130,125
125  WRITE (6,385) K
      LIMIT(K)=0
130  CONTINUE
      IF (INCK) 135,140,135
135  CALL INVCK (XX,XINV,K)
140  CONTINUE
      REWIND 1
C
C   THE JIM DO LOOP RUNNING TO STATEMENT 300 CONTROLS WHICH Z IS BEING
C   FITTED.
C
  DO 300 JIM=1,4
    IF (NZ(JIM)) 145,300,145
145  DO 150 I=1,NCARDS
150  READ (1) ID(I),X(I),Y(I),Z(I,1),Z(I,2),Z(I,3),Z(I,4)
    SSZ=SSQZ(JIM)
    DO 155 I=1,N
155  B(I)=BB(I,JIM)
C
C   COMPUTE COEFFICIENTS
C
  DO 170 K=1,5
    IF (LIMIT(K)) 160,170,160
160  NTERMS=((K+1)*(K+2))/2

```



```

DO 165 I=1, NTERMS
  A(I,K)=0.0
DO 165 J=1, NTERMS
  A(I,K)=A(I,K)+XINV(I,J,K)*B(J)
165
170 CONTINUE
  WRITE (6,455)
DO 175 I=1, NLINES
  WRITE (6,460) (TITL(II,I), II=1,8)
  WRITE (6,395) ORDIN(JIM,1), ORDIN(JIM,2)
  WRITE (6,390) NCARDS
DO 185 K=1,5
  IF (LIMIT(K)) 180,185,180
180 NTERMS=((K+1)*(K+2))/2
  WRITE (6,400) K, (A(I,K), I=1, NTERMS)
185 CONTINUE
C
C ANALYSIS OF VARIANCE
C ERROR ESTIMATES FOR COEFFICIENTS
C
  ZSUM=0.0
DO 190 K=1, NCARDS
  ZSUM=ZSUM+Z(K,JIM)
190 ZBAR=ZSUM/FLOAT(NCARDS)
  SSZBAR=ZSUM*ZBAR
  SSZ=SSZ-SSZBAR
  WRITE (6,405)
DO 210 K=1,5
  IF (LIMIT(K)) 195,210,195
195 NTERMS=((K+1)*(K+2))/2
  SSR(K)=0.0
DO 200 J=1, NTERMS
  SSR(K)=SSR(K)+A(J,K)*B(J)
200 SSR(K)=SSR(K)-SSZBAR
  SSE(K)=SSZ-SSR(K)
  DFREF(K)=NCARDS-NTERMS-1
  SIGMAE=SQRT(SSE(K)/DFREF(K))
DO 205 J=1, NTERMS
  FRR(J)=SIGMAE*SQRT(XINV(J,J,K))
205 WRITE (6,410) K, (ERR(J), J=1, NTERMS)
210 CONTINUE
C
C ANALYSIS OF VARIANCE
C
  WRITE (6,455)
DO 215 I=1, NLINES
215 WRITE (6,460) (TITL(II,I), II=1,8)
  WRITE (6,470) ORDIN(JIM,1), ORDIN(JIM,2)
  WRITE (6,415)
  NDF=NCARDS-1
  WRITE (6,350) NDF, SSZBAR

```

```

DO 225 K=1,5
  IF (LIMIT(K)) 220,225,220
220  NTERMS=((K+1)*(K+2))/2
      XSE=SSE(K)/DFREE(K)
      XSR=SSR(K)/FLOAT(NTERMS)
      F=XSR/XSE
      NDF=DFREE(K)
      WRITE (6,420) K,NTERMS,NDF,SSR(K),XSR,SSE(K),XSF,F
225  CONTINUE
      JACK=6-JUMP
      WRITE (6,355) SSZ
      WRITE (6,360)
      DO 235 K=1,5
        IF (LIMIT(K)) 230,235,230
230  RR=SSR(K)/SSZ
        PCENT=RR*100.0
        R=SQRT(RR)
        WRITE (6,365) K,PCENT,RR,R
235  CONTINUE
      WRITE (6,425) JACK
      KSWT=1
      DO 255 K=1,5
        IF (LIMIT(K)) 240,255,240
240  NTERMS=((K+1)*(K+2))/2
        GO TO (245,250), KSWT
245  KSWT=2
        NTERMS=NTERMS-1
        XMSQ=SSR(K)/FLOAT(NTERMS)
        F=XMSQ/(SSE(JACK)/DFREE(JACK))
        WRITE (6,430) K,NTERMS,SSR(K),XMSQ,F
        NTE=NTERMS+1
        J=K
        GO TO 255
C
C
250  DF=NTERMS-NTE
        SSQ=SSR(K)-SSR(J)
        XMSQ=SSQ/DF
        F=XMSQ/(SSE(JACK)/DFREE(JACK))
        NDF=DF
        WRITE (6,430) K,NDF,SSQ,XMSQ,F
        J=K
        NTE=NTERMS
255  CONTINUE
      IF (NRES) 260,300,260
260  WRITE (6,455)
      DO 265 I=1,NLINES
265  WRITE (6,460) (TITL(II,I),II=1,8)
      WRITE (6,435) ORDIN(JIM,1),ORDIN(JIM,2)
      WRITE (6,440)

```

```

270      DO 270 I=1,10
      ZR(I)=0.0
      IF (IOUT1.NE.1) GO TO 275
      WRITE (8) NCARDS
275      DO 285 I=1,NCARDS
          XD=X(I)
          YD=Y(I)
          ZD=Z(I,JIM)
          CALL POLY (ZR,LIMIT,XD,YD,ZD)
          WRITE (6,445) ID(I),X(I),Y(I),Z(I,JIM),(ZR(K),K=1,10)
          IF (IOUT1.NE.1) GO TO 280
          WRITE (8) ID(I),X(I),Y(I),Z(I,JIM),(ZR(K),K=1,10)
280      CONTINUE
285      CONTINUE
          DO 295 I=1,5
              IF (ISURF(I).NE.1.AND.ISURF(I).NE.2) GO TO 290
              CALL EVALU (A,I,ISURF,TITL,NLINES,ORDIN,JIM)
290      CONTINUE
              REWIND 1
295      CONTINUE
300      CONTINUE
          GO TO 5
C
C
305      WRITE (6,450)
          GO TO 5
C
C
310      CONTINUE
          IF (IOUT1.NE.1) GO TO 315
          END FILE 8
          REWIND 8
315      CONTINUE
          STOP
C
C
C
320      FORMAT (8A10)
325      FORMAT (1H1,13HTHE XX MATRIX,///,4H ROW)
330      FORMAT (1H0,I3,2X,11E10.3,/,6X,10E10.3)
335      FORMAT (1H1,13HTHE BB MATRIX,///,4H ROW)
340      FORMAT (1H0,I3,2X,E16.4)
345      FORMAT (1H1,21HTHE REVISED XX MATRIX,///,4H ROW)
350      FORMAT (1H0,12H MEAN      1,/,I4,E17.8)
355      FORMAT (///30X,47HCORRECTED TOTAL SS= TOTAL SS - SS DUE TO MEAN =,
1F20.6)
360      FORMAT (///1X,81HPERCENT SS EXPLAINED BY REGRESSION=MULTIPLE CORR
RELATION COEFFICIENT ( R-SQUARED ),///,54H DEGREE   PERCENT VARIAT
ION EXPLAINED R-SQUARED      R)
365      FORMAT (1H0,I4,15X,F10.3,10X,F7.5,3X,F7.5)

```

```

370  FORMAT (A6)
375  FORMAT (A6,4X,5I1,5I1,4X,I1,3X,I2,6X,4I1,9X,I1,9X,I1)
380  FORMAT (1H0,///,5X,52HTREND SURFACE ANALYSIS USING POWER SERIES EX
1PANSION.,/,5X,48HPOLYNOMIALS UP TO FIFTH DEGREE CAN BE REQUESTED./
2)
385  FORMAT (46H THE COEFFICIENT MATRIX FOR THE FIT OF DEGREE ,I1,70H I
1S MACHINE SINGULAR. THE PROGRAM WILL TRY THE OTHER FITS ASKED FOR
2. )
390  FORMAT (1H0,15X,39H THE NUMBER OF POINTS IN THIS GROUP IS,I5,///
1)
395  FOPMAT (1H0,25X,28HTREND SURFACE EQUATIONS FOR , 2A10, /
181HTHE COEFFICIENTS, WITH THE CONSTANT TERM LISTED FIRST. THE FOR
2M OF THE POLY IS //12CH Z=A1+A2X+A3Y+A4X2+A5XY+A6Y2+A7X3+A8X2Y+
3A9XY2+A10Y3+A11X4+A12X3Y+A13X2Y2+A14+XY3+A15Y4+A16X5+A17X4Y+A18X3Y
42+ ... ETC. //1X,7H DEGREE)
400  FORMAT (1H0,I4,3X,7E16.7//E24.7,6E16.7//E24.7,6E16.7)
405  FORMAT (///51H ESTIMATE OF ERROR IN THE COEFFICIENTS OF THE POLYS/
1/10H DEGREE)
410  FORMAT (1H0,I6,1X,7E16.2,///F24.2,6F16.2,///F24.2,6E16.2)
415  FORMAT (56H0 ANALYSIS OF VARIANCES FOR ALL REGRESSION
1S////1X,99H SOURCE D.F. SS DUE REG. MS DUE REG.
2 SS ERROR MS ERROR F-RATIO )
420  FORMAT (1H0,7HDEGREE ,I1,I3,1H,,I4,E17.8,E16.8,E19.8,F18.5,F14.3)
425  FORMAT (////34H ANALYSIS OF VARIANCE FOR ,I1,12H DEGREE PO
1LY////75H DEGREE OF SOURCE D.F. SUM OF SQUARES MEAN SQUA
2RE F-RATIO )
430  FORMAT (7X,I1,12X,I2,E20.8,E20.8,F17.5)
435  FORMAT (1H0,18X,82HCOORDINATES,ORIGINAL AND COMPUTED VALUES,AND RE
1SIDUALS FOR ALL SURFACES REQUESTED.,//,40X,12HDATA IS FOR ,2A10,
2//)
440  FORMAT (1H0,8X,I15HID X Y Z Z-LINEAR RES-L
1 Z-QUAD. RES-QD Z-CUBIC RES-C Z-QUAR. RES-QR Z-QUINT RES-
2QT/1X)
445  FORMAT (1H ,A10,2F8.2,F9.3,5(F9.3,F9.3))
450  FORMAT (104HTHE LIMIT PARAMETER IS ZERO FOR THIS GROUP. THIS MEANS
1 NO FIT WAS ASKED FOR. GOING ON TO NEXT GROUP. )
455  FORMAT (1H1)
460  FORMAT (1H ,20X,8A10)
465  FORMAT (8A10)
470  FORMAT (1H0,30X, 9HDATA FOR ,2A10,/)
END

```

SUBROUTINE READ1

PURPOSE -

TO READ ID,X,Y,Z1,Z2,Z3,Z4 DATA FROM THE DATA CARDS.

THE DATA CARDS SHOULD BE PRECEDED BY A FORMAT CARD (COLS 7-78) AND BE FOLLOWED BY A BLANK CARD. THE SUBROUTINE DETERMINES THE NUMBER OF POINTS IN THE DATA SET BY SEARCHING FOR A CARD CONTAINING BLANKS IN COLUMNS 1-10 .

USAGE -

CALL READ1(NCARDS)

NCARDS - THE NUMBER OF DATA POINTS BEING ANALYZED. THIS IS DETERMINED BY READ1.

SUBROUTINE READ1 (NCARDS)

DIMENSION X(1000), Y(1000), Z(1000,4), ID(1000)

DIMENSION FMT(12)

COMMON X,Y,Z,ID

DATA NBLANK/10H

I=1

READ (5,20) FMT

5 READ (5,FMT) ID(I),X(I),Y(I),Z(I,1),Z(I,2),Z(I,3),Z(I,4)

WRITE (1) ID(I),X(I),Y(I),Z(I,1),Z(I,2),Z(I,3),Z(I,4)

IF (ID(I)-NBLANK) 10,15,10

10 I=I+1

GO TO 5

15 NCARDS=I-1

RETURN

20 FORMAT (6X,12A6)

END

SUBROUTINE INVER

PURPOSE -
TO INVERT THE XX MATRICES FOR ALL SURFACES BEING FITTED.

USAGE -

CALL INVER(XX,XINV,K,NDEGRF)

XX - MATRIX FOR WHICH INVERSE IS REQUIRED.

XINV - THE CALCULATED INVERSE.

K - NUMBER OF TERMS IN EQUATION BEING DETERMINED=SIZE OF MATRIX.

NDEGRF - DEGREE OF EQUATION BEING DETERMINED.

SUBROUTINE INVER (XX,XINV,K,NDEGRE)

DIMENSION XX(21,21), XINV(21,21,5), AM(21,22)

DIMENSION N(21), DUMMY(12310)

COMMON DUMMY,KSOS

DO 5 I=1,K

DO 5 J=1,K

AM(I,J)=XX(I,J)

KK=K+1

INITIALIZE THE ROW PERMUTATION CELLS TO ZERO.

DO 10 I=1,K

N(I)=0

DO 85 J=1,K

I=1

JJ=J-1

DO 20 L=1,JJ

IF (N(L)-1) 20,25,20

CONTINUE

IF (AM(I,1)) 35,25,35

I=I+1

IF (K-I) 30,15,15

KSOR=1

RETURN

AMA=ABS(AM(I,1))

II=I

II=II+1

IF (K-II) 60,45,45

DO 50 IZ=1,J

IF (N(IZ)-II) 50,40,50

CONTINUE

AMB=ABS(AM(II,1))

TEST FOR MAXIMAL SIZE PIVOTAL ELEMENT.

IF (AMA-AMB) 55,40,40

AMA=AMB

I=II

GO TO 40


```

C
C
60      N(J)=I
C
C      ADJOIN THE CORRECT IDENTITY COLUMN VECTOR.
C
      DO 65 IZ=1,K
65      AM(IZ,KK)=0.0
      AM(I,KK)=1.0
      DA=AM(I,1)
C
C      NORMALIZE THE PIVOTAL ROW.
C
      DO 70 IZ=2,KK
70      AM(I,IZ-1)=AM(I,IZ)/DA
      DO 85 IZ=1,K
      IF (IZ-1) 75,85,75
75      DB=AM(IZ,1)
C
C      ZERO OUT NON-PIVOTAL COLUMN ELEMENTS.
C
      DO 80 JZ=2,KK
80      AM(IZ,JZ-1)=AM(IZ,JZ)-AM(I,JZ-1)*DB
85      CONTINUE
      DO 100 I=1,K
      DO 90 J=1,K
      IF (N(J)-I) 90,95,90
90      CONTINUE
95      DO 100 I=1,K
      LL=N(L)
100     XINV(L,.,NDEGRE)=AM(LL,J)
      RETURN
      END

```

SUBROUTINE INVCK

PURPOSE -

TO DETERMINE AND PRINT OUT THE PRODUCT OF THE XX AND XX INVERSE
 MATRICES FOR ALL SURFACES BEING FITTED. THIS SUBROUTINE CALLED ONLY
 WHEN INCK (COL 25, MASTER CONTROL CARD) IS SET EQUAL TO 1 (SEE DES-
 CRIPTION OF CONTROL CARDS PAGE) .

THESE LISTINGS CAN BE EXAMINED TO DETERMINE IF STRONG DISCREP-
 ANCIES FROM AN IDENTITY MATRIX OCCUR FOR ANY SURFACE. IF DISCREP-
 ANCIES OCCUR, THE COEFFICIENTS SHOULD BE REGARDED WITH SUSPICION .

USAGE -

CALL INVCK(A,B,K)

A - ORIGINAL XX MATRIX.

B - INVERSE MATRICES FOR EACH DEGREE SURFACE.

K - NUMBER OF TERMS IN EQUATION OF EACH SURFACE=SIZE OF IDENTITY
 AND OTHER MATRICES.

SUBROUTINE INVCK (A,B,K)

DIMENSION A(21,21), B(21,21,5), C(21)

N=((K+1)*(K+2))/2

WRITE (6,15) K

DO 10 I=1,N

DO 5 J=1,N

C(J)=0.0

DO 5 L=1,M

C(J)=A(I,L)*B(L,J,K)+C(J)

WRITE (6,20) I, (C(J), J=1, N)

RETURN

FORMAT (1H1,77H THE PRODUCT OF THE COEFFICIENT MATRIX AND ITS INVE-
 RSE FOR THE FIT OF DEGREE ,I2,///4H ROW)

FORMAT (1H0,I3,2X,11F10.7, /6X,10F10.7)

END

SUBROUTINE POLY

PURPOSE --

TO EVALUATE THE EQUATIONS OF THE REQUESTED SURFACES AT EACH
OBSERVED DATA LOCATION IN ORDER TO DETERMINE THE ESTIMATED VALUES
AND THE RESIDUALS FOR EACH DATA POINT.

USAGE -

CALL POLY(ZR,LIMIT,XDD,YDD,ZDD)

ZR - UP TO TEN VALUES WHICH ARE THE CALCULATED AND RESIDUAL VALUES
FOR THIS DATA POINT FOR ALL SURFACES REQUESTED.

LIMIT - PARAMETER SPECIFYING WHICH SURFACES ARE BEING FITTED.

XDD - X COORDINATE OF THIS DATA POINT.

YDD - Y COORDINATE OF THIS DATA POINT.

ZDD - Z COORDINATE OF THIS DATA POINT.

```

SUBROUTINE POLY (ZR,LIMIT,XDD,YDD,ZDD)
  DIMENSION A(21,5), ZR(10), XD(1), YD(1), ZD(1), PT(1)
  DIMENSION XDD(1), YDD(1), ZDD(1)
  DIMENSION LIMIT(5), DUMMY(12205)
  COMMON DUMMY,A
  XD=XDD
  YD=YDD
  ZD=ZDD
  DO 40 K=1,5
    IF (LIMIT(K)) 5,40,5
    GO TO (10,15,20,25,30), K
    PT=A(1,K)+XD*A(2,K)+YD*A(3,K)
    GO TO 35

1  PT=A(1,2)+XD*A(2,2)+YD*A(3,2)+XD*XD*A(4,2)+XD*YD*A(5,2)+YD*YD*A
    (6,2)
    GO TO 35

C
C
C
20  XD2=XD*XD
    YD2=YD*YD
    PT=A(1,3)+XD*A(2,3)+YD*A(3,3)+XD2*A(4,3)+XD*YD*A(5,3)+YD2*A(6,3)
1  )+XD2*XD*A(7,3)+XD2*YD*A(8,3)+XD*YD2*A(9,3)+YD2*YD*A(10,3)
    GO TO 35

C
C
C
25  XD2=XD*XD
    XD3=XD2*XD
    YD2=YD*YD
    YD3=YD2*YD
    PT=A(1,4)+XD*A(2,4)+YD*A(3,4)+XD2*A(4,4)+XD*YD*A(5,4)+YD2*A(6,4)
    )+XD3*A(7,4)+XD2*YD*A(8,4)+XD*YD2*A(9,4)+YD3*A(10,4)+XD2*XD2*A(
    11,4)+XD3*YD*A(12,4)+XD2*YD2*A(13,4)+XD*YD3*A(14,4)+YD2*YD2*A(1
    5,4)
    GO TO 35

```

```

C
30      XD2=XD*XD
        XD3=;D2*XD
        XD4=;D3*XD
        YD2=YD*YD
        YD3=YD2*YD
        YD4=YD3*YD
        PT=A(1,5)+XD*A(2,5)+YD*A(3,5)+XD2*A(4,5)+XD*YD*A(5,5)+YD2*A(6,5)
1      )+XD3*A(7,5)+XD2*YD*A(8,5)+XD*YD2*A(9,5)+YD3*A(10,5)
        PT=PT+XD4*A(11,5)+XD3*YD*A(12,5)+XD2*YD2*A(13,5)+XD*YD3*A(14,5)
1      +YD4*A(15,5)+XD4*XD*A(16,5)+XD4*YD*A(17,5)+XD3*YD2*A(18,5)+XD2*
2      YD3*A(19,5)+XD*YD4*A(20,5)+YD*YD4*A(21,5)
35     ZR(2*K-1)=PT
        ZR(2*K)=ZD-PT
40     CONTINUE
        RETURN
        END

```

SUBROUTINE EVALU

PURPOSE -

TO EVALUATE THE EQUATIONS OF THE SURFACES AT A SERIES OF EQUALLY SPACED (GRIDDED) LOCATIONS SO THAT CONTOUR MAPS OF THE SURFACES CAN BE PREPARED,

USAGE -

CALL EVALU(A,K,ISURF,TITL,NLINES,ORDIN,JIM)

A - MATRIX CONTAINING POLYNOMIAL COEFFICIENTS

K - COUNTER USED TO IDENTIFY SURFACES IN MAP TITLES.

ISURF - PARAMETER USED TO SPECIFY MAPPING OR GRIDDING OPTIONS.

TITL - GENERAL ALPHANUMERIC TITLE(S), NUMBER SPECIFIED BY NLINES

NLINES - NUMBER OF TITLE LINES (NUMBER OF CARDS), MAXIMUM= 5 .

ORDIN - SPECIFIC ALPHANUMERIC TITLES USED TO IDENTIFY VARIABLES.

JIM - COUNTER USED TO IDENTIFY WHICH VARIABLE (1-4) BEING ANALYZED

SUBROUTINE EVALU (A,K,ISURF,TITL,NLINES,ORDIN,JIM)

INTEGER COLS,ROWS

DIMENSION ISURF(5)

DIMENSION A(21,5), C(100,100), DUMMY(2205)

DIMENSION TITL(8,5), ORDIN(4,2)

COMMON C,DUMMY,A

READ (5,90) XMAX,XMIN,YMAX,YMIN

READ (5,95) ROWS,COLS,NMAP,IPUN

XINC=(XMAX-XMIN)/FLOAT(COLS-1)

YINC=(YMAX-YMIN)/FLOAT(ROWS-1)

ZERO C ARRAY

DO 5 KK=1,95

DO 5 JJ=1,95

C(JJ,KK)=0.0

DEFINE STARTING X AND Y

XD=XMIN

YD=YMAX

DO 45 JJ=1,ROWS

DO 40 KK=1,COLS

GO TO (10,15,20,25,30), K

PT=A(1,1)+XD*A(2,1)+YD*A(3,1)

GO TO 35

PT=A(1,2)+XD*A(2,2)+YD*A(3,2)+XD*XD*A(4,2)+XD*YD*A(5,2)+YD*YD*A(6,2)

GO TO 35

```

C
20      XD2=XD*XD
      YD2=YD*YD
      PT=A(1,3)+XD*A(2,3)+YD*A(3,3)+XD2*A(4,3)+XD*YD*A(5,3)+YD2*A(
1      6,3)+XD2*XD*A(7,3)+XD2*YD*A(8,3)+XD*YD2*A(9,3)+YD2*YD*A(10,3)
2      )
      GO TO 35

C
C
25      XD2=XD*XD
      XD3=XD2*XD
      YD2=YD*YD
      YD3=YD2*YD
      PT=A(1,4)+XD*A(2,4)+YD*A(3,4)+XD2*A(4,4)+XD*YD*A(5,4)+YD2*A(
1      6,4)+XD3*A(7,4)+XD2*YD*A(8,4)+XD*YD2*A(9,4)+YD3*A(10,4)+XD2*
2      XD2*A(11,4)+XD3*YD*A(12,4)+XD2*YD2*A(13,4)+XD*YD3*A(14,4)+YD
3      2*YD2*A(15,4)
      GO TO 35

C
C
30      XD2=XD*XD
      XD3=XD2*XD
      XD4=XD3*XD
      YD2=YD*YD
      YD3=YD2*YD
      YD4=YD3*YD
      PT=A(1,5)+XD*A(2,5)+YD*A(3,5)+XD2*A(4,5)+XD*YD*A(5,5)+YD2*A(
1      6,5)+XD3*A(7,5)+XD2*YD*A(8,5)+XD*YD2*A(9,5)+YD3*A(10,5)
      PT=PT+XD4*A(11,5)+XD3*YD*A(12,5)+XD2*YD2*A(13,5)+XD*YD3*A(14,
1      5)+YD4*A(15,5)+XD4*XD*A(16,5)+XD4*YD*A(17,5)+XD3*YD2*A(18,5)
2      )+XD2*YD3*A(19,5)+XD*YD4*A(20,5)+YD*YD4*A(21,5)
35      C(JJ,KK)=PT
40      XD=XD+XINC
      XD=XMIN
45      YD=YD-YINC
      WRITE (6,130)
      DO 50 I=1,NLINES
50      WRITE (6,135) (TITL(II,I),II=1,8)
      WRITE (6,145) ORDIN(JIM,1),ORDIN(JIM,2)
      WRITE (6,100) K,COLS,ROWS
      WRITE (6,110) XMAX,XMIN,YMAX,YMIN
      DO 55 JJ=1,ROWS
        WRITE (6,115) (C(JJ,KK),KK=1,COLS)
55      WRITE (6,120)
      IF (IPUN) 60,75,60
60      DO 65 I=1,NLINES
65      PUNCH 1,0, (TITL(II,I),II=1,8)
      PUNCH 1,0, ORDIN(JIM,1),ORDIN(JIM,2)
      PUNCH 1,0, K,COLS,ROWS
      DO 70 J=1,ROWS
        PUNCH 1,25, (C(J,KK),KK=1,COLS)
70      CONTINUE

```



```

75  CONTINUE
   IF (ISURF(K).NE.2.OR.COLS.GT.42) GO TO 85
   DO 80 I=1,NMAF
80  CALL PLOT (C,ROWS,COLS,K,TITL,NLINES,ORDIN,UM)
85  CONTINUE
   RETURN

C
C
C
90  FORMAT (4F10.3)
95  FORMAT (3I3,I1)
100 FORMAT (1H0,36HGRIDDED VALUES OF SURFACE OF DEGREE ,I1,9H. GRID IS
1, I3, 12H COLUMNS BY ,I3,6H ROWS.)
105 FORMAT (3X,36HGRIDDED VALUES OF SURFACE OF DEGREE ,I1,9H. GRID IS
1I3, 12H COLUMNS BY ,I3,6H ROWS.)
110 FORMAT (1H0,55HMAXIMUM AND MINIMUM COORDINATE VALUES READ IN ARE
1MAX=,F10.3,6H YMIN=,F10.3,6H YMAX=,F10.3,6H YMIN=,F10.3//)
115 FORMAT (1H ,12F10.3)
120 FORMAT (1H0)
125 FORMAT (8F10.3)
130 FORMAT (1H1)
135 FORMAT (1H ,2CX,3A10)
140 FORMAT (8A10)
145 FORMAT (1H0,1 X,13HANALYSIS FOR ,2A10,////)
150 FORMAT (2CX,2A10)
   END

```

SUBROUTINE PLOT

PURPOSE --

TO DEVELOP PRINTER CONTOUR MAPS OF THE REQUESTED SURFACES. THIS SUBROUTINE IS A SPECIAL VERSION OF SUBROUTINE PLTCON1. THUS THE SAME BASIC DESIGN IS RETAINED AND ACCORDINGLY THE INSTRUCTIONS FOR PLTCON1, FOUND ON PAGE , SHOULD BE FOLLOWED.

REQUIRED SUBROUTINES --

STATS TO CALCULATE CERTAIN STATISTICAL MEASURES.

CONTROL CARD ORDER --

THIS SUBROUTINE REQUIRES TWO TYPES OF CONTROL CARDS .

0) MASTER CONTROL CARD (CON, TOUR, LINES, INCHES)

2) SPECIAL CARD (S) -- REQUIRED ONLY IF TOUR = 1 OR 2 .

THE FUNCTIONS OF THESE CARDS ARE DESCRIBED ON PAGE .

SUBROUTINE PLOT (Z,ROWS,COLS,KOLD,TITLE,NLINES,ORDIN,JIM)

```
DIMENSION SYM(131), PS(131), INCON(10), DRANG(25), ZFRG(111),
1 SYM(131), Z(100,100), T TL(5,5), ORDIN(4,2)
INTEGER ROWS, COLS, CON, TOUR, COLMAX, COL, PSY, PS, GRID, SYM, BLANK, PLUS,
1 MINUS, STAR, SYMTAB, XSTOP, YSTOP
REAL MINZ, MAXZ, INCHES, INCON
DATA (SYMTAB(1), I=1, 21) / 50, 1H1, 1H2, 1H3, 1H4, 1H5, 1H6, 1H7, 1H8, 1H9, 1H
1A, 1HB, 1HC, 1HD, 1HE, 1HF, 1HG, 1HH, 1HI, 1HJ, 1HK /, PLANK/14 /, PLUS/1H+/, I
2 NOS/1H-/, STAR/1H*/
```

```
5 READ (5,170) CON, TOUR, LINES, INCHES
```

```
JJ=0
```

```
NN=0
```

```
NN=ROWS*COLS
```

```
*****
```

```
4 = NUMBER OF DATA POINTS
```

```
*****
```

```
WRITE (6,175)
```

```
DO 10 I=1,NLINES
```

```
10 WRITE (6,180) (TITLE(I,1), I=1,8)
```

```
WRITE (6,185) ORDIN(JIM,1), ORDIN(JIM,2)
```

```
WRITE (6,190) KOLD, N, COLS, ROWS
```

```
CALL STATS (ROWS, COLS, 100, 100, Z, ZBAR, XP, ZSIG, MAXZ, MINZ)
```

```
*****
```

```

C DETERMINE SWITCHE LINE PLACEMENTS
C YOUR VALUE DETERMINES METHOD USED IN DEFINING CONTOURS
C *****
C
    IF (TOUR.GT.3.OR.TOUR.LE.0) GO TO 30
    GO TO (15,20,25), TOUR
15  WRITE (6,195)
    READ (5,200) ZMIN,ZMAX
    GO TO 35
C
20  READ (5,205) INCON
    WRITE (6,210)
    READ (5,INCON) (DRANG(I),I=1,CON)
    ZMIN=DRANG(1)
    ZMAX=DRANG(CON)
    GO TO 35
C
21  ZMIN=ZMIN-R*3.0*ZSIG
    ZMAX=ZMAX+R*3.0*ZSIG
    CON=12
    WRITE (6,215)
    GO TO 35
C
20  WRITE (6,220)
    ZMIN=MINZ
    ZMAX=MAXZ
35  WRITE (6,225) ROWS,COLS,IBAR,ZSIG,MAXZ,MINZ
C
C *****
C CALCULATE MAP WIDTH IN CHARACTERS (COL)
C *****
C
    IF (INCHES.LE.0.0) COL=100
    IF (INCHES.GT.12.7) COL=127
    IF (INCHES.GT.0.0.AND.INCHES.LE.12.7) COL=INCHES*10.0
    PS=(COL-COLS)/(COLS-1)
C
C *****
C TEST GRID SIZE--IF GRID SMALLER THAN 2 CHARACTERS BETWEEN COLUMNS,
C AN ERROR STATEMENT IS PRINTED AND PLOT ABORTED
C *****
C
    IF (PS.GT.1) GO TO 40
    WRITE (6,230)
    GO TO 165
C
C *****
C CALCULATE REQUIRED CONSTANTS
C *****
40  COLMAX=PS*(COLS-1)+COLS

```

```

YINC=1.0/((FLOAT(PS+1))*0.6)
GRID=PS+1
XINC=1.0/FLOAT(GRID)
RANGZ=ZMAX-ZMIN
RHIGH=ZMAX+RANGZ
RLOW=ZMIN-RANGZ
IF (CON.EQ.0.OR.CON.GT.19) CON=5
FCON=CON
CI=RANGZ/FCON
IF (TOUR.EQ.2) GO TO 50
JJJ=CON+1
DO 45 I=1,JJJ
45 DRANG(I)=ZMIN+FLOAT(I-1)*CI
50 CONTINUE
WRITE (6,235)
WRITE (6,240) ZMIN,ZMAX,CI,GRID,XINC,YINC,CON,PS,COLMAX
C
C *****
C WRITE OUT CONTOUR SYMBOL TABLE
C *****
C
WRITE (6,245)
IF (LINES.EQ.1) WRITE (6,250)
WRITE (6,255)
IF (LINES.NE.0) GO TO 55
WRITE (6,260)
WRITE (6,265) (SYMTAB(I),DRANG(I),I=1,CON)
WRITE (6,270)
GO TO 60
C
55 WRITE (6,275)
WRITE (6,280) (SYMTAB(I),DRANG(I),DRANG(I+1),I=1,CON)
WRITE (6,285) DRANG(CON+1)
60 WRITE (6,175)
DO 65 I=1,NLINES
65 WRITE (6,180) (TITL(II,I),II=1,8)
WRITE (6,185) ORDIN(JIM,1),ORDIN(JIM,2)
WRITE (6,190) KOLD,N,CCLS,ROWS
XSTOP=GRID
GRID=COLS-1
COL=3
DO 75 J=1,GRID
DO 70 I=2,XSTOP
SYM(COL)=BLANK
70 COL=COL+1
SYM(COL)=PLUS
75 COL=COL+1
N=COLMAX+2
SYM(2)=PLUS
SYM(1)=BLANK
SYM(N)=BLANK
WRITE (6,290) (SYM(I),I=1,N)

```

```

C      *****
C      ESTIMATE VALUE OF ALL PRINTING POSITIONS ON MAP
C      *****
C      LOOP THROUGH MAP LENGTH, ROW BY ROW
C      *****
      ITOP=1
      IROW=ROWS+1
      DO 160 MM=2,IROW
        YSTOP=1./YINC+.5
        IF (MM.EQ.IROW) YSTOP=1
        M=MM-1
        YP=0.0
        PSYM(1)=PLUS
        PSYM(N)=PLUS
      DO 160 KJ=1,YSTOP
        COL=1
        Z1=YP*(Z(MM,1)-Z(M,1))+Z(M,1)
C      *****
C      LOOP THROUGH MAP WIDTH,COLUMN BY COLUMN
C      *****
        II=COLS-1
        JLFT=2
        DO 135 J=1,II
          J1=J+1
          Z1=YP*(Z(MM,JJ)-Z(M,JJ))+Z(M,JJ)
          ZDELTA=Z2-Z1
          XP=0.0
          DO 130 KK=1,XSTOP
            JLFT=JLFT-1
            COL=COL+1
            ZEST=XP*ZDELTA+Z1
            IF (ZEST.GE.ZMIN.AND.ZEST.LE.ZMAX) GO TO 95
            IF (ZEST.LT.ZMIN.AND.(ITOP.EQ.1.OR.MM.EQ.IROW.OR.JLFT.EQ.
1              1)) GO TO 80
            IF (ZEST.GT.ZMAX.AND.(ITOP.EQ.1.OR.MM.EQ.IROW.OR.JLFT.EQ.
1              1)) GO TO 85
            PSYM(COL)=BLANK
            ZPREV(COL)=ZEST
            ZLAST=ZEST
            GO TO 130
C
80          IF (ZEST.LE.RLOW) GO TO 90
            PSYM(COL)=MINUS
            ZPREV(COL)=ZEST
            ZLAST=ZEST
            GO TO 130
C

```

23

```

85      IF (ZEST.GE.RHIGH) GO TO 90
        PSYM(COL)=PLUS
        ZPREV(COL)=ZEST
        ZLAST=ZEST
        GO TO 130

C
90      PSYM(COL)=STAP
        ZPREV(COL)=ZEST
        ZLAST=ZEST
        GO TO 130

C
95      I=((ZEST-ZMIN)/CI)+1.
        LVAL=LINES+1
        IF (ITOP.EQ.1.OR.MM.FC.IROW.OR.JLFT.EQ.1) LVAL=3
        GO TO (100,120,125), LVAL
100     DO 105 I=1,CON
            ZSTEP=DRANG(I)
            SW1=1.
            SW2=1.
            SW3=1.
            SW4=1.
            IF (ZSTEP.GE.ZLAST.OR.ZSTEP.GE.ZPREV(COL)) SW1=0.
            IF (ZSTEP.LE.ZEST) SW2=0.
            IF (ZSTEP.LT.ZLAST.OR.ZSTEP.LT.ZPREV(COL)) SW3=0.
            IF (ZSTEP.GE.ZEST) SW4=0.
            IF ((SW1.EQ.0..AND.SW2.EQ.0.)..OR.(SW3.EQ.0..AND.SW4.EQ
1      .).)) GO TO 110
105     CONTINUE
        PSYM(COL)=BLANK
        GO TO 115

C
110     PSYM(COL)=SYMTAB(I)
115     ZLAST=ZEST
        ZPREV(COL)=ZEST
        GO TO 130

C
120     K=I/2
        IF ((K*2).NE.I) PSYM(COL)=SYMTAB(I)
        IF ((K*2).EQ.I) PSYM(COL)=BLANK
        GO TO 130

C
125     PSYM(COL)=SYMTAB(I)
        ZPREV(COL)=ZFST
130     XP=XP+XINC
        Z1=Z2
135     JLFT=0
        COL=COL+1
        IF (Z(M,COLS).GE.ZMIN.AND.Z(M,COLS).LE.ZMAX) GO TO 150
        IF (Z(M,COLS).GT.ZMAX) GO TO 140
        IF (Z(M,COLS).LE.RLOW) GO TO 145
        PSYM(COL)=MINUS
        GO TO 155

```

```

C
140      IF (Z(M, COLS).GE.RHIGH) GO TO 145
        PSYM(COL)=PLUS
        GO TO 155
C
145      PSYM(COL)=STAR
        GO TO 155
C
150      I=((Z(M, COLS)-ZMIN)/CI)+1.
        PSYM(COL)=SYMTAB(I)
155      WRITE (6,290) (PSYM(L),L=1,N)
        YP=YP+YINC
        PSYM(1)=BLANK
        PSYM(N)=BLANK
160      ITOP=0
        WRITE (6,290) (SYM(L),L=1,N)
165      CONTINUE
        RETURN
C
170      FORMAT (I2,2I1,F4.0)
175      FORMAT (1H1)
180      FORMAT (1H ,20X,8A10)
185      FORMAT (1H0,10X,21HANALYSIS OF DATA FOR ,2A10,///)
190      FORMAT (1H0,33HCONTOUR MAP OF SURFACE OF DEGREE ,I1,37H. THE EQUAT
11ION HAS BEEN EVALUATED AT ,I4,21H LOCATIONS ON A GRID ,I3,I2H COLU
2MNS BY ,I3,6H ROWS.//)
195      FORMAT (25H CONTOUR LEVELS SPECIFIED)
200      FORMAT (2F10.0)
205      FORMAT (10A6)
210      FORMAT (37H VARIABLE CONTOUR INTERVALS SPECIFIED)
215      FORMAT (30H CONTOUR INTERVAL = U1/2 SIGMA)
220      FORMAT (26H CONTOUR LEVELS CALCULATED)
225      FORMAT (14H GRIDDED DATA/,42H LINEAR INTERPOLATION WITHIN GRID SQU
1ARES ///,17H OBSERVED VALUES //,8H ROWS = ,I3,10H COLS = ,I3,/,8
2H ZBAR = ,F10.3,10H ZSIG = ,F10.3,10H MAXZ = ,F10.3,10H MINZ
3 = ,F10.3)
230      FORMAT (25H TOO MANY COLUMNS IN GRID)
235      FORMAT (1H /,16H VALUES EMPLOYED)
240      FORMAT (8H ZMIN = ,F10.3,10H ZMAX = ,F10.3,8H CI = ,F10.3,/,8H
1GRID = ,I5,10H XINC = ,F10.3,10H YINC = ,F10.3,/,7H CON = I5,8
2H PS = ,I5,12H COLMAX = ,I5)
245      FORMAT (35H4CONTOUR SYMBOL TABLE IS AS FOLLOWS)
250      FORMAT (43H0(ONLY EVEN SYMBOLS PRINTED IN BODY OF MAP))
255      FORMAT (7H0SYMBOL,11X,5HVALUE)
260      FORMAT (5H0 * ,6X,7HNO DATA,/,5H -,4X,10HBELOW LOW)
265      FORMAT (4X,A1,2X,F12.4)
270      FORMAT (4X,1H+,4X,10HABOVE HIGH)
275      FORMAT (5H0 * ,25X,7HNO DATA,/,5H -,23X,10HBELOW LOW)
280      FORMAT (4X,A1,2X,F12.4,6H TO ,F12.4)
285      FORMAT (4X,1H+,2X,F12.4,1CH OR OVER)
290      FORMAT (1H9,129A1)
        END

```


C JOB CONTROL CARDS NECESSARY TO RUN POLYFIT AND RESMAP AS ONE JOB
C -----
C COL 1
C ACCT,NAME,T800,CM70000,PRIORITY
C RUN(S,,,,,77777)
C REQUEST(TAPE8,HI) USER TAPE IDENTIFICATION (THIS CARD OPTIONAL
C LGO.
C RFL,70000.
C REWIND(LGO)
C RUN(S,,,,,77777)
C LGO.
C 7-8-9 CARD
C PROGRAM POLYFIT SOURCE DECK
C 7-8-9 CARD
C POLYFIT CONTROL AND DATA CARDS (SEE BELOW)
C 7-8-9 CARD
C PROGRAM RESMAP SOURCE DECK
C 7-8-9 CARD
C RESMAP CONTROL CARDS
C 6-7-8-9 CARD
C -----

PROGRAM POLYFIT - SAMPLE DATA CARDS

NOTE - THESE CARDS WILL FIT TRENDS 1-4, PRODUCE PRINTER MAPS, PUNCH GRIDDED TREND VALUES FOR A 1/2 INCH GRID, AND STORE DATA FOR RESMAP. FOUR DIFFERENT VARIABLES WILL BE ANALYZED.

THE DATA REPRESENTS WATER WELL OBSERVATIONS DURING THE LAST FOUR MONTHS OF 1967 IN BARTHOLOMEW COUNTY, INDIANA.

```
POLYFT
POLYFT      1111 2222      1      1      1111      1      1
BARTHOLOMEW COUNTY, INDIANA  ANALYSIS OF WATER-WELL LEVELS
SEPTEMBER 1967      OCTOBER 1967      NOVEMBER 1967      DECEMBER 1967
(A10,2F10.2,4F10.3)
01      00485      00115      597800      595600      596600      596700
02      00719      00134      590200      589300      591400      592900
03      00828      00231      609000      607700      608700      610900
  4      00674      00253      593000      592400      592100      595500
07      00414      00369      602600      601700      601100      601100
77      00573      00347      592700      592700      592700      592700
08      00684      00331      596400      595000      595900      597900
10      00587      00485      600000      599500      590200      600600
11      00727      00570      609900      609300      608800      609000
14      00166      00739      613200      613200      613200      613200
16      00414      00736      611600      611300      611100      612900
18      00762      00666      614500      613900      613500      614600
20      00467      00845      614500      614300      614400      615300
24      00458      01049      623300      623200      626500      626600
26      00759      01116      646000      644900      644600      646800
27      00990      01229      652200      651800      651700      651900
28      00478      01225      634100      633800      633400      635500
30      00221      01163      629600      628800      629100      631700
36      00410      01510      646800      645400      644800      644400
37      00292      01420      643700      642800      642100      641900
38      00414      01417      645500      644400      644100      643800
48      00444      00656      605700      604700      604800      604400
50      00706      01360      645300      644200      643900      643800
51      00705      01513      651000      650700      650700      652100
92      00634      00736      617600      617300      617000      617300
93      00630      00761      612800      612900      612700      613700
94      00639      01167      635400      634900      634400      634000
95      00517      00740      615400      614900      614400      614400
96      00574      00924      627900      627400      627000      627000

11.0      0.0      16.0      0.0
33 23 11
100111.2
11.0      0.0      16.0      0.0
33 23 11
100111.2
```

11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			
11.0	0.0	16.0	0.0
33 23 11			
100111.2			

C
C
C

PROGRAM RESMAP SHOULD FOLLOW IMMEDIATELY

ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518
ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518

ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518
ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518

GRAPH OF SURFACE OF TREND 1, THE ANALYSIS HAS BEEN EVALUATED AT THE LOCATION ON A GRID 22 COLUMN BY 22 ROWS.

ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518
ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518

GRAPH OF SURFACE OF TREND 2, THE ANALYSIS HAS BEEN EVALUATED AT THE LOCATION ON A GRID 22 COLUMN BY 22 ROWS.

ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518
ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518

GRAPH OF SURFACE OF TREND 3, THE ANALYSIS HAS BEEN EVALUATED AT THE LOCATION ON A GRID 22 COLUMN BY 22 ROWS.

ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518
ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518

GRAPH OF SURFACE OF TREND 4, THE ANALYSIS HAS BEEN EVALUATED AT THE LOCATION ON A GRID 22 COLUMN BY 22 ROWS.

ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518
ANALYSIS OF DATA FOR THE SITE OF WATERWELL 1-0518

PROGRAM RESMAP - GENERAL INSTRUCTIONS

PURPOSE -

TO BE USED IN CONJUNCTION WITH PROGRAM POLYFIT . THIS PROGRAM ANALYZES THE ORIGINAL AND RESIDUAL VALUES STORED ON TAPE8 BY PROGRAM POLYFIT. GRIDDED VALUES AND PRINTER CONTOUR MAPS ARE PRODUCED BY SUBROUTINES GRID AND PLTCON1 OR PLTCON2 . A VARIETY OF CONTOUR MAPS MAY BE SPECIFIED, MULTIPLE MAPS OF ANY DATA MAY BE PRODUCED . THE GRIDDED VALUES MAY PRODUCE CALCOMP CONTOUR MAPS USING PROGRAM CONTUR

PURDUE UNIVERSITY VERSION 2.0

A. KEITH TURNER,
CIVIL ENGINEERING,
FEBRUARY, 1968 .

TAPE REQUIREMENTS -

TAPE8 IS USED TO STORE DATA DEVELOPED BY PROGRAM POLYFIT.

SUBROUTINES REQUIRED -

1)GRID - TO GRID THE IRREGULARLY SPACED DATA

2)PRTCO1- TO PRODUCE PRINTER CONTOUR MAPS

OR

PRTCO2- TO PRODUCE GRADED DENSITY PRINTER CONTOUR MAPS

3)STATS- TO CALCULATE CERTAIN STATISTICAL VALUES

NOTE 1 -- GRID CONTROL CARDS ARE REQUIRED FOR EACH ANALYSIS REQUESTED . SEE SECTION III.

NOTE 2 -- PRTCO1 OR PRTCO2 CONTROL CARDS REQUIRED FOR EACH MAP REQUESTED (NUMBER OF MAPS = NUMBER OF MAPS PER REQUEST TIMES NUMBER OF ANALYSES REQUESTED). SEE SECTION IV .

C
C

PROGRAM RESMAP - MAIN PROGRAM

```

PROGRAM RES (AP, INPUT, OUTPUT, TAPE8, PUNCH, TAPE5=INPUT, TAPE6=OUTPUT)
DIMENSION X(1000), Y(1000), Z(1000), IVAL(6), TITL(8)
5 READ(5,65) TITL
  IF(EOF,5) 55,6
6 READ(5,85) (IVAL(I), I=1,6)
  DO 50 I=1,6
    IF(IVAL(I).NE.1) GO TO 50
    READ(8) NUM
    IF(EOF,8) 55,10
10 WRITE(6,60) NUM
    WRITE(6,70) TITL
    GO TO (20,21,22,23,24,25) , I
20 DO 11 N=1,NUM
11 READ (8) ID,X(N),Y(N),Z(N),ZC1,ZR1,ZC2,ZR2,ZC3,ZR3,ZC4,ZR4,ZC5,ZR5
    GO TO 45
21 DO 12 N=1,NUM
12 READ (8) ID,X(N),Y(N),ZD,ZC1,Z(N) ,ZC2,ZR2,ZC3,ZR3,ZC4,ZR4,ZC5,ZR5
    GO TO 45
22 DO 13 N=1,NUM
13 READ (8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,Z(N) ,ZC3,ZR3,ZC4,ZR4,ZC5,ZR5
    GO TO 45
23 DO 14 N=1,NUM
14 READ (8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,ZR2,ZC3,Z(N) ,ZC4,ZR4,ZC5,ZR5
    GO TO 45
24 DO 15 N=1,NUM
15 READ (8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,ZR2,ZC3,ZR3,ZC4,Z(N) ,ZC5,ZR5
    GO TO 45
25 DO 16 N=1,NUM
16 READ (8) ID,X(N),Y(N),ZD,ZC1,ZR1,ZC2,ZR2,ZC3,ZR3,ZC4,ZR4,ZC5,Z(N)
45 REWIND 8
    CALL GRID (NUM,X,Y,Z)
50 CONTINUE
    GO TO 5
55 STOP
60 FORMAT(1H1,10X,32H NUMBER OF POINTS TO BE READ IN=,I4,////)
65 FORMAT(8A10)
70 FORMAT(1H ,5X,8A10)
85 FORMAT(6I1)
END

```


PROGRAM RESMAP - SAMPLE DATA CARDS

NOTE -THESE CARDS ARE DESIGNED TO ANALYZE DATA PRODUCED BY PROGRAM POLYFIT FROM THE SAMPLE DATA SHOWN THERE. THESE CARDS REQUEST THE PRODUCTION OF ORIGINAL AND FOUR DIFFERENT RESIDUAL MAPS FOR THE SAME FOUR MONTHS. PUNCHED CARD OUTPUT FOR THE GRIDDED VALUES WILL ALSO BE PRODUCED.

BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR SEPTEMBER 1967
 11111
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA,SEPTEMBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER- 1ST DEGREE RESIDUALS , SEPTEMBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER- 2ND DEGREE RESIDUALS , SEPTEMBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER- 3RD DEGREE RESIDUALS , SEPTEMBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER- 4TH DEGREE RESIDUALS , SEPTEMBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR OCTOBER 1967
 11111
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA,OCTOBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER- 1ST DEGREE RESIDUALS , OCTOBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER- 2ND DEGREE RESIDUALS , OCTOBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1
 BARTHOLOMEW COUNTY GROUND WATER- 3RD DEGREE RESIDUALS , OCTOBER 1967
 11.0 0.0 16.0 0.0
 100111.2
 33 23 101 1

BARTHOLOMEW COUNTY GROUND WATER- 4TH DEGREE RESIDUALS , OCTOBER 1967

11.0 0.0 16.0 0.0

100111.2

BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR NOVEMBER 1967

11111

33 23 101 1

BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA,NOVEMBER 1967

11.0 0.0 16.0 0.0

100111.2

33 23 101 1

BARTHOLOMEW COUNTY GROUND WATER- 1ST DEGREE RESIDUALS , NOVEMBER 1967

11.0 0.0 16.0 0.0

100111.2

33 23 101 1

BARTHOLOMEW COUNTY GROUND WATER- 2ND DEGREE RESIDUALS , NOVEMBER 1967

11.0 0.0 16.0 0.0

100111.2

33 23 101 1

BARTHOLOMEW COUNTY GROUND WATER- 3RD DEGREE RESIDUALS , NOVEMBER 1967

11.0 0.0 16.0 0.0

100111.2

33 23 101 1

BARTHOLOMEW COUNTY GROUND WATER- 4TH DEGREE RESIDUALS , NOVEMBER 1967

11.0 0.0 16.0 0.0

100111.2

BARTHOLOMEW COUNTY WATER SURFACE ANALYSIS FOR DECEMBER 1967

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BARTHOLOMEW COUNTY GROUND WATER-ORIGINAL WELL ELEV. DATA,DECEMBER 1967

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BARTHOLOMEW COUNTY GROUND WATER- 1ST DEGREE RESIDUALS , DECEMBER 1967

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BARTHOLOMEW COUNTY GROUND WATER- 2ND DEGREE RESIDUALS , DECEMBER 1967

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BARTHOLOMEW COUNTY GROUND WATER- 3RD DEGREE RESIDUALS , DECEMBER 1967

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BARTHOLOMEW COUNTY GROUND WATER- 4TH DEGREE RESIDUALS , DECEMBER 1967

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DEVELOPED FROM TWO POSITIVE VALUES, CONSISTING OF 43 COLUMNS BY 53 ROWS.

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IN RE: JAMES EARL RAY, Defendant
 THE UNITED STATES OF AMERICA, Plaintiff

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PART III

PROCEDURES FOR ASSIGNING IRREGULARLY SPACED (RANDOM) DATA TO A SQUARE GRID

NOTE - This procedure must precede any attempt to machine-contour irregularly spaced data. Since potential users may wish to clearly understand the underlying principles used in subroutine GRID, a description of the algorithm is included.

CONTENTS OF THIS SECTION

- 1) Description of Interpolation
Algorithm
- 2) SUBROUTINE GRID
- 3) SUBROUTINE STATS

AN INTERPOLATION ALGORITHM FOR GEOGRAPHICAL DATA

The documentation for this algorithm and a MAD language program were obtained from Professor W. R. Tobler, Geography Department, University of Michigan. The MAD language program formed the basis of the Subroutine GRID. The algorithm involves a weighted moving average procedure, and appears to give results which are comparable to those obtained by the fitting of local polynomials, but is computationally much simpler. Following considerable (empirical) testing, the main disadvantage appears to be a slight dampening (or smoothing) effect on the data. This approaches 10% of the data range for extremely erratic data, but for commonly encountered data distributions is much less. Competing schemes are described in the references cited.

The following discussion was obtained from Tobler: -

Definitions:

An observation is recorded as X_i, Y_i, Z_i ; $i = 1, \dots, N$, where X, Y are locational coordinates and Z is a value at S, Y .

Lattice points are labelled jk in standard matrix notation (j = row subscript, and k = column subscript). The problem is to estimate Z_{jk} .

Procedure:

- (1) Calculate A , the area of the rectangle bounded by the maximum and minimum of the coordinate values X and Y .
- (2) Let the grid size, G , equal the square root of the area divided by the number of observations,

$$G = (A/N)^{1/2}$$

- (3) The number of rows in the matrix is computed as the (truncated) integer part of

$$R = (\Delta Y/G) + 1.5$$

and the number of columns as the integer part of

$$C = (\Delta X/G) + 1.5$$

This yields a matrix which has approximately N entries.

- (4) In general, because of truncation,

$$(C - 1) \cdot G \neq \Delta X$$

$$(R - 1) \cdot G \neq \Delta Y$$

Split the difference, letting

$$\Delta^0 X = (\Delta X - (C - 1) \cdot G)/2$$

$$\Delta^0 Y = (\Delta Y - (R - 1) \cdot G)/2$$

and assign X and Y coordinates to positions in the matrix. For example the j^{th} row and the k^{th} column will have the coordinates

$$X_k = X_{\min} + \Delta^0 X + (k - 1) \cdot G$$

$$Y_j = Y_{\max} - \Delta^0 Y - (j - 1) \cdot G$$

- (5) For each position in the matrix calculate the square of the distance to each observation using

$$D_i^2 = (X_k - X_i)^2 + (Y_j - Y_i)^2$$

and rank the points in order of increasing distance from the

jk^{th} lattice point as they are computed, saving the results for

only the nearest six points, except if $D_i^2 \leq \epsilon$ in which case

set $Z_{jk} = Z_i$ and proceed to the next position in the matrix

since the assignment has been completed. (We have taken $\epsilon = G/25$,

but this is arbitrary).

- (6) Assign a value to the jk^{th} position by using a weighted mean of the value at the nearest point with the weighted mean of the nearest six points. Symbolically, using the notation $D_{i\alpha}$ to denote the rank α of the distance from the jk^{th} position to the point i and Z_{i1} for the observed value at the nearest point, this can be written as

$$Z_{jk} = Z_{i1} + \frac{\sum_{\alpha=1}^6 \frac{Z_{i\alpha}}{D_{i\alpha}}}{\sum_{\alpha=1}^6 \frac{1}{D_{i\alpha}}}$$

References:

- J. P. Batcha, and J. R. Reese, "Surface Determination and Automatic Contouring for Mineral Exploration, Extraction, and Processing," International Symposium on Applications of Statistics, Operations Research, and Computers in the Mineral Industries, Colorado School of Mines, Quarterly, 59, 4 (1964), A, pp. 1-15.
- B. Gilchrist, and G. F. Cressman, "An Experiment in Objective Analysis," Tellus, 6, 4 (1954).
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- J.R. Mackay, "Some Problems and Techniques in Isopleth Mapping," Economic Geography, XXVII (1951), 1-9.
- D. Ojakangas, and W. Basham, "Simplified Computer Contouring of Exploration Data," Computers in the Mineral Industries, Stanford University Publications; Geological Sciences, IX, 2 (1964), 757-771.
- P. Switzer, et. al., Statistical Analyses of Ocean Terrain and Contour Plotting Procedures, Cambridge, A. D. Little, (OS AD 601535), 1964, 77 pp.
- R. C. Weaver, "Relative Merits of Interpolation and Approximating Functions . . .," Computers in the Mineral Industries, op. cit., pp. 171-185.

SUBROUTINE GRID

PURPOSE -

TO ASSIGN SCATTERED OBSERVATIONS TO A SQUARE GRID. THE PROGRAM INVOLVES A WEIGHTED MOVING AVERAGE TECHNIQUE AND LINEAR INTERPOLATION WITHIN GRID SQUARES.

PURDUE UNIVERSITY VERSION 2.0

A. KEITH TURNER,
CIVIL ENGINEERING,
FEBRUARY, 1968.

USAGE CALL GRID (N,X,Y,W)

DESCRIPTION OF PARAMETERS -

- N - NUMBER OF SCATTERED OBSERVATIONS
- X - X CO-ORDINATES OF SCATTERED OBSERVATIONS
- Y - Y CO-ORDINATES OF SCATTERED OBSERVATIONS
- W - ELEVATION (Z CO-ORDINATE) VALUES OF SCATTERED OBSERVATIONS

DESCRIPTION OF CONTROL CARDS -

1) GRID SPECIFICATION CARD -

- ROWS (COLS 1-3) NUMBER OF ROWS IN GRID .
- COLS (COLS 4-6) NUMBER OF COLUMNS IN GRID .
- Gsize (COLS 7-10) SIZE OF GRID IN X-Y INPUT DATA UNITS .
- BND (COL11) IF BND=0, GRID BOUNDARIES CALCULATED FROM DATA.
IF BND=1, GRID BOUNDARIES SPECIFIED ON CARD 3 .
- LIST (COL12) IF LIST=1, INPUT DATA IS LISTED.
IF LIST=2, INTERPOLATED VALUES ARE LISTED.
IF LIST=3, BOTH INPUT AND INTERPOLATED VALUES ARE LISTED.
- IPUN (COL13) IF IPUN=1, GRID VALUES ARE PUNCHED .
- NMAP (COL14-15) NMAP = NUMBER OF DIFFERENT MAPS DESIRED .
- IPLOT (COL16) IF IPLOT=1, GRID CALLS SUBROUTINE PRTCOL1 .
IF IPLOT=2, GRID CALLS SUBROUTINE PRTCOL2 .

NOTE--- IF ANY ONE OF ROWS, COLS, OR GSIZE SPECIFIED, PROGRAM WILL COMPUTE THE OTHERS. IF NONE ARE SPECIFIED, PROGRAM SELECTS A GRID SIZE.

2) TITLE CARD -

ANY ALPHANUMERIC TITLE IN COLS 1-72.

3) BOUNDARY SPECIFICATION CARD (OPTIONAL-REQUIRED ONLY IF BND=1)

MAXIMUM AND MINIMUM X-Y COORDINATE VALUES (XMAX,XMIN,YMAX,YMIN) IN COLS 1-10,11-20,21-30,31-40 WITH DECIMALS PUNCHED.

REQUIRED SUBROUTINES

1) SUBROUTINE STATS

2) MAPPING SUBROUTINES (IF NMAP GREATER THAN ZERO)

- IF IPLOT=1, SUBROUTINE PRTCON1 (PRODUCES BANDS OR LINES)
- IF IPLOT=2, SUBROUTINE PRTCON2 (PRODUCES SHADED DENSITY MAPS)


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C
SUBROUTINE GRID (N,X,Y,W)

  DIMENSION X(1000), Y(1000), W(1000), Z(100,100), D(20), N1(20), FO
1RM(10), TITL(12), A(6), B(6), C(6)
  REAL MAXX,MINX,MAXY,MINY,MAXW,MINW,MAXZ,MINZ
  INTEGER TAPE,YES,BND,ROWS,COLS
  READ (5,110) ROWS,COLS,GSIZE,BND,LIST,IPUN,NMAP,IPLOT
  READ (5,115) (TITL(I),I=1,12)
  IF (LIST.LT.1.OR.LIST.GT.3) GO TO 5
  IF(LIST.NE.2) WRITE(6,120) (TITL(I),I=1,12)
5  IF (IPUN.EQ.1) PUNCH 125, (TITL(I),I=1,12)
  DO 10 I=1,N
10  IF (LIST.EQ.1.OR.LIST.EQ.3) WRITE(6,130) I,X(I),Y(I),W(I)
  CALL STATS (N,1,1000,1,X,XBAR,DUM,XSIG,MAXX,MINX)
  CALL STATS (N,1,1000,1,Y,YBAR,DUM,YSIG,MAXY,MINY)
  CALL STATS (N,1,1000,1,W,WBAR,DUM,WSIG,MAXW,MINW)
  WRITE (6,135) (TITL(I),I=1,12),N
  IF (BND.NE.4) GO TO 15
  WRITE (6,140)
  READ (5,145) XMAX,XMIN,YMAX,YMIN
  GO TO 20

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15  WRITE (6,150)
  XMAX=MAXX
  XMIN=MINX
  YMAX=MAXY
  YMIN=MINY
20  FN=MAXW-MINW
  WMAX=FN+MAXW
  WMIN=MINW-FN
  MAXZ=MAXW
  MINZ=MINW
  WRITE (6,155) NMAP,LIST,BND,TAPE
  M=0
  FN=M+0
  DX=XMAX-XMIN
  DY=YMAX-YMIN
  AREA=DX*DY
  BEST=SQRT(AREA/FN)
  AVEDIS=BEST*1.07346
  WRITE (6,160) XBAR,XSIG,MAXX,MINX,YBAR,YSIG,MAXY,MINY,WBAR,WSIG,MA
1XW,MINW,AREA,AVEDIS,BEST,GSIZE,ROWS,COLS
  IF (GSIZE.LE.0) GO TO 25
  COLS=(1.5+DX/GSIZE)
  ROWS=(1.5+DY/GSIZE)
  M=1
  GO TO 45

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25  IF (COLS.LE.1) GO TO 35
30  GSIZE=DX/FLOAT(COLS-1)

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      ROWS=(1.5+DY/GSIZE)
      M=1
      GO TO 45
C
35  IF (ROWS.LE.1) GO TO 40
      GSIZE=DY/FLOAT(ROWS-1)
      COLS=(1.5+DX/GSIZE)
      M=1
      GO TO 45
C
40  GSIZE=BEST
      COLS=(1.5+DX/GSIZE)
      ROWS=(1.5+DY/GSIZE)
45  CONTINUE
      IF (COLS.LE.100) GO TO 50
      COLS=100
      GO TO 30
C
50  WRITE (6,165)
      IF (M.EQ.1) WRITE (6,170)
      IF (M.NE.1) WRITE (6,175)
      WRITE (6,180) XMAX,XMIN,YMAX,YMIN,GSIZE,ROWS,COLS
      IF (LIST.EQ.2.OR.LIST.EQ.3) WRITE(6,185) (TITL(I),I=1,12)
      DY=(DY-(ROWS-1.)*GSIZE)/2.0
      DX=(DX-(COLS-1.)*GSIZE)/2.0
      YMAX=YMAX-DY
      XMIN=XMIN+DX
      HGRID=GSIZE/25.0
      FN=(WMAX-MAXW)/2.0
      MAXX=MAXW+FN
      MINX=MINW-FN
      DO 95 M=1,ROWS
          YP=YMAX-(FLOAT(M-1))*GSIZE
          DO 90 J=1,COLS
              XP=XMIN+(FLOAT(J-1))*GSIZE
              DO 55 I=1,9
                  D(I)=1.E10
                  N1(I)=1
                  N1(2)=1
              DO 75 I=1,N
                  DIST=((XP-X(I))**2)+((YP-Y(I))**2)
                  IF (DIST.GE.HGRID) GO TO 60
                  Z(M,J)=W(I)
                  GO TO 85
C
60  YES=MIN0(I,8)
              DO 70 K=1,YES
                  IF (DIST.GE.D(K)) GO TO 70
                  DO 65 JJ=K,YES
                      KK=YES+K-JJ
                      MN=KK+1
                      D(MM)=D(KK)
                      N1(MM)=N1(KK)

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D(K)=DIST
NI(K)=I
GO TO 75

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70      CONTINUE
75      CONTINUE
        DUM1=0.0
        PSUM=0.0
        DO 80 I=1,6
          YES=N1(I)
          MAXW=1.0/(SQRT(D(I)))
          PSUM=PSUM+MAXW
80      DUM1=DUM1+W(YES)*MAXW
        DUM6=DUM1/PSUM
        N11=N1(I)
        DUM2=W(N11)
        DUM=(DUM2+DUM6)/2.0
        IF (DUM.GT.MAXX.OR.DUM.LT.MINX) Z(M,J)=DUM2
        IF (DUM.LE.MAXX.AND.DUM.GE.MINX) Z(M,J)=DUM
85      CONTINUE
90      CONTINUE
        IF (LIST.EQ.2.OR.LIST.EQ.3) WRITE(6,190) (Z(M,I),I=1,COLS)
        IF (IPUN.EQ.1) PUNCH 195, (Z(M,I),I=1,COLS)
95      CONTINUE
        NEWTOT=ROWS*COLS
        CALL STATS (ROWS,COLS,100,100,Z,ZBAR,XP,ZSIG,ZMAX,ZMIN)
        YMIN=YF
        WRITE (6,200) NEWTOT,XMIN,YMIN,ZMAX,ZMIN,ZBAR,ZSIG
        WRITE (6,205)
        IF (NMAP.LT.1) GO TO 105
        DO 100 JNUM=1,NMAP
          IF (IPLOT.EQ.1) CALL PRTCON1(Z,ROWS,COLS,TITLE)
          IF (IPLOT.EQ.2) CALL PRTCON2(Z,ROWS,COLS,TITLE)
100      CONTINUE
105      CONTINUE
        RETURN
C
110     FORMAT (2I3,F4.0,3I1,I2,I1)
115     FORMAT (12A6)
120     FORMAT (1H1,12A6,/,/,3X,24H COORDINATE OBSERVATIONS)
125     FORMAT (6X,12A6)
130     FORMAT (5X,4H I =,I3,7H X(I) =,F10.3,7H Y(I) =,F10.3,7H W(I) =,F10
1.3)
135     FORMAT (1H1,12A6,/,/,3X,15,13H OBSERVATIONS,/)
140     FORMAT (3X,25H BOUNDARIES PREDETERMINED)
145     FORMAT (4F10.0)
150     FORMAT (3X,32H BOUNDARIES CALCULATED FROM DATA)
155     FORMAT (3X,6HNMAP =,I3,7H LIST =,I3,6H 3ND =,I2,7H TAPE =,I3)
160     FORMAT (3X,15HOBSERVED VALUES,/,/,3X,6HXBAR =,F10.3,6HXSIG =,F10.3,
16HMAXX =,F10.3,6HMINX =,F10.3,/,/,3X,6HYBAR =,F10.3,6HYSIG =,F10.3,6
2HMAXY =,F10.3,6HMINY =,F10.3,/,/,3X,6HWBAR =,F10.3,6HWSIG =,F10.3,6H
3HMAXW =,F10.3,6HMINW =,F10.3,/,/,3X,6HAREA =,F10.3,8HAVEDIS =,F10.3,6
4HBEST =,F10.3,/,/,3X,7HGSIZE =,F10.3,6HROWS =,I4,6HCOLS =,I4,/)

```

```

155  FORMAT (3X,2RH ROWS=,6PCOLYMS, OR GRID SIZE)
175  FORMAT (3X,214 CALCULATED FROM DATA,/)
180  FORMAT (3X,164 VALUES EMPLOYED,/,3X,7H XMAX =,F10.3,3X,7H Y=1 =,F
110.3,3X,7H YMAX =,F10.3 7H YMIN =,F10.3,/,3X,8H GSIZE =,F10.3,3X,7
2H ROWS=,I4,8X,7H COLS = ,I4)
185  FORMAT (1H1,12A6,/,3X, 0H INTERPOLATED VALUES)
190  FORMAT (1H0,(10F10.3))
195  FORMAT (8F10.3)
200  FORMAT (1H0,3X,3HM =,I3,6HXMIN =,F10.3,3X,6HMIN =,F10.3,/,3X,6HZ
1MAY =,F10.3,3X,6HZMIN =,F10.3,3X,6HZBAR =,F10.3,3X,6HZSIG =,F10.3)
205  FORMAT (13H1 END OF CAT/)
      END

```

SUBROUTINE STATS

PURPOSE -

TO CALCULATE STATISTICAL MEASURES OF ONE OR TWO DIMENSIONAL DATA
ARRAYS. MEASURES DETERMINED ARE 1) MEAN, 2) VARIANCE, 3) STANDARD DEVI-
ATION, 4) MAXIMUM VALUE, 5) MINIMUM VALUE.

USAGE -

CALL STATS(ROWS, COLS, II, JJ, X, XBAR, XVAR, XSIG, XMAX, XMIN)

ROWS - NUMBER OF ROWS IN ARRAY BEING ANALYZED.

COLS - NUMBER OF COLUMNS IN ARRAY BEING ANALYZED.

II - MAXIMUM NUMBER OF ROWS ALLOWED FOR ARRAY BEING ANALYZED.

JJ - MAXIMUM NUMBER OF COLUMNS ALLOWED FOR ARRAY BEING ANALYZED.

X - DATA ARRAY BEING ANALYZED.

XBAR - MEAN OF ARRAY.

XVAR - VARIANCE OF ARRAY.

XSIG - STANDARD DEVIATION OF ARRAY.

XMAX - MAXIMUM VALUE OF ARRAY.

XMIN - MINIMUM VALUE OF ARRAY.

SUBROUTINE STATS (ROWS, COLS, II, JJ, X, XBAR, XVAR, XSIG, XMAX, XMIN)

PROGRAM TO FIND STATISTICAL MEASURES

INTEGER ROWS, COLS

PARAMETER X(II, JJ)

FNO=ROWS*COLS

XSQR=0.0

XSUM=0.0

XMAX=X(1,1)

XMIN=X(1,1)

DO 5 I=1, ROWS

DO 5 J=1, COLS

IF (X(I, J) .GT. XMAX) XMAX=X(I, J)

IF (X(I, J) .LT. XMIN) XMIN=X(I, J)

XSUM=XSUM+X(I, J)

XSQR=XSQR+X(I, J)*X(I, J)

XBAR=XSUM/FNO

XVAR=XSQR-2.0*XBAR*XSUM/FNO+(XBAR**2)*FNO/FNO

XSIG=SQRT(XVAR)

RETURN

END

PART IV

PRODUCTION OF CONTOUR MAPS ON THE PRINTER

CONTENTS OF THIS SECTION

- 1) Subroutine PRICON 1
- 2) Subroutine PRICON 2
- 3) Subroutine HYPSON
- 4) Program MAPPER
- 5) SAMPLE DATA

SUBROUTINES PRTCN1 AND PRTCN2 - GENERAL INSTRUCTIONS

THESE PROGRAMS ARE BASED ON A MAD LANGUAGE PROGRAM OBTAINED FROM PROFESSOR W. R. TORLER, DEPT. OF GEOGRAPHY, UNIVERSITY OF MICHIGAN, ANN ARBOR. BOTH SUBROUTINES PRODUCE CONTOUR MAPS OF GRIDDED DATA ON THE PRINTER USING LINEAR INTERPOLATION WITHIN THE GRID SQUARES. HOWEVER PRTCN1 ASSIGNS A SINGLE CHARACTER TO EACH CONTOUR INTERVAL (ALLOWING A MAXIMUM OF 19 INTERVALS) WHILE PRTCN2 USES THE OVERPRINT OPTION TO PRODUCED PATTERNS FOR EACH INTERVAL THAT ARE LIGHT FOR LOW AREAS AND DARK FOR HIGH AREAS (A MAXIMUM OF 10 CONTOUR INTERVALS IS POSSIBLE). PRTCN1 HAS THREE OPTIONS - CONTOUR LINES MAY BE PRINTED, ALTERNATE CONTOUR BANDS MAY BE PRINTED, OR ALL PRINT POSITIONS ON THE MAP MAY BE PRINTED. PRTCN2 HAS TWO OPTIONS - THE MAPS MAY BE PRINTED WITH OR WITHOUT WHITE BORDERS SEPARATING THE CONTOUR INTERVALS.

BOTH SUBROUTINES CAN CONTOUR IRREGULARLY SHAPED AREAS IF THE GRID POINTS FALLING OUTSIDE THE AREA OF INTEREST ARE GIVEN ARBITRARILY VERY HIGH OR LOW VALUES (VALUES MUST BE ONE DATA ELEVATION RANGE BELOW LOW OR ABOVE HIGH) .

THE SUBROUTINES PREPARE A FREQUENCY TABLE SHOWING THE PERCENT MAP AREA (OR PERCENT AREA OF INTEREST FOR IRREGULAR AREAS) BY NUMERICAL INTEGRATION. THE VALUES MAY BE FURTHER ANALYZED BY SUBROUTINE HYPISO WHICH PERFORMS HYPSONETRIC (AREA-ALTITUDE) ANALYSIS.

SPECIAL NOTE -

THE MAXIMUM MAP WIDTH IS 12.7 INCHES, THE WIDTH OF THE PAPER. THE MAXIMUM NUMBER OF COLUMNS OF INPUT DATA IS A FUNCTION OF THE SPECIFIED MAP WIDTH. IF $PS = (COL - COLS) / (COLS - 1)$ (SEE DEFINITIONS BELOW) IS LESS THAN 2, FEWER THAN 2 PRINTING POSITIONS WOULD BE ASSIGNED TO EACH COLUMN SPACE AND SO AN UNSATISFACTORY MAP WOULD RESULT. THUS THE PROGRAM WILL NOT PLOT A MAP IF PS IS LESS THAN 2, AND ACCORDINGLY THE MAXIMUM NUMBER OF COLUMNS FOR A MAP OF MAXIMUM WIDTH IS 42. IF MORE COLUMNS ARE REQUIRED THE MAP MUST BE MADE IN SECTIONS BY USING ONLY PART OF THE DATA IN EACH PASS. THE NUMBER OF COLUMNS SHOULD BE THE SAME IN EACH PASS FOR THE MAPS TO BE AT THE SAME SCALE. TO DO THIS IT MAY BE NECESSARY, AND IS ADVISABLE, TO REPEAT SOME COLUMNS.

SUBROUTINE PPTCON1

PURPOSE -
TO PRODUCE CONTOUR MAPS ON THE PRINTER.

USAGE -

CALL PRTCON1(Z,ROWS,COLS,TITL)
Z - ARRAY OF GRIDDED ELEVATION VALUES (MAXIMUM = 100 X 100).
ROWS - NUMBER OF ROWS IN Z ARRAY
COLS - NUMBER OF COLUMNS IN Z ARRAY.
TITL - ALPHANUMERIC TITLE 1-72 CHARACTERS.

PUDUE UNIVERSITY VERSION 2.0

A. KEITH TURNER,
CIVIL ENGINEERING,
FEBRUARY 1968.

CONTROL CARD ORDER -

1) MASTER CONTROL CARD -

CON (COLS 1-2) THE NUMBER OF CONTOUR INTERVALS (MAXIMUM= 19).
(CON = DATA RANGE / DESIRED CONTOUR INTERVAL).
TOUR (COL 3) IF TOUR=0, PROGRAM USES MAXIMUM AND MINIMUM FROM
DATA FOR UPPER AND LOWER CONTOUR LIMITS.
IF TOUR=1, DESIRED TOP AND BOTTOM CONTOURS READ
IN FROM SPECIAL PROGRAM CARD (SEE BELOW).
IF TOUR=2, VARIABLE CONTOURS READ IN (LOW TO
HIGH). IN THIS CASE SET CON EQUAL TO THE NUMBER
OF VALUES TO BE READ IN .
IF TOUR=3, CONTOUR INTERVAL BECOMES 1/2 STANDARD
DEVIATION (MAX=+3 SIGMA, MIN=-3 SIGMA).
LINES (COL 4) IF LINES=0, CONTOUR LINES ARE PRINTED.
IF LINES=1, ALTERNATE (EVEN VALUED) CONTOUR BANDS
ARE PRINTED.
IF LINES=2, ALL BANDS PRINTED (ALL PRINT POSNS).
INCHES (COLS 5-8) INCHES IS MAP WIDTH IN INCHES. IF GREATER THAN
12.7 OR BLANK, SET TO 10.0
(COL =MAP WIDTH IN CHARACTERS=INCHES*10.0)
IHYP50 (COL10) IF IHYP50=1 SUBROUTINE HYP50 CALLED.

2) SPECIAL CARD(S) -

REQUIRED ONLY WHEN TOUR = 1 OR 2
IF TOUR=1, THIS CARD SPECIFIES MINIMUM AND MAXIMUM ELEVATION
VALUES. -- ZMIN (COLS 1-10) AND ZMAX (COLS 11-20).
IF TOUR=2, THIS CARD SPECIFIES A FORMAT (INCON) TO BE USED IN
READING IN A SERIES OF IRREGULARLY SPACED CONTOUR LINES. THE
VALUES ARE ARRANGED FROM LOWEST TO HIGHEST ON SUBSEQUENT CARDS.

```

SUBROUTINE PRTCN1(Z,ROWS,COLS,TITL)
  DIMENSION FORM(10),TITL(12),SYMTAB(21),PSYM(131),Z(100,100),
1  INCON(10),DRANG(25),TABE(25),ZPREV(131),SYM(131)
  DIMENSION CUMH(27)
  INTEGER ROWS,COLS,CON,TOUR,COLMAX,COL,PSYM,PS,GRID,TOUT,TLOW,
1  SYM,ILANK,PLUS,MINUS,STAR,SYMTAB
  INTEGER XSTOP,YSTOP
  REAL MINZ,MAXZ,INCHES,INCON
  DATA (SYMTAB(I),I=1,21)/1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,
1  1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK/,PLANK/1H /,PLUS/1H+,
2  ,MINUS/1H-/,STAR/1H*/
1  READ (5,1000) CON,TOUR,LINES,INCHES ,IHYP50
1000 FORMAT(I2,2I1,F4.0,2X,I1)
C *****
C ZERO COUNTERS AND ARRAYS USED IN FREQUENCY TABLE
C *****
  JJ=0
  MM=0
  SUM=0.0
  TLOW=0
  TOUT=0
  DO 5 I=1,25
5  TABE(I)=0.0
  N=ROWS*COLS
C *****
C N = NUMBER OF DATA POINTS
C *****
  WRITE(6,1030) TITL,N,COLS,ROWS
1030 FORMAT(1H1,12A6,/,/,22H MAP IS DEVELOPED FROM,15,30H GRIDDED VALUES
1,CONSISTING OF ,13,12H COLUMNS BY ,13,6H ROWS,/)
  CALL STATS(ROWS,COLS,10,100,Z,ZBAR,XP,ZSIG,MAXZ,MINZ)
C *****
C DETERMINE CONTOUR LINE ELEVATIONS
C TOUR VALUE DETERMINES METHOD USED IN DEFINING CONTOURS
C *****
  IF (TOUR .GT. 3 .OR. TOUR .LE. 0) GO TO 60
  GO TO (30,40,50),TOUR
30  WRITE (6,1060)
1060 FORMAT (25H CONTOUR LEVELS SPECIFIED)
  READ (5,1070) ZMIN,ZMAX
1070 FORMAT (2F10.0)
  GO TO 70
40  READ (5,1020) INCON
1020 FORMAT (10A6)
  WRITE (6,1080)
1080 FORMAT (37H VARIABLE CONTOUR INTERVALS SPECIFIED)
  READ (5,INCON) (DRANG(I),I=1,CON)
  ZMIN=DRANG(1)
  ZMAX=DRANG(CON)
  GO TO 70
50  ZMIN=ZBAR-3.0*ZSIG
  ZMAX=ZBAR+3.0*ZSIG
  CON=13

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WRITE (6,1090)
1090 FORMAT (30H CONTOUR INTERVAL = U1/2 SIGMA)
GO TO 70
60 WRITE (6,1100)
1100 FORMAT (26H CONTOUR LEVELS CALCULATED)
ZMIN=MINZ
ZMAX=MAXZ
70 WRITE(6,1110) ROWS,COLS,ZBAR,ZSIG,MAXZ,MINZ
1110 FORMAT (13H GRIDDED DATA/,42H LINEAR INTERPOLATION WITHIN GRID SQU
1ARES /,17H OBSERVED VALUES /, 8H ROWS = ,I3,10H COLS = ,
2I3,/,8H ZBAR = ,F10.3,10H ZSIG = ,F10.3,10H MAXZ = ,F10.3,10H
3 MINZ = ,F10.3)
C *****
C CALCULATE MAP WIDTH IN CHARACTERS (COL)
C *****
IF (INCHES.LE.0.0) COL=100
IF (INCHES.GT. 12.7) COL=127
IF (INCHES.GT.0.0.AND.INCHES.LE.12.7) COL=INCHES*10.0
PS=(COL-COLS)/(COLS-1)
C *****
C TEST GRID SIZE--IF GRID SMALLER THAN 2 CHARACTERS BETWEEN COLUMNS,
C AN ERROR STATEMENT IS PRINTED AND PLOT ABORTED
C *****
IF (PS.GT.1) GO TO 80
WRITE (6,1120)
1120 FORMAT (25H TOO MANY COLUMNS IN GRID)
GO TO 999
C
C CALCULATE REQUIRED CONSTANTS
C
80 COLMAX=PS*(COLS-1)+COLS
YINC=1.0/((FLOAT(PS+1))*0.6)
GRID=PS+1
XINC=1.0/FLOAT(GRID)
RANGZ=ZMAX-ZMIN
RHIGH=ZMAX+RANGZ
RLOW=ZMIN-RANGZ
IF (CON.EQ.0.OR.CON.GT.19) CON=5
FCON=CON
CI=RANGZ/FCON
IF (TOUR.EQ.2) GO TO 100
JJJ=CON+1
DO 90 J=1,JJJ
90 DRANG(J)=ZMIN+FLOAT(J-1)*CI
100 CONTINUE
WRITE (6,1130)
1130 FORMAT (1H /,16H VALUES EMPLOYED)
WRITE (6,1140) ZMIN,ZMAX,CI,GRID,XINC,YINC,CON,PS,COLMAX
1140 FORMAT (8H ZMIN = ,F10.3,10H ZMAX = ,F10.3,PH CI = ,F10.3/,8H
1GRID = ,I5,10H XINC = ,F10.3,10H YINC = ,F10.3,/,7H CON = I5,
2 8H PS = ,I5,12H COLMAX = ,I5)

```

```

C      ****
C  WRITE OUT CONTOUR SYMBOL TABLE
C      ****
      WRITE (6,1150)
1150  FORMAT (35H4CONTOUR SYMBOL TABLE IS AS FOLLOWS)
      IF (LINES.EQ.1) WRITE (6,1160)
1160  FORMAT (43H(ONLY EVEN SYMBOLS PRINTED IN BODY OF MAP) )
      WRITE (6,1170)
1170  FORMAT (7H0SYMBOL,11X,5HVALUE)
      IF (LINES.NE.0) GO TO 110
      WRITE (6,1180)
1180  FORMAT (5H0      *,6X,7HNO DATA,/,5H      -,4X,10HBELOW LOW)
      WRITE (6,1190) (SYMTAB(I),DRANG(I),I=1,CON)
1190  FORMAT (4X,A1,2X,F12.4)
      WRITE (6,1200)
1200  FORMAT (4X,1H+,4X,10HABOVE HIGH)
      GO TO 120
110   WRITE (6,1210)
1210  FORMAT (5H0      *,25X,7HNO DATA,/,5H      -,23X,10HBELOW LOW)
      WRITE (6,1220) (SYMTAB(I),DRANG(I),DRANG(I+1),I=1,CON)
1220  FORMAT (4X,A1,2X,F12.4,6H TO ,F12.4)
      WRITE (6,1230) DRANG(CON+1)
1230  FORMAT (4X,1H+,2X,F12.4,10H OR OVER)
120   WRITE(6,1030) TITL,N,COLS,ROWS
      XSTOP = GRID
      GRID=COLS-1
      COL=3
      DO 140 J=1,GRID
      DO 130 I = 2,XSTOP
      SYM(COL)=BLANK
130   COL=COL+1
      SYM(COL)=PLUS
140   COL=COL+1
      N=COLMAX+2
      SYM(2)=PLUS
      SYM(1)=BLANK
      SYM(N)=BLANK
      WRITE (6,1240) (SYM(I),I=1,N)
1240  FORMAT (1H9,129A1)
C
C  ESTIMATE VALUE OF ALL PRINTING POSITIONS ON MAP
C
C  LOOP THROUGH MAP LENGTH, ROW BY ROW
C
      ITOP=1
      IROW = ROWS + 1
      DO 340 MM = 2,IROW
      YSTOP = 1./YINC + .5
      IF (MM.EQ.IROW) YSTOP=1
      M=MM-1

```

```

145  YP=0.0
      PSYM(1) = PLUS
      PSYM(N) = PLUS
      DO 340 KJ=1,YSTOP
150  COL=1
      Z1 = YP*(Z(MM,1)-Z(M,1))+Z(M,1)
C
C      LOOP THROUGH MAP WIDTH,COLUMN BY COLUMN
C
190  II=COLS-1
      JLFT=2
      DO 330 J=1,II
      JJ=J+1
      Z2=YP*(Z(MM,JJ)-Z(M,JJ))+Z(M,JJ)
      ZDELTA=Z2-Z1
      XP=0.0
      DO 480 KK = 1,XSTOP
      JLFT=JLFT-1
195  COL=COL+1
200  ZEST=XP*ZDELTA+Z1
      IF(ZEST.GE.ZMIN.AND.ZEST.LE.ZMAX) GO TO 325
      IF(ZEST.GT.ZMAX) GO TO 203
      IF (ZEST.LE.RLOW) GO TO 206
      IF(ITOP.EQ.1.OR.MM.EQ.IROW.OR.JLFT.EQ.1) GO TO201
      PSYM(COL)=BLANK
      GO TO 202
201  PSYM(COL)=MINUS
202  TLOW=TLOW+1
      ZPREV(COL)=ZEST
      ZLAST=ZEST
      GO TO 124
203  IF(ZEST.GE.RHIGH) GO TO 206
      IF(ITOP.EQ.1.OR.MM.EQ.IROW.OR.JLFT.EQ.1) GO TO204
      PSYM(COL)=BLANK
      GO TO 205
204  PSYM(COL)=PLUS
205  TABE(CON+1)=TABE(CON+1)+1.0
      ZPREV(COL)=ZEST
      ZLAST=ZEST
      GO TO 124
206  IF(ITOP.EQ.1.OR.MM.EQ.IROW.OR.JLFT.EQ.1) GO TO207
      PSYM(COL)=BLANK
      GO TO 208
207  PSYM(COL)=STAR
208  TOUT=TOUT+1
      ZPREV(COL)=ZEST
      ZLAST=ZEST
      GO TO 480
325  I=((ZEST-ZMIN)/CI)+1.
      TABE(I)=TABE(I)+1.0
      LVAL=LINES+1

```

```

IF (ITOP.EQ.1.OR.XM.EQ.IROW.OR.JLFT.EQ.1) LVAL=3
GO TO (326,327,328) ,LVAL
326 DO 309 I=1,CON
ZSTEP=DRANG(I)
SW1=1.
SW2=1.
SW3=1.
SW4=1.
IF (ZSTEP.GF.ZLAST.OR.ZSTEP.GF.ZPREV(COL)) SW1=0.
IF (ZSTEP.LE.ZEST) SW2=0.
IF (ZSTEP.LT.ZLAST.OR.ZSTEP.LT.ZPREV(COL)) SW3=0.
IF (ZSTEP.GE.ZEST) SW4=0.
IF ((SW1.EQ.0..AND.SW2.EQ.0.) .OR. (SW3.EQ.0..AND.SW4.EQ.0.)) GO TO 310
309 CONTINUE
PSYM(COL)=BLANK
GO TO 320
310 PSYM(COL)=SYMTAB(I)
320 ZLAST=ZEST
ZPREV(COL)=ZEST
GO TO 124
327 K=I/2
IF ((K*2).NE.I) PSYM(COL)=SYMTAB(I)
IF ((K*2).EQ.I) PSYM(COL)=BLANK
GO TO 124
328 PSYM(COL)=SYMTAB(I)
ZPREV(COL)=ZEST
124 SUM=SUM+1.0
480 XP=XP+XINC
Z1=Z2
330 JLFT=0
COL = COL + 1
IF (Z(M,COLS).GE.ZMIN.AND.Z(M,COLS).LE.ZMAX) GO TO 333
IF (Z(M,COLS).GT.ZMAX) GO TO 335
IF (Z(M,COLS).LE.RLOW) GO TO 336
PSYM(COL)=MINUS
TLOW=TLOW+1
GO TO 334
335 IF (Z(M,COLS).GE.RHIGH) GO TO 336
PSYM(COL)=PLUS
TABE(CON+1)=TABE(CON+1)+1.0
GO TO 334
336 PSYM(COL)=STAR
TOUT=TOUT+1
GO TO 332
333 I = ((Z(M,COLS)-ZMIN)/C1)+1.
TABE(I)=TABE(I)+1.0
PSYM(COL)=SYMTAB(I)
334 SUM=SUM+1.0
332 WRITE (6,1240) (PSYM(L),L=1,N)
YP=YP+YINC
PSYM(1) = BLANK
PSYM(N)=BLANK
340 ITOP=0
WRITE (6,1240) (SYM(L),L=1,N)

```

```

C *****
C  CALCULATE AND PRINT FREQUENCY TABLE
C  *****
WRITE (6,1250) TOUT
1250  FORMAT (16H1FREQUENCY TABLE ,/,12X,8HINTERVAL ,16X,5HUNITS ,6X,10HP
      1ERCENTAGE ,4X,10HCUMULATIVE ,/,16X,7HNO DATA ,11X,18)
      PTAB=(FLOAT(TLOW)/SUM)*100.0
      CTAB=PTAB
      WRITE (6,1260) TLOW,PTAB,CTAB
1260  FORMAT (14X,9HBELOW LOW,11X,18,2(3X,F12.4))
      DO 350 I=1,CON
      VALUE=DRANG(I)
      VAL1=DRANG(I+1)
      VAL1=DRANG(I+1)
      PTAB=(TABE(I)/SUM)*100.0
      CTAB=CTAB+PTAB
350   WRITE (6,1270) VALUE,VAL1,TABE(I),PTAB,CTAB
1270  FORMAT (1X,F12.4,6H TO ,F12.4,3X,F8.0,2(3X,F12.4))
      I=CON+1
      PTAB=(TABE(I)/SUM)*100.0
      CTAB=PTAB+CTAB
      WRITE (6,1280) VAL1,TABE(I),PTAB,CTAB,SUM,CTAB,CTAB
1280  FORMAT (1X,F12.4,10H OR OVER ,11X,F8.0,2(3X,F12.4),/,18X,5HTOTAL
      1,11X,F8.0,2(3X,F12.4))
C *****
C  IF IHPSO = 1 , PERFORM HYPSONOMETRIC ANALYSIS
C  *****
      IF (IHPSO) 450,999,450
450   CALL HYPSON(DRANG,ZMAX,ZMIN,CON,CUMH,TITL)
999   CONTINUE
      RETURN
      END

```


C
C SUBROUTINE PRTRCON2
C

C PURPOSE -
C

C TO PRODUCE GRADED DENSITY CONTOUR MAPS ON THE PRINTER
C

C USAGE -
C

C CALL PRTRCON2(Z,ROWS,CLS,TITL)
C

C Z - ARRAY OF GRIDDED ELEVATION VALUES (MAXIMUM = 100 X 100).
C

C ROWS - NUMBER OF ROWS IN Z ARR 8
C

C CLS - NUMBER OF COLUMNS IN Z ARRAY.
C

C TITL - ALPHANUMERIC TITLE 1-72 CHARACTERS.
C

C
C PUDUE UNIVERSITY VERSION 1.0
C

C KEITH TURNER,
C CIVIL ENGINEERING
C FEBRUARY 1968.
C

C CONTROL CARD ORDER -
C

C 1) MASTER CONTROL CARD -
C

C CON (CLS 1-2) THE NUMBER OF CONTOUR INTERVALS (MAXIMUM=10).
C (CON = DATA RANGE / DESIRED CONTOUR INTERVAL).

C TOUR (CLS 3) IF TOUR=0, PROGRAM USES MAXIMUM AND MINIMUM FROM
C DATA FOR UPPER AND LOWER CONTOUR LIMITS.
C IF TOUR=1, DESIRED TOP AND BOTTOM CONTOURS READ
C IN FROM SPECIAL PROGRAM CARD (SEE BELOW).
C IF TOUR=2, VARIABLE CONTOURS READ IN (LOW TO
C HIGH). IN THIS CASE SET CON EQUAL TO THE NUMBER
C OF VALUES TO BE READ IN .

C LINES (CLS 4) IF LINES=0, BLANK BORDERS ARE PLACED BETWEEN
C CONTOUR INTERVALS.

C IF LINES=1, BLANK BORDERS NOT DEVELOPED.

C INCHES (CLS 5-8) INCHES IS MAP WIDTH IN INCHES. IF GREATER THAN
C 12.7 OR BLANK, SET TO 10.0

C (CLS = MAP WIDTH IN CHARACTERS = INCHES * 10.0)

C IHYPSO (CLS 10) IF IHYPSO=1 SUBROUTINE HYPSON CALLED.
C

C 2) SPECIAL CARD(S) -
C

C REQUIRED ONLY WHEN TOUR = 1 OR 2

C IF TOUR=1, THIS CARD SPECIFIES MINIMUM AND MAXIMUM ELEVATION
C VALUES. -- ZMIN (CLS 1-10) AND ZMAX (CLS 11-20).

C IF TOUR=2, THIS CARD SPECIFIES A FORMAT (INCON) TO BE USED IN
C READING IN A SERIES OF IRREGULARLY SPACED CONTOUR LINES. THE
C VALUES ARE ARRANGED FROM LOWEST TO HIGHEST ON SUBSEQUENT CARDS.
C

```

SUBROUTINE(PRTCON2(Z,ROWS,COLS,TITL)
DIMENSION FORM(10),TITL(12),Z(100,100),DRANG(25),SYM(131)
DIMENSION SYMTAB(10,2),PSYM(131,2)
DIMENSION ZPREV(131),INCON(10),TABE(25),CUMH(27)
INTEGER ROWS,COLS,CON,COLMAX,COL,PSYM,PS,GRID,SYM,BLANK,PLUS,
1SYMTAB,XSTOP,YSTOP
INTEGER TOUR,STAR
INTEGER MINUS,DOT,OWF,EYE,LPAR,RPAR,SLASH,EGGS,EQUAL
REAL INCHES,MINZ,MAXZ,INCON
DATA BLANK/1H /,PLUS/1H+/,MINUS/1H-/,DOT/1H./,OWF/1HO/,EYE/1HI/,
1EGGS/1HX/,EQUAL/1H=/,SLASH/1H//,LPAR/1H(/,RPAR/1H)/,STAR/1H*/
SYMTAB(1,1)=DOT
SYMTAB(1,2)=BLANK
SYMTAB(2,1)=LPAR
SYMTAB(2,2)=BLANK
SYMTAB(3,1)=OWE
SYMTAB(3,2)=OWE
SYMTAB(4,1)=EGGS
SYMTAB(4,2)=EGGS
SYMTAB(5,1)=LPAR
SYMTAB(5,2)=RPAR
SYMTAB(6,1)=OWE
SYMTAB(6,2)=MINUS
SYMTAB(7,1)=EYE
SYMTAB(7,2)=EQUAL
SYMTAB(8,1)=EGGS
SYMTAB(8,2)=MINUS
SYMTAB(9,1)=OWE
SYMTAB(9,2)=SLASH
SYMTAB(10,1)=OWE
SYMTAB(10,2)=STAR

```

```

C
1  READ (5,1000) CON,TOUR,LINES,INCHES ,IHYP50
1000 FORMAT(I2,2I1,F4.0,2X,I1)
C  ****
C  ZERO COUNTERS AND ARRAYS USED IN FREQUENCY TABLE
C  ****
  JJ=0
  MM=0
  SUM=0.0
  TLOW=0
  TOUT=0
  DO 5 I=1,25
5  TABE(I)=0.0
  N=ROWS*COLS
C  ****
C  N = NUMBER OF DATA POINTS
C  ****
  WRITE(6,1030) TITL,N,COLS,ROWS
1030 FORMAT(1H1,12A6,///,22H MAP IS DEVELOPED FROM,15,30H GRIDDED VALUES
1,CONSISTING OF ,13,12H COLUMNS BY ,13,6H ROWS,/)
  CALL STATS(ROWS,COLS,1.0,100,Z,ZBAR,XP,ZSIG,MAXZ,MINZ)

```

```

C *****
C DETERMINE CONTOUR LINE ELEVATIONS
C TOUR VALUE DETERMINES METHOD USED IN DEFINING CONTOURS
C *****
  IF (TOUR.GT.2.0R.TOUR.LE.0) GO TO 60
  GO TO (30,40),TOUR
30  WRITE (6,1060)
1060 FORMAT (25H CONTOUR LEVELS SPECIFIED)
  READ (5,1070) ZMIN,ZMAX
1070 FORMAT (2F10.0)
  GO TO 70
40  READ (5,1020) INCON
1020 FORMAT (10A6)
  WRITE (6,1080)
1080 FORMAT (37H VARIABLE CONTOUR INTERVALS SPECIFIED)
  READ (5,INCON) (DRANG(I),I=1,CON)
  ZMIN=DRANG(1)
  ZMAX=DRANG(CON)
  GO TO 70
60  WRITE (6,1100)
1100 FORMAT (26H CONTOUR LEVELS CALCULATED)
  ZMIN=MINZ
  ZMAX=MAXZ
70  WRITE(6,1110) ROWS,COLS,ZBAR,ZSIG,MAXZ,MINZ
1110 FORMAT (13H GRIDDED DATA/,42H LINEAR INTERPOLATION WITHIN GRID SQUARES /,17H OBSERVED VALUES /, 8H ROWS = ,I3,10H COLS = ,
2I3,/,8H ZBAR = ,F10.3,10H ZSIG = ,F10.3,10H MAXZ = ,F10.3,10H
3 MINZ = ,F10.3)
C *****
C CALCULATE MAP WIDTH IN CHARACTERS (COL)
C *****
  IF (INCHES.LE.0.0) COL=100
  IF (INCHES .GT. 12.7) COL=127
  IF (INCHES.GT.0.0.AND.INCHES.LE.12.7) COL=INCHES*10.0
  PS=(COL-COLS)/(COLS-1)
C *****
C TEST GRID SIZE--IF GRID SMALLER THAN 2 CHARACTERS BETWEEN COLUMNS.
C AN ERROR STATEMENT IS PRINTED AND PLOT ABORTED
C *****
  IF (PS.GT.1) GO TO 80
  WRITE (6,1120)
1120 FORMAT (25H TOO MANY COLUMNS IN GRID)
  GO TO 999
C
C CALCULATE REQUIRED CONSTANTS
C
80  COLMAX=PS*(COLS-1)+COLS
  YINC=1.0/((FLOAT(PS+1))2*0.5)
  GRID=PS+1
  XINC=1.0/FLOAT(GRID)
  RANGZ=ZMAX-ZMIN

```

```
RHIGH=ZMAX+RANGZ
RLOW=ZMIN-RANGZ
IF (CON.EQ.0.OR.CON.GT.10) CON=5
FCON=CON
CI=RANGZ/FCON
IF (TOUR.EQ.2) GO TO 100
JJJ=CON+1
DO 90 I=1,JJJ
90 DRANG(I)=ZMIN+FLOAT(I-1)*CI
100 CONTINUE
WRITE (6,1130)
1130 FORMAT (1H /,16H VALUES EMPLOYED)
WRITE (6,1140) ZMIN,ZMAX,CI,GRID,XINC,YINC,CON,PS,COLMAX
1140 FORMAT (8H ZMIN = ,F10.3,10H ZMAX = ,F10.3,8H CI = ,F10.3/,8H
1GRID = ,I5,10H XINC = ,F10.3,10H YINC = ,F10.3/,7H CON = I5,
2 8H PS = ,I5,12H COLMAX = ,I5)
C *****
C WRITE OUT CONTOUR SYMBOL TABLE
C *****
WRITE (6,1150)
1150 FORMAT (35H4CONTOUR SYMBOL TABLE IS AS FOLLOWS)
WRITE (6,1170)
1170 FORMAT (7H0SYMBOL,11X,5HVALUE)
110 WRITE (6,1210)
1210 FORMAT(5H0 *,25X,7HNO DATA,/,5H -,23X,10HBELOW LOW)
DO 450 I=1,CON
WRITE (6,1221) SYMTAB(I,2)
1221 FORMAT(1H+,4X,A1)
WRITE(6,1220) SYMTAB(I,1),DRANG(I),DRANG(I+1)
1220 FORMAT(1H ,4X,A1,2X,F12.4,6H TO ,F12.4)
450 CONTINUE
WRITE (6,1230) DRANG(CON+1)
1230 FORMAT (4X,1H+,2X,F12.4,10H OR OVER)
120 WRITE(6,1030) TITL,N,COLS,ROWS
XSTOP = GRID
GRID=COLS-1
COL=3
DO 140 J=1,GRID
DO 130 I = 2,XSTOP
SYM(COL)=BLANK
130 COL=COL+1
SYM(COL)=PLUS
140 COL=COL+1
N=COLMAX+2
SYM(2)=PLUS
SYM(1)=BLANK
SYM(N)=BLANK
WRITE (6,1240) (SYM(I),I=1,N)
1240 FORMAT (1H9,129A1)
```

```

C
C ESTIMATE VALUE OF ALL PRINTING POSITIONS ON MAP
C
C LOOP THROUGH MAP LENGTH, ROW BY ROW
C
    ITOP=1
    IROW = ROWS + 1
    DO 340 MM = 2,IROW
    YSTOP = 1./YINC + .5
    IF (MM.EQ.IROW) YSTOP=1
    M=MM-1
145  YP=0.0
    PSYM(1,1)=PLUS
    PSYM(1,2)=BLANK
    PSYM(N,1)=PLUS
    PSYM(N,2)=BLANK
    DO 340 K = 1, YSTOP
150  COL=1
    Z1 = YP*(Z(MM,1)-Z(M,1))+Z(M,1)
C
C LOOP THROUGH MAP WIDTH,COLUMN BY COLUMN
C
190  II=COLS-1
    JLFT=?
    DO 330 J=1,II
    JJ=J+1
    Z2=YP*(Z(MM,JJ)-Z(M,JJ))+Z(M,JJ)
    ZDELT=Z2-Z1
    XP=0.0
    DO 480 KK = 1,XSTOP
    JLFT=JLFT-1
195  COL=COL+1
200  ZEST=XP*ZDELT+Z1
    IF(ZEST.GE.ZMIN.AND.ZEST.LE.ZMAX) GO TO 325
    IF(ZEST.GT.ZMAX) GO TO 203
    IF (ZEST.LE.RLOW) GO TO 206
    IF(ITOP.EQ.1.OR.MM.EQ.IROW.OR.JLFT.EQ.1) GO TO 201
    PSYM(COL,1)=BLANK
    GO TO 202
201  PSYM(COL,1)=MINUS
202  PSYM(COL,2)=BLANK
    TLOW=TLOW+1
    ZPREV(COL)=ZEST
    ZLAST=ZEST
    GO TO 124
203  IF(ZEST.GE.RHIGH) GO TO 206

```

```

IF(ITOP.EQ.1.OR.MM.EQ.1ROW.OR.JLFT.EQ.1) GO TO204
PSYM(COL,1)=BLANK
GO TO 205
204 PSYM(COL,1)=PLUS
205 PSYM(COL,2)=BLANK
TABE(CON+1)=TABE(CON+1)+1.0
ZPREV(COL)=ZEST
ZLAST=ZEST
GO TO 124
206 IF(ITOP.EQ.1.OR.MM.EQ.1ROW.OR.JLFT.EQ.1) GO TO207
PSYM(COL,1)=BLANK
GO TO 208
207 PSYM(COL,1)=STAR
208 PSYM(COL,2)=BLANK
TOUT=TOUT+1
ZPREV(COL)=ZEST
ZLAST=ZEST
GO TO 480
325 CONTINUE
LVAL=LINES+1
IF(ITOP.EQ.1.OR.MM.EQ.1ROW.OR.JLFT.EQ.1)LVAL=2
GO TO (326,327),LVAL
326 DO 309 I=1,CON
ZSTEP=DRANG(I)
SW1=1.
SW2=1.
SW3=1.
SW4=1.
IF (ZSTEP.GE.ZLAST.OR.ZSTEP.GE.ZPREV(COL)) SW1=0.
IF (ZSTEP.LE.ZEST) SW2=0.
IF (ZSTEP.LT.ZLAST.OR.ZSTEP.LT.ZPREV(COL)) SW3=0.
IF (ZSTEP.GE.ZEST) SW4=0.
IF((SW1.EQ.0..AND.SW2.EQ.0.)..OR.(SW3.EQ.0..AND.SW4.EQ.0.))GO TO310
309 CONTINUE
327 I=((ZEST-ZMIN)/CI)+1.
PSYM(COL,1)=SYMTAB(I,1)
PSYM(COL,2)=SYMTAB(I,2)
TABE(I)=TABE(I)+1.0
GO TO 320
310 PSYM(COL,1)=BLANK
PSYM(COL,2)=BLANK
TABE(I)=TABE(I)+1.0
320 ZLAST=ZEST
ZPREV(COL)=ZEST
124 SUM=SUM+1.0
480 XP=XP+XINC
Z1=Z2
JLFT= )
330 COL = COL + 1
IF(Z(M,COLS).GE.ZMIN.AND.Z(M,COLS).LE.ZMAX) GO TO 333
IF(Z(M,COLS).GT.ZMAX) GO TO 335
IF(Z(M,COLS).LE.RLOW) GO TO 336
PSYM(COL,1)=MINUS
PSYM(COL,2)=BLANK
TLOW=TLOW+1
GO TO 332

```

```
335 IF(Z(M,COLS).GE.0RHIGH) GO TO 336
    PSYM(COL,1)=PLUS
    PSYM(COL,2)=BLANK
    TABE(CON+1)=TABE(CON+1)+1.0
    GO TO 332
336 PSYM(COL,1)=STAR
    PSYM(COL,2)=BLANK
    TOUT=TOUT+1
    GO TO 334
333 I = ((Z(M,COLS)-ZMIN)/CI)+1.
    PSYM(COL,1)=SYMTAB(I,1)
    PSYM(COL,2)=SYMTAB(I,2)
332 SUM=SUM+1.0
334 WRITE(6,1241) (PSYM(L,2),L=1,N)
1241 FORMAT(1H+,129A1)
    WRITE(6,1240) (PSYM(L,1),L=1,N)
    YP=YP+YINC
    PSYM(1,1)=BLANK
    PSYM(1,2)=BLANK
    PSYM(N,1)=BLANK
    PSYM(N,2)=BLANK
340 ITOP=0
    WRITE(6,1240) (SYM(L),L=1,N)
C *****
C CALCULATE AND PRINT FREQUENCY TABLE
C *****
    WRITE(6,1250) TOUT
1250 FORMAT(16H1FREQUENCY TABLE,/,12X,8HINTERVAL,16X,5HUNIT'S,6X,10HP
1ERCENTAGE,4X,10HCUMULATIVE,/,16X,7HNO DATA,11X,I8)
    PTAB=(FLOAT(TLOW)/SUM)*100.0
    CTAB=PTAB
    WRITE(6,1260) TLOW,PTAB,CTAB
1260 FORMAT(14X,9HBELOW LOW,11X,I8,2(3X,F12.4))
    DO 350 I=1,CON
    VALUE=DRANG(I)
    VAL1=DRANG(I+1)
    VAL1=DRANG(I+1)
    PTAB=(TABE(I)/SUM)*100.0
    CTAB=CTAB+PTAB
350 WRITE(6,1270) VALUE,VAL1,TABE(I),PTAB,CTAB
1270 FORMAT(1X,F12.4,6H TO,1X,F12.4,3X,F8.0,2(3X,F12.4))
    I=CON+1
    PTAB=(TABE(I)/SUM)*100.0
    CTAB=PTAB+CTAB
    WRITE(6,1280) VAL1,TABE(I),PTAB,CTAB,SUM,CTAB,CTAB
1280 FORMAT(1X,F12.4,10H OR OVER,11X,F8.0,2(3X,F12.4),/,18X,5HTOTAL
1,11X,F8.0,2(3X,F12.4))
C *****
C IF IHYPSO = 1, PERFORM HYPSONETRIC ANALYSIS
C *****
    IF (IHYPSO) 450,999,450
    CALL HYPSO(DRANG,ZMAX,ZMIN,CON,CUMH,TITL)
450 CONTINUE
999 RETURN
END
```


SUBROUTINE HYP SO

PURPOSE - TO PERFORM HYP SO METRIC (AREA-ALTITUDE) ANALYSIS.

REFERENCE-

A. N. STRAHLER-1952-HYPSOMETRIC (AREA-ALTITUDE) ANALYSIS
OF EROSIONAL TOPOGRAPHY-GEOL. SOC. AMERICA BULL. VOL.63
PAGES 1117-1142 .

USAGE -

CALL HYP SO(DRANG,ZMAX,ZMIN,CON,CUMH,TITL)
DRANG-ARRAY CONTAINING CONTOUR LEVELS.
ZMAX -MAXIMUM ELEVATION VALUE.
ZMIN -MINIMUM ELEVATION VALUE.
CON -NUMBER OF CONTOUR INTERVALS.
CUMH -ARRAY CONTAINING CUMULATIVE PCT AREAS BELOW EACH CONTOUR.
TITL - ALPHANUMERIC TITLE (1-72 CHARACTERS).

SUBROUTINE HYP SO(DRANG,ZMAX,ZMIN,CON,CUMH,TITL)

DIMENSION IROW(49,81),RELH(25),REL A(25)

DIMENSION TITL(12),CUMH(27),DRANG(27)

DATA DOT,BLANK,STAR/1H,1H,1H*/

REAL IROW

INTEGER CON

INTEGER CON

MAKE PLOT ALL BLANKS,DRAW BORDERS WITH DOTS,AND PLOT A STAR AT TOP
LEFT AN) BOTTOM RIGHT CORNERS

DO 2 M=1,49

DO 2 N=1,81

IROW(M,N)=BLANK

IROW(1,1)=STAR

DO 3 N=2,81

IROW(1,N)=DOT

IROW(49,81)=STAR

DO 4 N=1,80

IROW(49,N)=DOT

DO 5 M=2,48

IROW(M,1)=DOT

IROW(M,81)=DOT

DETERMINE POSITIONS OF STARS WITHIN THE PLOT

K=CON+1

DO 20 J=1,K

```

RELH(I)=(DRANG(I)-ZMIN)/(ZMAX-ZMIN)
RELA(I)=1.0-((CUMH(I)-CUMH(1))/(CUMH(CON+1)-CUMH(1)))
M=(49.0-(RELH(I)*49.0))+0.5
N=(RELA(I)*81.0)+0.5
20   IROW(M,N)=STAR
C   *****
C   PRINT OUT ALL THE PLOT SEQUENTIALLY
C   *****
    WRITE(6,1000) TITL
1000  FORMAT(1H1,22HHYPSOMETRIC CURVE FOR ,12A6)
    WRITE(6,1001)
1001  FORMAT(1H ,8HREL. HT./)
    WRITE(6,1002)
1002  FORMAT(1H ,8X,3H0.0,37X,1H0.5,37X,3H1.0)
    WRITE (6,1003)
1003  FORMAT(1H ,9X,1H+,39X,1H+,39X,1H+)
    WRITE(6,1004) (IROW(1,N),N=1,81)
1004  FORMAT(1H ,4X,5H1.0 +,81A1,5H+ 1.0)
    DO 10J M=2,24
100  WRITE(6,1005) (IROW(M,N),N=1,81)
1005  FORMAT(1H ,9X,81A1)
    WRITE(6,1006) (IROW(25,N),N=1,81)
1006  FORMAT(1H ,4X,5H0.5 +,81A1,5H+ 0.5)
    DO 101 M=26,48
101  WRITE(6,1005) (IROW(M,N),N=1,81)
    WRITE(6,1007) (IROW(49,N),N=1,81)
1007  FORMAT(1H ,4X,5H0.0 +,81A1,5H+ 0.0)
    WRITE(6,1003)
    WRITE(6,1002)
    WRITE(6,1008)
1008  FORMAT (1H ,44X,13HRELATIVE AREA /)
C   *****
C   CALCULATE AREA BELOW THE CURVE USING DECIMAL VALUES OF POINTS FOR
C   THE BEST OBTAINABLE ACCURACY.
C   *****
    AREA=0.0
    DO 200 I=1,CON
    A=((RELH(I)+RELH(I+1))*(RELA(I)-RELA(I+1)))/2.0
200  AREA=AREA+A
    WRITE(6,1010) AREA
1010  FORMAT(1H ,77HTHE HYPOMETRIC INTEGRAL FOR THE ABOVE CURVE (THE A
    AREA BELOW THE CURVE ) IS ,F1.4)
C   *****
C   WRITE OUT COORDINATES OF HYPOMETRIC CURVE
C   *****
    WRITE (6,2001)
2001  FORMAT(1H1,50HCALCULATED VALUES OF HYPOMETRIC CURVE COORDINATES,
1//,5X,12HPOINT NUMBER,5X,6FA-1XIS,10X,6HH-AXIS )
    DO 21 I=1,CON
21  WRITE (6,2000) I,RELA(I),RELH(I)
2000  FORMAT(1H0,10X,12,10X,F6.4,10X,F6.4)
    RETURN
    END

```

PROGRAM MAPPER

PURPOSE - A SIMPLE PROGRAM TO READ IN GRIDDED DATA FOR CONTOURING.

CONTROL CARD ORDER -

1) SPECIFICATION CARD -

ROWS(COLS1-3) NUMBER OF ROWS IN GRID. (MAX=100)
 COLS(COLS4-6) NUMBER OF COLS IN GRID. (MAX=100)
 LIST(COL 7) IF LIST=1, LIST INPUT DATA
 NMAP(COLS8-9) NUMBER OF MAPS REQUESTED FOR THIS DATA SET.

2) TITLE CARD -

ANY ALPHANUMERIC TITLE IN COLUMNS 1-72.

3. FORMAT CARD -

SPECIFIES FORMAT OF INPUT DATA (COLS 1-60)

4) DATA CARDS

PROGRAM MAPPER(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
 DIMENSION FORM(10),TITL(12),Z(100,100)

INTEGER ROWS,COLS

READ (5,1000) ROWS,COLS,LIST,NMAP

FORMAT (2I3,1I,12)

IF (EOF,5) 999,2

IF (NMAP.LT.1) NMAP=1

READ (5,1010) TITL

FORMAT (12A6)

READ (5,1020) FORM

FORMAT (10A6)

DO 7 I=1,ROWS

READ (5,FORM) (Z(I,J),J=1,COLS)

IF LIST =1 LIST INPUT DATA,OTHERWISE GO TO 20

IF (LIST.NE.1) GO TO 20

WRITE (6,1030) TITL

FORMAT (1H1,12A6//)

WRITE(6,1025)

FORMAT(1H0,25X,22HLISTING OF INPUT DATA.)

DO 10 I=1, ROWS

WRITE (6,1040) (Z(I,J),J=1,COLS)

FORMAT(1H0,10F10.3,/(1X,10F10.3))

DO 25 I=1,NMAP

CALL PRICON1(Z,ROWS,COLS,TITL)

GO TO 1

999 STOP

END

CONTOUR MAP OF DRAINAGE BASIN IN VERDUGO HILLS, STRAHLER FIG 15 .

320 OBSERVATIONS

CONTOUR LEVELS SPECIFIED

GRIDDED DATA

LINEAR INTERPOLATION WITHIN GRID SQUARES

OBSERVED VALUES

(16F4.0)

ROWS = 20 COLS = 16

ZBAR = 6145.009 ZSIG = 4262.532 MAXZ = 9999.000 MINZ = 1080.000

VALUES EMPLOYED

ZMIN = 1080.000 ZMAX = 1880.000 CI = 50.000

GRIO = 4 XINC = 0.167 YINC = 0.278

CON = 16 PS = 5 CULMAX = 91

CONTOUR SYMBOL TABLE IS AS FOLLOWS

(ONLY EVEN SYMBOLS PRINTED IN BODY OF MAP)

SYMBOL

VALUE

+			NO DATA
-			BELOW LOW
0	1080.0000	TO	1130.0000
1	1130.0000	TO	1180.0000
2	1180.0000	TO	1230.0000
3	1230.0000	TO	1280.0000
4	1280.0000	TO	1330.0000
5	1330.0000	TO	1380.0000
6	1380.0000	TO	1430.0000
7	1430.0000	TO	1480.0000
8	1480.0000	TO	1530.0000
9	1530.0000	TO	1580.0000
A	1580.0000	TO	1630.0000
B	1630.0000	TO	1680.0000
C	1680.0000	TO	1730.0000
D	1730.0000	TO	1780.0000
E	1780.0000	TO	1830.0000
F	1830.0000	TO	1880.0000
+	1880.0000	OR OVER	

FREQUENCY TABLE

INTERVAL

UNITS

PERCENTAGE

CUMULATIVE

		NO DATA	3081		
		BELOW LOW	0	0.	0.
1080.0000	TO	1130.0000	39.	1.7751	1.7751
1130.0000	TO	1180.0000	98.	4.4606	6.2358
1180.0000	TO	1230.0000	171.	7.7833	14.0191
1230.0000	TO	1280.0000	184.	8.3751	22.3942
1280.0000	TO	1330.0000	223.	10.1502	32.5444
1330.0000	TO	1380.0000	230.	10.4688	43.0132
1380.0000	TO	1430.0000	230.	10.4688	53.4820
1430.0000	TO	1480.0000	213.	9.6950	63.1771
1480.0000	TO	1530.0000	182.	8.2840	71.4611
1530.0000	TO	1580.0000	146.	6.6454	78.1065
1580.0000	TO	1630.0000	136.	6.1903	84.2968
1630.0000	TO	1680.0000	88.	4.0055	88.3022
1680.0000	TO	1730.0000	84.	3.8234	92.1256
1730.0000	TO	1780.0000	67.	3.0496	95.1752
1780.0000	TO	1830.0000	34.	1.5476	96.7228
1830.0000	TO	1880.0000	17.	0.7738	97.4966
1880.0000	OR OVER		55.	2.5034	100.0000
TOTAL			2197.	100.0000	100.0000

SAMPLE OUTPUT FROM SUBROUTINES PRICON I AND HYPISO

CONTOUR MAP OF DRAINAGE BASIN IN VERDUGO HILLS, STRALLER FIG 15.

HYPSONETRIC CURVE FOR CONTOUR MAP OF DRAINAGE BASIN IN VERDUGO HILLS, STRALLER FIG 15.

THE HYPSONETRIC INTEGRAL FOR THE ABOVE CURVE (THE AREA BELOW THE CURVE) IS 0.4288

PART V

PRODUCTION OF CONTOUR MAPS
ON THE CALCOMP PLOTTER

PROGRAM CONTUR

PROGRAM CONTUR - GENERAL INSTRUCTIONS

PURPOSE -

TO PLOT CONTOUR MAPS OF GRIDDED DATA ON THE CALCOMP PLOTTER.
THIS PROGRAM IS BASED ON A FORTRAN II PROGRAM WRITTEN BY FRANK J.
RENS, UNIVERSITY OF MICHIGAN DEPARTMENT OF GEOGRAPHY.

PURDUE UNIVERSITY VERSION 1.2
PROGRAMMED BY -- SANDRA L. TURNER, A. KEITH TURNER,
COMPUTER SCIENCE, CIVIL ENGINEERING,
FEBRUARY 1968.

THIS PROGRAM CAN PRODUCE MAPS TO ANY SCALE WITHIN THE LIMITS
OF THE PLOTTER PAPER WIDTH (MAXIMUM = 28 INCHES).

MANY OPTIONS ARE AVAILABLE AND CAN BE SPECIFIED THROUGH THE USE
OF CONTROL CARDS. THE USER MAY SPECIFY CONTOURS AT REGULAR OR IRREG-
ULAR INTERVALS, AND MAY TRANSFORM MAP COORDINATES BY TRANSLATION OR
ROTATION ABOUT ANY OF THE THREE MAJOR AXES (X, Y, OR Z).

THE PROGRAM CAN PRODUCE ISOMETRIC BLOCK DIAGRAMS OF THE CONTOUR
MAPS BY ROTATING THE DATA ABOUT ALL THREE AXES BEFORE PLOTTING. THE
USE OF A PERSPECTIVE OPTION IN COMBINATION WITH TRANSLATION WILL
ALLOW THE PLOTTING OF LEFT AND RIGHT VIEWS FOR STEREOSCOPIC (3-D)
EFFECTS.

THE PROGRAM IS CAPABLE OF PLOTTING A NUMBER OF DIFFERENT MAPS
OF A SINGLE SET OF DATA, EACH INVOLVING DIFFERENT MAP SCALES, CONTOUR
INTERVALS, ROTATIONS OR TRANSLATIONS, WITHOUT REREADING THE DATA.
VALUES OF CONTOUR LINE COORDINATES ARE CALCULATED AND STORED ON A
SCRATCH TAPE. THESE VALUES ARE MODIFIED AND PLOTTED FOR EACH MAP
REQUESTED SO THAT THE CALCULATIONS ARE MINIMIZED AND THE PLOTTING
OF MULTIPLE MAPS IS EFFICIENT.

TAPE REQUIREMENTS -

1) A SCRATCH TAPE (TAPE 3) IS USED TO STORE CONTOUR COORDINATES
PRIOR TO PLOTTING.

2) A PLOT TAPE IS REQUIRED.

SINCE TWO TAPES ARE USED, REASSIGNMENT OF TAPE UNITS IS REQUIRED
THIS IS ACCOMPLISHED BY A MAP ROUTINE, INCLUDED IN THE LISTING.

ROUTINES REQUIRED -

A) MAIN PROGRAM (CONTUR) PERFORMS OPERATIONS ACCORDING TO CONTROL
CARD SPECIFICATIONS.

B) SUBROUTINES -

1) SCAN --SCANS DATA TO LOCATE CONTOURS.

2) TRACE --TRACES OUT CONTOUR LINE.

3) CALC --PERFORMS INTERPOLATION.

4) DRAFT --PERFORMS ROTATIONS AND TRANSLATIONS, WRITES PLOT TAPE.

5) PROJ --DUMMY SUBROUTINE TO ALLOW ADDITION OF USER-DEVELOPED
MODIFICATIONS.

DESCRIPTION OF CONTROL CARDS AND THEIR OPERATIONS -

EACH CONTROL CARD CONTAINS A CONTROL INTEGER (NCON) IN COLUMNS 1-2. SOME OPERATIONS REQUIRE INPUT DATA IN THE FORM OF VARIABLES AND/OR DATA ON ADDITIONAL CARDS. ANY VARIABLES REQUIRED SHOULD BE PLACED IN COLUMNS 3-12, 13-22, 23-32, 33-42, ETC WITH DECIMAL POINTS PUNCHED. WHEN THE CONTROL INTEGER INDICATES THAT ADDITIONAL CARDS ARE NECESSARY FOR A COMPLETE OPERATION, THESE CARDS SHOULD FOLLOW IMMEDIATELY.

NCON	REMARKS
01	OPERATION- READ AND CONTOUR DATA MATRIX VARIABLES-1)NUMBER OF ROWS 2)NUMBER OF COLUMNS 3)WIDTH OF MAP IN INCHES 4)SCALE FACTOR FOR Z VALUES ($Z=Z/ZSCALE$) (IF BLANK=1) ADDL CARDS- THE DATA MATRIX IS READ IN ROW BY ROW FROM TOP TO BOTTOM (EACH ROW IS SCANNED FROM LEFT TO RIGHT). THE MATRIX IS READ ACCORDING TO A PREVIOUSLY DEFINED FORMAT (SEE NCON=19). MAXIMUM SIZE IS 100X100 .
02	OPERATION-ROTATE THE VIEWING POSITION OF THE SURFACE THETA DEGREES IN THE X DIRECTION. VARIABLES-1) THETA IN DEGREES. ADDL CARDS- NONE
03	OPERATION-ROTATE THE VIEWING POSITION OF THE SURFACE THETA DEGREES IN THE Y DIRECTION. VARIABLES-1) THETA IN DEGREES. ADDL CARDS- NONE
04	OPERATION-ROTATE THE VIEWING POSITION OF THE SURFACE THETA DEGREES IN THE Z DIRECTION. VARIABLES-1) THETA IN DEGREES. ADDL CARDS- NONE
05	OPERATION-CALL SUBROUTINE PROJ FOR USER-DEFINED MODIFICATIONS. VARIABLES- NONE ADDL CARDS- NONE
06	OPERATION-PLOT USERS NAME AND ACCOUNT NUMBER ON PLOT. VARIABLES- NONE ADDL CARDS- NAME AND ACCOUNT NUMBER
08	OPERATION-PLOT CONTOURS WITH PERSPECTIVE TRANSFORMATION TO PRODUCE LEFT OR RIGHT STEREO MODELS. VARIABLES-1)DISTANCE TO PERSPECTIVE PLANE. 2)DISTANCE TO OBJECT PLANE. ADDL CARDS- NONE
10	OPERATION-TRANSLATION OF CONTOUR COORDINATES. VARIABLES-1)TRANSLATION OF X IN INCHES(NOT SCALED,TRUE MEASURE) 2)TRANSLATION OF Y IN INCHES(NOT SCALED,TRUE MEASURE) 3)TRANSLATION OF Z IN INCHES(NOT SCALED,TRUE MEASURE) ADDL CARDS- NONE

NCON

REMARKS

- 11 OPERATION- DEFINE PLOTTER TAPE AS OTHER THAN NORMAL NUMBER.
VARIABLES-1) PLOTTER TAPE NUMBER
ADDL CARDS- NONE
- 12 OPERATION- READ TITLE FOR PLOT(PLOTTED AT TOP OF MAP).
VARIABLES- NONE
ADDL CARDS- TITLE PUNCHED IN COLUMNS 1-48
- 13 OPERATION- TERMINATE PLOT TAPE
VARIABLES- NONE
ADDL CARDS- NONE
- 14 OPERATION- READ LABELS AND COORDINATES(IMAX, PER PLOT = 10).
VARIABLES-1) X COORDINATE OF LABEL
2) Y COORDINATE OF LABEL
3) Z COORDINATE OF LABEL
4) HEIGHT OF LABEL LETTERS.
ADDL CARDS- A LABEL PUNCHED IN COLUMNS 1-36
- 15 OPERATION-DEFINE REGULARLY SPACED CONTOURS.
VARIABLES-1)STARTING CONTOUR
2) CONTOUR INTERVAL
3) FINAL (HIGHEST) CONTOUR
ADDL CARDS- NONE
- 16 OPERATION-REDEFINE CONTOUR INTERVALS FOR SAME DATA.
VARIABLES- SAME AS FOR NCON=15
- 17 OPERATION-DEFINE IRREGULARLY SPACED CONTOURS.
VARIABLES-1)NCON=NUMBER OF CONTOURS.
ADDL CARDS-1)FORMAT OF CONTOURS
2)CONTOUR LEVELS AS DEFINED ABOVE.
- 18 OPERATION- SPECIFY WIDTH OF PAPER(11 OR 28 INCHES)
VARIABLES-1) WIDTH OF PAPER
ADDL CARDS- NONE
- 19 OPERATION- SPECIFY FORMAT OF DATA
VARIABLES- NONE
ADDL CARDS-FORMAT OF DATA MATRIX IN COLUMNS 1-72
- 20 OPERATION-PLOT MAP ACCORDING TO ALL CONTROLS GIVEN SINCE LAST
CALL TO PLOT (LAST NCON=20)
VARIABLES- NONE
ADDL CARDS- NONE
- 21 OPERATION- CHANGE WIDTH OF PLOTTED MAP (CHANGE SCALE)
VARIABLES-1) NEW WIDTH IN INCHES
ADDL CARDS- NONE

COMMENTS AND RESTRICTIONS

PRIOR TO READING IN DATA MATRIX, THE FORMAT(NCON=19)AND CONTOUR INTERVALS(NCON=15 OR 17) MUST BE DEFINED.
BEFORE CALL TO PLOT (NCON=20) PAPER WIDTH (NCON=18) AND ACCOUNT CODE (NCON=06) MUST BE DEFINED. PLOTTING THE MAP RESETS ALL CONTROLS TO PLOT A NEW SET OF DATA USE NCON=1 WITH OR WITHOUT A NEW FORMAT OR CONTOURING CONTROLS.

```

$ID
$IBSYS

$ATTACH          CD00/0
$AS              SYSUT1,050,050,00
$*      CSC PLOT TAPE REQD ON A1
$$$     CSC PLOT TAPE REQD ON A1
$EXECUTE        IBJOB
$IBJOB

$IBFC  CONTOR DFCK
      DIMENSION AM(100,100),REC(800),X(1500),Y(1500),IPT(3,3),INX(8),
1     INY(8),IOP(20),XL(10),YL(10),ZL(10),LAB(10,6),DX(2),DY(2),DZ(2),
2     HT(10),CTHETA(4),STHETA(4),TEMP(6),FMT(12),Z(1500),TIT(8),
3     CFMT(12),VCON(20),WORK(1024)
      DIMENSION USER(8)
      COMMON MT,NT,NI,IX,IY,IDX,IDY,ISS,IT,IV,NP,N,JT,PY,REC,CV,X,Y,IPT,
1     INX,INY,DL,AM,IOP,DP,DO,ILAB,XL,YL,ZL,LAB,DX,DY,DZ,XMAX,HT,SCALE,
2     YMAX,CTHETA,STHETA,FM2,FNN,NN,M,CL,D,NLINES,NCURV,Z,TIT,WORK
      COMMON MAXX,MAYX,MINX,MINY,SIZE
      COMMON ZSCALE
      REAL MAXX,MINX,MAYX,MINY
      NPLOT=1
      IOP(1)=0
      NLINFS=0
      ISTAP=5
      D=0.
9999  ILAB=0
      REWIND 3
      DO 9981 I=2,20
9981  IOP(I)=0
      NBOUND=0
1000  READ (5,100) NCON,{TEMP(I),I=1,6)
100   FORMAT (I2,6F10.0)
      WRITE (6,1001) NCON,{TEMP(I),I=1,6)
1001  FORMAT (3X,I5,6F10.3)
      IF(NCON.LE. 0 .OR. NCON .GT. 21) GO TO 30
      GO TO (1,2,2,2,5,6,30,8,8,10,11,12,13,14,15,16,17,18,19,20,21),
1     NCON
C
C NCON=1
1     M=TEMP(1)
      NN=TEMP(2)
      TEMP(1)=TEMP(2)-1.
      SCALE=TEMP(1)/TEMP(3)
      IF (TEMP(4).EQ.0.) TEMP(4)=1.
      ZSCALE=TEMP(4)
      FM2=FLOAT(M)/2.
      FNN=FLOAT(NN)/2.
      YMAX=(FM2/SCALE)+2.5
      XMAX=(FNN/SCALE)+2.5
      MAXX=0.0
      MAYX=0.0
      MINX=1.E15
      MINY=1.E15

```

```

      IF (IOP(1) .EQ. 0) GO TO 5027
      IOP(15)=1
      IOP(19)=1
5027  IOP(1)=1
      IF(IOP(19) .EQ. 0) GO TO 902
      DO 2026 I=1,M
2026  READ (ISTAP,FMT) ((AM(J,I),J=1,NN)
      WRITE(6,FMT) ((AM(J,I),J=1,NN),I=1,M)
      IF(IOP(15) .EQ. 0) GO TO 903
      IF (IOPV .EQ. 0) GO TO 2065

C
C VARIABLE CONTOURS
2027  DO 2069 I=1,NVCON
      CL=VCON(I)
      CV=CL
      CALL SCAN
2069  CONTINUE
      GO TO 200

C
C REGULAR CONTOURS
2065  CV=CBGN
      NLINES=0
2066  CL=CV
      CALL SCAN
      CV=CV+CINC
      IF (CV .LE. CEND) GO TO 2066
200   END FILE 3
2068  REWIND 3
      GO TO 1000

C
C NCON=2,3,4
C DEFINE THETA FOR ROTATION
2    IOP(NCON)=1
      NBOUND=1
      THETA=-TEMP(1)/57.295795
      STHETA(NCON)=SIN(THETA)
      CTHETA(NCON)=COS(THETA)
      GO TO 1000

C
C NCON=5
5    IOP(NCON)=1
      GO TO 1000

C

```

```

C NCON=6
6      IOP(NCON)=1
      READ (5,6000) (USER(I),I=1,8)
6000   FORMAT (8A6)
      GO TO 1000

C
C NCON=8,9
C DEFINE PERSPECTIVE CONSTANTS
8      IOP(NCON)=1
      IF (NCON-8) 7083,7084,7083
7084   NBOUND=1
7083   CONTINUE
      DP=TEMP(1)
      DO=TEMP(2)
      GO TO 1000

C
C NCON=10
C DEFINE TRANSLATION
10     DX(1)=TEMP(1)
      DY(1)=TEMP(2)
      DZ(1)=TEMP(3)
      IOP(NCON)=1
      GO TO 1000

C
C NCON=11
11     ISTAP=TEMP(1)
      GO TO 1000

C
C NCON=12
12     IOP(12)=1
      READ (5,556) (TIT(I),I=1,8)
      WRITE (6,1008) (TIT(I),I=1,8)
556    FORMAT (8A6)
      GO TO 1000
1008   FORMAT (1H0,12A6)

C
C NCON=13
C END PLOT TAPE
13     CALL PLOT (0,0,999)
      STOP

C

```

C NCON=14
C READ LABELS AND THEIR CORRESPONDING COORDINATES

```
14      IOP(14)=1
        ILAB=ILAB+1
        XL(ILAB)=TEMP(1)
        YL(ILAB)=TEMP(2)
        IF (ZSCALE) 92,96,92
96      ZL(ILAB)=TEMP(3)
        GO TO 94
92      ZL(J)=TEMP(3)/ZSCALE
94      XT(ILAB)=TEMP(4)
        READ (5,102) (LAB(I,ILAB),I=1,6)
102     FORMAT (6A6)
        GO TO 1000
```

C

C NCON=15
C DEFINE CONTOUR INCREMENTS

```
15      CBGN=TEMP(1)
        CINC=TEMP(2)
        CEND=TEMP(3)
        IOP(15)=1
        IOPV=0
        GO TO 1000
```

C

C NCON=16
16 CBGN=TEMP(1)
 CINC=TEMP(2)
 CEND=TEMP(3)
 IOPV=0
 LEWIND 3
 GO TO 2065

C

C NCON=17
17 NVCON=TEMP(1)
 IOP(15)=1
 IOPV=1
 READ (5,105) (CFMT(I),I=1,12)
 READ (5,105) (VCON(I),I=1,NVCON)
 GO TO 1000

C NCON=18

```
18      IOP(13)=1
        SIZE=TEMP(1)
        GO TO 1000
```

C


```

C NCON=19
C READ FORMAT FOR MATRIX
19 READ (5,105) (FMT(I),I=1,12)
105 FORMAT (12A6)
    IOP(19)=1
    GO TO 1000

C
C NCON=20
C BEGIN PLOTTING
20 IF (IOP(20).EQ.1) GO TO 953
    IF (IOP(6).EQ.0) GO TO 6001
    CALL PLOTS (WORK(1),1024,0)
    CALL SYMBOL(0.,0.,.2,USER,90.,48)
    CALL PLOT(1.,0.,-3)
    IOP(20)=1
953 IF (IOP(8).EQ.0) IOP(9)=1
    IF (IOP(18).EQ.0) GO TO 954
    XCEN=(MAXX+MINX)/2.
    YCEN=(MAXY+MINY)/2.
    YCEN1=YCEN
    XCEN1=XCEN
    IF (IOP(17).EQ.0) GO TO 955
    CBGN=VCON(1)
    CEND=VCON(NVCON)
955 IF (IOP(2).EQ.0) GO TO 956
    YCEN1=CTHETA(2)*YCEN-CBGN*STHETA(2)/ZSCALE
    YCEN=CTHETA(2)*YCEN-CEND*STHETA(2)/ZSCALE
956 IF (IOP(3).EQ.3) GO TO 957
    XCEN1=CTHETA(3)*XCEN+CBGN*STHETA(3)/ZSCALE
    XCEN=CTHETA(3)*XCEN+CEND*STHETA(3)/ZSCALE
957 IF (IOP(3).EQ.0) GO TO 958
    XCEN1=CTHETA(4)*XCEN1-STHETA(4)*YCEN1
    XCEN=CTHETA(4)*XCEN-STHETA(4)*YCEN
958 XCEN=(XCEN1+XCEN)/2.
    XCFN=XCEN/SCALE+XMAX
    XMAX=XMAX-XCEN+SIZE/2.
954 IF (IOP(1).EQ.0) GO TO 904
C
C CALL DRAFT TO PLOT
    CBGN=-53139.E15
    NCURV=0
    NCOUNT=0
    NCMAX=0
    IF (NLines) 23,23,25
25 READ(3) N,CV
    IF (CBGN.EQ. -53139.E15) CBGN=CV/ZSCALE-.5
    READ (3) (X(I),Y(I),I=1,N)
    NCURV=NCURV+1
    NCOUNT=NCOUNT+N

```

```

      IF (N-NCMAX) 7337,7338,7338
7338  NCMAX=N
      CLMAX=CV
7337  CV=CV/ZSCALE
      CALL DRAFT
      IF (NCURV-NLINES) 25,22,22
23    CRGN=0.
22    N=5
      CV=CRGN
      X(1)=FNN
      X(2)=-X(1)+1.
      X(3)=X(2)
      X(4)=X(1)
      X(5)=X(1)
      Y(1)=FM2
      Y(2)=Y(1)
      Y(3)=-Y(2)+1.
      Y(4)=Y(3)
      Y(5)=Y(1)
      CALL DRAFT
      XNEW=YMAX*2.
28    CALL PLOT(XNEW,0.,-3)
      GO TO 1000
C
C NCON=21
C CHANGE SCALE
21  SCALE =(FLOAT(M)-1.)/TEMP(1)
      GO TO 1000
6001  WRITE (6,6002)
6002  FORMAT (41H0****PLOT USER IDENTIFICATION NOT DEFINED)
      GO TO 920
902  WRITE (6,402)
402  FORMAT (32H0****FORMAT NOT DEFINED FOR DATA)
      GO TO 920
903  WRITE (6,403)
403  FORMAT (31H0****CONTOUR LEVELS NOT DEFINED)
      GO TO 920
904  WRITE (6,404)
404  FORMAT (12H0****NO DATA)
      GO TO 920
30  WRITE (6,531) NCON
531  FORMAT (27H0****NCON NOT LEGAL, NCON =,I5)
920  WRITE (6,6003)
6003  FORMAT (20H0****PLOT TERMINATED)
      STOP
      END
$IBFTC SCANS    DECK

```

```

SUBROUTINE SCAN
  DIMENSION AM(100,100),REC(800),X(1500),Y(1500),IPT(3,3),INX(8),
1 INY(8),IOP(20),XL(10),YL(10),ZL(10),LAB(10,6),DX(2),DY(2),DZ(2),
2 HT(10),CTHETA(4),STHETA(4),Z(1500),TIT(8),WORK(1024)
  COMMON MT,NT,NI,IX,IY,IDY,IDY,ISS,IT,IV,NP,M,JT,PY,REC,CV,X,Y,IPT,
1 INX,INY,DL,AM,IOP,DP,DO,ILAB,XL,YL,ZL,LAB,DX,DY,DZ,YMAX,HT,SCALE,
2 YMAX,CTHETA,STHETA,FM2,FNN,NN,M,CL,D,NLINES,NCURV,Z,TIT,WORK
  IZX=1
  NP=0
  DL=D
  NT=M
  MT=NN
  IF (IZX) 3,3,1
1 IPT(1,1)=8
  IPT(1,2)=1
  IPT(1,3)=2
  IPT(2,1)=7
  IPT(2,3)=3
  IPT(3,1)=6
  IPT(3,2)=5
  IPT(3,3)=4
  INX(1)=-1
  INX(2)=-1
  INX(3)=0
  INX(4)=1
  INX(5)=1
  INX(6)=1
  INX(7)=0
  INX(8)=-1
  INY(1)=0
  INY(2)=1
  INY(3)=1
  INY(4)=1
  INY(5)=0
  INY(6)=-1
  INY(7)=-1
  INY(8)=-1
  IZX=0
3 XT=MT
  DO 58 J=1,800
58 REC(J)=0.
  ISS=0
  MT1=MT-1
  DO 110 I=1,MT1
    IF (AM(I,1)-CV) 55,110,110
55 IF (AM(I+1,1)-CV) 110,57,57
57 IX=I+1

```

```

        IY=1
        IDX=-1
        IDY=0
        CALL TRACE
110 CONTINUE
        NT1=NT-1
        DO 20 I=1,NT1
            IF (AM(MT,I)-CV) 15,20,20
15 IF (AM(MT,I+1)-CV) 20,17,17
17 IX=MT
        IY=I+1
        IDX=0
        IDY=-1
        CALL TRACE
20 CONTINUE
22 DO 30 I=1,MT1
        MT2=MT-1-I
        IF (AM(MT2,NT)-CV) 25,30,30
25 IF (AM(MT2-1,NT)-CV) 30,27,27
27 IX=MT2-1
        IY=NT
        IDX=1
        IDY=0
        CALL TRACE
30 CONTINUE
        DO 40 I=1,NT1
        NT2=NT+1-I
        IF (AM(1,NT2)-CV) 35,40,40
35 IF (AM(1,NT2-1)-CV) 40,37,37
37 IX=1
        IY=NT2-1
        IDX=0
        IDY=1
        CALL TRACE
40 CONTINUE
        ISS=1
        NT1=NT-1
        MT1=MT-1
        DO 10 J=2,NT1
        DO 10 I=1,MT1
            IF (AM(I,J)-CV) 5,10,10
5 IF (AM(I+1,J)-CV) 10,7,7
7 COM=100*(I+1)+J
            IF (NP) 12,11,12
12 DO 9 ID=1,NP
            IF (REC(ID)-COM) 9,10,9
9 CONTINUE
11 IX=I+1
        IY=J
        IDX=-1
        IDY=0
        CALL TRACE
10 CONTINUE
        RETURN
        END

```

```

SIBFTC TRACES DECK
SUBROUTINE TRACE
DIMENSION AM(100,100),REC(800),X(1500),Y(1500),ZPT(3,3),INX(8),
1 INY(8),IOP(20),XL(10),YL(10),ZL(10),LAB(10,6),DX(2),DY(2),DZ(2),
2 HT(10),CTHETA(4),STHETA(4),Z(1500),TIT(8),WORK(1024)
COMMON MT,NT,NI,IX,IY,IDX,IDY,ISS,IT,IV,NP,N,JT,PY,REC,CV,X,f,IPT,
1 INX,INY,DL,AM,IOP,DP,DO,LAB,XL,YL,ZL,LAB,DX,DY,DZ,XMAX,HT,SCALE,
2 YMAX,CTHETA,STHETA,FM2,FNN,NN,M,CL,D,NLINES,NCURV,Z,TIT,WORK
COMMON MAXX,MAXY,MINX,MINY,SIZE
REAL MAXX,MAXY,MINX,MINY
PY=0.0
501 JT=0
N=0
IX0=IX
IY0=IY
ISX=IDX+2
ISY=IDY+2
IS=IPT(ISX,ISY)
JTB=0
ISO=IS
IF (ISO-8) 18,18,17
17 ISO=ISO-8
18 IT=0
5 CALL CALC
NZ=N
N=NZ
IF (IT+JT-1) 49,49,47
47 XS=X(N-1)
YS=Y(N-1)
X(N-1)=X(N)
Y(N-1)=Y(N)
X(N)=XS
Y(N)=YS
49 IS=IS+1
JT=IT
9 IF (IS-9) 8,7,7
7 IS=IS-8
8 IDX=INX(IS)
IDY=INY(IS)
IX2=IX+IDX
IY2=IY+IDY
JTB=JTB+1
IF (JTB-1500) 51,51,308
308 WRITE (6,103) CV
103 FORMAT (21H0 A CONTOUR AT LEVEL ,F6.2,16H WAS TERMINATED.)
RETURN
51 IF (ISS) 10,10,20
20 IF (IX-IX0) 12,21,12
21 IF (IY-IY0) 12,22,12
22 IF (IS-ISO) 12,23,12
23 CALL CALC
GO TO 73

```

```

10 IF (IX2) 13,50,13
13 IF (IX2-MT) 19,19,50
19 IF (IY2) 11,50,11
11 IF (IY2-NT) 12,12,50
12 IF (CV-AM(IX2,IY2)) 206,206,5
206 IF (IDX**2+IDY**2-1) 213,6,213
213 DCP=(AM(IX,IY)+AM(IX2,IY)+AM(IX,IY2)+AM(IX2,IY2))/4.0
IF (DCP-CV) 5,217,217
217 IF (INX(IS-1)) 214,215,214
214 IX=IX+IDX
IDX=-IDX
PY=2.0
CALL CALC
IX=IX+IDX
GO TO 6
215 IY=IY+IDY
IDY=-IDY
PY=2.0
CALL CALC
IY=IY+IDY
6 IF (AM(IX-1,IY)-CV) 306,16,16
306 NP=NP+1
REC(NP)=100*IX+IY
16 IS=IS+5
IX=IX2
IY=IY2
GO TO 9
50 XT=MT
IF (AM(IX-1,IY)-CV) 307,73,73
307 NP=NP+1
REC(NP)=100*IX+IY
73 NLINES=NLINES+1
DO 135 K=1,N
X(K)=X(K)-FNN
Y(K)=Y(K)-FM2
135 CONTINUE
C
C STORE CURVE ON TAPE 3 (A4)
IF (N) 2072,2072,2071
2071 WRITE (3) N,CL
071 WRITE (3) (X(I),Y(I),I=1,N)
WRITE (6,104) CV
104 FORMAT (16H0CONTOUR LEVEL =,F6.2)
WRITE (6,105) (X(I),Y(I),I=1,N)
105 FORMAT (2X,5F10.3)
IF (IOP(18) .EQ. 0) GO TO 2072
DO 72 I=1,N
IF (X(I) .GT. MAXX) MAXX=X(I)
IF (Y(I) .GT. MAXY) MAXY=Y(I)
IF (X(I) .LT. MINX) MINX=X(I)
IF (Y(I) .LT. MINY) MINY=Y(I)
72
2072 N=-1
RETURN
END

```

\$IBFTC CALCS DFCK

SUBROUTINE CALC

```

    DIMENSION AM(100,100),REC(800),X(1500),Y(1500),IPT(3,3),INX(8),
1  INY(8),IOP(20),XL(10),YL(10),ZL(10),LAB(10,6),DX(2),DY(2),DZ(2),
2  HT(10),CTHETA(4),STHETA(4),Z(1500),TIT(8),WORK(1024)
    COMMON NT,NT,NI,IX,IY,IDX,IDY,ISS,IT,IV,NP,N,JT,PY,REC,CV,X,Y,IPT,
1  INX,INY,DL,AM,IOP,DP,DO,ILAB,XL,YL,ZL,LAB,DX,DY,DZ,XMAX,HT,SCALE,
2  YMAX,CTHETA,STHETA,FM2,FNN,NN,M,CL,D,NLINES,NCURV,Z,TIT,WORK
    IT=0
    N=N+1
    IF (IDX**2+IDY**2-1) 20,1,20
1  IF (IDX) 10,2,10
2  X(N)=IX
    Z=IY
    IY2=IY+IDY
    DY=IDY
41  Y(N)=((AM(IX,IY)-CV)/(AM(IX,IY)-AM(IX,IY2)))*DY+Z
    RETURN
10  Y(N)=IY
    W=IX
    DX=IDX
    IX2=IX+IDX
44  X(N)=((AM(IX,IY)-CV)/(AM(IX,IY)-AM(IX2,IY)))*DX+W
    RETURN
20  IX2=IX+IDX
    IY2=IY+IDY
    W=IX
    Z=IY
    DX=IDX
    DY=IDY
    DCP=(AM(IX,IY)+AM(IX2,IY)+AM(IX,IY2)+AM(IX2,IY2))/4.0
    IF (PY=2.0) 24,21,24
24  IF (DCP-CV) 21,21,25
21  AL=AM(IX,IY)-DCP
23  V=.5*(AL+DCP-CV)/AL
27  X(N)=V*DX+W
    Y(N)=V*DY+Z
    PY=0.0
    RETURN
25  IT=1
    AL=AM(IX2,IY2)-DCP
33  V=.5*(AL+DCP-CV)/AL
28  X(N)=-V*DX+W+DX
    Y(N)=-V*DY+Z+DY
    RETURN
END

```


SIBFTC DRAFTS DECK

SUBROUTINE DRAFT

```

DIMENSION AM(100,100),REC(800),X(1500),Y(1500),IPT(3,3),INX(8),
1 INY(8),IOP(20),XL(10),YL(10),ZL(10),LAB(10,6),DX(2),DY(2),DZ(2),
2 HT(10),CTHETA(4),STHETA(4),Z(1500),TIT(8),WORK(1024)
DIMENSION PART1(2)
COMMON MT,NT,NI,IX,IY,IDX,IDY,ISS,IT,IV,NP,N,JT,PY,REC,CV,X,Y,IPT,
1 INX,INY,DL,AM,IOP,DP,DO,ILAB,XL,YL,ZL,LAB,DX,DY,DZ,XMAX,HT,SCALE,
2 YMAX,CTHETA,STHETA,FM2,FNN,NN,M,CL,D,NLINES,NCURV,Z,TIT,WORK
COMMON MAXX,MAXY,MINX,MINY,SIZE
COMMON ZSCALE
REAL MAXX,MAXY,MINX,MINY

```

303 KTYPE=3

DO 80 I=2,14

IF (IOP(I)) 80,80,81

81 GO TO (101,101,102,103,80,80,80,8,8,10,80,80,80,14),I

C

C ROTATION ABOUT X

```

101 D1=1.
D2=0.
D3=0.
D4=0.
D5=CTHETA(2)
D8=STHETA(2)
D7=0.
D6=-D8
D9=D5
GO TO 106

```

C

C ROTATION ABOUT Y

```

102 D1=CTHETA(3)
D2=0.
D3=STHETA(3)
D4=0.
D5=1.
D6=0.
D7=-D3
D8=0.
D9=D1
GO TO 106

```

C ROTATION ABOUT Z

```

103 D1=CTHETA(4)
D4=STHETA(4)
D3=0.
D2=-D4
D5=D1
D6=0.
D7=0.
D8=0.
D9=1.

```

C

C ROTATE

```

106  CVD3=CV*D3
      CVD6=CV*D6
      CVD9=CV*D9
      DO 20 J=1,N
      XX=D1*X(J)+D2*Y(J)+CVD3
      YY=D4*X(J)+D5*Y(J)+CVD6
      Z(J)=D7*X(J)+D8*Y(J)+CVD9
      X(J)=XX
20   Y(J)=YY
      GO TO 80

```

C

C PRINT HEADING INFORMATION

```

8     TITCOD=.9
      IF (I-8) 401,401,301
401   NN1=2
      WRITE (6,1010) DP,DO
1010  FORMAT (24H0      DISTANCE TO PLANE =,F9.2,22H, DISTANCE TO OBJECT =
1,F9.2)
      GO TO 86
301   NN1=1
86    IF (IOP(12)) 565,566,565
565   CALL SYMBOL (TITCOD,3.,.14,TIT,90.,48)
566   IOP(8)=0
      IOP(9)=0
      GO TO 80

```

C PLOT LABEL ON GRAPH

```

14   DO 935 J=1,ILAB
      GO TO (751,752),NN1
752  E=(DO-ZL(J))/DP*SCALE
      F=(DO/DP)*SCALE
      C1=(XL(J)-F IN)/E+XMAX
      C2=(YL(J)-F IN2)/E+YMAX
      GO TO 934
751  C1=XL(J)/SCALE+XMAX
      C2=YL(J)/SCALE+YMAX
      F=SCALE
934  HT(J)=HT(J)/F
935  IOP(14)=0
893  GO TO 80

```

C TRANSLATE DATA

```

10   DO 602 J=1,N
      X(J)=X(J)+DX(1)
      Y(J)=Y(J)+DY(1)
602  Z(J)=Z(J)+DZ(1)

```

C PLOT PLANE OR PERSPECTIVE VIEW OF SURFACE

```

80 CONTINUE
  IOPC=IOP(2)+IOP(3)+IOP(4)
405 DO 300 J=1,N
    IF (IOPC) 894,894,892
894 Z(J)=CV
892 GO TO (402,403),NN1
402 C1=X(J)/SCALE+XMAX
    C2=Y(J)/SCALE+YMAX
    GO TO 406
403 E=(DO-Z(J))/DP*SCALE
    C1=X(J)/E+XMAX
    C2=Y(J)/E+YMAX
406 IF (IOP(5)) 933,933,930
930 CALL PROJ(C1,C2)
933 IF (C1.GT.SIZE.OR.C1.LT.-1.) GO TO 936
    CALL PLOT (C2,C1,KTYPE)
    IF(KTYPE.EQ.2) GO TO 304
    CVV=CV*ZSCALE
    CALL NUMBER (C2,C1,.07,CVV,90.,2)
    CALL PLOT (C2,C1,3)
    CB1=C1
    CB2=C2
304 KTYPE=2
    GO TO 300
936 KTYPE=3
300 CONTINUE
    IF(CB2.EQ.C2.AND.CB1.EQ.C1) GO TO 305
    CALL NUMBER (C2,C1,.07,CVV,90.,2)
305 CONTINUE
    RETURN
    END

```

```
$IBFTC PROJS  DECK
      SUBROUTINE PROJ(X,Y)
      X=1.
      Y=1.
      RETURN
      END
```

```
$IBMAP INPUT
      ENTRY  *UN08.
*UN08. PZF  UNIT08
UNIT08 FILE  *A,READY,INPUT,BLK=22,HIGH,BCD
      END
```

ATA

10.3)

595.

5.

720.

H DEGREE TREND SURFACE, APRIL 1967

28.0

RNER 3402

33.

23.

11.0

673.488	672.534	670.131	666.802	663.009	659.149	655.554	652.493
650.171	648.728	648.240	648.719	650.114	652.309	655.123	658.312
661.569	664.519	666.728	667.694	666.853	663.575	657.168	
665.263	665.634	664.417	662.142	659.275	656.221	653.316	650.836
648.992	647.929	647.730	648.412	649.931	652.176	654.973	658.083
661.204	663.969	665.949	666.648	665.507	661.904	655.151	
657.412	659.002	658.873	657.560	655.538	653.214	650.933	648.977
647.560	645.836	646.893	647.754	649.380	651.656	654.445	657.483
660.485	663.090	664.873	665.345	663.954	660.082	653.049	
649.965	652.666	653.525	653.065	651.824	650.157	648.435	646.944
645.906	643.479	645.759	646.773	648.490	650.309	653.570	656.544
659.443	661.912	663.530	663.817	662.224	658.141	650.893	
642.949	646.655	648.404	648.745	648.163	647.079	645.850	644.766
644.457	643.887	644.356	645.500	647.290	649.634	652.376	655.296
658.108	660.464	661.952	662.093	660.348	656.111	648.713	
636.392	640.994	643.535	644.568	644.583	644.008	643.205	642.472
642.043	642.088	642.714	643.961	645.809	648.170	650.894	653.766
656.508	658.777	660.165	660.203	658.355	654.022	646.540	
630.320	635.713	638.947	640.581	641.111	640.972	640.529	640.089
639.891	640.111	640.860	642.187	644.076	646.445	649.151	651.984
654.672	656.878	658.201	658.177	656.275	651.903	644.402	
624.750	630.838	634.666	636.811	637.775	637.997	637.850	637.645
637.629	637.982	638.823	640.295	642.118	644.488	647.175	649.978
652.629	654.797	656.088	656.042	654.136	649.782	642.330	
619.739	626.394	630.719	633.285	634.600	635.110	635.193	635.167
635.283	635.729	636.629	638.042	639.963	642.325	644.995	647.776
650.406	652.562	653.853	653.827	651.966	647.689	640.350	
615.282	622.409	627.132	630.029	631.614	632.328	632.586	632.681
632.681	633.379	634.305	635.724	637.639	639.936	642.638	645.405
648.032	650.199	651.624	651.560	649.794	645.651	638.492	
611.415	618.907	623.930	627.068	628.842	629.706	630.055	630.214
630.449	630.958	631.878	633.280	635.171	637.495	640.131	642.893
645.533	647.738	649.130	649.265	647.647	643.697	636.784	
608.162	615.914	621.139	624.429	626.309	627.241	627.624	627.791
628.012	628.493	629.375	630.735	632.587	634.880	637.499	640.266
642.936	645.203	646.696	646.979	645.552	641.853	635.252	
605.549	613.453	618.783	622.135	624.040	624.967	625.520	625.438
625.597	626.008	626.819	628.114	629.911	632.166	634.770	637.550
640.268	642.623	644.250	644.719	643.537	640.146	633.924	
603.599	611.551	616.888	620.212	622.061	622.910	623.167	623.179
623.227	623.529	624.238	625.444	627.170	629.380	631.969	634.771
637.553	640.022	641.817	642.514	641.827	638.603	632.827	
602.336	610.229	615.476	618.683	620.395	621.092	621.189	621.039
620.928	621.081	621.655	622.748	624.389	626.546	629.121	631.954
634.819	637.425	639.423	640.390	639.848	637.250	631.985	
601.784	609.513	614.571	617.572	619.066	619.538	619.411	619.042
618.724	618.687	619.096	620.052	621.591	623.688	626.251	629.124
632.089	634.861	637.093	638.373	638.226	636.111	631.425	
601.965	609.424	614.196	616.902	618.097	618.272	617.855	617.212

616.639	616.372	616.583	617.379	618.802	620.832	623.383	626.307
629.388	632.350	634.852	636.487	636.786	635.214	631.173	
602.901	609.985	614.375	616.696	617.511	617.317	616.547	615.571
614.695	614.159	614.141	614.753	616.045	618.001	620.542	623.524
626.741	629.920	632.725	634.757	635.552	634.581	631.253	
604.616	611.219	615.128	616.976	617.330	616.694	615.507	614.143
612.916	612.071	611.792	612.198	613.343	615.218	617.751	620.802
624.171	627.592	630.735	633.207	634.548	634.238	631.689	
607.129	613.146	616.479	617.765	617.578	616.427	614.757	612.951
611.324	610.131	609.560	609.736	610.719	612.507	615.032	618.162
621.702	625.391	628.907	631.860	633.799	634.208	632.506	
610.464	615.790	618.448	619.083	618.274	616.536	614.321	612.015
609.942	608.361	607.466	607.389	608.196	609.890	612.409	615.628
619.356	623.340	627.262	630.740	633.328	634.515	633.727	
614.639	619.169	621.057	620.952	619.441	617.044	614.218	611.358
608.790	606.782	605.533	605.180	605.796	607.389	609.904	613.221
617.156	621.461	625.825	629.870	633.157	635.181	635.375	
619.676	623.305	624.326	623.393	621.099	617.971	614.471	611.000
607.891	605.416	603.782	603.130	603.540	605.027	607.539	610.965
615.124	619.777	624.616	629.272	633.309	636.230	637.473	
625.595	628.218	628.275	626.426	623.269	619.337	615.100	610.962
607.265	604.284	602.233	601.260	601.450	602.823	605.336	608.879
613.283	618.309	623.659	628.968	633.807	637.684	640.043	
632.415	633.928	632.923	630.070	625.970	621.163	616.125	611.265
606.931	603.406	600.908	599.591	599.547	600.800	603.314	606.987
611.652	617.079	622.974	628.979	634.671	639.564	643.107	
640.155	640.453	638.291	634.345	629.222	623.469	617.565	611.929
606.912	602.803	599.827	598.143	597.850	598.978	601.496	605.307
610.253	616.107	622.563	629.327	635.924	641.892	646.687	
648.834	647.812	644.397	639.270	633.045	626.273	619.441	612.972
607.224	602.493	599.008	596.937	596.380	597.376	599.900	603.861
609.106	615.415	622.506	630.033	637.586	644.689	650.804	
658.471	656.024	651.260	644.863	637.456	629.594	621.770	614.414
607.889	602.497	598.473	595.990	595.156	596.015	598.548	602.669
608.231	615.021	622.763	631.117	639.677	647.975	655.478	
669.082	665.106	658.897	651.144	642.474	633.451	624.572	616.273
608.925	602.832	598.239	595.323	594.198	594.914	597.457	601.749
607.648	614.947	623.375	632.598	642.217	651.770	660.729	
680.685	675.077	667.326	658.128	648.117	637.861	627.864	618.568
610.349	603.518	598.325	594.954	593.524	594.091	596.648	601.122
607.376	615.210	624.360	634.496	645.227	656.094	666.578	
693.297	685.953	676.565	665.835	654.403	642.842	631.665	621.316
612.180	604.573	593.750	594.901	593.152	593.566	596.138	600.804
607.433	615.831	623.737	636.831	648.724	660.967	673.043	
706.936	697.751	685.630	674.280	661.347	648.412	635.990	624.535
614.435	606.013	599.530	595.182	593.101	593.355	595.946	600.816
607.839	616.826	627.526	639.620	652.729	666.406	680.144	
721.616	710.487	697.537	683.480	668.963	654.586	640.858	628.241
617.131	607.856	600.683	595.815	593.388	593.476	596.090	601.174
608.174	618.215	629.743	642.882	657.258	672.431	687.898	

4TH DEGREE TREND SURFACE, APRIL 1967