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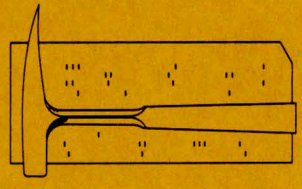
FORTRAN II PROGRAM FOR PROGRESSIVE LINEAR FIT OF SURFACES ON A QUADRATIC BASE USING AN IBM 1620 COMPUTER

By

A. J. COLE
C. JORDAN
St. Andrews University
and
D. F. MERRIAM
Kansas Geological Survey



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FORTRAN II PROGRAM FOR PROGRESSIVE LINEAR FIT OF SURFACES ON A QUADRATIC BASE USING AN IBM 1620 COMPUTER

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INTRODUCTION

Geologists are interested in graphic displays of information, especially maps. In recent years, surface-fitting techniques and automated contouring routines utilizing computers have been developed. Different methods have been found advantageous for different problems. This paper reports an application of surface fitting and contouring of structural data in areas of low regional dip. The technique and variations of it have been applied to data from the Midcontinent of the United States and Midland Valley of Scotland.

The technique essentially involves the fitting of a low-degree polynomial (a quadratic or second-degree surface) to the original, irregularly spaced data to establish a rectangular grid. The grid values are then smoothed by fitting a linear (first-degree surface) on a quadrant-by-quadrant basis moving progressively over the grid. Results indicate that surface configuration determined by this method closely approximates the hand-contoured configuration.

In essence, the true surface is approximated by a smoothed surface having high autocorrelation. That is, values at one point are strongly influenced by adjacent points. Geologic discontinuities will be emphasized in the residuals. The method differs from polynomial trend analysis in that the surface is more flexible (residuals will be smaller) and a point is dependent only on adjacent points (up to one-half length or height of the sliding field array) rather than upon all points as is the case in polynomial or Fourier analysis. Thus, major residuals should disappear or be greatly reduced.

Many methods of surface fitting have been investigated. Most studies have been concerned with three-dimensional trend-surface analysis and the separation of regional from local effects. Geologists seek trends and have readily adapted computer-oriented techniques to aid in solving their particular problems (Merriam, 1965, 1966, 1967). Numerous published applications of trend analysis to geologic problems attest to its importance and effectiveness (for example see, Allen and Krumbein, 1962; Duff and Walton, 1964; Harbaugh, 1964; Krumbein, 1959, 1966; Merriam, 1964; Merriam and Harbaugh, 1963, 1964; Merriam and Lippert, 1964, 1966; Merriam and Sneath, 1966; Peikert, 1965; Read and Merriam, 1965; Smith and Harbaugh, 1966; Whitten, 1959, 1961, 1963a, 1963b).

Automatic contouring of data is important for two reasons. First, the methods involved are relatively objective, and second, results are repeatable. The contouring procedure in this program uses linear interpolation between data values. Other routines are available and descriptions may be found in Ojakangas and Basham (1964), Batcha and Reese (1964), IBM (1965), Slack and others (1963), and Tobler (1965).

Acknowledgments.-We thank J.C. Davis and P.F. Smith, Kansas Geological Survey; T. V. Loudon, Sedimentology Research Laboratory at the University of Reading; W.C. Krumbein, Northwestern University; and P.H.A. Sneath, MRC Unit at The University, Leicester, for help in formulating ideas and for reviewing the manuscript. Machine time was made available through the Computing Laboratory at The University, Leicester (England) and the University of St. Andrews (Scotland).

DESCRIPTION OF PROGRAM

Computation of Grid Values

This FORTRAN II program fits a quadratic surface to a given set of xyz-coordinate values (maximum 300), and in turn residual values are modified by a progressive linear fit to adjust grid values for contouring. First a quadratic surface is fitted to the irregularly spaced data by the least-squares method to determine the calculated and residual values at each data point. A rectangular grid then is superposed on the xy-coordinate system and the value of the quadratic surface at each grid point calculated. Values at the grid points are further modified by the following calculations on quadratic residuals.

Each grid point is considered separately. A rectangular cell in the xy-coordinate system whose dimensions are either determined by the program or included as input data, is centered on each grid point. Locations of all data points within the cell are noted, and if there are fewer than five the cell is systematically enlarged until at least five are enclosed. A plane is fit to the quadratic residuals from original data points by least squares. The quadratic value of the grid point at the center of the cell then is modified by adding or subtracting the local linear value at that point. Concurrently, the quadratic value of the data point nearest the grid point also is modified and percentage deviation from the original value computed. Thus, the new

value at each grid point corresponds to the sum of the regional quadratic value and local linear value. This step is repeated progressively from grid point to grid point and the calculated grid values are used as a basis for contouring.

Contouring Procedure

Contouring is a standard procedure using linear interpolation between points and working successively up and down adjacent grid columns. All data points at which the calculated value differs from the measured value by more than a specified percentage may be indicated by a triangle. Contouring uses four plotter subroutines in machine code called PLOT, CHAR, POINT, and JCCONT.

PLOT basically is the IBM programming library subroutine PLOT with minor changes to enable re-initialization at a particular place. This subroutine sets plotting parameters, including scale factors, and moves the pen along the "best" straight line from its current position to the specified position.

CHAR is also an IBM programming library subroutine which writes Hollerith characters and variable values on the plotter according to an associated FORMAT statement.

POINT draws certain geometric figures about the current pen position.

The subroutine JCCONT draws the specified contours, enclosing them in a rectangular grid. The number of grid lines drawn, in general, is different from the number of grid lines used in surface fitting. These lines enable reference points to be located readily.

The contouring method is as follows: let P_1, P_2, P_3, and P_4 be the vertices of a basic grid cell and let C be the contour level under consideration. C is subtacted from each z value at P_i, and wherever a change of sign occurs at adjacent points, a linear interpolation gives the xy coordinates at which the zero occurs. If, as is usually the case, two such points are found in a basic cell, those points are joined by the "best" straight line. If one or three such points are found, an error message is printed and no lines are drawn. This is an exceptional case. If four points are found, an error message is printed, and points are joined in pairs in such a way that they do not cross. Two possible combinations exist and one is chosen arbitrarily. At map edges, contour lines are labelled with an integer corresponding to the key given.

In addition to graphical output, the program calculates regional linear and quadratic equations and percentage fits. A table of original xyz coordinates, calculated z values, corresponding residuals, and calculated z values as percentage of original z values is printed. If the measured z value is 0, it is arbitrarily set to 100. Lines in which the percentage value differs from 100 by more than a specified amount are marked by an asterisk. It is possible to specify that a smaller area be contoured than that covered by the complete set of data. A record of original data points and those actually used is then retained, together with the percentage fit at the data points and the sum of squares of the residuals.

Finally, a set of contour-map parameters is printed including minimum and maximum x and y values; size of the grid cell and rectangles used for linear-fit; number of grid rows and columns; scale factors, level at which percentage error indicators are plotted, and a key to contour levels indicated on the map. In the contouring process, certain ambiguous situations may arise; these are resolved in an arbitrary manner, usually without seriously affecting the map. Grid points at which arbitrary decisions result are recorded. In addition, optional output, given if switch 1 is on, assists in choice of input parameters in difficult instances. Optional output consists of a record of all grid points and x, y, and progressive linearly calculated z values (ZLIN); number of data points used in the local linear calculation; corresponding regional linear z value (ZGLO), number of times the basic linear-fit area was expanded; and ratio of ZLIN to ZGLO expressed as a percentage.

LEAD CARDS

Card 1	Column 1	Blank.
	Columns 2-80	Contains job name.
Card 2	Column 1	Blank.
	Columns 2-4	Number of sets of xyz values that are read in as data. Value must be between 1 and 300 and must be right justified.

DATA CARD

This is first of a set of N cards containing xyz values where N is value specified in column 2-4 of Card 2.

Columns 1-11	These columns are ignored.
Columns 12-26	Contain x coordinate. If no decimal point is punched, it is assumed to be between columns 20 and 21.
Columns 27-41	Contain y coordinate. If no decimal point is punched, it is assumed to be between columns 35 and 36.
Columns 42-56	Contain z coordinate. If no decimal point is punched, it is assumed to be between columns 50 and 51.

TRAILER CARDS

Card 1 Column 1 Blank.
Column 2 Indicator for plotting limits. If this is 1, minimum and maximum values are calculated from original data. If this is 2, plotting limits are set in columns 21-80 of this card.
Columns 3-5 Number of rows of grid lines to be drawn on contour map (2 to 10). This and succeeding numbers must be right justified.
Columns 6-8 Number of columns of grid lines to be drawn on contour map (2 to 10).
Columns 9-11 Physical length of plot in y direction (1 to 20). This is actual length of plot in inches.
Columns 12-14 Number of rows of grid lines to be used in calculation.
Columns 15-17 Number of columns of grid lines to be used in calculation (1 to 50).
Columns 18-20 Blank. Next and successive values are set only if column 2 contains a 2.
Columns 21-35 Minimum x value to be plotted. If no decimal point is punched, it is assumed to be between columns 29 and 30.
Columns 36-50 Maximum x value to be plotted. If no decimal point is punched, it is assumed to be between columns 44 and 45.
Columns 51-65 Minimum y value to be plotted. If no decimal point is punched, it is assumed to be between columns 59 and 60.
Columns 66-80 Maximum y value to be plotted. If no decimal point is punched, it is assumed to be between columns 74 and 75.

Card 2 Column 1 Blank.
Column 2 Indicator to determine whether linear-fit area dimensions are to be calculated or to be read in as data. If indicator is 0, program calculates dimensions and columns 3-32 are left blank. If it is 1, program uses data given in columns 3-32.
Columns 3-17 Half length of grid cell. If no decimal point is punched, it is assumed to be between columns 11 and 12.
Columns 18-32 Half height of grid cell. If no decimal point is punched, it is assumed to be between columns 26 and 27.
Columns 33-35 Percentage difference at which triangular indicator is to be plotted. This is an integer and must be right justified. If it is 0, then no indicators are plotted.

Card 3 Columns 1-15 Minimum contour level to be plotted. If no decimal point is punched, it is assumed to be between columns 9 and 10.
Columns 16-30 Increment between contours. If no decimal point is punched, it is assumed to be between columns 24 and 25.
Columns 31-35 Number of contours to be plotted. This must be right justified.

Card 4 This is usually but not necessarily an exact copy of LEAD CARD 1 and is the title to be printed on plotter.

ERROR MESSAGES

In addition to the usual output, programmed error messages may be printed during the program run. Possible errors are listed below.

Program Errors (Part JCLPF5)

1. Number of data points outside allowable range (1,300).
2. Plotting indicator outside allowable range (1, 2).
3. Number of rows of grid lines outside allowable range (2, 10).
4. Number of columns of grid lines outside allowable range (2, 10).
5. Physical length of plot in y direction outside allowable range (1, 20).
6. Number of rows of grid lines used in calculation outside allowable range (1, 50).
7. Total number of grid points (M1 x M2) used in calculation outside allowable range (1,2500).

Subroutine JC101 Error

The determinant is singular. This can only occur if the determinant of the least-squares equation vanishes. This is most unlikely with any

practical problem.

Subroutine JCCONT Errors (Part JCLPF2)

These errors occur only if the contour has 1, 3, or 4 intersections with the grid cell at bottom left-hand vertex (n, m) where n, m are rows and columns counted from the bottom left-hand corner. In cases 1 and 3, no contours are drawn. In case 4, an arbitrary join of the points in pairs is made.

PROGRAM LISTING

Table 1 is a complete listing of the program for progressive linear-fit trend surfaces to a quadratic base written in FORTRAN II-D. The program requires an IBM 1620, Model II with 60K core storage, line printer, plotter, and disk storage package. With minor modifications, the program is adaptable to other machines. Additional information on the trend-surface program is available from Harbaugh (1963) and Good (1964).

Table 1.- Listing of progressive linear-fit trend-surface program.

```
C      PROGRAM - PROGRESSIVE LINEAR FIT TREND SURFACE (JCLPF5)
C      LANGUAGE - FORTRAN II D
C      COMPUTER - IBM 1620 MODEL 2, 60 K STORE , LINE PRINTER , PLOTTER
C      DISK STORAGE
C      PROGRAMMER - A.J.COLE
C      DATE COMPLETED - JAN 1967
C      FOR DOCUMENTATION SEE KANSAS GEOLOGICAL SURVEY SPECIAL
C      DISTRIBUTION PUBLICATION
       DIMENSION W(12),ZZ(300),X(300),Y(300),Z(300),S(6),ZC(50),WW(42),
      1C(7),WWW(42),ZCALC(300)
       COMMON N,M1,M2,XMINI,XMAXI,YMINI,YMAXI,N1,N2,YL,D11,D21,D1,D2,PER
       DEFINE DISK(10,250)
       READ 20
   20  FORMAT(80H  THIS FORMAT WILL BE FILLED BY JOB NAME.
      1                          )
       READ 95,N
    95 FORMAT(1X,I3)
C      ----------------------
C      CHECK  DATA PARAMETERS
C      ----------------------
  599  NERR=0
       CALL JCKU11(1,300,N,NKR)
       KAW=1
       IF(NKR)710,710,700
   700 PRINT 705,KAW
   705 FORMAT(1X, 14H PROGRAM ERROR I3)
       NERR=1
       GO TO (710,220,225,230,235,240,245),KAW
   710 IF(NERR)100,100,706
   706 TYPE 707
   707 FORMAT(12HINVALID DATA)
       CALL EXIT
C      ------------------------------------------------------------------
C      READ IN X Y Z - COORDINATES AND CALCULATE GLOBAL FIT PLANE
C      ------------------------------------------------------------------
   100 READ 105, X(1),Y(1),Z(1)
   105 FORMAT(11X,3F15.6)
       DO 106 I=1,42
   106 WW(I)=0.0
       XMAX=X(1)
       XMIN=X(1)
       YMAX=Y(1)
       YMIN=Y(1)
       ZMAX=Z(1)
       ZMIN=Z(1)
       T=0
       DO 110 I=1,N
```

```
      ZCALC(I)=1000000.0
      IF (I-1) 171,170,171
  171 READ 105,X(I),Y(I),Z(I)
      IF(XMAX-X(I))135,140,140
  135 XMAX=X(I)
  140 IF(XMIN-X(I))150,150,145
  145 XMIN=X(I)
  150 IF(YMAX-Y(I))155,160,160
  155 YMAX=Y(I)
  160 IF(YMIN-Y(I))161,161,165
  165 YMIN=Y(I)
  161 IF(ZMAX-Z(I))166,167,167
  166 ZMAX=Z(I)
  167 IF (ZMIN-Z(I))170,170,169
  169 ZMIN=Z(I)
  170 C(1)=X(I)*X(I)
      C(2)=X(I)*Y(I)
      C(3)=Y(I)*Y(I)
      C(4)=X(I)
      C(5)=Y(I)
      C(6)=1.0
      C(7)=Z(I)
      J=1
      DO1171 K=1,6
      DO1171 L=1,7
      WW(J)=WW(J)+C(L)*C(K)
 1171 J=J+1
C
C     SET COEFFICIENTS FOR GLOBAL LINEAR FIT NORMAL EQUATIONS
C
  110 T=T+Z(I)*Z(I)
      W(1)=WW(25)
      W(2)=WW(26)
      W(3)=WW(27)
      W(4)=WW(28)
      W(5)=WW(32)
      W(6)=WW(33)
      W(7)=WW(34)
      W(8)=WW(35)
      W(9)=WW(39)
      W(10)=WW(40)
      W(11)=WW(41)
      W(12)=WW(42)
      G=W(12)*W(12)
      CALL JC101(W,3,S)
      PRINT 20
      PRINT 200,S(3),S(1),S(2)
      PRINT 201
  201 FORMAT(1H0,/)
  200 FORMAT(20H GLOBAL PLANE FIT Z=F15.5,2H +F14.5,4H X +F13.5,2H Y,//)
      CC1=S(1)
      CC2=S(2)
      CC3=S(3)
      WK=N
      T=T-G/WK
      T3=T
      T1=0
      T2=0
      DO 205 I=1,N
      G=X(I)*S(1)+Y(I)*S(2)+S(3)
```

```
      T1=T1+G
  205 T2=T2+G*G
      T=((T2-T1*T1/WK)/T)*100.
      PRINT 210,T
  210 FORMAT(25H PLANE PERCENTAGE FIT IS ,F8.3,//)
      IF(SENSE SWITCH1)213,212
  213 PRINT 211
  211 FORMAT (9X,1HX,11X,1HY,9X,4HZLIN,5X,9HNO OF PTS,3X,5HZ GLO,4X,18HE
     1XPANSION  PERCENT)
  212 READ 215,IND,N1,N2,YL,M1,M2,XMINI,XMAXI,YMINI,YMAXI
  215 FORMAT(1X,I1,5I3,3X,4F15.6)
      READ 216,IND2,XLEN,YHT,PER
  216 FORMAT(1X,I1,2F15.6,I3)
      CALL JCKU11(1,2,IND,NKR)
      KAW=2
      IF(NKR)220,220,700
  220 CALL JCKU11(2,10,N1,NKR)
      KAW=3
      IF(NKR)225,225,700
  225 CALL JCKU11(2,10,N2,NKR)
      KAW=4
      IF(NKR)230,230,700
  230 IYL=YL
      CALL JCKU11(1,20,IYL,NKR)
      KAW=5
      IF(NKR)235,235,700
  235 CALL JCKU11(1,50,M1,NKR)
      KAW=6
      IF(NKR)240,240,700
  240 J=M1*M2
      CALL JCKU11(1,2500,J,NKR)
      KAW=7
      IF(NKR)245,245,700
  245 IF(NERR)250,250,706
  250 G=M1-1
      DO 246 I=1,42
  246 WWW(I)=WW(I)
      T1=0.0
      T2=0.0
C     REMOVE QUADRATIC FIT FROM Z VALUES
      CALL JC101(WW,6,S)
      DO 500 I=1,N
      ZZ(I)=Z(I)
      Z(I)=Z(I)-S(1)*X(I)*X(I)-S(2)*X(I)*Y(I)-S(3)*Y(I)*Y(I)-S(4)*X(I)-
     1S(5)*Y(I)-S(6)
      T4=ZZ(I)-Z(I)
      T1=T1+T4
  500 T2=T2+T4*T4
      T3=((T2-T1*T1/WK)/T3)*100.
      PRINT 501,T3
  501 FORMAT(29H QUADRATIC PERCENTAGE FIT IS ,F8.3,//)
      CQ1=S(1)
      CQ2=S(2)
      CQ3=S(3)
      CQ4=S(4)
      CQ5=S(5)
      CQ6=S(6)
C     SORT INTO ASCENDING Y(I)
      II=N-1
      DO 251 J=1,II
```

```
      I=J
      KK=J+1
      AA=Y(J)
      DO 252 K=KK,N
      IF(AA-Y(K))252,252,253
  253 I=K
      AA=Y(K)
  252 CONTINUE
      IF(I-J)251,251,254
  254 AA=X(I)
      X(I)=X(J)
      X(J)=AA
      AA=Y(I)
      Y(I)=Y(J)
      Y(J)=AA
      AA=Z(I)
      Z(I)=Z(J)
      Z(J)=AA
      AA=ZZ(I)
      ZZ(I)=ZZ(J)
      ZZ(J)=AA
  251 CONTINUE
      III=1
      IF(IND-2)255,260,255
  255 XMINI=XMIN
      XMAXI=XMAX
      YMINI=YMIN
      YMAXI=YMAX
  260 D11=(XMAXI-XMINI)/G
      G=M2-1
      D21=(YMAXI-YMINI)/G
      DX=D11/2.0+.00000001
      DY=D21/2.0+.00000001
      C2=YMINI-D21
C
C     SET DISK SECTOR COUNT
C
      IDT=1
      XD=XMAXI-XMINI
      YD=YMAXI-YMINI
      XL=XD*YL/YD
C     ENSURE PEN IS AT LEAST ONE INCH FROM EDGE
      CALL PLOT(20l,0.0,1.0,1.0,1.0,0.0,1.0,1.0,1.0)
      CALL PLOT(99)
      CALL PLOT(98,0.0,-10.0)
      CALL PLOT(98,0.0,-9.0)
      CALL PLOT(8)
      CALL PLOT(20l,XMINI,XMAXI,XL,XD,YMINI,YMAXI,YL,YD)
      DO 265 I=1,M2
      C2=C2+D21
      C1=XMINI-D11
      LL=0
      II=III
      III=N
      DO 270 J=1,M1
      C1=C1+D11
C
C     TEST IF LINEAR FIT AREAS ARE TO BE CALCULATED OR HAVE BEEN READ
C
      IF(IND2)271,272,271
```

```
  271 D1=XLEN
      D2=YHT
      LLL=-1
      GO TO 275
  272 D1=D11
      D2=D21
      LLL=-1
  275 L=0
      LLL=LLL+1
      DO 280 K=1,12
  280 W(K)=0.0
      MK=0
      DO295 K=II,N
      IF(ABSF(Y(K)-C2)-D2)285,285,296
  285 IF(MK) 286,287,286
  287 MK=1
  286 IF(ABSF(X(K)-C1)-D1)290,290,295
  290 L=L+1
      W(1)=W(1)+X(K)*X(K)
      W(2)=W(2)+X(K)*Y(K)
      W(3)=W(3)+X(K)
      W(4)=W(4)+X(K)*Z(K)
      W(6)=W(6)+Y(K)*Y(K)
      W(7)=W(7)+Y(K)
      W(8)=W(8)+Y(K)*Z(K)
      W(12)=W(12)+Z(K)
      IF(III-K)295,295,298
  298 III=K
      GO TO 295
  296 IF(MK)297,295,297
  295 CONTINUE
  297 IF(L-5)300,305,305
  305 W(5)=W(2)
      W(9)=W(3)
      W(10)=W(7)
      W(11)=L
C
C     SOLVE NORMAL EQUATIONS FOR LOCAL LINEAR FIT
C
      CALL JC101(W,3,S)
      LL=LL+1
      ZL=CC1*C1+CC2*C2+CC3
      ZC(LL)=C1*S(1)+C2*S(2)+S(3)+CQ1*C1*C1+CQ2*C1*C2+CQ3*C2*C2+CQ4*C1+
     1CQ5*C2+CQ6
      DO 600 K=II,N
      IF(ABSF(Y(K)-C2)-DY)605,605,600
  605 IF(ABSF(X(K)-C1)-DX)610,610,600
  610 ZCALC(K)=ZZ(K)-Z(K)+S(1)*X(K)+S(2)*Y(K)+S(3)
  600 CONTINUE
      IF(SENSE SWITCH1)306,270
  306 IF(ZL)307,308,307
  308 PERCNT=100.0
      GO TO 309
  307 PERCNT=100.*ZC(LL)/ZL
  309 PRINT 310,C1,C2,ZC(LL),L,ZL,LLL,PERCNT
  310 FORMAT(1X,3F12.3,I8,F12.3,I8,F12.3)
      GO TO 270
  300 D1=D1*1.25
      D2=D2*1.25
      GO TO 275
```

```
  270 CONTINUE
      RECORD (IDT) (ZC(J),J=1,M1)
      DO 273 J=1,M1
      ZC(J)=ABSF(ZC(J))
      IF(ZC(J)-99998.)273,274,274
  274 ZC(J)=99998.
  273 CONTINUE
      III=II
  265 CONTINUE
      PRINT 630
  630 FORMAT(1H1,6X,1HX,11X,1HY,11X,1HZ,9X,5HZCALC,5X,8HRESIDUAL,3X,10HP
     1ERCENTAGE)
      K=0
      T1=0.0
      T2=0.0
      T3=0.0
      T=0.0
      G=0
C
C     PLOT PERCENTAGE ERROR INDICATORS
C
      DO 620 I=1,N
      IF(ZCALC(I)-999999.0)625,625,620
  625 K=K+1
      IF(ZZ(I))624,623,624
  623 P=100.0
      GO TO 627
  624 R=ZZ(I)-ZCALC(I)
      P=ZCALC(I)/ZZ(I)*100.0
      IF(ABSF(100.-P)-PER)627,627,626
  626 CALL PLOT(99)
      CALL PLOT(98,X(I),Y(I))
      CALL POINT(7,0.1,1,0)
      PRINT 628,X(I),Y(I),ZZ(I),ZCALC(I),R,P
  628 FORMAT(6F12.3,4X,1H*)
      GO TO 629
  627 PRINT 635,X(I),Y(I),ZZ(I),ZCALC(I),R,P
  635 FORMAT(6F12.3)
  629 G=G+ZZ(I)
      T=T+ZZ(I)*ZZ(I)
      T1=T1+ZCALC(I)
      T3=(ZZ(I)-ZCALC(I))**2+T3
      T2=T2+ZCALC(I)*ZCALC(I)
  620 CONTINUE
      PRINT 621,N,K
  621 FORMAT(//,34H ORIGINAL NUMBER OF DATA POINTS IS,I5,5X,30H NUMBER O
     1F DATA POINTS USED IS,I8,//)
      WK=K
      T=((T2-T1*T1/WK)/(T-G*G/WK))*100.0
      PRINT 640,T,T3
  640 FORMAT(30HOPROGRESSIVE PERCENTAGE FIT IS F8.3,//,31HOSUM OF SQUARE
     1S OF RESIDUALS IS,F12.4,////)
      CALL PLOT(99)
      CALL PLOT(98,XMINI,YMINI)
      IF(IND2)645,650,645
  645 D1=XLEN
      D2=YHT
      GO TO 655
  650 D1=D11
      D2=D21
  655 CALL LINK (JCLPF2)
      END
```

```
*LIST PRINTER
*LDISKJCLPF2
C      PROGRAM - CONTINUATION OF PROGRESSIVE LINEAR FIT TREND SURFACE
C      (JCLPF2)
C      LANGUAGE - FORTRAN II D
C      COMPUTER - IBM 1620 MODEL 2, 60K STORE, LINE PRINTER, PLOTTER
C      PROGRAMMER - A.J.COLE
C      DATE COMPLETED - JAN 1967
C      FOR DOCUMENTATION SEE KANSAS GEOLOGICAL SURVEY SPECIAL
C      PUBLICATION
       DIMENSION B(50,50)
       COMMON N,M1,M2,XMINI,XMAXI,YMINI,YMAXI,N1,N2,YL,D11,D21,D1,D2,PER
       DEFINE DISK (10,250)
       IDT=1
       DO 5 I=1,M2
    5  FETCH (IDT) (B(I,J),J=1,M1)
       X=XMAXI-XMINI
       Y=YMAXI-YMINI
       XL=X*YL/Y
       XD=N2
       YD=N1
       XD=(XMAXI-XMINI)/XD
       YD=(YMAXI-YMINI)/YD
       D1=2.0*D1
       D2=2.0*D2
       T=YMINI-0.5*(YMAXI-YMINI)/YL
       CALL PLOT (101,XMINI,XMAXI,XL,XD,YMINI,YMAXI,YL,YD)
       READ 10,CMIN,CINC,NUMC
       READ 25
       CALL PLOT(99)
       CALL PLOT(90,XMINI,T)
       CALL CHAR(0,0.14,0)
   25  FORMAT(80H  THIS FORMAT WILL BE FILLED BY JOB NAME.
      1                          )
   10  FORMAT(2F15.6,I5)
       XD=M2-1
       YD=M1-1
       XD=(XMAXI-XMINI)/XD
       YD=(YMAXI-YMINI)/YD
       PRINT 15,XMINI,XMAXI,YMINI,YMAXI,CMIN,CINC,NUMC
   15  FORMAT(24H1 CONTOUR MAP PARAMETERS,//,19H MINIMUM X-VALUE IS,F15.6
      1,5X,19H MAXIMUM X-VALUE IS,F15.6,//,19H MINIMUM Y-VALUE IS,F15.6,5
      2X,19H MAXIMUM Y-VALUE IS,F15.6,//,25H MINIMUM CONTOUR VALUE IS,F15
      3.6,5X,20H CONTOUR INTERVAL IS,F15.6,5X,28H NUMBER OF CONTOUR LEVEL
      4S IS,I6,//)
       W=(XMAXI-XMINI)/XL
       WW=(YMAXI-YMINI)/YL
       PRINT 30,D11,D21,M1,M2,D1,D2,W,WW
   30  FORMAT(26H BASIC CELL DIMENSIONS ARE,F15.4,5X,3HAND,F15.4,//,20H N
      1UMBER OF GRID ROWS,I7,5X,23H NUMBER OF GRID COLUMNS,I7, //,37HOBAS
      3IC LINEAR FIT AREA DIMENSIONS ARE,F15.4,4X,3HAND,F15.4,//,18H X-SC
      4ALE FACTOR IS,F12.3,5X,18H Y-SCALE FACTOR IS,F12.3,//)
       PRINT 60,PER
   60  FORMAT(39HOPERCENTAGE ERROR INDICATORS PLOTTED AT,F15.4,4X,14H PER
      2CENT LEVEL,///,22H KEY TO CONTOUR LEVELS,/)
       W=CMIN
       DO 35 I=1,NUMC
       PRINT 40,I,W
```

```
   40 FORMAT(I4,1H=,F12.4)
   35  W=W+CINC
       CALL JCCONT(B,CMIN,CINC,NUMC,M1,M2,XMINI,XD,YMINI,YD,XL,YL)
C      MOVE FOR NEXT PLOT
       T=3.0*(XMAXI-XMINI)/XL+XMAXI
       CALL PLOT (99)
       CALL PLOT(98,T,YMINI)
       CALL EXIT
       END

*LIST PRINTER
*FANDK2005
*POBJP4
       SUBROUTINE  JC101(E,N,S)
       SUBROUTINE IJC101(E,N,S)
       DIMENSION E(1),S(1)
C      SUBROUTINE JC101 TO SOLVE LINEAR EQUATIONS
C      E K A LINEAR ARRAY WITH COEFFICIENTS AND RIGHT
C      HAND SIDES BY ROWS. N IS THE ORDER AND S IS
C      A LINEAR ARRAY TO HOLD THE SOLUTIONS.
       I3=N+1
       I6=N-1
       T2=1.
       DO 5 I2 = 1,I6
       K=I2-1
       K=K*I3
       IQ=I2+K
       I4=I3-I2
       T=0
       II=IQ+I3*(I4-1)
       DO 10 I=IQ,II,I3
       G=ABSF(E(I))
       IF(G-ABSF(T))10,10,15
   15  T=E(I)
       J=I
   10  CONTINUE
       IF(T)20,25,20
   25  PRINT 30
   30  FORMAT (21H DETERMINANT SINGULAR)
       CALL EXIT
   20  J=J-IQ
       I4=I4+1
       II=IQ+I4-1
       IF(J)35,35,40
    40 DO 45 I=IQ,II
       JJ=I+J
       EE=E(I)
       E(I)=E(JJ)
   45  E(JJ)=EE
    35 I5=I4-2
       DO 50 I=1,I5
       IH=I*I3
       K=IQ+IH
       T1=E(K)/T
       DO 50 J=IQ,II
       JJ=J+IH
   50  E(JJ)=E(JJ)-E(J)*T1
     5 T2=T2*E(IQ)
       K=N*I3-1
       IF(E(K))55,25,55
```

```
   55 S(N)=E(K+1)/E(K)
      J=1
      I=I6
      DO 60 II=1,I6
      K=K-I3
      S(I)=E(K+1)
      IQ=N
      IH=K
      DO 65 IHH=1,J
      S(I)=S(I)-E(IH)*S(IQ)
      IQ=IQ-1
   65 IH=IH-1
      IH=K-J
      S(I)=S(I)/E(IH)
      J=J+1
   60 I=I-1
      RETURN
      END
```

```
*LDISKJCKU11
      SUBROUTINEJCKU11(LL,LU,N,NER)                                    12000001
C                                                                      12000002
C     RANGE DETERMINES WHETHER OR NOT N FALLS IN THE CLOSED            12000003
C     INTERVAL (LL,LU)                                                 12000004
C                                                                      12000005
      NER = 0                                                          12000006
      IF (LL - N) 5, 15, 10                                            12000007
    5 IF (LU - N) 10, 15, 15                                           12000008
   10 NER = 1                                                          12000009
   15 RETURN                                                           12000010
      END                                                              12000011
```

```
*LIST PRINTER
* ASSEMBLE RELOCATABLE
* STORE RELOADABLE
* OUTPUT CARD
* NAME PLOT
00010*          1620-LM-042-PLOT
00020*
00030******     PROGRAM 1620-FO-042  POINT-TO-POINT PLOT
00040****  LAMONT VERSION WITH CALL PLOT(8) AND CALL PLOT(98,X,Y)
00050*          A CONTROL DIGIT OF 8 WILL REINITIALISE THE CO-ORDINATE
00060*          SYSTEM TO THE PRESENT POSITION OF THE PEN
00070**     A CONTROL FIELD OF 98 WILL LIFT THE PEN, MOVE TO
00080**     CO-ORDINATES X, Y, AND LEAVE THE PEN IN THE UP POSITION.
00090**     THIS CODE IS USEFUL PRIOR TO CALLING CHAR.
00100SS     DS   ,*+101
00110       DC   6,987898,5-SS
00120       DAC  6,PLOT   ,7-SS
00130       DVLC22-SS,5,RCM,2,08,2,04,5,PLOT-6,5,0,30,0
00140       DSC  17,0,0
00150       DORGSS-100
00160       DS   5
00170PLOT   SF   PLOT-1,,0
00180FPMAX  DS   5,*
00190       AM   PLOT-1,05,01011,          BRING IN CONTROL CHARACTER ADDRESS
00200       C    ZRONE,PLOT-1,0111
00210       BV   *+12,,0
00220       BE   XORG,,0,                   GO TO XFRAME ROUTINE
00230       CM   PLOT-1,07,0610
00240       BE   FINPLT,,0,                 GO TO FINISH PLOT ROUTINE.
00250       CM   PLOT-1,08,0610, COMPARE AND BRANCH IF PLOT8 REQUIRED
00260       BE   CLPLT8
00270       TD   XCROSS+16,PLOT-1,0111,  ADJUST PEN CONTROL TO PROPER MODE
00280       CM   PLOT-1,98,0610
00290       BE   NCHAR,,0
00300       CM   PLOT-1,90,0610
00310       BE   *+32,,0
00320       BL   *+32,,0
00330       B    FINFIN,,0
00340       DORG*-3
00350DD90   TFM  WRITEX+1,41,010
00360       CF   PLOT-1,,0
00370FPD    DS   5,*
00380       BTM  INCADD,FPXVAL,017,       BRING IN XVALUE ADDRESS
00390       BTM  INCADD,FPYVAL,017,       BRING IN YVALUE ADDRESS
00400       BT   TOFAC, FPXVAL,1,          XVALUE TO FAC
00410PLOTXBBTM  FSB,FPXMIN,17,            XVALUE - XMIN TO FAC
00420       BTM  FMP,CX1,17,               CX1(XVALUE - XMIN) TO FAC
00430       BTM  FIX1,*+12,017
00440       TFM  CKFRM2+6,PLOTXC,017
00450       SF   FAC-4,,,                  FIX AT 5 DIGETS
00460FPXVALDS   5,*
00470       CM   FAC,0,10,                 IS PLOTXVALUE LT ZEROO
00480       BL   CKFRM,,0,                 IF SO, CHECK IF PART OF FRAME.
00490PLOTXCTF   XN,FAC,0,                  STORE PLOTXVALUE IN XN
00500PLOTYANOP  ENTRPT,,0,                 GO TO PLOT IF IN XFRAME ROUTINE.
00510FPMIN  DS   5,*
00520       BT   TOFAC, FPYVAL,1,          YVALUE TO FAC
00530PLOTYBBTM  FSB,FPYMIN,17,            YVALUE - YMIN TO FAC
```

```
00540       BTM FMP,CY1,17,                CY1(YVALUE -YMIN, TO FAC
00550       BTM FIX1,*+12,017
00560       TFM CKFRM2+6,PLOTYC,017
00570       SF  FAC-4,,,                   FI XAT 5 DIGETS
00580FPYVALDS  5,*
00590       BNF PLOTYC,FAC,0
00600CKFRM CM   XYRETN+1,49,010
00610       BE  YESFRM,,0,                FRAME IS NOW COMPLETE
00620CKFRM2B    PLOTXC,,0,                  OTHERWISE PLOT POINT IN ERROR.
00630       DORG*-3
00640PLOTYCTF   YN,FAC,0,                 STORE PLOTYVALUE IN YN
00650ENTRPTBTM XYPLOT,0,010,              GO TO PLOT ALGORITHM
00660XYRETNNOP FRAMX2,,0,                 IF FRAME RTN, RETURN TO PROPER SPOT 0053
00670FPLH   DS  5,*
00680FRMFRMAM   PLOT-1,02,010,            RETURN TO RPOGRAM
00690       B   PLOT-1,,06,                FROM THIS SUBPROGRAM
00700       DORG*-3
00710XORG   TFM ENTPLT+6,PLOTXB,017,      INITIALIZE
00720       TFM SXYMIN+11,FPXMIN,017
00730       TFM STRCON+11,CX1,017,          ROUTINE
00740       TDM XCROSS+16,0,0,            SET PEN DOWN FOR FRAME
00750       TFM PLOTYA+1,49,010,             FOR
00760       TFM WRITEX+1,41,010
00770       WN  LWRPEN,200,0,             LOWER PEN FOR FRAME
00780       CM  PLOT-1,201,069
00790       BNE *+24,,0
00800       TFM XYPLOT+1,42,010
00810       CM  PLOT-1,101,069
00820       BNE *+24,,0
00830       TDM CHART0+1,1,0
00840       CF  PLOT-1,,0
00850XLSTORDS  5,*
00860       AM  PLOT-1,30,010
00870       BTM INCADD,TEMPAD,017,        GET Y HIGH ADDRESS
00880       BT  TOFAC,TEMPAD,1
00890       BTM FIX1,*+12,017
00900       SF  FAC-4
00910COUNT  DC  5,0,*
00920       BTM FMFAC,CHRTCT,17
00930       SM  PLOT-1,35,010
00940       TFM CHART4+6,ONE,017
00950       TFM CHART2+6,FIVE,017
00960       TFM XYRETN+1,49,010
00970       B   XYORG,,0
00980PENMEMDS  ,*-4
00990       DORG*-3
01000YORG   TFM ENTPLT+6,PLOTYB,017
01010       TFM SXYMIN+11,FPYMIN,017
01020       TFM XYSWCH+1,41,010
01030       TFM STRCON+11,CY1,017
01040       TFM FRAMX2+1,41,010
01050       TF  CHRTCT,XLSTOR,01
01060       TFM CHART4+6,THREE,017
01070       TFM CHART2+6,SEVEN,017
01080       TFM XN,0,07
01090       TFM YN,0,07
01100       BTM XYPLOT,0,010,              GO TO INITIALIZE PLOTTER FOR FRAME
01110XYORG  BTM INCADD,FPMIN,017,         BRING IN MINIMUM ADDRESS
01120       BT  TOFAC,FPMIN,1
01130SXYMINBTM FMFAC,FPXMIN,17
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01140       BTM INCADD,FPMAX,017,       BRING IN MAXIMUM ADDRESS
01150       BTM INCADD,FPLH,017,        BRING IN LENGTH (HEIGHT) ADDRESS
01160       BTM INCADD,FPD,017,         BRING IN FRAME INCREMENT ADDRESS
01170       BT  TOFAC, FPMAX,1,         CALCULATE
01180       BT  FSB, FPMIN,1,            X (Y) VALUE
01190       BT  FDVR, FPLH,1,             SCALING
01200STRCONBTM FMFAC,CX1,17,               FACTOR CX1 (CY1)
01210       BT  TOFAC, FPMAX,1
01220       BTM FMFAC,TWARXY,17,         SET UP XMAXIMUM FOR XFRAME PLOT
01230       B   ENTPLT,,0,              GO TO PLOT FRAME
01240       DORG*-3
01250FRAMX2TF  XLSTOR,XN,01,             SAVE XMAX FOR INITIALIZING THE
01260       TFM FRAMX2+1,41,010,         NEXT PLOT
01270       BTM TOFAC,TWARXY,17,        SET UP
01280       BT  FSB,FPD,1,               GRID
01290       BTM FMFAC,TWARXY,17
01300ENTPLTB   PLOTXB,,0,               GO TO  PLOT GRID POINTS
01310       DORG*-3
01320YESFRMCM  CHART1+1,41,010
01330       BE  XYSWCH,,0
01340       BTM XYPLOT,5,010
01350XYSWCHB   YORG,,0
01360E      DC  5,0,*
01370ENDFRMTFM PLOTYA+1,41,010,         NOP PLOTYA
01380       TFM XYRETN+1,41,010,         NOP XYRETN
01390       TFM XYSWCH+1,49,010
01400       TDM CHART0+1,9,0
01410       TFM XYPLOT+1,24,010
01420FINFINWN  LIFTPN,200,0,            LIFT PEN
01430       CF  PLOT-1,,0
01440       TDM PENMEM,9,0
01450       B   FRMFRM,,0,               GO TO EXIT
01460       DORG*-3
01470CLPLT8TFM XN,0,7
01480       TFM YN,0,7
01490       TFM XZ,0,7
01500       TFM YZ,0,7
01510       TFM WRITEX+1,41,010
01520       TFM FRAMX2+1,26,010
01530       B7  FINFIN,,0
01540NCHAR  WN  LIFTPN,200,0
01550       TDM PENMEM,9,0
01560       TDM GOOP+1,9,0
01570       B7  DO90,,0
01580FINPLTAM  XLSTOR,250,09,           ADJUST XMAX FOR INITIALIZING
01590       TF  XN,XLSTOR,01,            NEXT  PLOT
01600       TFM YN,0,07,                 SET YN = ZERO
01610       WN  LIFTPN,200,0,            LIFT PEN
01620       TFM WRITEX+1,41,010
01630       BTM XYPLOT,0,010,            GO TO  SET UP NEXT PLOT IF ANY
01640       TFM XZ,0,07,                SET XZ = ZERO
01650       TFM FRAMX2+1,26,010,         SET FRAMX2 TO TRANSFER
01660       B   FINFIN,,0,               GO TO EXIT
01670FIX1   AM  FAC,2,10
01680       AM  FAC-2,5,10
01690       BNV FIX9,,0
01700       TFM FIX2+11,FAC-2,07
01710       SM  FIX2+11,1,010
01720FIX2   BNF FIX2-12,,0
01730       TDM FIX2+11,1,0611
```

```
01740        AM   FAC,1,10
01750FIX9    BTM  FIX,0,10
01760        B    FIX1-1,,06
01770INCADDAM   PLOT-1,05,010
01780        BNF  *+24,PLOT-1,0111
01790        TDM  TEMPAD+1,2,0
01800        TF   *+35,PLOT-1,0111
01810        CF   *+23,,0
01820TEMPADDS   ,*
01830        TFM  INCADD-1,,06
01840        TDM  *-12,1,0
01850        BB
01860        DORG*-9
01870TWARXYDS   30
01880FPXMINDS   30
01890FPYMINDS   30
01900CX1     DS   30
01910CY1     DS   30
01920XCROSSDSC  18,115555113377773390
01930TABLE   DSC  16,1232345456767818
01940LWRPENDSC  2,0@
01950LIFTPNDSC  2,9@
01960ONE     DSC  2,1@
01970THREE   DSC  2,3@
01980FIVE    DSC  2,5@
01990SEVEN   DSC  2,7@
02000ZRONE   DC   2,01
02010        DS   2
02020XYPLOTC    XZ,XN,01
02030        BE   TEST1,,0
02040ENTER   TF   A,XN,01
02050        S    A,XZ,01
02060        TF   R,YN,01
02070        S    R,YZ,01
02080        TFM  Q,0,07
02090        TF   C,A,01
02100        A    C,R,01
02110        TF   D,R,01
02120        S    D,A,01
02130        BNF  ADD1,R,01
02140        B    TESTC,,0
02150XZ      DC   5,0,*
02160ADD1    AM   Q,2,07
02170TESTC   BNF  ADD2,C,01
02180        B    TESTD,,0
02190YZ      DC   5,0,*
02200ADD2    AM   Q,2,07
02210TESTD   BNF  ADD3,D,01
02220        B    TESTA,,0
02230OUTPT1DSC   2,1@,*-3
02240ADD3    AM   Q,2,07
02250TESTA   BNF  TMIN8,A,01
02260        AM   Q,10,07
02270        B    ABS,,0
02280XN      DC   5,0,*
02290TMIN8   TFM  TT,8,07
02300        S    TT,Q,01
02310        TF   Q,TT,01
02320ABS     CF   A,,0
02330YN      DC   5,0,*
```

```
02340       CF  R,,0
02350A      DC  5,0,*
02360       TF  F,A,01
02370       A   F,R,01
02380       SM  F,1,07
02390       TF  C,R,01
02400       S   C,A,01
02410       BNF DEQA,C,01
02420       TF  D,R,01
02430       B   EEQZRO,,0
02440R      DC  5,0,*
02450DEQA   TF  E,C,01,                    E USED AS TEMPORARY STORAGE
02460       TFM C,0,07
02470       S   C,E,01
02480       TF  D,A,01
02490EEQZRO TFM E,0,07
02500       TFM INSTR1+11,TABLE-1,017
02510       TFM INSTR2+11,TABLE-2,017
02520       A   INSTR1+11,Q,01
02530       A   INSTR2+11,Q,01
02540INSTR1TD   OUTPT1,,0
02550INSTR2TD   OUTPT2,,0
02560AGAIN  TF  A,C,01
02570       A   A,E,01
02580       A   E,D,01
02590       TF  R,A,01
02600       A   R,E,01
02610       BNL EEQA,,0
02620       SM  F,1,010
02630       WN  OUTPT2,200,0
02640TEST9  BNL AGAIN,,0
02650       B   TESTE,,0
02660Q      DC  5,0,*
02670EEQA   TF  E,A,01
02680       SM  F,2,010
02690       WN  OUTPT1,200,0
02700       B   TEST9,,0
02710C      DC  5,0,*
02720TESTE  CM  E,0,07
02730       BE  RETURN,,0
02740       H   ,,,                        ERROR HALT
02750D      DC  5,0,*-5
02760TT     DC  5,0,*
02770TEST1  C   YZ,YN,01
02780       BE  RETURN,,0
02790       B   ENTER,,0
02800F      DC  5,0,*
02810RETURNTF   XZ,XN,01
02820       TF  YZ,YN,01
02830GOOP   NOP WRITEX+12,,0
02840       BD  CHART0-12,PENMEM,01
02850       B   CHART0,,0
02860       DORG*-3
02870       WN  LWRPEN,200,0
02880CHART0B    WRITEX-12,,0
02890CHART1NOP  CHART2,,0
02900CHART4WN   ONE,200,0
02910       AM  COUNT,1,07
02920       CM  COUNT,0,07
02930CHRTCTDS   5,*
```

```
02940       BNE CHART4,,0
02950       TDM CHART1+1,9,0
02960       B   WRITEX+24,,0
02970       DORG*-3
02980CHART2WN   FIVE,200,0
02990       SM  COUNT,1,010
03000       BNZ CHART2,,0
03010       TDM CHART1+1,1,0
03020       B   WRITEX+24,,0
03030       DORG*-3
03040       TD  PENMEM,XCROSS+16,01
03050WRITEXWN   XCROSS,200,0
03060       TFM WRITEX+1,38,010
03070       TDM GOOP+1,1,0
03080       BV  *+12,,0
03090       BB
03100OUTPT2DSC  2,2@,*-9
03110FAC    DS  ,2492
03120FIX    DS  ,3854
03130FMFAC  DS  ,3452
03140FSB    DS  ,4066
03150FMP    DS  ,4138
03160FDVR   DS  ,4186
03170TOFAC  DS  ,3408
03180RCM    NOP
03190       DC  1,@,RCM
03200       DEND
```

```
*LIST PRINTER
* ERROR STOP
* ASSEMBLE RELOCATABLE
* STORE RELOADABLE
* NAME POINT
*OUTPUT CARD
00010*  SUBROUTINE POINT
00020S      DS   ,*+101,STANDARD FORTRAN SUBPROGRAMME HEADING
00030       DC   6,987898,5-S
00040       DAC  6,POINT ,7-S
00050       DVLC22-S,5,END-1,2,08,2,05,5,POINT-6,5,0,30,0
00060       DSC  17,0,0
00070       DORGS-100
00080       DS   5
00090POINT  SF   LINK,,,BEGIN TRANSFER OF ARGUMENTS
00100       SM   LINK,5,10
00110       TF   STYLE,LINK,11
00120       SM   LINK,5,10
00130CF     CF   LINK
00140       TF   *+35,-LINK
00150SF     SF   LINK
00160       BTM  TOFAC
00170       SM   LINK,5,10
00180       TF   TIMES,LINK,11
00190       SM   LINK,5,10
00200       TF   DOT,LINK,11
00210       SM   LINK,1,10,CALCULATE RETURN ADDRESS
00220       CF   LINK
00230       BTM  FDV,FOUR,7,SCALE AND FIX SIZE
00240       BTM  FAD,HALF,7
00250BTM    BTM  FIX,FAC,7
00260       TF   SIZE,FAC
00270       SF   STYLE-1,,,SPLIT STYLE IN TWO
            SF   STYLE-3
00280DAVID  CM   STYLE,10,10,EXAMINE ARGUMENTS FOR ERRORS
00290       BP   ER1
00300       CM   STYLE,1,10
00310       BN   ER1
00320       CM   SIZE,30,10
00330       BP   ER2
00340       CM   SIZE,1,10
00350       BN   ER3
00360       CM   TIMES,5,10
00370       BP   ER4
00380       CM   TIMES,1,10
00390       BN   ER4
00400       BD   NODOT,DOT,,EXAMINE DOT AND BRANCH IF NOT REQUIRED
00410       WN   R1,200,,PLOT DOT
00420NODOT  WN   R2,200,,PEN DOWN
00430       TF   X,TIMES,,SET TIMES LOOP
00440       MM   STYLE,5,10,CALCULATE STYLE ADDRESS
00450       SF   95
00460       CF   96
00470CT     AM   99,PLUS-5,7
00480ROUND  TF   N,-99,,PLANT INDIRECT ADDRESS OF PLOTTING INSTRUCTION
00490       SF   N
00500LOOP   TF   COUNT,SIZE,,SET LOOP FOR NUMBER OF TIMES EACH SIDE IS TO BE
00510BIGGERWN    ,200,,PLOT SIDE                                    REPEATED
00520       BNF  SKIP,N,11,DETERMINE IF PEN UP OR DOWN,IF SO DO ONLY ONCE
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00530       SM  COUNT,1,10
00540       CM  COUNT,0,10
00550       BNE BIGGER,,,COMPLETE LOOP FOR ONE SIDE
00560SKIP   SM  N,5,10,INCREMENT PLOTTING ADDRESS
00570       BNR LOOP,N,711,DETERMINE IF CHARACTER IS COMPLETE
00580       SM  X,1,10
00590       CM  X,0,10,DETERMINE IF TIMES LOOP IS COMPLETE,IF NOT,
00600       BNE ROUND,,,REPEAT CHARACTER
00610       CM  STYLE2,0,10,SEE IF A SECOND CHARACTER IS REQUIRED,IF NOT,
00620       BE  OUT,,,RETURN
00630       TF  STYLE,STYLE2,,,PLACE STYLE2 IN STYLE AND
00640       TFM STYLE2,0,10,PUT NAUGHT IN STYLE AND
00650       B7  DAVID,,,REPEAT OPERATION
00660OUT    B7  -LINK,,     ****RETURN****
00670ER1    RCTY,,,PRINT APPROPRIATE ERROR MESSAGES
00680       WATYEC
00690       WATYE1
00700       B7  -LINK
00710ER2    RCTY
00720       WATYEC
00730       WATYE2
00740       B7  -LINK
00750ER3    RCTY
00760       WATYEC
00770       WATYE3
00780       B7  -LINK
00790ER4    RCTY
00800       WATYEC
00810       WATYE4
00820       B7  -LINK
00830N      DS  ,BIGGER+6,P ADDRESS OF PLOTTER INSTRUCTION
00840COUNT  DS  ,CT-1
00850X      DS  ,LOOP-1
00860*ADDRESSES OF ADDRESSES OF FIRST SIDES
00870PLUS   DSA ONE,TWO,THREE,FOURQ,FIVE,SIX,SEVEN,EIGHT,NINE,TEN
00880*ADDRESSES OF SIDES
00890ONE    DSA    A,B,B,A,G,H,H,G,END1
00900TWO    DSA UP,P,A,DN,I,L,A,A,UP
00910       DSA B,R,DN,END1
00920THREE  DSA    C,D,D,C,F,E,E,F,END1
00930FOURQ  DSA UP,E,DN,G,G,B,B,H,H,A
00940       DSA A,UP,F,DN,END1
00950FIVE   DSA UP,H,DN,C,F,D,E, UP
00960       DSA      G,DN,END1
00970SIX    DSA UP,R,A,DN,L,I,A,A,UP,B
00980       DSA P,DN,END1
00990SEVEN  DSA UP,T,H,DN,J,K,H,H,UP,G
01000       DSA Q,DN,END1
01010EIGHT  DSA UP,Q,H,DN,K,J,H,H,UP,G
01020       DSA T,DN,END1
01030NINE   DSA    G,Q,A,Q,H,H,Q,A,Q
01040       DSA G,END1
01050TEN    DSA    A,R,H,R,B,B,R,H,R
01060       DSA A,END1
01070*PLOTTING OPERATIONS
01080A      DSC 3,N5@
01090B      DSC 3,J1@
01100C      DSC 3,M4@
01110D      DSC 3,Q8@
01120E      DSC 3,06@
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01130F      DSC 3,K2@
01140G      DSC 3,L3@
01150H      DSC 3,P7@
01160I      DSC 4,K32@
01170J      DSC 4,K12@
01180K      DSC 4,M54@
01190L      DSC 4,Q78@
01200P      DSC 2,P@
01210Q      DSC 2,J@
01220R      DSC 2,L@
01230T      DSC 2,N@
01240UP     DSC 2,9@
01250DN     DSC 2,0@
01260END1   DSC 1,@
01270*ERROR MESSAGES
01280EC     DAC 13,POINT ERROR-@
01290E1     DAC 14,UNKOWN SYMBOL@
01300E2     DAC 15,SIZE TOO LARGE@
01310E3     DAC 15,SIZE TOO SMALL@
01320E4     DAC 18,TOO MANY RETRACES@
01330STYLE  DS  ,BTM+11,DEFINE SYMBOLS IN Q ADDRESSES OF
01340STYLE2 DS  ,STYLE-2, SF AND CF INSTRUCTIONS
01350LINK   DS  ,POINT-1,RETURN ADDRESS
01360SIZE   DS  5
01370TIMES  DS  ,POINT+11
01380FOUR   DC  10,M0000000-J
01390HALF   DC  10,N0000000-0
01400COUNT1 DS  ,SF+11
01410R1     DSC 6,07135@
01420R2     DS  ,DN
01430DOT    DS  ,CF+11
01440FDV    DS  ,4162,ADDRESSES OF FORTRAN SUBROUTINES
01450FAD    DS  ,4090
01460FIX    DS  ,3854
01470FAC    DS  ,2492
01480TOFAC  DS  ,3408
01490END    DAC 1, ,
01500       DC  1,@,END-1
01510       DEND
```

```
*LIST PRINTER
* ASSEMBLE RELOCATABLE
* STORE RELOADABLE
* NAME CHAR
* ERROR STOP
00010*          1620-LM-042-CHAR
00020*
00030SS     DS   ,*+101
00040       DC   6,987898,5-SS
00050       DAC  6,CHAR  ,7-SS
00060       DVLC22-SS,5,RCM,2,08,2,04,5,CHAR-6,5,0,30,0
00070       DSC  17,0,0
00080       DORGSS-100
00090       DS   5
00100CHAR   TFM  CREC-1,14219,07, SUBR SET 3
00110       BD   CHAR1,3408,0,  TEST FOR SET 3 OR SET 4
00120       TFM  CREC-1,13121,07, SUBR SET 4
00130CHAR1  BTM  INCADD,NN,017,
00140       MM   NN,5,010
00150       BD   ODDNN,99,0
00160       TDM  AD1718+11,8,0
00170ODDNN  SF   95
00180AD1718AM   99,17,10
00190       TDM  AD1718+11,7,0
00200       A    99,CHAR-1,1
00210       TF   GOWATY+11,99,0
00220       TF   EXIT+6,99,011
00230       BTM  INCADD,CPR,017
00240       BNF  *+44,CPR,01
00250       RCTY
00260       WATYERR1,,0
00270       B    OUT99,,0
00280       DORG*-3
00290       CM   CPR,2,010
00300       BNH  *+44,,0
00310       RCTY
00320       WATYERR2,,0
00330       B    OUT99,,0
00340       DORG*-3
00350START1TFM  ITCT,0,07
00360       CF   INCAD1+11,,0
00370       BT   TOFAC,INCAD1+11,1
00380       AM   FAC,2,10
00390       BTM  FIX,0,10
00400       SF   FAC-5
00410       BTM  FMFAC,ITCT+1,17
00420       BTM  INCADD,CPR,017
00430GOWATYBTM  WAPT
00440       TFM  DATINH+2,06,10
00450       BD   NUMV1,CPR,01
00460       TFM  WRITE+6,START,17
00470       B    NUMV1+12
00480       DORG*-3
00490NUMV1  TFM  WRITE+6,NUMV,17
00500       TFM  LAST-5,41,10
00510       TFM  WRITE+1,49,10
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00520AGAIN CM   NN,0,08
00530      BE   OUT99,,0
00540      AM   CHAR-1,5,010
00550      BNF  *+24,CHAR-1,0111
00560      TDM  *+36,2,0
00570      TF   *+35,CHAR-1,0111
00580      CF   *+23,,0
00590GOSWC BTM  SWC,0,7
00600      TDM  *-12,1,0
00610      SM   NN,1,010
00620      B    AGAIN,,0
00630INCADDAM   CHAR-1,5,010
00640      TF   *+23,CHAR-1,0111
00650INCAD1TF   INCADD-1,0,06
00660      BB
00670      DORG*-9
00680OUT99 BTM  COMPLT,0,10
00690      TFM  WRITE+1,16,10
00700      TFM  WRITE+6,IORT
00710      TFM  LAST-5,34,10
00720EXIT  B    0
00730      DORG*-4
00740NN    DC   10,0
00750NUMV  WNPTPENUP,,0
00760      BD   CREC-12,GO+21,01
00770      TFM  GO+23,100,09
00780      TDM  SUBT+11,1,0
00790      TDM  SUBST,8,0
00800      TDM  SUBT+1,2,0
00810      TFM  TEST+11,A-1,017
00820      AM   TEST+11,1,07
00830TEST  TD   TST,A,0
00840      BNR  DIG,TST,01
00850      B    TEST-12,,0
00860      DORG*-3
00870DIG   BD   SUBT-36,TST,01
00880      B    TEST-12,,0
00890      DORG*-3
00900      CF   SUBT+11,,0
00910      BNF  *+24,TST,01
00920      SF   SUBT+11,,0
00930SUBT  SM   TST,1,010
00940      BD   *+48,TST,01
00950      TD   TST,SUBST,01
00960      BNF  *+24,SUBT+11,01
00970      SF   TST,,0
00980      TD   TEST+11,TST,016
00990      TDM  TST-1,5,011
01000      CM   TEST+11,NINE+39,017
01010      BL   TEST-12,,0
01020OUT   NOP  *+32,,0
01030      TDM  OUT+1,9,0
01040      B    TEST-60,,0
01050      DORG*-3
01060      TDM  OUT+1,1,0
01070      BNF  CREC-12,CT,01
01080      CF   CT,,0
01090      B    START+48,,0
01100      DORG*-3
01110START WNPTPENUP,,0
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01120GO     BD   CREC-12,GO+23,01
01130       SF   CT,1,0
01140       TFM  GO+23,1,09
01150       TDM  SUBT+11,2,0
01160       TDM  SUBT+1,1,0
01170       TDM  SUBST,2,0
01180       B    TEST-24,,0
01190       DORG*-3
01200       TFM  CREC+11,INH,07
01210CREC   BNR  CHECK,,0
01220       M    CTR,ITCT,01
01230       TFM  CTR,0,08
01240       WNPTRTRN,,0
01250       SM   99,1,10
01260       BP   *-24,,0
01270       B    OUT99+12,,0
01280       DORG*-3
01290CHECK  TF   *+23,CREC+11,01
01300       TD   CPR,,0
01310       SM   *-1,1,010
01320       TD   CPR-1,*-13,0111
01330       CF   CPR,,0
01340       AM   CREC+11,2,07
01350       TDM  SETADD,2,0
01360       CM   CPR,0,010
01370       BE   SETADD-24,,0
01380       TFM  COMP1+11,41,010
01390       TFM  SETADD+11,TABLE,017
01400COMP1  CM   CPR,41,010
01410       BE   SETADD,,0
01420       AM   COMP1+11,01,010
01430       AM   SETADD+11,5,010
01440       CM   COMP1+11,80,010
01450       BNE  COMP1,,0
01460       CM   CPR,03,010
01470       TFM  SETADD+11,DEC,017
01480       BE   SETADD-12,,0
01490       CM   CPR,20,010
01500       TFM  SETADD+11,MINUS,017
01510       BE   SETADD-12,,0
01520       CM   CPR,10,010
01530       TFM  SETADD+11,PLUS,017
01540       BE   SETADD-12,,0
01550       CM   CPR,33,010
01560       TFM  SETADD+11,EQUAL,017
01570       BE   SETADD-12,,0
01580       CM   CPR,04,010
01590       TFM  SETADD+11,RPAREN,017
01600       BE   SETADD-12,,0
01610       CM   CPR,14,010
01620       TFM  SETADD+11,STAR,017
01630       BE   SETADD-12,,0
01640       CM   CPR,21,010
01650       TFM  SETADD+11,SLASH,017
01660       BE   SETADD-12,,0
01670       CM   CPR,13,010
            TFM  SETADD+11,POUND,017
01690       BE   SETADD-12,,0
01700       CM   CPR,23,010
01710       TFM  SETADD+11,COMMA,017
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01720       BE   SETADD-12,,0
01730       CM   CPR,24,010
01740       TFM  SETADD+11,LPAREN,017
01750       BE   SETADD-12,,0
            CM   CPR,34,010
            TFM  SETADD+11,PLSMNS,017
            BE   SETADD-12,,0
01760       TFM  SETADD+11,BLANK,017
01770       TDM  SETADD,1,0
01830       DSA  FIVE,SIX,SEVEN,EIGHT,NINE,
01780SETADDBT   WPL,,0
01790TABLE  DSA  A,B,C,D,E,F,G,H,I,BLANK
01800       DSA  J,K,L,M,N,O,P,Q,R,BLANK
01810       DSA  BLANK,S,T,U,V,W,X,Y,Z
01820       DSA  O,ONEQ,TWO,THREE,FOUR
01840       DS   5
01850WPL    TF   ITCTR,ITCT,01
01860       TD   WACC,WPL-1,0111
01870       BD   *+64,WACC,01
01880       BNF  *+32,WACC,01
01890       WNPTPENUP,,0
01900       B    JMP,,0
01910       DORG*-3
01920       WNPTPNDOWN,,0
01930       B    JMP,,0
01940       DORG*-3
01950       BNF  JMP-36,WACC,01
01960       TFM  SBTRR,1,010
01970       AM   WPL-1,1,010
01980       AM   SBTRR,1,010
01990       BNF  *-24,WPL-1,0111
02000       TF   WACC,WPL-1,0111
02010       TFM  *+30,WACC+1,017
02020       S    *+18,SBTRR,01
02030       WNPT
02040       SM   ITCTR,1,010
02050       BP   *-24,,0
02060       B    JMP,,0
02070       DORG*-3
02080       WNPTWACC,,0
02090       SM   ITCTR,1,010
02100       BP   *-24,,0
02110JMP    AM   WPL-1,1,010
02120       BNR  WPL,WPL-1,0111
02130       AM   CTR,1,010
02140       B    CREC,,0
02150PRTRVRCM   618,25,10
02160       BNE  DHH1,,0,
02170       TFM  GOWATY+18,PDTINH+2,07
02180       TFM  GOWATY+42,PWRITE+6,07
02190       TFM  NUMV1+6,PWRITE+6,07
02200       TFM  NUMV1+18,PLAST-5,07
02210       TFM  NUMV1+30,PWRITE+1,07
02220       TFM  GOSWC+6,PSWC,07
02230       TFM  OUT99+6,PCMPLT,07
02240       TFM  OUT99+18,PWRITE+1,07
02250       TFM  OUT99+23,45,010
02260       TFM  OUT99+30,PWRITE+6,07
02270       TFM  OUT99+35,WRITE1,07
02280       TFM  OUT99+42,PLAST-5,07
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02290       BD  DHH,7365,0,  TEST FOR 144 CHAR PRINTER
02300       TFM CREC-1,PINH,07,  120 POSITIONS
02310       AM  OUT99+35,4,010
02320       BD  DHH1,2461,0,
02330       B7  NOPRTR,,0,
02340DHH    BD  SHORT,2461,0, TEST FOR LONG FORM
02350       B7  NOPRTR,,0,
02360SHORT  TFM CREC-1,  XINH,07,  144 POSITIONS
02370DHH1   TFM CHAR+1,49,010,
02380       TFM CHAR+6,CHAR1,017,
02390NOPRTRTRA
02400       TCD PRTRVR,,0
02410       DORGPRTRVR
02420       DC  28,0
02430CPR    DC  2,0
02440CTR    DC  4,0
02450PENUP  DSC 2,9@
02460PNDOWNDSC 2,0@
02470A      DSC 39,330111111111233334555777777333333555555
02480       DC  4,033@
02490B      DSC 43,3301111133333455567777711111111113333345556
02500       DC  7,044455@
02510C      DSC 33,22233333055677778111111123333455
02520       DC  9,04455555@
02530D      DSC 33,330111111111133333455555555677777
02540       DC  10,033333333@
02550E      DSC 39,22222222110777777555553337775555533333
02560       DC  4,033@
02570F      DSC 33,2222222211077777755553337755555
02580       DC  10,033333333@
02590G      DSC 37,22222223011877776555555554333321117 75
02600       DC  6,04443@
02610H      DSC 37,330111111111155553333331111555555555
02620       DC  4,033@
02630I      DSC 31,330333337771111111111777333333
02640       DC  12,04455555555@
02650J      DSC 25,223075533333111111111733
02660       DC  12,04455555555@
02670K      DSC 33,330111111111155555522222666644444
02680       DC  4,033@
02690L      DSC 28,221111111105555555553333331
02700       DC  4,043@
02710M      DSC 13,3301111111111
02720       DC  5,-45454
02730       DC  5,-21212
02740       DSC 10,5555555555
02750       DC  4,033@
02760N      DSC 13,3301111111111
02770       DC  10,-4545445454
02780       DSC 10,1111111111
02790       DC  12,04455555555@
028000      DSC 31,320111111112333345555555677778
02810       DC  10,033333334@
02820P      DSC 27,330111111111133333455677777
02830       DC  10,044444433@
02840Q      DSC 42,32011111111233334555555556777784333328 8444
02850       DC  3,03@
02860R      DSC 34,330111111111133333455567777734444 4
02870       DC  4,033@
02880S      DSC 29,22054333321118777781112333345
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02890       DC  10,044555555@
02900T      DSC 35,221111111013333335177555555555733
02910       DC  6,03333@
02920U      DSC 35,221111111105555555543333211111111
02930       DC  12,04455555555@
02940V      DSC 11,22111111110
02950       DC  10,-5554554554
02960       DC  10,-2112112111
02970       DC  12,04455555555@
02980W      DSC 21,2211111111105555555555
02990       DC  5,-21212
03000       DC  5,-45454
03010       DSC 10,1111111111
03020       DC  12,04455555555@
03030X      DSC 3,330
03040       DC  10,-2121221212
03050       DC  5,-65656
03060       DC  5,-81818
03070       DC  10,-4545445454
03080       DC  4,033@
03090Y      DSC 10,3333301111
03100       DC  6,-818181
03110       DC  6,-545454
03120       DC  6,-212121
03130       DC  12,04455555555@
03140Z      DSC 17,22111111110333333
03150       DC  10,-6565665656
03160       DSC 6,333333
03170       DC  4,033@
03180RTRN   DSC 10,7777777777
03190       DC  1,@
03200BLANK  DSC 11,3333333333@
03210MINUS  DSC 12,221110333333
03220       DC  7,044555@
03230LPARENDSC 24,22222222110665555555544
03240       DC  4,032@
03250RPARENDSC 15,3402211111111188
03260       DC  13,044444444555@
03270COMMA  DSC 12,333402211753
03280       DC  6,04433@
      POUND DSC 35,33303333215677771111266212662111123
            DC  12,04444455555@
03310PLUS   DSC 24,221110333333777111555555
03320       DC  7,044333@
      PLSMNSDSC 33,2211103333337771115555557773333333
            DC  4,044@
03330SLASH  DSC 10,2022222222
03340       DC  11,0555555554@
03350STAR   DSC 28,22202222667773333333777884444
03360       DC  5,0444@
03370DEC    DSC 11,33332201753
03380       DC  6,04433@
03390       DC  8,0333333@
03400EQUAL  DSC 16,2222222330777777
03410       DC  12,055550333333
03420       DC  5,0455@
03430ONEQ   DSC 22,33303333771111111111166
03440       DC  10,044444445@
03450TWO    DSC 35,2211111101233334555677776555533333 3
03460       DC  4,033@
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03470THREE DSC 33,22054333321118777733321118777765
03480      DC  10,044444444@
03490FOUR  DSC 37,2211101111555533333377111115555555555
03500      DC  6,03333@
03510FIVE  DSC 29,230433332111187777711113333333
03520      DC  12,04455555555@
03530SIX   DSC 34,221102333345556777781111111233334
03540      DC  11,0445555555@
03550SEVEN DSC 17,22111111101333333
03560      DC  10,-6565656565
03570      DC  9,03333333@
03580EIGHT DSC 38,22211065554333321118777781112333345556
03590      DC  7,044455@
03600NINE  DSC 33,22054333321111111187777655543333 2
03610      DC  8,0445555@
03620CT    DS  1
03630SUBST DS  1
03640TST   DC  2,50
03650      DS  16
03660WACC  DSC 2,@
03670ITCTR DC  5,0
03680SBTRR DS  2
03690ERR1  DAC 38,CHARACTER SIZE SMALLER THAN 1/10 INCH@
03700ERR2  DAC 39,CHARACTER SIZE LARGER THAN 99.9 INCHES@
03710ITCT  DC  5,0
03720      DC  1,0
03730      DS  5
03740FAC   DS  ,2492
03750TOFAC DS  ,3408
03760FMFAC DS  ,3452
03770FIX   DS  ,3854
03780LAST  DS  ,5736
03790INH   DS  ,6063
03800WRITE DS  ,6632
03810COMPLTDS  ,6698
03820WAPT  DS  ,4306
03830DATINHDS  ,6057
03840SWC   DS  ,5982
03850IORT  DS  ,565
03860RCM   NOP
03870      DC  1,@,RCM
03880****** THE FOLLOWING ADDRESSES ARE FOR PRINTER VERSION
03890PDTINHDS  ,6173
03900PWRITEDS  ,6816
03910PLAST DS  ,5820
03920PSWC  DS  ,6090
03930PCMPLTDS  ,7006
03940WRITE1DS  ,6940
03950PINH  DS  ,6179
03960XINH  DS  ,7453
03970      DEND
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      SUBROUTINE JCCONT(B,CMIN,CINC,NUMC,M,N,XMIN,XINC,YMIN,YINC,XL,YL)
C     GIVEN AMATRIX B OF FUNCTION VALUES OVER A RECTANGULAR GRID WITHM
C    1ROWS AND N COLUMNS,CLCONT DRAWS NUMC CONTOURS STARTING AT CMIN
C    1AND CONTINUING AT INCREMENTS OF CINC. IT IS ASSUMED THAT THE
C    1PARAMETERS FOR PLOT HAVE ALREADY BEEN SET AND THAT THE ORIGIN OF
C     COORDINATES IS (XMIN,YMIN). THE VALUES OF XINC AND YINC CORRESPOND
C     TO THE ACTUAL DATA VALUES OF THE SIDES OF A CELL OF THE GRID.
C     CERTAIN INDETERMINATE CASES CAN OCCUR IN THIS VERSION.
C     ERROR INDICATIONS ARE PRINTED.
      DIMENSION B(50,50),H(4),D(5),R(4)
      X=XMIN-XINC
      CMINI=CMIN-CINC
      CALL PLOT (99)
      M1=M-1
      N1=N-1
      H(1)=YINC
      H(2)=XINC
      H(3)=YINC
      H(4)=XINC
      P2=0.0
      Q2=0.0
      YMAX=YMIN
      DO 200 I=1,M1
  200 YMAX=YMAX+YINC
      XMAX=XMIN
      DO 205 I=1,N1
  205 XMAX=XMAX+XINC
C
C     CALCULATE PARAMETER FOR KEY LEVEL PLOT POSITION
C
      S=(XMAX-XMIN)/XL*0.3
      S1=(YMAX-YMIN)/YL*0.3
      IT=0
      DO 5 I=1,N1
      X=X+XINC
      IF(IT)405,400,405
  400 IT=1
      Y=YMIN-YINC
      GO TO 410
  405 IT=0
      Y=YMAX
  410 DO 10 J=1,M1
C
C     SET VALUES AT GRID CELL VERTICES.
C     DIFFERENT ORDERING ON PROGRESSING UP OR DOWN COLUMN
C
      IF(IT)425,430,425
  425 D(1)=B(J,I)-CMINI
      D(2)=B(J+1,I)-CMINI
      D(3)=B(J+1,I+1)-CMINI
      D(4)=B(J,I+1)-CMINI
      D(5)=D(1)
      Y=Y+YINC
      GO TO 420
  430 JK=M1-J+1
      D(1)=B(JK,I)-CMINI
      D(2)=B(JK+1,I)-CMINI
      D(3)=B(JK+1,I+1)-CMINI
      D(4)=B(JK,I+1)-CMINI
      D(5)=D(1)
```

```
      Y=Y-YINC
  420 DO 15 K=1,NUMC
      KK=0
      D(1)=D(1)-CINC
      DO 21 II=1,4
      R(II)=99999.
      D(II+1)=D(II+1)-CINC
      E=D(II)
      F=D(II+1)
      IF(E*F)25,30,21
   25 R(II)=H(II)*E/(E-F)
      GO TO 20
   30 IF (E) 40,45,40
   45 IF(F)21,55,21
   55 PRINT 50,K,I,J,II
   50 FORMAT (1X,14HCONTOUR NUMBER,I3,11H AT POINT (,I3,1H,,I3,
     136H) HAS ZEROS AT BOTH ENDS OF BOUNDARY,I3)
   40 R(II)=H(II)
   20 KK=KK+1
   21 CONTINUE
      IF(KK-2) 60,65,70
   60 IF(KK)75,15,75
   75 PRINT 80,K,I,J
   80 FORMAT (1X,14HCONTOUR NUMBER,I3,11H AT POINT (,I3,1H,,I3,41H) HAS
     1ONLY ONE INTERSECTION WITH BOUNDARY)
      GO TO 15
   70 PRINT 71,K,I,J,KK
   71 FORMAT(1X,14HCONTOUR NUMBER,I3,11H AT POINT (,I3,1H,,I3,5H) HAS,I3
     1,28H INTERSECTIONS WITH BOUNDARY)
      IF(KK-4)15,85,15
   65 IF(R(1)-99998.)85,85,90
   85 P=X
      Q=Y+R(1)
      GO TO 105
   90 IF(R(2)-99998.)95,95,100
  95  P=X+R(2)
      Q=Y+YINC
      GO TO 115
  100 P=X+XINC
      Q=Y+YINC-R(3)
      GO TO 125
  105 IF(R(2)-99998.)110,110,115
  110 P1=X+R(2)
      Q1=Y+YINC
      GO TO 130
  115 IF(R(3)-99998.)120,120,125
  120 P1=X+XINC
      Q1=Y+YINC-R(3)
      GO TO 130
  125 P1=X+XINC-R(4)
      Q1=Y
C     PEN UP AND MOVE TO(P,Q). THEN PEN DOWN.
  130 E=(P-P2)*(P-P2)+(Q-Q2)*(Q-Q2)-(P1-P2)*(P1-P2)-(Q1-Q2)*(Q1-Q2)
      IF(E)131,131,132
  132 E=P
      P=P1
      P1=E
      E=Q
      Q=Q1
      Q1=E
```

```
  131 CALL PLOT(90,P,Q)
C     DRAW CONTOUR INCREMENT
      CALL PLOT(90,P1,Q1)
      CALL PLOT (99)
      P2=P1
      Q2=Q1
      L=0
C
C     DETERMINE MINIMUM PEN MOVEMENT
C
      IF(XMIN-P)220,225,220
  225 U=XMIN-S
      V=Q
      GO TO 300
  220 IF(XMIN-P1)230,235,230
  235 U=XMIN-S
      V=Q1
      GO TO 300
  230 IF(XMAX-P)240,245,240
  245 U=XMAX
      V=Q
      GO TO 300
  240 IF(XMAX-P1)250,255,250
  255 U=XMAX
      V=Q1
      GO TO 300
 250  L=1
      IF(YMIN-Q)260,265,260
  265 U=P
      V=YMIN-S1
      GO TO 300
  260 IF(YMIN-Q1)270,275,270
  275 U=P1
      V=YMIN-S1
      GO TO 300
  270 IF(YMAX-Q)280,285,280
  285 U=P
      V=YMAX
      GO TO 300
  280 IF(YMAX-Q1)290,295,290
  295 U=P1
      V=YMAX
 300  CALL PLOT(90,U,V)
      CALL CHAR(1,0.1,L,K)
  305 FORMAT(I2)
      CALL PLOT(99)
  290 KK=KK-2
      IF(KK-2)15,100,15
   15 CONTINUE
   10 CONTINUE
    5 CONTINUE
      RETURN
      END
```

SAMPLE PROBLEM

The data shown in Table 2 are for structure on top of the Lansing Group (Pennsylvanian) in south-central Kansas (Merriam and Lippert, 1966). Comparison of the computer-drawn map (Fig. 1a) to the hand-drawn map (Fig. 1b) from Lippert (1964) reveals remarkable similarity. The computer map is more generalized, which is to be expected. Preliminary results indicate, however, this method will give good approximation of regional structure and reveal some anomalous areas.

The first two cards with record marks in the first column are system control cards for the IBM 1620 monitor II. These cards are followed by a title card and a card specifying that 186 data points are to follow (Table 2). Each data card specifies the xyz coordinates at the relevant points. The card following the last data card is interpreted as follows:

1 specifies that plotting limits are to be minimum and maximum x- and y-values from preceding data,
10 specifies number of grid intervals to be drawn in x direction,
10 specifies number of grid intervals to be drawn in y direction,
12 specifies actual length of plot in y direction to be 12 inches,
50 specifies number of grid points to be calculated in x direction, and
50 specifies number of grid points to be calculated in y direction.

The integer 1 on the next card indicates that dimensions of the basic cell are to be read from the same card. These are both 2.5; therefore, the basic cell used in the linear-fit calculation is a square of side 5. These dimensions are chosen empirically as follows. Total area covered by the map is approximately 890 square units. Dividing this area by the total number of points, we obtain approximately 4.8; thus, on an average, 5 points will be covered by an area of 24 square units. The linear least-squares fit is made when at least five points lie inside the basic cell; therefore, sides of this cell are chosen to include an area of approximately 24 square units. The last number on this card specifies that error indicators will be plotted if the calculated value differs from the given value by more than 4 percent.

Table 2.- Structure on top of Lansing Group (Pennsylvanian) in south-central Kansas used as data for program.

```
#JOB
#XEQSJCLPF5
STRUCTURE - TOP OF LANSING. LINEAR FIT CONTOUR
186
```

1.800000	-25.500000	-2080.000000
30.500000	-.800000	-1167.000000
32.100000	-1.700000	-1146.000000
28.600000	-1.300000	-1260.000000
30.100000	-2.300000	-1199.000000
26.000000	-1.800000	-1305.000000
22.400000	-1.700000	-1360.000000
22.300000	-2.500000	-1406.000000
19.500000	-.300000	-1331.000000
18.000000	-2.000000	-1431.000000
12.900000	-1.000000	-1382.000000
13.300000	-2.000000	-1420.000000
10.900000	-2.000000	-1428.000000
11.400000	-.500000	-1390.000000
7.200000	-.100000	-1432.000000
8.600000	-3.000000	-1441.000000
3.300000	-1.000000	-1505.000000
3.900000	-2.400000	-1525.000000
.100000	-2.900000	-1583.000000
.200000	-.200000	-1507.000000
32.600000	-5.100000	-932.000000
32.700000	-3.800000	-1053.000000
30.000000	-4.000000	-1180.000000
28.200000	-4.800000	-1214.000000
25.900000	-4.900000	-1369.000000
21.500000	-5.200000	-1497.000000
22.800000	-3.500000	-1434.000000
20.200000	-3.300000	-1479.000000
20.800000	-4.000000	-1487.000000
17.900000	-4.700000	-1518.000000
15.700000	-4.500000	-1468.000000
14.800000	-5.600000	-1512.000000
13.200000	-4.200000	-1465.000000
11.900000	-4.000000	-1476.000000
9.200000	-5.100000	-1539.000000
8.400000	-3.500000	-1452.000000
6.200000	-5.200000	-1522.000000
4.000000	-5.400000	-1621.000000
4.900000	-4.200000	-1540.000000
1.500000	-4.900000	-1608.000000
33.100000	-6.000000	-1079.000000
.200000	-4.300000	-1633.000000
31.700000	-9.000000	-1205.000000
29.400000	-8.300000	-1176.000000
28.300000	-7.000000	-1223.000000
24.700000	-6.300000	-1437.000000
26.600000	-7.000000	-1383.000000
22.200000	-6.300000	-1486.000000
23.200000	-7.600000	-1510.000000
18.700000	-6.500000	-1572.000000
19.100000	-7.500000	-1522.000000
17.400000	-6.900000	-1613.000000

15.900000	-7.300000	-1607.000000
12.800000	-6.200000	-1511.000000
10.300000	-7.200000	-1564.000000
11.300000	-8.700000	-1602.000000
7.100000	-7.200000	-1616.000000
6.800000	-8.800000	-1668.000000
3.300000	-8.000000	-1666.000000
5.300000	-7.700000	-1594.000000
.600000	-7.600000	-1734.000000
2.100000	-8.900000	-1691.000000
31.900000	-10.000000	-1262.000000
33.000000	-10.500000	-1304.000000
27.900000	-11.000000	-1307.000000
28.700000	-9.500000	-1207.000000
26.500000	-10.000000	-1354.000000
24.900000	-11.800000	-1418.000000
23.100000	-9.500000	-1544.000000
21.800000	-10.200000	-1595.000000
19.900000	-9.700000	-1603.000000
16.000000	-10.000000	-1695.000000
17.700000	-11.500000	-1684.000000
14.800000	-9.500000	-1674.000000
12.800000	-10.600000	-1700.000000
11.700000	-10.000000	-1668.000000
9.500000	-11.000000	-1702.000000
6.700000	-9.900000	-1680.000000
6.800000	-11.500000	-1739.000000
3.500000	-11.400000	-1755.000000
5.800000	-11.200000	-1739.000000
.400000	-9.100000	-1747.000000
3.000000	-10.500000	-1756.000000
32.900000	-12.400000	-1348.000000
30.900000	-14.900000	-1406.000000
28.300000	-13.800000	-1447.000000
26.600000	-12.100000	-1381.000000
26.500000	-14.000000	-1439.000000
23.700000	-14.700000	-1555.000000
19.500000	-13.000000	-1662.000000
20.500000	-14.100000	-1677.000000
15.600000	-13.100000	-1776.000000
18.000000	-14.200000	-1700.000000
14.000000	-13.200000	-1759.000000
15.000000	-14.800000	-1796.000000
12.300000	-12.200000	-1735.000000
10.000000	-14.600000	-1800.000000
8.800000	-12.800000	-1758.000000
7.600000	-14.700000	-1750.000000
4.600000	-14.600000	-1828.000000
6.300000	-14.200000	-1787.000000
1.400000	-15.000000	-1893.000000
1.200000	-12.500000	-1804.000000
32.200000	-15.500000	-1399.000000
33.000000	-17.500000	-1433.000000
28.900000	-17.000000	-1511.000000
30.500000	-17.700000	-1367.000000
26.200000	-17.000000	-1549.000000
26.200000	-17.700000	-1583.000000
22.500000	-17.000000	-1638.000000
23.200000	-15.500000	-1580.000000
18.900000	-16.400000	-1714.000000

21.200000	-15.300000	-1681.000000
15.700000	-17.500000	-1773.000000
16.200000	-16.000000	-1704.000000
14.200000	-15.300000	-1793.000000
13.000000	-17.000000	-1727.000000
10.200000	-17.100000	-1867.000000
9.000000	-15.500000	-1828.000000
7.100000	-16.300000	-1847.000000
6.100000	-17.800000	-1879.000000
5.000000	-17.000000	-1902.000000
.600000	-17.200000	-1963.000000
1.000000	-15.500000	-1906.000000
30.800000	-19.800000	-1642.000000
33.200000	-18.200000	-1499.000000
29.800000	-18.500000	-1510.000000
27.900000	-20.200000	-1656.000000
25.000000	-18.500000	-1614.000000
24.900000	-19.900000	-1670.000000
23.200000	-20.100000	-1675.000000
24.200000	-18.500000	-1632.000000
18.900000	-18.700000	-1770.000000
21.500000	-19.600000	-1729.000000
15.500000	-20.200000	-1876.000000
16.500000	-18.000000	-1792.000000
14.200000	-18.800000	-1845.000000
15.000000	-20.500000	-1916.000000
11.300000	-18.900000	-1811.000000
11.300000	-20.700000	-1897.000000
7.300000	-19.800000	-1915.000000
7.700000	-20.800000	-1894.000000
5.000000	-19.000000	-1932.000000
5.500000	-19.500000	-1947.000000
3.500000	-20.000000	-1949.000000
.600000	-18.000000	-1956.000000
32.800000	-23.000000	-1655.000000
27.700000	-23.400000	-1800.000000
29.200000	-21.500000	-1755.000000
26.000000	-22.500000	-1737.000000
27.200000	-23.000000	-1789.000000
24.000000	-22.000000	-1751.000000
2.200000	-22.500000	-1792.000000
19.000000	-23.300000	-1887.000000
16.000000	-23.500000	-1921.000000
17.400000	-22.300000	-1880.000000
14.300000	-23.000000	-1985.000000
12.900000	-23.300000	-1918.000000
10.500000	-21.500000	-1948.000000
11.300000	-23.300000	-2033.000000
7.500000	-22.700000	-1991.000000
4.200000	-21.700000	-2107.000000
6.200000	-23.000000	-1999.000000
2.500000	-23.000000	-2014.000000
1.500000	-21.000000	-1992.000000
32.600000	-24.500000	-1617.000000
31.800000	-26.000000	-1710.000000
28.500000	-24.000000	-1728.000000
29.000000	-25.700000	-1871.000000
25.600000	-24.000000	-1769.000000
27.000000	-24.500000	-1792.000000
21.500000	-26.000000	-1878.000000

```
 23.000000     -25.000000    -1823.000000
 19.300000     -26.100000    -1909.000000
 21.200000     -25.400000    -1858.000000
 17.900000     -26.800000    -1969.000000
 15.800000     -25.900000    -1971.000000
 13.100000     -26.500000    -2058.000000
 14.200000     -25.300000    -2019.000000
 11.000000     -24.500000    -2045.000000
 12.500000     -26.500000    -2092.000000
  7.400000     -26.100000    -2076.000000
  8.500000     -24.800000    -2026.000000
  5.200000     -25.200000    -2082.000000
  5.700000     -27.000000    -2071.000000
  1.800000     -24.300000    -2038.000000


1 10 10 12 50 50
1   2.5           2.5          004
 -2100.0       +100.0           11
STRUCTURE - TOP OF LANSING. LINEAR FIT CONTOUR
# # # #
```

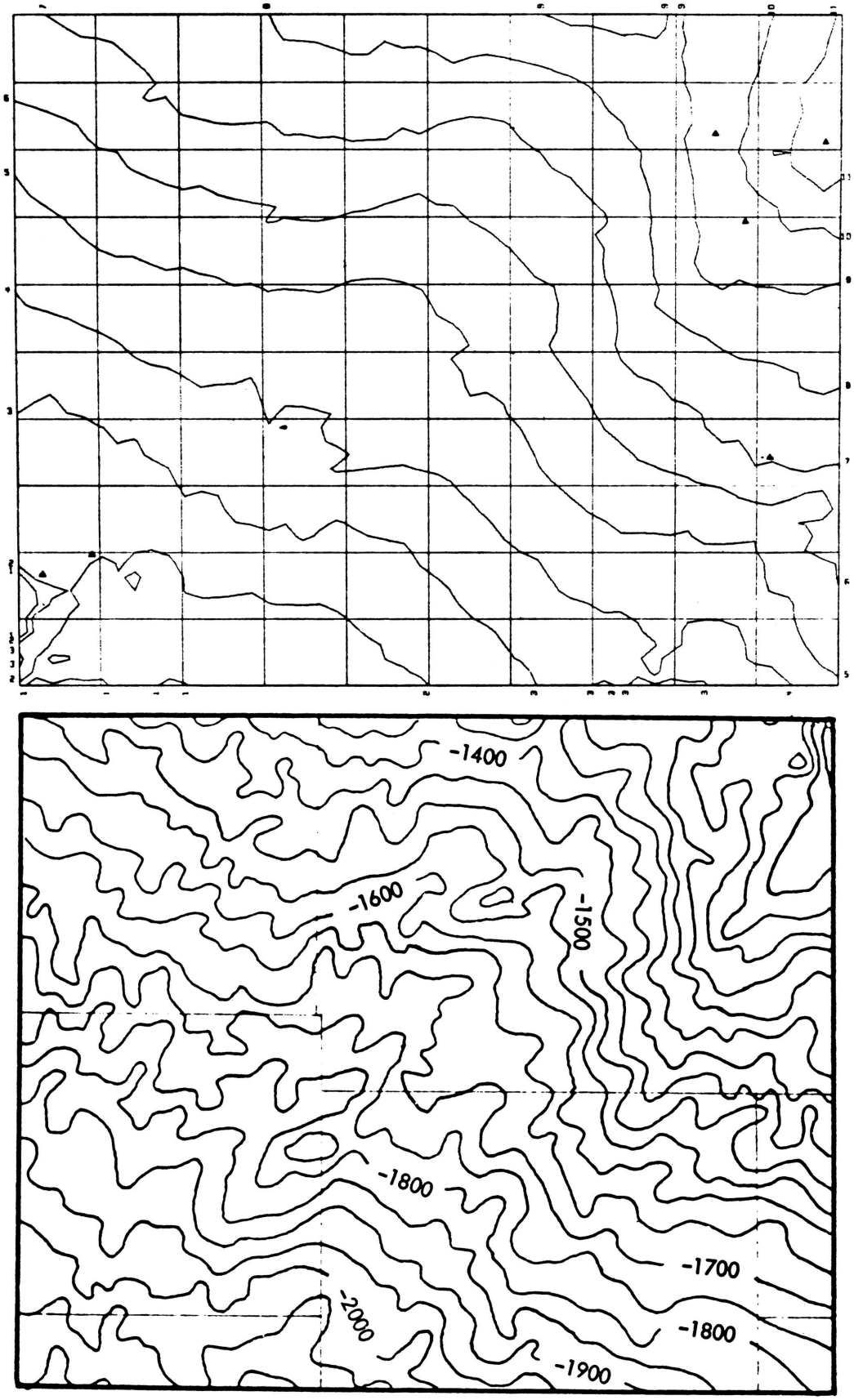

Figure 1.- Computer drawn map (A) as compared with hand-drawn map (B).

The next card indicates that contours will be plotted starting at -2100 sea level at an interval of 100 feet with a total of 11 contours. This card is followed by a title to be printed with the contour map. In general it will be the same as the previous title, but not necessarily. The final card contains four record marks and is a 1620 monitor II end of job card.

Output for this problem is shown in Figure 1 and Table 3. The title heads the first sheet and is followed by the regional, linear-fit equation and corresponding regional plane and quadratic percentage fits. These may be compared with the progressive linear fit which follows. Optional output (switch 1 on) can follow this (see Table 4), but needs to be used only on rare occasions to help choose basic cell dimensions.

The next section contains the original xyz data followed by the calculated z value, the residual being the difference between given and calculated z values and the ratio of z calculated to z expressed as a percentage. If this value differs from 100 by more than 4, an asterisk is printed on the corresponding row (4 is the value read in previously).

Next is an indication that all 186 data points have been used. This number of data points used is printed with each run, unless the plotting area is smaller than the actual area. The progressive percentage fit and the sum of squares of residuals follow.

Finally, plotting parameters and the contour key are given. Figure 1 shows the contoured map. Data points at which the percentage error is more than 4 are indicated by triangles with a dot in the middle.

Table 3.- Output for data shown in Table 2.

```
JCLPF5  11500 30634 LOADED
JCKU11  42134 00390 LOADED
JC101   42524 03304 LOADED
PLOT    45828 03128 LOADED
POINT   48956 01822 LOADED
16      50778 00058 LOADED
05      50836 01530 LOADED



STRUCTURE - TOP OF LANSING. LINEAR FIT CONTOUR
GLOBAL PLANE FIT Z=     -1561.40370 +       14.29424 X +      23.92464 Y


PLANE PERCENTAGE FIT IS    91.955


QUADRATIC PERCENTAGE FIT IS    94.670
```

X	Y	Z	ZCALC	RESIDUAL	PERCENTAGE	
5.700	-27.000	-2071.000	-2087.577	16.577	100.800	
17.900	-26.800	-1969.000	-1962.023	-6.976	99.645	
13.100	-26.500	-2058.000	-2064.483	6.483	100.315	
12.500	-26.500	-2092.000	-2062.771	-29.228	98.602	
19.300	-26.100	-1909.000	-1919.162	10.162	100.532	
7.400	-26.100	-2076.000	-2062.791	-13.208	99.363	
31.800	-26.000	-1710.000	-1728.623	18.623	101.089	
21.500	-26.000	-1878.000	-1867.764	-10.235	99.454	
15.800	-25.900	-1971.000	-1988.691	17.691	100.897	
29.000	-25.700	-1871.000	-1818.000	-52.999	97.167	
1.800	-25.500	-2080.000	-2102.660	22.660	101.089	
21.200	-25.400	-1858.000	-1866.761	8.761	100.471	
14.200	-25.300	-2019.000	-2007.176	-11.823	99.414	
5.200	-25.200	-2082.000	-2056.177	-25.822	98.759	
23.000	-25.000	-1823.000	-1829.915	6.915	100.379	
8.500	-24.800	-2026.000	-2048.121	22.121	101.091	
32.600	-24.500	-1617.000	-1651.414	34.414	102.128	
27.000	-24.500	-1792.000	-1800.740	8.740	100.487	
11.000	-24.500	-2045.000	-2024.614	-20.385	99.003	
1.800	-24.300	-2038.000	-1995.542	-42.457	97.916	
28.500	-24.000	-1728.000	-1787.285	59.285	103.430	
25.600	-24.000	-1769.000	-1772.836	3.836	100.216	
16.000	-23.500	-1921.000	-1934.546	13.546	100.705	
27.700	-23.400	-1800.000	-1768.097	-31.902	98.227	
19.000	-23.300	-1887.000	-1876.328	-10.671	99.434	
12.900	-23.300	-1918.000	-1976.523	58.523	103.051	
11.300	-23.300	-2033.000	-1998.347	-34.652	98.295	
32.800	-23.000	-1655.000	-1610.427	-44.572	97.306	
27.200	-23.000	-1789.000	-1766.124	-22.875	98.721	
14.300	-23.000	-1985.000	-1948.132	-36.868	98.142	
6.200	-23.000	-1999.000	-2028.515	29.515	101.476	
2.500	-23.000	-2014.000	-2003.525	-10.474	99.479	
7.500	-22.700	-1991.000	-1987.931	-3.068	99.845	
26.000	-22.500	-1737.000	-1748.239	11.239	100.647	
2.200	-22.500	-1792.000	-1976.232	184.232	110.280	*
17.400	-22.300	-1880.000	-1889.756	9.756	100.518	
24.000	-22.000	-1751.000	-1745.598	-5.401	99.691	
4.200	-21.700	-2107.000	-1974.786	-132.213	93.725	*
29.200	-21.500	-1755.000	-1708.883	-46.116	97.372	
10.500	-21.500	-1948.000	-1927.288	-20.711	98.936	
1.500	-21.000	-1992.000	-1931.239	-60.760	96.949	
7.700	-20.800	-1894.000	-1918.220	24.220	101.278	
11.300	-20.700	-1897.000	-1890.376	-6.623	99.650	
15.000	-20.500	-1916.000	-1894.658	-21.341	98.886	
27.900	-20.200	-1656.000	-1644.340	-11.659	99.295	
15.500	-20.200	-1876.000	-1874.344	-1.655	99.911	
23.200	-20.100	-1675.000	-1701.446	26.446	101.578	
3.500	-20.000	-1949.000	-1959.215	10.215	100.524	
24.900	-19.900	-1670.000	-1669.419	-.580	99.965	
30.800	-19.800	-1642.000	-1613.827	-28.172	98.284	
7.300	-19.800	-1915.000	-1925.990	10.990	100.573	
21.500	-19.600	-1729.000	-1730.899	1.899	100.109	
5.500	-19.500	-1947.000	-1943.920	-3.079	99.841	
5.000	-19.000	-1932.000	-1927.608	-4.391	99.772	
11.300	-18.900	-1811.000	-1854.634	43.634	102.409	
14.200	-18.800	-1845.000	-1826.356	-18.643	98.989	
18.900	-18.700	-1770.000	-1763.094	-6.905	99.609	
29.800	-18.500	-1510.000	-1522.406	12.406	100.821	
25.000	-18.500	-1614.000	-1616.548	2.548	100.157	

24.200	-18.500	-1632.000	-1633.886	1.886	100.115	
33.200	-18.200	-1499.000	-1512.932	13.932	100.929	
16.500	-18.000	-1792.000	-1785.215	-6.784	99.621	
.600	-18.000	-1956.000	-1960.835	4.835	100.247	
6.100	-17.800	-1879.000	-1893.100	14.100	100.750	
30.500	-17.700	-1367.000	-1485.892	118.892	108.697	*
26.200	-17.700	-1583.000	-1576.235	-6.764	99.572	
33.000	-17.500	-1433.000	-1465.392	32.392	102.260	
15.700	-17.500	-1773.000	-1779.699	6.699	100.377	
.600	-17.200	-1963.000	-1950.090	-12.909	99.342	
10.200	-17.100	-1867.000	-1813.874	-53.125	97.154	
28.900	-17.000	-1511.000	-1500.921	-10.078	99.332	
26.200	-17.000	-1549.000	-1551.966	2.966	100.191	
22.500	-17.000	-1638.000	-1648.827	10.827	100.661	
13.000	-17.000	-1727.000	-1784.626	57.626	103.336	
5.000	-17.000	-1902.000	-1897.938	-4.062	99.786	
18.900	-16.400	-1714.000	-1725.403	11.403	100.665	
7.100	-16.300	-1847.000	-1841.883	-5.116	99.722	
16.200	-16.000	-1704.000	-1754.031	50.031	102.936	
32.200	-15.500	-1399.000	-1406.500	7.500	100.536	
23.200	-15.500	-1580.000	-1595.128	15.128	100.957	
9.000	-15.500	-1828.000	-1815.340	-12.660	99.307	
1.000	-15.500	-1906.000	-1900.485	-5.514	99.710	
21.200	-15.300	-1681.000	-1654.142	-26.857	98.402	
14.200	-15.300	-1793.000	-1761.901	-31.098	98.265	
1.400	-15.000	-1893.000	-1891.605	-1.394	99.926	
30.900	-14.900	-1406.000	-1412.575	6.575	100.467	
15.000	-14.800	-1796.000	-1758.210	-37.789	97.895	
23.700	-14.700	-1555.000	-1554.758	-.242	99.984	
7.600	-14.700	-1750.000	-1793.787	43.787	102.502	
10.000	-14.600	-1800.000	-1779.799	-20.200	98.877	
4.600	-14.600	-1828.000	-1831.906	3.906	100.213	
18.000	-14.200	-1700.000	-1705.885	5.885	100.346	
6.300	-14.200	-1787.000	-1801.936	14.936	100.835	
20.500	-14.100	-1677.000	-1672.473	-4.526	99.730	
26.500	-14.000	-1439.000	-1468.730	29.730	102.066	
28.300	-13.800	-1447.000	-1418.108	-28.891	98.003	
14.000	-13.200	-1759.000	-1763.217	4.217	100.239	
15.600	-13.100	-1776.000	-1748.604	-27.395	98.457	
19.500	-13.000	-1662.000	-1669.014	7.014	100.422	
8.800	-12.800	-1758.000	-1749.278	-8.721	99.503	
1.200	-12.500	-1804.000	-1812.576	8.576	100.475	
32.900	-12.400	-1348.000	-1341.197	-6.802	99.495	
12.300	-12.200	-1735.000	-1735.293	.293	100.016	
26.600	-12.100	-1381.000	-1393.981	12.981	100.939	
24.900	-11.800	-1418.000	-1465.025	47.025	103.316	
17.700	-11.500	-1684.000	-1687.050	3.050	100.181	
6.800	-11.500	-1739.000	-1729.704	-9.295	99.465	
3.500	-11.400	-1755.000	-1759.781	4.781	100.272	
5.800	-11.200	-1739.000	-1735.664	-3.335	99.808	
27.900	-11.000	-1307.000	-1315.488	8.488	100.649	
9.500	-11.000	-1702.000	-1706.662	4.662	100.273	
12.800	-10.600	-1700.000	-1692.685	-7.314	99.569	
3.000	-10.500	-1756.000	-1739.695	-16.305	99.071	
33.000	-10.500	-1304.000	-1288.405	-15.594	98.804	
21.800	-10.200	-1595.000	-1584.516	-10.483	99.342	
16.000	-10.000	-1695.000	-1682.858	-12.141	99.283	
26.500	-10.000	-1354.000	-1331.383	-22.616	98.329	

11.700	-10.000	-1668.000	-1663.015	-4.984	99.701	
31.900	-10.000	-1262.000	-1259.473	-2.527	99.799	
6.700	-9.900	-1680.000	-1690.668	10.668	100.635	
19.900	-9.700	-1603.000	-1605.630	2.630	100.164	
14.800	-9.500	-1674.000	-1672.290	-1.709	99.897	
23.100	-9.500	-1544.000	-1508.305	-35.694	97.688	
28.700	-9.500	-1207.000	-1221.030	14.030	101.162	
.400	-9.100	-1747.000	-1749.307	2.307	100.132	
31.700	-9.000	-1205.000	-1216.949	11.949	100.991	
2.100	-8.900	-1691.000	-1716.807	25.807	101.526	
6.800	-8.800	-1668.000	-1661.257	-6.742	99.595	
11.300	-8.700	-1602.000	-1616.715	14.715	100.918	
29.400	-8.300	-1176.000	-1245.820	69.820	105.937	*
3.300	-8.000	-1666.000	-1666.330	.330	100.019	
5.300	-7.700	-1594.000	-1640.730	46.730	102.931	
23.200	-7.600	-1510.000	-1501.360	-8.640	99.427	
.600	-7.600	-1734.000	-1709.742	-24.257	98.601	
19.100	-7.500	-1522.000	-1571.275	49.275	103.237	
15.900	-7.300	-1607.000	-1595.811	-11.188	99.303	
7.100	-7.200	-1616.000	-1606.385	-9.614	99.405	
10.300	-7.200	-1564.000	-1579.672	15.672	101.002	
26.600	-7.000	-1383.000	-1339.710	-43.289	96.869	
28.300	-7.000	-1223.000	-1232.744	9.744	100.796	
17.400	-6.900	-1613.000	-1573.706	-39.293	97.563	
18.700	-6.500	-1572.000	-1553.874	-18.125	98.846	
24.700	-6.300	-1437.000	-1430.504	-6.495	99.547	
22.200	-6.300	-1486.000	-1499.395	13.395	100.901	
12.800	-6.200	-1511.000	-1533.691	22.691	101.501	
33.100	-6.000	-1079.000	-1059.581	-19.418	98.200	
14.800	-5.600	-1512.000	-1520.782	8.782	100.580	
4.000	-5.400	-1621.000	-1605.338	-15.661	99.033	
6.200	-5.200	-1522.000	-1555.376	33.376	102.192	
21.500	-5.200	-1497.000	-1488.724	-8.275	99.447	
9.200	-5.100	-1539.000	-1512.628	-26.371	98.286	
32.600	-5.100	-932.000	-1036.870	104.870	111.252	*
25.900	-4.900	-1369.000	-1336.909	-32.090	97.655	
1.500	-4.900	-1608.000	-1626.688	18.688	101.162	
28.200	-4.800	-1214.000	-1262.668	48.668	104.008	*
17.900	-4.700	-1518.000	-1517.514	-.485	99.968	
15.700	-4.500	-1468.000	-1497.886	29.886	102.035	
.200	-4.300	-1633.000	-1628.104	-4.895	99.700	
13.200	-4.200	-1465.000	-1473.358	8.358	100.570	
4.900	-4.200	-1540.000	-1542.870	2.870	100.186	
20.800	-4.000	-1487.000	-1481.374	-5.625	99.621	
30.000	-4.000	-1180.000	-1163.458	-16.541	98.598	
11.900	-4.000	-1476.000	-1475.777	-.223	99.984	
32.700	-3.800	-1053.000	-1061.280	8.280	100.786	
8.400	-3.500	-1452.000	-1463.564	11.564	100.796	
22.800	-3.500	-1434.000	-1425.298	-8.701	99.393	
20.200	-3.300	-1479.000	-1456.782	-22.218	98.497	
8.600	-3.000	-1441.000	-1466.231	25.231	101.750	
.100	-2.900	-1583.000	-1582.927	-.073	99.995	
22.300	-2.500	-1406.000	-1400.691	-5.308	99.622	
3.900	-2.400	-1525.000	-1528.199	3.199	100.209	
30.100	-2.300	-1199.000	-1194.412	-4.587	99.617	
13.300	-2.000	-1420.000	-1411.061	-8.938	99.370	
10.900	-2.000	-1428.000	-1422.017	-5.982	99.581	
18.000	-2.000	-1431.000	-1402.919	-28.080	98.037	

26.000	-1.800	-1305.000	-1308.612	3.612	100.276
32.100	-1.700	-1146.000	-1117.742	-28.257	97.534
22.400	-1.700	-1360.000	-1365.101	5.101	100.375
28.600	-1.300	-1260.000	-1240.150	-19.849	98.424
3.300	-1.000	-1505.000	-1501.574	-3.425	99.772
12.900	-1.000	-1382.000	-1389.317	7.317	100.529
30.500	-.800	-1167.000	-1191.642	24.642	102.111
11.400	-.500	-1390.000	-1385.317	-4.682	99.663
19.500	-.300	-1331.000	-1333.871	2.871	100.215
.200	-.200	-1507.000	-1517.994	10.994	100.729
7.200	-.100	-1432.000	-1447.334	15.334	101.070

ORIGINAL NUMBER OF DATA POINTS IS 186 NUMBER OF DATA POINTS USED IS 186

PROGRESSIVE PERCENTAGE FIT IS 96.341

SUM OF SQUARES OF RESIDUALS IS 167225.7800

```
JCLPF2 11500 28536 LOADED
PLOT   40036 03128 LOADED
CHAR   43164 04336 LOADED
JCCONT 47500 06716 LOADED
05     54216 01530 LOADED
03     55746 00474 LOADED
```

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 CONTOUR MAP PARAMETERS

MINIMUM X-VALUE IS          .100000      MAXIMUM X-VALUE IS       33.200000

MINIMUM Y-VALUE IS       -27.000000      MAXIMUM Y-VALUE IS         -.100000

MINIMUM CONTOUR VALUE IS   -2100.000000      CONTOUR INTERVAL IS      100.000000
NUMBER OF CONTOUR LEVELS IS     11
BASIC CELL DIMENSIONS ARE            .6755      AND            .5489

NUMBER OF GRID ROWS      50      NUMBER OF GRID COLUMNS      50

BASIC LINEAR FIT AREA DIMENSIONS ARE          5.0000     AND          5.0000

X-SCALE FACTOR IS        2.241       Y-SCALE FACTOR IS        2.241


PERCENTAGE ERROR INDICATORS PLOTTED AT          4.0000      PERCENT LEVEL


KEY TO CONTOUR LEVELS

   1=  -2100.0000
   2=  -2000.0000
   3=  -1900.0000
   4=  -1800.0000
   5=  -1700.0000
   6=  -1600.0000
   7=  -1500.0000
   8=  -1400.0000
   9=  -1300.0000
  10=  -1200.0000
  11=  -1100.0000
CONTOUR NUMBER  2 AT POINT (  7,  9) HAS  4 INTERSECTIONS WITH BOUNDARY
CONTOUR NUMBER  7 AT POINT (  9, 44) HAS  4 INTERSECTIONS WITH BOUNDARY
CONTOUR NUMBER  6 AT POINT ( 16, 15) HAS  4 INTERSECTIONS WITH BOUNDARY
CONTOUR NUMBER  4 AT POINT ( 16, 30) HAS  4 INTERSECTIONS WITH BOUNDARY
CONTOUR NUMBER  4 AT POINT ( 39,  3) HAS  4 INTERSECTIONS WITH BOUNDARY
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Table 4.- Optional output.

STRUCTURE - TOP OF LANSING. LINEAR FIT CONTOUR

GLOBAL PLANE FIT Z= -1506.00170 + 12.96972 X + 25.81690 Y

PERCENTAGE FIT IS 75.997

X	Y	ZLIN	NO OF PTS	Z GLO	EXPANSION	PERCENT
0.000	-27.000	-1870.012	7	-2203.058	5	84.882
.677	-27.000	-1981.460	8	-2194.270	5	90.301
1.355	-27.000	-2079.022	6	-2185.482	4	95.128
2.032	-27.000	-2087.141	6	-2176.695	4	95.885
2.710	-27.000	-2083.226	8	-2167.907	4	96.093
3.387	-27.000	-2090.480	8	-2159.119	4	96.820
4.065	-27.000	-2097.070	9	-2150.332	4	97.523
4.742	-27.000	-2086.273	5	-2141.544	3	97.419
5.420	-27.000	-2084.617	5	-2132.757	3	97.742
6.097	-27.000	-2109.575	9	-2123.969	4	99.322
6.775	-27.000	-2101.906	10	-2115.181	4	99.372
7.453	-27.000	-2067.397	6	-2106.394	3	98.148
8.130	-27.000	-2065.165	5	-2097.606	2	98.453
8.808	-27.000	-2092.480	7	-2088.818	3	100.175
9.485	-27.000	-2094.431	8	-2080.031	3	100.692
10.163	-27.000	-2094.207	5	-2071.243	2	101.108
10.840	-27.000	-2099.891	8	-2062.455	3	101.815
11.518	-27.000	-2091.714	5	-2053.668	2	101.852
12.195	-27.000	-2088.524	9	-2044.880	3	102.134
12.873	-27.000	-2088.655	5	-2036.092	2	102.581
13.551	-27.000	-2072.246	5	-2027.305	2	102.216
14.228	-27.000	-2061.075	9	-2018.517	3	102.108
14.906	-27.000	-2043.687	5	-2009.729	2	101.689
15.583	-27.000	-2027.163	5	-2000.942	2	101.310
16.261	-27.000	-2016.501	9	-1992.154	3	101.222
16.938	-27.000	-1986.800	7	-1983.367	3	100.173
17.616	-27.000	-1971.845	8	-1974.579	3	99.861
18.293	-27.000	-1952.480	7	-1965.791	3	99.322
18.971	-27.000	-1940.092	7	-1957.004	3	99.135
19.648	-27.000	-1927.183	8	-1948.216	3	98.920
20.326	-27.000	-1941.694	5	-1939.428	2	100.116
21.004	-27.000	-1932.362	5	-1930.641	2	100.089
21.681	-27.000	-1880.110	6	-1921.853	3	97.827
22.359	-27.000	-1859.665	6	-1913.065	3	97.208
23.036	-27.000	-1884.975	5	-1904.278	3	98.986
23.714	-27.000	-1928.788	5	-1895.490	3	101.756
24.391	-27.000	-1879.732	6	-1886.702	3	99.630
25.069	-27.000	-1828.951	7	-1877.915	3	97.392
25.746	-27.000	-1916.727	6	-1869.127	3	102.546
26.424	-27.000	-1916.489	6	-1860.339	3	103.018
27.102	-27.000	-1906.619	5	-1851.552	3	102.974
27.779	-27.000	-1907.126	5	-1842.764	3	103.492
28.457	-27.000	-1861.333	6	-1833.976	3	101.491
29.134	-27.000	-1867.083	7	-1825.189	3	102.295
29.812	-27.000	-1890.875	5	-1816.401	2	104.100
30.489	-27.000	-1828.494	6	-1807.614	3	101.155
31.167	-27.000	-1814.246	5	-1798.826	3	100.857
31.844	-27.000	-1744.027	8	-1790.038	4	97.429
32.522	-27.000	-1723.374	6	-1781.251	4	96.750
33.199	-27.000	-1706.563	5	-1772.463	4	96.282

0.000	-26.448	-1872.578	7	-2188.832	5	85.551
.677	-26.448	-1926.232	5	-2180.044	4	88.357
1.355	-26.448	-1988.834	7	-2171.257	4	91.598
2.032	-26.448	-2005.083	7	-2162.469	4	92.721
2.710	-26.448	-2083.206	5	-2153.681	3	96.727
3.387	-26.448	-2082.381	5	-2144.894	3	97.085
4.065	-26.448	-2085.666	7	-2136.106	3	97.638
4.742	-26.448	-2083.777	8	-2127.319	3	97.953
5.420	-26.448	-2081.350	8	-2118.531	3	98.244
6.097	-26.448	-2079.117	7	-2109.743	3	98.548
6.775	-26.448	-2074.484	6	-2100.956	3	98.740
7.453	-26.448	-2080.037	8	-2092.168	3	99.420
8.130	-26.448	-2063.117	5	-2083.380	2	99.027
8.808	-26.448	-2086.558	9	-2074.593	3	100.576
9.485	-26.448	-2078.182	10	-2065.805	3	100.599
10.163	-26.448	-2081.303	5	-2057.017	2	101.180
10.840	-26.448	-2079.763	10	-2048.230	3	101.539
11.518	-26.448	-2077.180	5	-2039.442	2	101.850
12.195	-26.448	-2066.218	10	-2030.654	3	101.751
12.873	-26.448	-2071.622	5	-2021.867	2	102.460
13.551	-26.448	-2053.187	6	-2013.079	2	101.992
14.228	-26.448	-2030.950	5	-2004.291	2	101.330
14.906	-26.448	-2026.547	6	-1995.504	2	101.555
15.583	-26.448	-2010.297	6	-1986.716	2	101.186
16.261	-26.448	-1993.167	5	-1977.929	2	100.770
16.938	-26.448	-1977.137	5	-1969.141	2	100.406
17.616	-26.448	-1960.877	9	-1960.353	3	100.026
18.293	-26.448	-1943.873	5	-1951.566	2	99.605
18.971	-26.448	-1935.161	5	-1942.778	2	99.607
19.648	-26.448	-1918.117	8	-1933.990	3	99.179
20.326	-26.448	-1918.055	5	-1925.203	2	99.628
21.004	-26.448	-1908.804	5	-1916.415	2	99.602
21.681	-26.448	-1872.379	6	-1907.627	3	98.152
22.359	-26.448	-1855.301	6	-1898.840	3	97.707
23.036	-26.448	-1869.945	5	-1890.052	3	98.936
23.714	-26.448	-1851.090	6	-1881.264	3	98.396
24.391	-26.448	-1846.913	7	-1872.477	3	98.634
25.069	-26.448	-1806.123	8	-1863.689	3	96.911
25.746	-26.448	-1764.835	5	-1854.901	2	95.144
26.424	-26.448	-1882.270	5	-1846.114	2	101.958
27.102	-26.448	-1883.432	5	-1837.326	2	102.509
27.779	-26.448	-1884.020	5	-1828.539	2	103.034
28.457	-26.448	-1884.035	5	-1819.751	2	103.532
29.134	-26.448	-1853.908	5	-1810.963	2	102.371
29.812	-26.448	-1828.702	6	-1802.176	2	101.471
30.489	-26.448	-1817.398	5	-1793.388	2	101.338
31.167	-26.448	-1758.666	6	-1784.600	3	98.546
31.844	-26.448	-1739.085	5	-1775.813	3	97.931
32.522	-26.448	-1709.689	6	-1767.025	4	96.755
33.199	-26.448	-1691.598	5	-1758.237	4	96.209
0.000	-25.897	-1925.881	8	-2174.606	5	88.562
.677	-25.897	-1919.425	5	-2165.819	4	88.623
1.355	-25.897	-1982.312	7	-2157.031	4	91.900
2.032	-25.897	-2106.235	5	-2148.244	3	98.044
2.710	-25.897	-2054.170	6	-2139.456	3	96.013
3.387	-25.897	-2072.032	5	-2130.668	2	97.247
4.065	-25.897	-2070.714	5	-2121.881	2	97.588
4.742	-25.897	-2072.201	6	-2113.093	2	98.064
5.420	-25.897	-2071.129	6	-2104.305	2	98.423

6.097	-25.897	-2068.652	5	-2095.518	2	98.717
6.775	-25.897	-2063.831	5	-2086.730	2	98.902
7.453	-25.897	-2058.436	5	-2077.942	2	99.061
8.130	-25.897	-2066.742	6	-2069.155	2	99.883
8.808	-25.897	-2067.402	6	-2060.367	2	100.341
9.485	-25.897	-2072.233	5	-2051.579	2	101.006
10.163	-25.897	-2070.592	7	-2042.792	2	101.360
10.840	-25.897	-2073.265	6	-2034.004	2	101.930
11.518	-25.897	-2063.282	8	-2025.216	2	101.879
12.195	-25.897	-2067.042	7	-2016.429	2	102.510
12.873	-25.897	-2052.124	8	-2007.641	2	102.215
13.551	-25.897	-2044.087	5	-1998.853	1	102.262
14.228	-25.897	-2022.219	5	-1990.066	1	101.615
14.906	-25.897	-1999.777	5	-1981.278	1	100.933
15.583	-25.897	-1993.266	5	-1972.491	1	101.053
16.261	-25.897	-1978.656	7	-1963.703	2	100.761
16.938	-25.897	-1964.318	7	-1954.915	2	100.480
17.616	-25.897	-1946.429	5	-1946.128	2	100.015
18.293	-25.897	-1932.649	6	-1937.340	2	99.757
18.971	-25.897	-1922.621	6	-1928.552	2	99.692
19.648	-25.897	-1910.487	5	-1919.765	2	99.516
20.326	-25.897	-1896.118	6	-1910.977	2	99.222
21.004	-25.897	-1880.596	6	-1902.189	2	98.864
21.681	-25.897	-1862.525	5	-1893.402	2	98.369
22.359	-25.897	-1853.883	8	-1884.614	3	98.369
23.036	-25.897	-1849.245	7	-1875.826	3	98.582
23.714	-25.897	-1855.349	8	-1867.039	3	99.373
24.391	-25.897	-1838.148	5	-1858.251	2	98.918
25.069	-25.897	-1808.872	5	-1849.463	2	97.805
25.746	-25.897	-1769.624	6	-1840.676	2	96.139
26.424	-25.897	-1837.821	6	-1831.888	2	100.323
27.102	-25.897	-1860.098	5	-1823.101	1	102.029
27.779	-25.897	-1860.766	5	-1814.313	1	102.560
28.457	-25.897	-1845.708	6	-1805.525	2	102.225
29.134	-25.897	-1821.435	6	-1796.738	2	101.374
29.812	-25.897	-1781.605	8	-1787.950	2	99.645
30.489	-25.897	-1768.220	6	-1779.162	2	99.384
31.167	-25.897	-1746.614	5	-1770.375	2	98.657
31.844	-25.897	-1723.812	5	-1761.587	3	97.855
32.522	-25.897	-1683.022	7	-1752.799	4	96.019
33.199	-25.897	-1654.505	6	-1744.012	4	94.867
0.000	-25.346	-1883.178	5	-2160.381	4	87.168
.677	-25.346	-1913.730	6	-2151.593	4	88.944
1.355	-25.346	-1946.044	5	-2142.806	3	90.817
2.032	-25.346	-1955.724	6	-2134.018	3	91.645
2.710	-25.346	-2066.678	5	-2125.230	2	97.244
3.387	-25.346	-2040.903	6	-2116.443	2	96.430
4.065	-25.346	-2060.297	5	-2107.655	1	97.753
4.742	-25.346	-2048.800	8	-2098.867	2	97.614
5.420	-25.346	-2060.055	7	-2090.080	2	98.563
6.097	-25.346	-2058.019	5	-2081.292	1	98.881
6.775	-25.346	-2053.278	5	-2072.504	1	99.072
7.453	-25.346	-2047.963	5	-2063.717	1	99.236
8.130	-25.346	-2055.918	7	-2054.929	2	100.048
8.808	-25.346	-2057.334	7	-2046.141	2	100.547
9.485	-25.346	-2060.670	6	-2037.354	2	101.144
10.163	-25.346	-2054.697	8	-2028.566	2	101.288
10.840	-25.346	-2055.115	6	-2019.778	1	101.749
11.518	-25.346	-2082.399	5	-2010.991	1	103.550

12.195	-25.346	-2051.712	7	-2002.203	1	102.472
12.873	-25.346	-2041.053	7	-1993.416	1	102.389
13.551	-25.346	-2024.294	8	-1984.628	1	101.998
14.228	-25.346	-2013.340	5	-1975.840	-0	101.897
14.906	-25.346	-1996.510	7	-1967.053	1	101.497
15.583	-25.346	-1984.269	6	-1958.265	1	101.327
16.261	-25.346	-1968.363	5	-1949.477	1	100.968
16.938	-25.346	-1946.774	5	-1940.690	1	100.313
17.616	-25.346	-1936.975	5	-1931.902	1	100.262
18.293	-25.346	-1926.602	5	-1923.114	1	100.181
18.971	-25.346	-1912.640	7	-1914.327	2	99.911
19.648	-25.346	-1902.077	5	-1905.539	1	99.818
20.326	-25.346	-1886.196	5	-1896.751	1	99.443
21.004	-25.346	-1870.669	5	-1887.964	1	99.083
21.681	-25.346	-1856.731	5	-1879.176	2	98.805
22.359	-25.346	-1846.616	8	-1870.388	3	98.728
23.036	-25.346	-1836.497	5	-1861.601	2	98.651
23.714	-25.346	-1826.662	5	-1852.813	2	98.588
24.391	-25.346	-1837.318	6	-1844.025	2	99.636
25.069	-25.346	-1826.212	6	-1835.238	2	99.508
25.746	-25.346	-1805.902	7	-1826.450	2	98.874
26.424	-25.346	-1756.861	5	-1817.663	1	96.654
27.102	-25.346	-1836.615	5	-1808.875	-0	101.533
27.779	-25.346	-1828.495	6	-1800.087	1	101.578
28.457	-25.346	-1832.985	5	-1791.300	1	102.327
29.134	-25.346	-1825.656	5	-1782.512	1	102.420
29.812	-25.346	-1768.393	8	-1773.724	2	99.699
30.489	-25.346	-1753.260	5	-1764.937	1	99.338
31.167	-25.346	-1731.112	5	-1756.149	2	98.574
31.844	-25.346	-1699.543	6	-1747.361	3	97.263
32.522	-25.346	-1669.027	5	-1738.574	3	95.999
33.199	-25.346	-1646.491	6	-1729.786	4	95.184
0.000	-24.795	-1909.919	6	-2146.155	4	88.992
.677	-24.795	-1915.557	5	-2137.368	3	89.622
1.355	-24.795	-1942.620	6	-2128.580	3	91.263
2.032	-24.795	-1962.333	7	-2119.792	3	92.571
2.710	-24.795	-1983.856	6	-2111.005	2	93.976
3.387	-24.795	-2026.561	5	-2102.217	1	96.401
4.065	-24.795	-2027.075	6	-2093.429	1	96.830
4.742	-24.795	-2036.865	9	-2084.642	2	97.708
5.420	-24.795	-2050.481	5	-2075.854	1	98.777
6.097	-24.795	-2046.664	6	-2067.066	1	99.012
6.775	-24.795	-2041.864	6	-2058.279	1	99.202
7.453	-24.795	-2036.490	6	-2049.491	1	99.365
8.130	-24.795	-2035.069	5	-2040.703	1	99.723
8.808	-24.795	-2045.570	5	-2031.916	1	100.671
9.485	-24.795	-2049.288	5	-2023.128	1	101.293
10.163	-24.795	-2038.304	8	-2014.340	2	101.189
10.840	-24.795	-2036.817	6	-2005.553	1	101.558
11.518	-24.795	-2059.032	5	-1996.765	-0	103.118
12.195	-24.795	-2027.572	5	-1987.978	-0	101.991
12.873	-24.795	-2025.656	7	-1979.190	-0	102.347
13.551	-24.795	-2012.657	5	-1970.402	-0	102.144
14.228	-24.795	-1992.482	7	-1961.615	-0	101.573
14.906	-24.795	-1983.666	5	-1952.827	-0	101.579
15.583	-24.795	-1973.582	7	-1944.039	1	101.519
16.261	-24.795	-1957.898	6	-1935.252	1	101.170
16.938	-24.795	-1936.351	6	-1926.464	1	100.513
17.616	-24.795	-1926.629	6	-1917.676	1	100.466

18.293	-24.795	-1916.333	6	-1908.889	1	100.389
18.971	-24.795	-1902.580	5	-1900.101	1	100.130
19.648	-24.795	-1890.091	6	-1891.313	1	99.935
20.326	-24.795	-1877.719	5	-1882.526	1	99.744
21.004	-24.795	-1864.647	5	-1873.738	1	99.514
21.681	-24.795	-1847.867	6	-1864.950	2	99.083
22.359	-24.795	-1833.704	5	-1856.163	2	98.790
23.036	-24.795	-1825.519	6	-1847.375	2	98.816
23.714	-24.795	-1816.290	6	-1838.588	2	98.787
24.391	-24.795	-1821.276	7	-1829.800	2	99.534
25.069	-24.795	-1808.641	5	-1821.012	1	99.320
25.746	-24.795	-1777.020	5	-1812.225	1	98.057
26.424	-24.795	-1781.041	6	-1803.437	1	98.758
27.102	-24.795	-1810.399	6	-1794.649	-0	100.877
27.779	-24.795	-1820.912	5	-1785.862	-0	101.962
28.457	-24.795	-1814.237	5	-1777.074	-0	102.091
29.134	-24.795	-1806.989	5	-1768.286	1	102.188
29.812	-24.795	-1755.032	8	-1759.499	2	99.746
30.489	-24.795	-1737.529	5	-1750.711	1	99.247
31.167	-24.795	-1715.462	5	-1741.923	2	98.480
31.844	-24.795	-1691.220	6	-1733.136	3	97.581
32.522	-24.795	-1660.310	5	-1724.348	3	96.286
33.199	-24.795	-1638.330	6	-1715.560	4	95.498
0.000	-24.244	-1898.758	6	-2131.930	4	89.062
.677	-24.244	-1910.832	5	-2123.142	3	90.000
1.355	-24.244	-1942.388	6	-2114.354	3	91.866
2.032	-24.244	-1964.549	7	-2105.567	3	93.302
2.710	-24.244	-1983.570	6	-2096.779	2	94.600
3.387	-24.244	-2009.852	7	-2087.991	2	96.257
4.065	-24.244	-2039.183	5	-2079.204	1	98.075
4.742	-24.244	-2027.603	9	-2070.416	2	97.932
5.420	-24.244	-2053.562	8	-2061.628	2	99.608
6.097	-24.244	-2042.750	5	-2052.841	1	99.508
6.775	-24.244	-2035.093	5	-2044.053	-0	99.561
7.453	-24.244	-2026.862	5	-2035.265	1	99.587
8.130	-24.244	-2029.585	8	-2026.478	2	100.153
8.808	-24.244	-2033.511	5	-2017.690	1	100.784
9.485	-24.244	-2037.309	5	-2008.902	1	101.414
10.163	-24.244	-2023.260	9	-2000.115	2	101.157
10.840	-24.244	-2018.371	6	-1991.327	1	101.358
11.518	-24.244	-2035.516	5	-1982.540	1	102.672
12.195	-24.244	-2020.608	7	-1973.752	1	102.373
12.873	-24.244	-2009.239	5	-1964.964	-0	102.253
13.551	-24.244	-1995.117	8	-1956.177	1	101.990
14.228	-24.244	-1968.248	5	-1947.389	-0	101.071
14.906	-24.244	-1968.228	8	-1938.601	1	101.528
15.583	-24.244	-1957.932	5	-1929.814	-0	101.457
16.261	-24.244	-1935.394	5	-1921.026	1	100.747
16.938	-24.244	-1924.028	5	-1912.238	1	100.616
17.616	-24.244	-1914.170	5	-1903.451	-0	100.563
18.293	-24.244	-1903.738	5	-1894.663	1	100.478
18.971	-24.244	-1892.143	7	-1885.875	2	100.332
19.648	-24.244	-1880.514	5	-1877.088	1	100.182
20.326	-24.244	-1867.051	7	-1868.300	2	99.933
21.004	-24.244	-1858.477	5	-1859.512	1	99.944
21.681	-24.244	-1835.172	5	-1850.725	1	99.159
22.359	-24.244	-1823.325	5	-1841.937	2	98.989
23.036	-24.244	-1813.779	6	-1833.150	2	98.943
23.714	-24.244	-1805.287	5	-1824.362	1	98.954

24.391	-24.244	-1806.795	7	-1815.574	2	99.516
25.069	-24.244	-1795.500	6	-1806.787	1	99.375
25.746	-24.244	-1768.298	5	-1797.999	-0	98.348
26.424	-24.244	-1783.915	5	-1789.211	-0	99.703
27.102	-24.244	-1794.738	7	-1780.424	-0	100.804
27.779	-24.244	-1800.084	6	-1771.636	-0	101.605
28.457	-24.244	-1795.342	5	-1762.848	-0	101.843
29.134	-24.244	-1788.174	5	-1754.061	1	101.944
29.812	-24.244	-1746.023	9	-1745.273	2	100.042
30.489	-24.244	-1721.651	5	-1736.485	1	99.145
31.167	-24.244	-1708.254	6	-1727.698	2	98.874
31.844	-24.244	-1686.700	5	-1718.910	2	98.126
32.522	-24.244	-1651.446	5	-1710.122	3	96.568
33.199	-24.244	-1629.558	7	-1701.335	4	95.781
0.000	-23.693	-1992.812	5	-2117.704	3	94.102
.677	-23.693	-1921.532	6	-2108.916	3	91.114
1.355	-23.693	-1942.583	5	-2100.129	2	92.498
2.032	-23.693	-1978.633	5	-2091.341	2	94.610
2.710	-23.693	-1990.442	5	-2082.553	1	95.577
3.387	-23.693	-2022.537	5	-2073.766	-0	97.529
4.065	-23.693	-2024.913	6	-2064.978	1	98.059
4.742	-23.693	-2015.018	9	-2056.190	2	97.997
5.420	-23.693	-2073.768	5	-2047.403	1	101.287
6.097	-23.693	-2056.092	6	-2038.615	1	100.857
6.775	-23.693	-2020.008	5	-2029.827	1	99.516
7.453	-23.693	-2011.858	5	-2021.040	1	99.545
8.130	-23.693	-2011.002	5	-2012.252	1	99.937
8.808	-23.693	-2015.394	6	-2003.465	1	100.595
9.485	-23.693	-2019.031	6	-1994.677	1	101.220
10.163	-23.693	-2002.581	11	-1985.889	2	100.840
10.840	-23.693	-2000.480	5	-1977.102	1	101.182
11.518	-23.693	-2000.304	10	-1968.314	2	101.625
12.195	-23.693	-2001.963	6	-1959.526	1	102.165
12.873	-23.693	-1994.382	5	-1950.739	-0	102.237
13.551	-23.693	-1979.091	6	-1941.951	1	101.912
14.228	-23.693	-1956.903	5	-1933.163	1	101.228
14.906	-23.693	-1948.564	6	-1924.376	1	101.256
15.583	-23.693	-1951.216	5	-1915.588	1	101.859
16.261	-23.693	-1928.758	5	-1906.800	1	101.151
16.938	-23.693	-1915.039	5	-1898.013	1	100.897
17.616	-23.693	-1905.262	5	-1889.225	1	100.848
18.293	-23.693	-1894.911	5	-1880.437	1	100.769
18.971	-23.693	-1881.672	7	-1871.650	2	100.535
19.648	-23.693	-1873.384	5	-1862.862	1	100.564
20.326	-23.693	-1856.964	7	-1854.074	2	100.155
21.004	-23.693	-1852.159	5	-1845.287	1	100.372
21.681	-23.693	-1824.564	5	-1836.499	1	99.350
22.359	-23.693	-1812.797	5	-1827.712	2	99.183
23.036	-23.693	-1801.891	6	-1818.924	2	99.063
23.714	-23.693	-1793.570	5	-1810.136	1	99.084
24.391	-23.693	-1792.167	7	-1801.349	2	99.490
25.069	-23.693	-1783.556	6	-1792.561	1	99.497
25.746	-23.693	-1772.655	6	-1783.773	-0	99.376
26.424	-23.693	-1775.126	5	-1774.986	-0	100.007
27.102	-23.693	-1770.769	6	-1766.198	-0	100.258
27.779	-23.693	-1768.628	5	-1757.410	-0	100.638
28.457	-23.693	-1791.877	7	-1748.623	1	102.473
29.134	-23.693	-1794.300	6	-1739.835	1	103.130
29.812	-23.693	-1749.631	5	-1731.047	1	101.073

30.489	-23.693	-1724.405	6	-1722.260	1	100.124
31.167	-23.693	-1712.207	5	-1713.472	1	99.926
31.844	-23.693	-1677.607	5	-1704.684	2	98.411
32.522	-23.693	-1639.669	6	-1695.897	3	96.684
33.199	-23.693	-1620.755	7	-1687.109	4	96.067
0.000	-23.142	-1987.366	5	-2103.478	3	94.479
.677	-23.142	-1910.155	6	-2094.691	3	91.190
1.355	-23.142	-1937.642	5	-2085.903	2	92.892
2.032	-23.142	-1973.773	5	-2077.115	1	95.024
2.710	-23.142	-1998.353	6	-2068.328	1	96.616
3.387	-23.142	-2025.930	6	-2059.540	1	98.368
4.065	-23.142	-2013.493	6	-2050.752	1	98.183
4.742	-23.142	-1998.372	9	-2041.965	2	97.865
5.420	-23.142	-2056.815	5	-2033.177	1	101.162
6.097	-23.142	-2036.523	6	-2024.389	1	100.599
6.775	-23.142	-1997.236	5	-2015.602	1	99.088
7.453	-23.142	-1988.956	5	-2006.814	1	99.110
8.130	-23.142	-1991.400	5	-1998.027	1	99.668
8.808	-23.142	-1992.828	7	-1989.239	1	100.180
9.485	-23.142	-2003.065	5	-1980.451	-0	101.141
10.163	-23.142	-1995.901	6	-1971.664	1	101.229
10.840	-23.142	-1983.790	6	-1962.876	1	101.065
11.518	-23.142	-1983.109	5	-1954.088	1	101.485
12.195	-23.142	-1982.153	7	-1945.301	1	101.894
12.873	-23.142	-1972.802	7	-1936.513	1	101.873
13.551	-23.142	-1959.554	6	-1927.725	1	101.651
14.228	-23.142	-1954.952	9	-1918.938	2	101.876
14.906	-23.142	-1935.174	5	-1910.150	1	101.310
15.583	-23.142	-1934.294	8	-1901.362	2	101.731
16.261	-23.142	-1929.300	9	-1892.575	2	101.940
16.938	-23.142	-1914.477	9	-1883.787	2	101.629
17.616	-23.142	-1899.669	7	-1874.999	2	101.315
18.293	-23.142	-1884.162	7	-1866.212	2	100.961
18.971	-23.142	-1876.032	6	-1857.424	2	101.001
19.648	-23.142	-1866.106	5	-1848.636	2	100.944
20.326	-23.142	-1834.590	7	-1839.849	2	99.714
21.004	-23.142	-1821.729	7	-1831.061	2	99.490
21.681	-23.142	-1807.324	7	-1822.274	2	99.179
22.359	-23.142	-1786.257	6	-1813.486	2	98.498
23.036	-23.142	-1778.119	7	-1804.698	2	98.527
23.714	-23.142	-1772.398	7	-1795.911	2	98.690
24.391	-23.142	-1773.380	8	-1787.123	2	99.230
25.069	-23.142	-1771.463	6	-1778.335	1	99.613
25.746	-23.142	-1768.087	6	-1769.548	-0	99.917
26.424	-23.142	-1766.189	5	-1760.760	-0	100.308
27.102	-23.142	-1766.072	6	-1751.972	-0	100.804
27.779	-23.142	-1767.160	6	-1743.185	-0	101.375
28.457	-23.142	-1754.935	5	-1734.397	-0	101.184
29.134	-23.142	-1728.331	5	-1725.609	1	100.157
29.812	-23.142	-1718.222	10	-1716.822	2	100.081
30.489	-23.142	-1699.295	8	-1708.034	2	99.488
31.167	-23.142	-1690.708	6	-1699.246	2	99.497
31.844	-23.142	-1668.366	5	-1690.459	2	98.693
32.522	-23.142	-1629.215	6	-1681.671	3	96.880
33.199	-23.142	-1603.342	8	-1672.884	4	95.843
0.000	-22.591	-1981.772	5	-2089.253	3	94.855
.677	-22.591	-1976.638	5	-2080.465	2	95.009
1.355	-22.591	-1932.301	6	-2071.677	2	93.272
2.032	-22.591	-1968.765	5	-2062.890	1	95.437

2.710	-22.591	-2004.403	5	-2054.102	-0	97.580
3.387	-22.591	-2039.467	5	-2045.314	-0	99.714
4.065	-22.591	-2001.745	5	-2036.527	1	98.292
4.742	-22.591	-1991.143	11	-2027.739	2	98.195
5.420	-22.591	-2014.858	10	-2018.951	2	99.797
6.097	-22.591	-2036.995	5	-2010.164	1	101.334
6.775	-22.591	-1998.912	8	-2001.376	2	99.876
7.453	-22.591	-1987.120	8	-1992.589	2	99.725
8.130	-22.591	-1974.208	5	-1983.801	1	99.516
8.808	-22.591	-1973.122	7	-1975.013	1	99.904
9.485	-22.591	-1984.112	6	-1966.226	-0	100.909
10.163	-22.591	-1976.526	6	-1957.438	1	100.975
10.840	-22.591	-1968.082	6	-1948.650	1	100.997
11.518	-22.591	-1961.218	5	-1939.863	-0	101.100
12.195	-22.591	-1931.188	5	-1931.075	-0	100.005
12.873	-22.591	-1955.114	5	-1922.287	-0	101.707
13.551	-22.591	-1950.711	7	-1913.500	1	101.944
14.228	-22.591	-1932.733	5	-1904.712	1	101.471
14.906	-22.591	-1925.741	6	-1895.924	1	101.572
15.583	-22.591	-1931.467	5	-1887.137	1	102.349
16.261	-22.591	-1910.697	5	-1878.349	1	101.722
16.938	-22.591	-1900.917	5	-1869.561	1	101.677
17.616	-22.591	-1891.360	5	-1860.774	2	101.643
18.293	-22.591	-1876.860	5	-1851.986	2	101.343
18.971	-22.591	-1854.582	5	-1843.199	2	100.617
19.648	-22.591	-1837.156	11	-1834.411	3	100.149
20.326	-22.591	-1826.032	6	-1825.623	2	100.022
21.004	-22.591	-1813.561	6	-1816.836	2	99.819
21.681	-22.591	-1797.744	6	-1808.048	2	99.430
22.359	-22.591	-1777.353	6	-1799.260	2	98.782
23.036	-22.591	-1769.398	8	-1790.473	2	98.822
23.714	-22.591	-1753.249	5	-1781.685	1	98.403
24.391	-22.591	-1748.919	5	-1772.897	1	98.647
25.069	-22.591	-1753.547	7	-1764.110	1	99.401
25.746	-22.591	-1763.372	6	-1755.322	-0	100.458
26.424	-22.591	-1757.104	5	-1746.534	-0	100.605
27.102	-22.591	-1761.227	6	-1737.747	-0	101.351
27.779	-22.591	-1763.459	6	-1728.959	-0	101.995
28.457	-22.591	-1763.990	5	-1720.171	-0	102.547
29.134	-22.591	-1742.792	6	-1711.384	1	101.835
29.812	-22.591	-1711.743	10	-1702.596	2	100.537
30.489	-22.591	-1695.037	8	-1693.808	2	100.072
31.167	-22.591	-1680.648	6	-1685.021	2	99.740
31.844	-22.591	-1655.876	5	-1676.233	2	98.785
32.522	-22.591	-1618.613	6	-1667.446	3	97.071
33.199	-22.591	-1599.381	9	-1658.658	4	96.426
0.000	-22.040	-1976.029	5	-2075.027	3	95.229
.677	-22.040	-1970.976	5	-2066.239	2	95.389
1.355	-22.040	-1965.350	5	-2057.452	1	95.523
2.032	-22.040	-1953.887	6	-2048.664	1	95.373
2.710	-22.040	-1986.490	6	-2039.876	1	97.382
3.387	-22.040	-2018.520	6	-2031.089	1	99.381
4.065	-22.040	-1993.930	6	-2022.301	1	98.597
4.742	-22.040	-1974.271	11	-2013.513	2	98.051
5.420	-22.040	-2021.213	6	-2004.726	1	100.822
6.097	-22.040	-2014.671	5	-1995.938	1	100.938
6.775	-22.040	-1989.452	8	-1987.151	2	100.115
7.453	-22.040	-1972.235	8	-1978.363	2	99.690
8.130	-22.040	-1965.654	5	-1969.575	1	99.800

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KANSAS GEOLOGICAL SURVEY COMPUTER PROGRAM
THE UNIVERSITY OF KANSAS, LAWRENCE

PROGRAM ABSTRACT

Title (If subroutine state in title):

FORTRAN II program for progressive linear fit of surfaces on a quadratic base using an IBM 1620 computer.

Computer: IBM 1620, model II Date: April 27, 1967

Programming language: FORTRAN II-D and SPS

Author, organization: A.J. Cole and C. Jordan, Computing Laboratory, University of St. Andrews, St. Andrew, Fife, Scotland; and D.F. Merriam, Kansas Geological Survey, University of Kansas, Lawrence, Kansas.

Direct inquiries to: Authors, or

Name: D.F. Merriam Address: Kansas Geological Survey, University of Kansas, Lawrence

Purpose/description: To produce a contour map of a surface determined by a given set of xyz-coordinate values.

Mathematical method: Systematic progressive linear fit by least squares after removal of a least-squares regional quadratic surface

Restrictions, range: Maximum of 300 data points

Storage requirements: 60K decimal digits, disk working area

Equipment specifications: Memory 20K ___ 40K ___ 60K X K ___

Automatic divide: Yes X No ___ Indirect addressing Yes X No ___

Other special features required Digital plotter, line printer, disk

Additional remarks (include at author's discretion: fixed/float, relocatability; optional: running time, approximate number of times run successfully, programming hours) Program has been run successfully on 15 different sets of data from Scotland and Kansas.

The Kansas Survey is the only geological organization now known to be distributing computer program decks as well as data decks. The programs are written in ALGOL, FORTRAN II, and FORTRAN IV, and sold for a limited time at a nominal cost. The programs are for Burroughs B5500, CDC 3400, GE 625, IBM 1620, 7040, and 7090/1401 or 7094/1401 computer systems. A list of available decks is given below.

	ALGOL	FORTRAN II	FORTRAN IV
* Marine Simulation (CC 1)			
2D Regression (CC 2)	$10.00	$10.00	$10.00
Trend-6 (CC 3)			$25.00
Discrim (CC 4)		$ 5.00	
Nongridded Double Fourier (CC 5)			$10.00
Cladistics (CC 6)			$25.00
Muskat (CC 8)	$10.00		
Marsim (CC 9)			$20.00
Response Surface (CC 10)		$10.00	
Vector Trend (CC 11)			$15.00
Markov (CC 13)			$15.00
Topog (CC 14)			$ 7.50
Contour (CC 15)		$10.00	
* Trend-3 (SDP 3)			
Match-Coeff (SDP 4)		$ 2.00	
* Correlation and Distance Coeff (SDP 9)			
Time-Trend (SDP 12)		$ 5.00	$ 5.00
Covap (SDP 13)		$15.00	
Trend-3 (SDP 14)		$25.00	
Cross-Association (SDP 23)			$10.00
Single and * Double Fourier (SDP 24)			$ 5.00
Precambrian Wells (SDP 25)			
List of about 2,650 Precambrian wells	$50.00		
Trend-4 (SDP 26)		$ 7.50	
Sediment Analysis (SDP 28)		$10.00	
4D Trend (B 171)			$10.00
Conversion of T&R to Cartesian Coordinates (B 170-3)		$ 5.00	$ 5.00
Hydrodynamic Oil-Trap Mapping (reprint, Colo. Sch. Mines)			$10.00

* Out of print, therefore not available.