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PROGRAM PDP004: CONTUR

by

M. M. Donzeau, L. D. North, M. E. Gettings

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> U.S. Geological Survey Jiddah, Saudi Arabia 1981

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Program Documentation Manual

Program Number	:	PDP004
Program Name	:	CONTUR
Programmer	• :	M. M. Donzeau
Language	:	FORTRAN IV PLUS
Computer/System	:	PDP-11/45
Date	:	8 March 1980
Institution	:	U.S. Geological Survey Saudi Arabian Project
Location	:	Jiddah, Saudi Arabia

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ABSTRACT

The CONTUR program was modified from a program initially designed by CALCOMP to generate contour maps from any data set for any CALCOMP digital plotting systems.

A contour map can be drawn from data entered as an array of Z-values, corresponding to regularly spaced data in X and Y. Also a grid can be created from irregularly spaced data points, and then the contour map can be drawn.

The grid is calculated by using a least-square bivariate polynomial determined from a few neighbors for each grid mesh point, or determined as a trend surface from all the data points.

The program has been updated in several steps by the U.S. Geological Survey (USGS) and the Bureau de Recherche Geologique et Mineries (BRGM) programmers, so that the size of the program was greatly reduced, a few more input parameters were added, and a few errors occurring during the plot was suppressed.

It is advised to read the CALCOMP Manual (Calcomp, 1973) to fully understand how CONTUR works, and the documentation of the program CTRL2D which was designed by USGS programmers to prepare the input files for CONTUR.

SOURCE DECK LOCATION AND UPDATE STATUS

The FORTRAN source program is scattered into eight overlays: CONT00.FTN, CONT10.FTN, CONT20.FTN, CONT30.FTN, CONT40.FTN, CONT50.FTN, CONT60.FTN, CONT70.FTN. These overlays and the task image CONTUR.TSK are on the system disk of the DGMR PDP-11/45 computer under the UIC of [22,50].

This report recapitulates all the updates which have been made to the program.

DESCRIPTION OF COMPUTED QUANTITIES

The computed quantities are the same as in the original program designed by CALCOMP (1974).

DESCRIPTION OF THE PROGRAM

Main modifications

The following is a list of the main modifications from the CALCOMP version.

- 1) The size of the grid to be plotted is increased from 2000 to 2500 points.
- 2) If the size of the grid to be plotted is bigger than 2500, use the program CTRL2D before running CONTUR. It will divide the map in several parts and calculate the new parameters of the control cards. Thus, there is no limit to the size of the grid, except the time used for running CONTUR, considering that a crash may occur during a long run when using the DGMR PDP-11/45 computer.
- 3) The size of the grid to be calculated is increased from 2000 to about 32000 x 32000, with a number of input data points limited to about 32000. If the grid is bigger than 2500, it will be calculated but not plotted. If a plot is desired, see section 2.
- To calculate the grid, the search for neighbors can be made either in a square of variable size (CALCOMP version), or in a circle of constant radius.
- 5) The program does not plot areas with blank values.
- 6) For the plot, the program takes care of the multi-crosses in the same sub-cell of the same track, thus avoiding track looping.
- 7) The contour levels can be equidistant (CALCOMP version), or chosen level by level. In the latter case, the number of levels is limited to 200, and the labels written on the curves may be different from the values of the contour levels.
- 8) The number of overlays is reduced from 19 to 7.
- 9) The scratch files are opened and closed in the overlays where they are needed, thus reducing the number of files open at the same time. There is now a maximum of five (no gridding) or six (gridding) files open simultaneously, instead of eight (CALCOMP version).

<u>Overlays</u>

The overlay structure is as follows:

	CONT10
	CONT20
	CONT30
CONT00	CONT40
	CONT50
	CONT60
	CONT70

The following is a brief description of the routines.

CONTOO: Main program

CONTLO: Initialization and termination routines INITA: initialize parameters and plot FINI: terminate CONTUR program activity

CONT20: Routines for reading and decoding control cards CONTL: read control cards

- CRDS1: decode LEVL, POST, RDGD, TREN control cards, and read Z-values of pre-gridded data
- CRDS2: decode MESH, NAOR, NDEC, PNCH, PRNT, REGN, TICK, TITL control cards DRWCD: decode DRAW control card

CONT30: Routines for reading (X, Y, Z) input data
points and sorting them into segments
GRDCD: decode GRID control card
GTPTS: read and print (X, Y, Z) input data
values, find min/max of X, Y, Z values
SEGS1: prepare scratch file to store (X, Y, Z)
input data points into segments
SEGS2: separate (X, Y, Z) input data points
into segments, sort, and store into
scratch file

SRTPT: sort (X, Y, Z) values with increasing X-value

CONT40:

Routines for calculating the grid GRID: main routine to calculate the grid EVAL: calculate least-square polynomial and Z-value for one grid intersection GRDST: calculate X, Y range of neighborhood GTSEG: locate segment of (X, Y, Z) input data points corresponding to point to calculate INVRT: invert matrix of coefficients of least-square polynomial

- find neighbors surrounding point to NABOR: calculate calculate coefficients of least-square NORMS:
- polynomial RANGE : find range of (X, Y, Z) values of
- neighbors VALUE: calculate Z-value from least-square
- polynomial coefficients WATES: calculate weight for each neighbor
- find min/max of (X, Y, Z) values of XTRMS: neighbors

CONT50:

- Routines for calculating the grid for a trend surface
 - TREND: main routine to calculate the grid EVALT: calculate least-square polymonial and Z-value for all grid intersections
 - GRDS2: initialization for calculation of the trend surface
 - INVR2: invert matrix of coefficients of least-square polymonial
 - NORM2: calculate coefficients of least-square polynomial
 - find range of (X, Y, Z) values of all RANG2: input data points
 - calculate Z-value from least-square VALU2: polynomial coefficients

CONT60:

Routines for plotting Z-values, print and/or punch grid values

SETUP: plot map title and boundaries, read Z-values of the grid

- punch Z-values of the grid PNCHR:
- print 2-values of the grid PRNTR:
- SET2: plot Z-values of (X, Y, Z) input data points, plot Z-values at each grid intersection
- TICKS: plot a tick mark at each grid intersection

CONT70:

Routines for plotting the contour lines DRAW: main routine to plot the contour lines find sub-cell next to origin of track, AJOIN: to prepare for second part of track CLNUM: select label of the contour level and

- calculate the number of characters of label
- find if sub-cell has already been CSUB: crossed by current contour level, and check for blank values in current grid cell

GRCK:	determine if contour level crosses any
	border of current grid cell
GT INT:	find coordinates of the point where
	track goes through sub-cell
LABEL:	plot label on track
SLOPE:	calculate angle parameters for labeling
MATGT:	get 4 x 4 matrix of grid values
·	surrounding current grid cell
FLAG3:	calculate missing value for edge of map
	check for blank values in first/last
	row/column of 4 x 4 matrix, and replace
	by the mean of surrounding Z-values.
SERCH:	find cross-over of track on grid cell
	borders
SUBGD:	divide grid cell into sub-grid, and
	calculate Z-values of sub-grid using
	third order Lagrangian interpolation
	technique
FLAGR:	interpolate using Lagrangian floating
	three point technique
TRAK:	draw contour line through current
	sub-cell, find next sub-cell

Table 1 indicates the relations between all the routines of the program CONTUR, by specifying the calls needed by each routine.

Table 1.-- Calls needed by each routine.

FINI (XYLBF4P) MAIN CONT20 CONTL CRDS1, CRDS2, DRWCD MAIN CRDS1 CRDS2 DRWCD (XYLBF4P) CONTL CONTL CONT30 GRDCD GTPTS, SEGS1, SEGS2 MAIN GTPTS	Overlay	Routine	Calls	Called by
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			CSUB, (XYLIBF4P)	

Modifications routine by routine

- Main program (CONT00) The main program contains the calls of the main routines only.
- 2) INITA (CONT10)

Initialization of the constants is contained in DATA statements. The scratch files FOR001.DAT and FOR002.DAT are opened to be created, then closed. The control data file CONTUR.CTR is opened to read the names of the input data file, the printer file, the output grid file, the plotter file, and the general title. The input data file is opened; the printer file is opened; the output grid file is opened to be created, then closed; and the plotter file is initialized. The general title is plotted.

3) FINI (CONT10)

The pen is moved outside the previous map and the plotter file is closed. The control data file and the input data file are closed. The scratch files FOR001.DAT and FOR002.DAT are opened, then closed and deleted. The output grid file is opened, then closed if there are data in it, or closed and deleted if there are no data. The printer file is closed.

- 4) CONTL (CONT20) No change.
- 5) CRDS1 (CONT20) The scratch file FOR001.DAT is opened to store Z values of pre-gridded data, then closed. The equidistant or non-equidistant levels are read in.
- 6) CRDS2 (CONT20) No change.
- 7) DRWCD (CONT20) The second DRAW card, containing the parameters ZBLANK, XORIG, YORIG, is read in. The pen is moved from the last origin to the new origin.
- 8) GRDCD (CONT30) The scratch file FOR002.DAT is opened to store (X, Y, Z) input data points, then closed.
- 9) GTPTS (CONT30) No change.

- 10) SEGS1 (CONT30) No change.
- 11) SEGS2 (CONT30)

If the number of points per segment is greater than 500, the number of segments is increased and the search is started again. The scratch file FOR004.DAT is opened to store the points by segment, then closed. The points are sorted with increasing X before being stored on file. The structure of the scratch file is as follows:

- record number 1: number of points in segment 1, location of first point of segment 1
- record number 2: number of points in segment 2, location of first point of segment 2
- record number NSEGS: number of points in segment NSEGS, location of first point of segment NSEGS
- record number NSEGS+1: (X, Y, Z) coordinates of first point of segment 1
- record number NSEGS+2: (X, Y, Z) coordinates of second point of segment 1 and so forth.
- 12) SRTPT (CONT30)
 This is a new routine from J.-P. Veyrier of BRGM.

13) GRID (CONT40)

The scratch file FOR001.DAT is opened to store the calculated grid, then closed. The scratch file FOR004.DAT is opened to read the segments, then closed and deleted. This routine prints the number of calculated points, the mean of the number of input points necessary for interpolation, the number of calculated points equal to the input data points, and the number of undefined points.

14) EVAL (CONT40) The arrays RVEC, WD, XD, YD, ZD are reduced from 687 to 500. This was possible with an EQUIVALENCE statement with array Z, which is not used in this overlay.

15) GRDST (CONT40)
There are a few minor changes due to the new
parameter RADIUS, which is the radius of the circle
of neighborhood.

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16) GTSÉG (CONT40)

In the CALCOMP version, this routine was reading all the points of the segment around the point to calculate XG, YG. Now it reads the number of points and the location in the scratch file of the first point of the segment around XG, YG.

- 17) INVERT (CONT40) No change.
- 18) NABOR (CONT40) There are a few changes due to the new parameter RADIUS. In the case of the search for neighbors in a circle, if the number of neighbors is insufficient, the Z-value of the calculated point is set to the blank value of -1.E35. In the CALCOMP version, the search started from the first point of the segment; now the search starts from the first good point found by the previous search.
- 19) NORMS (CONT40) No change.
- 20) RANGE (CONT40) No change.
- 21) VALUE (CONT40) No change.
- 22) WATES (CONT40) No change.
- 23) XTRMS (CONT40) No change.
- 24) TREND (CONT50) The scratch file FOR001.DAT is opened to store the calculated grid, then closed. The scratch file FOR002.DAT is opened to read (X, Y, Z) input data points, then closed.
- 25) EVALT (CONT50) The parameter EPS used in INVR2 is changed from 0.00001 to 0.0001.
- 26) GRDS2 (CONT50) No change.
- 27) INVR2 (CONT50) No change.

- 28) NORM2 (CONT50) No change.
- 29) RANG2 (CONT50) No change.
- 30) VALU2 (CONT50) No change.
- 31) SETUP (CONT60)

The title is plotted with letters big enough to fill the width of the map, with a maximum character height of 0.4 inches. This routine can either plot the boundaries of the map, or put a '+' at each corner of the map, and(or) put a '+' at each internal corner in the case of a multipart map. The scratch file FOR001.DAT is opened to read Z-values, then closed. If the grid is too big it will not be plotted.

- 32) PNCHR (CONT60) The output grid file is opened so that the Z-values are appended to the end, then the file is closed.
- 33) PRNTR (CONT60) The Z-values are printed on the printer file, except when the Z-value is equal to the blank value of -1.E35.
- 34) SET2 (CONT60) If plotting of the Z-values of the input data points was requested, the scratch file FOR002.DAT is opened to read and plot these Z-values, then closed. The new limits for multipart maps are calculated.
- 35) TICKS (CONT60) The tick marks are plotted, taking into account the new limits for multipart maps.
- 36) DRAW (CONT70)

This routine takes care of equidistant or nonequidistant contour levels. The percentage of cells crossed by each contour level is given. There is no plot in a cell where one or more of the four points has a blank value. This routine keeps reference of the sub-cells where multicrosses of the same contour level occur; there is a maximum of ten such sub-cells. If the current track is looping inside a sub-cell, an error message is produced and the plot continues with the next track. When the plot is complete, the pen goes back to the local origin (down-left corner of the map). 37) AJOIN (CONT70)

This routine checks if there is a blank value in the chosen grid cell, and if the chosen sub-cell has already been crossed.

- 38) CLNUM (CONT70) The number of statements was reduced by a factor of five by introducing an ENCODE statement.
- 39) CSUB (CONT70) This is a new routine which checks if a sub-cell has already been crossed. If this is the case, it checks in the table to determine if it is a multicross sub-cell. The second option is used to find if there is a blank value in one of the four points of the grid cell.
- 40) GRCK (CONT70) The grid cell is discarded if there is one blank value among the four points. The range of Z-value for the search of crossing of the track in the grid cell is reduced.
- 41) GTINT (CONT70) No change.
- 42) LABEL (CONT70) No change.
- 43) SLOPE (CONT70) No change.
- 44) MATGT (CONT70) There is a check for blank value in the 4 x 4 matrix surrounding the current grid cell.
- 45) FLAG3 (CONT70) This routine takes account of the blank values to calculate the missing row/column at the edge of the map.
- 46) CBLANK (CONT70) This is a new routine which checks for blank value in the 4 x 4 matrix surrounding the current grid cell. If a blank value is found, it is replaced by the mean of the Z-values of the two or three nearest points.
- 47) SERCH (CONT70) This routine checks if the sub-cell has already been crossed.

- 48) SUBGD (CONT70) No change.
- 49) FLAGR (CONT70) No change.
- 50) TRAK (CONT70)

This routine checks for multicrosses in the same sub-cell and keeps references of them in a table. When the plot in the sub-cell is complete, the routine calculates the adjacent sub-cell, and for each case it checks if the new sub-cell is at cell edge or map edge. If it is at cell edge, it checks for blank value in the next grid cell.

Files used in the program

The nine files used in the program CONTUR are described in table 2. Table 3 indicates the opening and closing of files in each overlay.

Input cards

There are two kinds of input cards: control data cards, which are in the control data file, and input data cards (or records), which are in the input data file.

Table 4 indicates in which routines the control data cards are read in and decoded. The input data records are read in CRDS1 for pre-gridded data, and in GTPTS for ungridded data.

Size of the program

The source program is scattered into eight overlays: CONT00.FTN, CONT10.FTN, CONT20.FTN, CONT30.FTN, CONT40.FTN, CONT50.FTN, CONT60.FTN, and CONT70.FTN. It requires 247 blocks of disk space in the PDP-11/45 computer, and the task image CONTUR.TSK requires 208 blocks.

Table 2.--Files used in the program CONTUR

ogical unit number	Variable used as logical unit number	Name of file	Description
1	IGDFL	DB1:FOR001.DAT	scratch file, containing Z-input or calculated grid
2	IPTFL	DB1:FOR002.DAT	scratch file, containing X, Y, Z input data points
3	JPTFL	• •	plotter file
4	KSEGS	DB1:FOR004.DAT	scratch file, containing X, Y, Z points by segment
5	ICARD	DB0:CONTUR.CTR	control data file
6	JPNTR		printer file
7	JPNCH		output grid file
8	IUNIT		input data file
9	ITERM	TI:	terminal file

Table 3.--Opening and closing of the files of the program CONTUR

Logical unit	CONT00		IT 10	CONT20	CONT30	CONT40	CONT50	CONT60	CONT70
number		INITA	FINI						
1	· · · ·	0-C	O-D	0-C		0-C	0 - C	0-C	
2		0-C	O-D		0-C		0-C	0-C	
· · 3		0	C	x	x	x	x	x	X .
4					0-C	O-D			
5	·	о	с	X	x	x	x	x	x
6		0	C	x	x	x	x	×	x
7		0-C	O-E					0-C	
8		0	c	x	x	x	x	x	X
9				0-C			0-C		0 - C

0 - open

م

- E close and delete if empty
- C close
 - ose X opened
- D close and delete

Table 4.--Reading and decoding of control data cards

Card name	Read in routine	Decoded in routine
DRAW FMT	CONTL, DRWCD CONTL (card, format)	DRWCD
GRID	CONTL	GRDCD, GTPTS
LEVL	CONTL, CRDS1	CRDS1
MESH	CONTL	CRDS2
NAOR	CONTL	CRDS2
NDEC	CONTL	CRDS2
PNCH	CONTL	CRDS2
POST	CONTL	CRDS1
PRNT	CONTL	CRDS2
RDGD	CONTL	CRDS1
REGN	CONTL	CRDS2
STOP	CONTL	
TICK	CONTL	CRDS2
TITL	CONTL (card), CRDS2 (titl	.e)
TREN	CONTL	CRDS1

PROGRAM OPERATION

Input files

Two input files are necessary to run the program: the control data file and the input data file.

Control data file

The control data file must be named CONTUR.CTR. It may have been created by the program CTRL2D, or by using the EDI utility program.

The structure of the control data file is shown in figure 1. The first five cards of the file are as follows:

- 1) input data filename (80 characters)
- 2) printer filename (80 characters)
- 3) output grid filename (80 characters)
- 4) plotter filename (80 characters)
- 5) general title: a 40-character title which will be plotted at 90° direction, before all other plots

Note that the last character of a filename must be a null character. It is automatically inserted when using the program CTRL2D. Note that only the first 32 characters of a filename are used by the computer.

The following are descriptions of the other control cards. Most of them are identical to those described in the CALCOMP's CONTOUR Applications Software Manual (1974).

DRAW Card

It is made up of two cards and initiates the drawing of a map.

First DRAW Card

Columns Parameter

1-5	TYPE	DRAW1
6-10		blank
11-20	FMAPX	width of map to be drawn, in inches (default = 10)
21-30	FMAPY	height of map to be drawn, in inches (default = 10)

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INPUT DATA FILENAME

PRINTER FILENAME

OUTPUT GRID FILENAME

PLOTTER FILENAME

GENERAL TITLE

Pregridded data	Ungridded data
FMT*	FMT
PRNT	NAOR
RDGD*	REGN
LEVL	TREN
MESH	PRNT
NDEC	GRID*
TICK	LEVL
TITL	MESH
DRAW	NDEC
	PNCH
	POST
	TICK
	TITL
	DRAW
STO	

* This card must be present in the first control card set.

Figure 1. Structure of the control data file. Use as many control card sets of either type as the number of desired maps, boxed cards are essential.

Columns	Parameter	
31-40	SN	number of divisions in the X direction that each grid cell is to be divided into (default = 4, max = 10)
41-50	SM	number of divisions, in the Y direction, that each grid cell is to be divided into (default = 4, max = 10)
51-60	IBXOPT	<pre>boundary parameter = 0, draw box boundary = 1, put a '+' at each external corner, no boundary drawn = 2, draw box boundary, and put a '+' at each internal corner = 3, put a '+' at each internal and external corner, no boundary drawn (default = 0)</pre>
Second DRA	W Card	
1-5 '	TYPE	DRAW2
6-10		blank
11-20	· · ·	<pre>ZBLANK Z-value given to blank areas (where there will be no contours). If there is no blank area, ZBLANK should be a Z-value different from all those of the data set. ZBLANK should be equal to -1.E35 for ungridded data. (default = 0)</pre>
21-30	XORIG	X-coordinate of down-left corner of boundary of map, in inches. (default = 0)
31-40	YORIG	Y-coordinate of down-left corner of boundary of map, in inches. (default = 0)
a	rea defined b	orner is one of the corners of the by the parameters FMAPX, FMAPY. An er is inside this area, at a distance

internal corner is inside this area, at a distance of one row and column from the corresponding external corner. It is used in the case of multipart maps (see the documentation of program CTRL2D for this kind of map).

FMT Card

It is made up of one card containing the TYPE parameter, and one card containing the format. It describes the format used to read the input data file. It remains in effect until changed by another FMT card.

First FMT Card

Columns Parameter

1-4 TYPE FMT

Second FMT Card

1-80	FRMT
------	------

- execution time format statement that describes data to be read in
- for pre-gridded data, the FMT card must be supplied, at least for the first map. The format should uniquely describe one row or column of the grid
- for ungridded data, the format should uniquely describe one data point by its alphanumeric field and its three coordinates.

default = previous format, or (A4, 6X, 3F10.0)

GRID Card

This card initiates the creation of a grid and specifies if ungridded data points are to be read in or not. NX, NY remain in effect until changed. IXPOS, IXPOS, IZPOS remain in effect for only this GRID card.

1-4 TYPE GRID

5-10 blank

11-20 NPT

number of data points used for gridding

if NPT is a positive number, the program tries to read that number of records on the input data file. The last record of the data set may be followed, if desired, by a record containing the word 'END' in the alphanumeric field with the format used to read the data. If less than NPT records are found, the number of data records will be kept as the NPT value

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Columns

- if NPT is a zero, the program will count the number of data records preceding the word 'END' in the alphanumeric field, or preceding the end of input data file
- if NPT is a negative number, the program uses the NPT records of the previous data set. If there are no such records, the program prints an error message and stops. (default = 0, max = about 32000)

21-30	NX	number of grid divisions in the X-direction that the map is to be divided into. Note that the number of columns of the grid is NX+1. If $NX \leq 0$, the NX value that was used for the previous grid is used. (default = 20)
31-40		number of grid divisions in the Y-direction that the map is to be divided into. Note that the number of rows of the grid is NY+1. If $NY \leq 0$, the NY value that was used for the previous grid is used. (default = 20)
41-50	IXPOS	relative position of X-coordinate in the data records
51-60	IYPOS	relative position of Y-coordinate in the data records
61-70	IZPOS	relative position of Z-coordinate in the data records. (if IXPOS< = 0, default values for IXPOS, IYPOS, IZPOS, are 1, 2, 3)

LEVL Card

This card defines the Z-values to be contoured. If the contour levels are defined one by one, there must be as many LEVL cards as the number of Z-values to be contoured. This card remains in effect for only one DRAW card. If this card is omitted for a data set, the program will attempt to calculate SLVL, DLVL, ELVL to give 10 satisfactory constant contour intervals (11 levels).

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Columns	Parameter	• • • • • • • • • • • • • • • • • • •
1-4	TYPE	LEVL
5-10		blank
11-20	SLVL	 lower Z-value on which contouring is to begin, if contour interval is constant Z-value to be contoured, if contour levels are defined one by one. (no default)
21-30	DLVL	 contour interval (>0), if contour interval is constant < 0 if contour levels are defined one by one. (default = 0)
31-40		 last (upper) contour level to be contoured, if contour interval is constant label to be plotted on contour level defined by SLVL, if contour levels are defined one by one (= 0, if same value as SLVL) Note: to plot the label "0" on a contour level, ELVL must be a nonzero value such that it will be plotted as a zero value, taking into account the parameter NDEC of MESH or NDEC card (ELVL = 0.01 will be plotted as "0." if NDEC = 0, or as "0.0" if NDEC = 1). (default = 0)

MESH Card

The presence of this card instructs the program to make a tick mark at each grid intersection and to plot the Z-value at that location. HEIGT remains in effect for only one DRAW card, but NDEC remains in effect until changed by another MESH card or by a NDEC card.

1-4	TYPE	MESH
5-10		blank
11-20	HEIGT	height of numbers to be plotted showing the Z-value at each grid intersection.

(default = 0.07 inches)

21-30 NDEC number of digits to follow decimal point for numbers to be plotted at each grid intersection, for annotating individual contour lines, and for posting the values of (X, Y, Z) input data points. (default = 0)	Columns	Parameters	
	21-30	NDEC	point for numbers to be plotted at each grid intersection, for annotating individual contour lines, and for posting the values of (X, Y, Z) input data points.

NAOR Card

This card indicates how to determine the least-square polynomial used to calculate the grid. It remains in effect until changed by another NAOR card.

1-4	TYPE	NAOR
5-10		blank
11-20	NABRS	<pre>minimum number of (X, Y, Z) input data points used in the determination of each individual grid mesh point. default = the exact number of normal equations required for the order of the polynomial used to approximate the surface = (IORD*2+3*IORD+2)/2 (recommended = 12) If a trend surface is being generated, the program uses all the input data points in the determination of the equation describing the surface</pre>
21-30	IORD	order of bivariate polynomial used to approximate the surface when determining a grid mesh point. If the matrix of normal equations is nearly singular when a trend surface is being generated, the program reduces the order by one and tries again. (default = 1, max = 4)
31-40	RADIUS	radius of circle of neighborhood sur- rounding each individual grid mesh point. Each mesh point is determined by all (X, Y, Z) input data points which are inside the circle. If there are not enough data points inside the circle, the grid mesh

Columns Parameter

point will have the value Z = -1.E35. If = 0, the program uses the number of input data points defined by NABRS. (default = 0)

NDEC Card

This card is necessary if a MESH card is not present and it is desired to assign NDEC a nonzero value for contour line annotation, and, if a POST card is present, for posting the values of the (X, Y, Z) input data points. NDEC remains in effect until changed by another NDEC card or by a MESH card.

1-4 TYPE NDEC

5-10 blank

11-20 NDEC number of digits to follow decimal
points for annotating individual
contour lines, and for posting the
values of (X, Y, Z) input data
points.
(default = 0)

PNCH Card

The presence of this card instructs the program to punch out, on the output grid file (disk or magnetic tape), the array that has been created by the grid routine. The grid is punched by rows from left to right, five values per record in format 5E14.6. Columns 71-74 of each record contain the row number, and columns 75-80 a record sequence number. It remains in effect for only one DRAW card.

1-4 TYPE PNCH

POST Card

The presence of this card instructs the program to plot the locations and values of the (X, Y, Z) input data points. It remains in effect for only one DRAW card.

1-4 TYPE POST

5-10 blank

Columns	Parameter	
11-20	PSTHT	height of numbers to be plotted showing the Z-values of the (X, Y, Z) input data points, and height of the corresponding tick marks. (default = 0.07 inches)
21-30	NVALU	<pre>indicates if Z-values of the (X, Y, Z) input data points are to be plotted. = 0, plot tick marks only = 1, plot tick marks and Z-values (default = 0)</pre>

PRNT Card

The presence of this card instructs the program to print the Z-value array that is to be drawn, and optionally print the (X, Y, Z) input data points. It remains in effect for only one DRAW card.

1-4	TY PE	PRNT
5-10		blank
11-20	NPRNT	<pre>indicates if (X, Y, Z) input data points are to be printed. = 0, no print = 1, print (default = 0)</pre>

RDGD Card

This card instructs the program that a pre-gridded Z-value array is to be read in and gives the dimensions of the array. The Z-values read in remain in effect until changed by another RDGD card.

1-4		TYPE	• .	RDGD
5-10				blank
11-20		NNX		number of columns in the data array to be read in.
			· · ·	(no default)
21-30	· · ·	NN Y		number of rows in the data array to be read in. (no default)

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Columns

Parameters

MANNR

31-40

flag to indicate how data is to be
read in.
= 1, read data in by columns, top to
bottom.
= 2, read data in by rows, left to
right.
(default = 2)

Note: first row read in is along top of map, first column is at left edge.

REGN Card

This card describes the (X, Y) limits of the grid that is to be produced. If this card is omitted, the limits used are those found by examining the data points. It remains in effect for only one GRID card.

1-4	TYPE	REGN	
5-10		blank	
11-20	XMPMN	minimum X-value of the grid produced, in data units. (no default)	to be
21-30	ХМРМХ	maximum X-value of the grid produced, in data units. (no default)	to be
31-40	YMPMN	minimum Y-value of the grid produced, in data units. (no default)	to be
41-50	YMPMX	maximum Y-value of the grid produced, in data units. (no default)	to be

STOP Card

This card terminates CONTUR program activity.

1-4 TYPE STOP

TICK Card

The presence of this card instructs the program to make a tick mark at each grid intersection, even though it does not plot the grid mesh values. It remains in effect for only one DRAW card.

Columns	Parameter	
1-4	TYPE	TIC

TITL Card

This card is made up of one card containing the TYPE parameter and one card containing the title. The title is drawn just below the map in letters whose height is such that the title will fill the width of the map, without exceeding a height of 0.4 inches. It remains in effect until changed by another TITL card.

K

First TITL Card

1-4 TYPE TITL

TITL

Second TITL Card

1-80

up to 80 characters of the desired title for the map.

TREN Card

The presence of this card tells the program that the grid to be produced should be a trend surface. It remains in effect for only one GRID card.

1-4 TYPE

TREN

Input data file

This file contains two kinds of data records.

- The first type of record contains the (X, Y, Z) input data points from which a grid will be created. The first field of the record is an alphanumeric field; the word 'END' in this field tells the program that the last input point for the current data set was reached. The location of the (X, Y, Z) and alphanumeric fields is specified by the FMT control card. The order in which the (X, Y, Z) fields appear in the record is specified on the GRID control card.
 The second type of record contains the Z-values of a
 - The second type of record contains the Z-values of a rectangular array of pre-gridded data. The FMT and RDGD control cards control the reading of this kind of data.

Error messages

The error messages appear on the printer file. Some of them appear on the terminal as well, so that the user can abort the program if desired.

1) *** BAD OR MISPLACED CARD ***

Routine:	CONTL (CONT20)
Explanation:	the card was read, but did not
	contain correct information in the
	first four columns, or the card
	was not located correctly
Program action:	stop
User action:	correct the control card

2) *** NO MORE CONTROL CARDS FOLLOWING A 'LEVL' CARD ***

Routine: Explanation:	CRDS1 (CONT20) in case of contour levels entered one by one, the program finds no control card following such a LEVL card
Program action: User action:	stop add the next control cards in the control data file

3) *** NX OR NY BAD ***

Routine:	CRDS1 (CONT20)
Explanation:	parameter NX or NY of RDGD card is negative or null, or the grid is
	too big (over 2500)
Program action:	stop
User action:	correct RDGD card, or run CTRL2D to divide map in several parts

4) *** BAD REGION CARD ***

Routine: Explanation:	CRDS2 (CONT20) the maximum and minimum X or Y values in a REGN card are in disorder
Program action: User action:	stop reorder the parameters of REGN card

5) *** IORD OUT OF RANGE.REDUCED TO FIRST ORDER ***

Routine:	CRDS2 (CONT20)
Explanation:	parameter IORD of NAOR card is outside the range 1-4
Program action:	continue with IORD = 1
User action:	none
Note:	this message appears on the terminal, as well as on the printer file

.6) *** SHOULD BE THE SECOND 'DRAW' CARD ***

Routine:	DRWCD (CONT20)
Explanation:	there is only one DRAW card
-	instead of two
Program action:	stop
User action:	add the second DRAW card

7) *** END OF CONTROL FILE INSTEAD OF SECOND 'DRAW' CARD ***

Routine: Explanation:	DRWCD (CONT20) there is only one DRAW card
•	instead of two, and there is no STOP card
Program action: User action:	stop add the second DRAW card and the STOP card

8) *** NOT ENOUGH INFO TO DRAW MAP ***

Routine: Explanation:	DRWCD (CONT20) a DRAW card has been encountered before a grid has been made available to the program
Program action: User action:	stop insert a RDGD or GRID card before the DRAW card

9) *** PLOT WILL BE IMPOSSIBLE: NX OR NY TOO BIG ***

Routine:	GRDCD (CONT30)
Explanation:	the grid to be calculated is too
	big to be plotted
Program action:	calculates the grid, eventually punches the grid, then prints
	error message number 15
User action:	none

10) *** NOT ENOUGH DATA TO GRID ***

Routine:	GRDCD (CONT30)
Explanation:	1) the program was told to produce
	a grid from points that were
	already either in core or on the
	program's point scratch file, but
-	there are no such points, or
	2) there are not enough points for
	the size of the neighborhood that
	has been requested or required by
	the order of the polynomial
Program action:	stop
User action:	modify the input data file, or the
	NAOR card in the control data file

11) *** IMPOSSIBLE TO GET SEGMENTS ***

Routine: Explanation:	SEGS2 (CONT30) (X, Y, Z) input points cannot be
2	divided into segments, because the
	density of points is too big. It
	gives more than 500 points by
· · · · · · · · · · · · · · · · · · ·	segment
Program action:	stop
User action:	see programmer to modify the calculation of the number of segments in routine SEGS1 (CONT30)

12) *** ARRAY TOO LARGE FOR SRTPT ***

Routine: Explanation:	SRTPT (CONT30) the number of points to sort in one segment exceeds the limit fixed in SRTPT (10,000 points)
Program action: User action: Note:	<pre>stop see programmer this error should never occur, as the number of points per segment is fixed to 500 in routine SEGS2 (CONT30)</pre>

13) *** NORMAL EQUATIONS UNSTABLE AT ORDER XXXXX. REDUCED BY 1 ***

Routine:	•	TREND (CONT50)
Explanation:		the matrix of normal equations for
		a trend surface could not be
		inverted

Program action:	if the order of polynomial is between 2 and 4, the program reduces the order by 1 and tries again to calculate the trend surface. If not, it prints error	
Heen estimat	message number 14	
User action:	none	
Note:	this message appears on the	
· · ·	terminal, as well as on the printer file	

14) *** ABNORMAL TERMINATION. IORD OUT OF RANGE ***

Routine:	TREND (CONT50)
Explanation:	the matrix of normal equations for
	a trend surface could not be
	inverted for an order equal to l
Program action:	stop
User action:	none

SETUP (CONT60)

15) *** IMPOSSIBLE TO PLOT: ARRAY IS TOO BIG ***

Routine: Explanation:

Program action: User action: the grid which was calculated is bigger than 2500, the maximum size for the plot read next control card if the plot is desired with posting of (X, Y, Z) input data points, run CTRL2D before running CONTUR. If the plot is desired without posting the input data points, run CTRL2D with the grid created by this current run of CONTUR; then run CONTUR with the new control and input data files

16) *** ERROR NO. XXXXX FOR CONTOUR LEVEL XXXXX, followed by the description of grid cell and sub-cell.

Routine:	DRAW (CONT70)
Explanation:	the current track is stuck in a sub-cell
Program action:	start the next track
User action:	see programmer
Note:	this message appears on the
(r_{1}, \ldots, r_{n})	terminal, as well as on the printer file

17) *** MORE THAN XXXXX GRID CELLS USED FOR CONTOUR LEVEL XXXXX ***

Routine: Explanation:	CSUB (CONT70) there are too many grid cells used for one contour level
Program action: User action:	start the next contour level run CTRL2D with a lower maximum
USEL ACCION:	size of Z-value array; it will divide the map in several parts. Then run CONTUR with the new control and input data files
Note:	this message appears on the terminal, as well as on the printer file

18) *** ARRAY FOR MULTI-CROSSING IS TOO SMALL ***

Routine: Explanation:	TRAK (CONT70) there are too many grid cells which contain a multi-cross of the same contour level
Program action: User action:	stop see programmer to increase the size of array IDOUBL in overlay CONT70

After the program has stopped because of an error during the run, look at the printer file to find the error message, then delete the following files if they exist:

- DB1:FOR001.DAT
- DB1:FOR002.DAT
- DB1:FOR004.DAT
- plotter file
- printer file
- output grid file

If the program has been aborted during a run, the above files should be deleted, and the following files unlocked: - CONTUR.CTR (control data file)

- input data file.

Errors in the plot

1). Unfinished contour levels.

The program prints error meassage number 17 for this type of error. If the user action advised for such an error is not desired, the arrays IJX, KLIN, KLOUT in overlay CONT70 may be increased but in such a way that the overlay is not too big.

2) Loop on a track.

This is usually due to error number 18. It could also be due to error number 16, but this kind of error has not occurred until now.

3) Very close contours at border of map. These occur near the blank areas and seem to be due to the manner of interpolating values in the 4 x 4 matrix surrounding one grid cell, when one or more of the values of the extreme row or column are blank values. The routine CBLANK in overlay CONT70 may be modified to avoid this problem.

Directions for use of program

To run the program, enter RUN CONTUR(\$)¹. When the program is finished, a message is printed on the terminal. If an error occurs, see the section on error messages.

There are two files needed to run CONTUR: the input data file, and the control data file. To create the input data file, follow the directions given in the description of the FMT, GRID, RDGD control cards. The control data file is named "CONTUR.CTR".

There are two ways to create the control data file: running the program CTRL2D, or using the EDI utility program. It is advised to use the program CTRL2D and to read the documentation of that program. Note that the input data file must exist before running the program CTRL2D. That program will create a control data file and a new input data file ready to be used by the program CONTUR.

It is necessary to run CTRL2D prior to CONTUR for plotting a contour map of a large array, as CTRL2D will divide the map into several adjacent parts. But in some cases, it could be of interest to use CONTUR directly; for example, to calculate a large grid without plotting the contour map.

The symbol (\$) means ALTmode or ESC key.

EXAMPLES

Following are two examples of runs of the program CONTUR. In the first one the grid is calculated, and in the second one the grid is entered as input data.

Example number one

The map to be produced is a contour map of the total intensity of the aeromagnetic field. The X and Y values are in kilometers, the Z-values in gammas.

The input data file "DBl:TEST5A.DAT" was output from another program, and contains the (X, Y, Z) values of the data points, with one point per record. The control data file "TEST5A.CTR" was created with the EDI utility program, its contents are shown on page 43.

The NAOR card indicates that the fitting polynomial is of the first order, and the search for neighbors is performed in a circle of 3.2 km of radius around each grid-mesh point. The X and Y limits of the grid are given in km in the REGN card. The size of the grid is given in the GRID card. The number of input data points and the place of the (X, Y, Z) values in the data records have the default values.

The Z-values to be contoured are given level by level from 5200 to 7000 gammas in the LEVL cards. The POST card instructs the program that tick marks are to be plotted at each (X, Y, Z) input data point, with a height of 0.04 inches, but with no indication of the Z-value.

The first DRAW card gives the size of the map in inches, instructs the program that there are 10 divisions for X and Y in each grid cell, and indicates to plot the box boundary. the second DRAW card gives -1.E35 as a Z-value for blank areas; this is the value given to grid-mesh points with not enough neighbors around them.

To run the program CONTUR, the control data file "CONTUR.CTR" was created by duplicating the file "TEST5A.CTR".

The printer file "DB1:TEST5A.PNT" resulting from the run is shown on page 44, and the plot appears in figure 2. The general title and the label "....END OF PLOTS" are outside the figure.

Here are the sizes of the files used for this example.

Filename	No. of blocks of	disk space
DB1:TEST5A.DAT	130	
TEST5A.CTR	5	
DBI TESTSA DNT	14	

DB1:TEST5A.PLT

The time to run the program CONTUR was 15 minutes, and the time to plot was 30 minutes.

Example number two

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The map to be produced is a topographic map, with the elevations in meters.

The input data file"DB1:TESTC1.DAT" was created with the EDI utility program, and its contents are shown on page 47. The control data file "TESTC1.CTR" was created with the program CTRL2D, and its contents are shown on page 48.

The RDGD card gives the number of columns and rows of the grid, and indicates that the data are to be read in by row. The FMT card specifies the format to read the Z-values. The Z-values to be contoured are equidistant, with an interval of two meters.

The first DRAW card gives the size of the map in inches, and instructs the program that there are five divisions for X and ten divisions for Y in each grid cell. The box boundary is not plotted, there will only be a '+' at each corner of the map. The second DRAW card gives -1. as a Z-value for blank areas.

After running the program CTRL2D, the new input data file "DB1:CONTUR.DAT" and the new control data file "CONTUR.CTR" were created; they are shown on page 49.

The printer file "DB1:TESTC1.PNT" resulting from the run of the program CONTUR is shown on page 50, and the plot appears in figure 3. The general title and the label "...END OF PLOTS" are outside the figure.

Here are the sizes of the files used for this example.

Filename	No. of blocks of disk space
DB1:TESTC1.DAT TESTC1.CTR	3
DB1:CONTUR.DAT	5
CONTUR.CTR	2
DB1:TESTC1.PNT	15
DB1:TESTC1.PLT	177

The time to run the program CONTUR was 5 minutes, and the time to plot was 20 minutes.

FILE : TEST54.CTR

DB1:TEST5A.DAT DB1:TFST5A.PNT DB1:BID. DB1:TEST5A.PLT TEST NO. 5A, 5 APR 80, M.DONZEAU PMT (A1, 3E13.7) Ø 1 3.200000 NAOR 813.5297 744.8433 847.6560 702.6623 REGN Ø 42 40 Ø GRID 5200,000 0.0000E+00 LEVL LEVL 5650.200 0.0000E+00 5700.000 0.03002+00 LEVL 0,2000E+30 LEVL 5800.000 LEVL 5980.900 0.00002+00 0.0000E+00 LEVL 6000.000 0.0000E+00 LEVL 6190.990 6200.300 0.0000E+00 LEVL 6690.000 0.00002+00 LEVL 0.0000E+00 7000.000 LEVL 9.0400 2 POST TITL AIRMAG N22.30-23.30/E41-42 SCALE 1:1000000 4.049338 10. 4.356579 DRAW1 10. -,1000E+36 DRAWZ STOP

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0

8

END OF FILE : TEST54.CTR

CALCOUP CONTOURING SYSTEM- MODIFIED MAR, 1979

37-APR-84 48156137

CONTRAL CARD FILENAME ;	CONTUR, CTR
INPUT DATA FILENAME ;	D91:TE9T54, DAT
PRINTER FILENAME ;	D91:TE9T54, PNT
DUTPUT GRID FILENAME :	DB1:BID.
PLOTTER FILENAME :	DB1:TEST54,PLT

TITLE FOR THE PUN : TEST NO. 54, 5 ADR 80, M.DONZEAU

FMT (41 3-4	85865999.6	A. 73777808	9,96989669	9,39999499	3,20000000	8.84883883	PLOTTER BLOCK	1
(41,3E1 NAOR REGN GRID	3./} 0.27227909 744.84339 0.02277902	1.0777300 847.55601 47.777777	3.2702027 777.66229 47.20407P	3,33333483 813,52472 2,373330433	9°34969986 9°34969986 9°34969986	8.73008088 8.83080888 8.34888888	PLOTTER BLOCK Plotter block Plotter block	1 1 t
TOTAL N	O CE INPUT DATA :	DINTS : 15	66					-
NO OF 5 NO OF H	EGMENTS TO STORE Orizontal segment	ІНРОТ ВАТА РЭТН' 13 8 — 5		FILE = 30 ICAL SEGMENTS =	ô			
SEGHENT	NO# 1 HoR.VF:	. 1 1	NO DE L	NPHT PRINTS.	112			

SEGUENI	NU	1	404, 7538	1	1	ND	Q₽	INPUT	POINTSE	132
SEGMENT	NC=	2	409, VER#	5	1	N0	0.	INPUT	POINT\$#	131
SEGMENT	N0.	3	407,VE7*	3	1	NO	0 F	INPUT	POINTŠe	124
SEGMENT	NOB	4	403,VE3=	4	1	NG	0F	INPUT	POINTS	136
SEGMENT	N C O	5	409,VE9=	5	1	NO	0F	INPUT	POINTSE	144
SEGMENT	N0.	6	HAR, VERS	. 6	1	N0	0F	INPUT	POINTAN	132
SEGMENT	N () #	7	HOR, VERE	1	2	NO	0F	INPUT	POINTSE	141
SEGMENT	NC=	8	HOR, VERE	5	2	NÖ	0F	INPUT	POINTSE	96
SEGMENT	NOR	9	402.VE3=	3	2	NO	0F	INPUT	POINTSE	58
SEGMENT	NG∎	. 10	HOP,VER=	4	5	NJ	GF	INPUT	POINTSE	87
SEGMENT	NG#	11	409, VE2=	5	2	ND	٥F	INPUT	POINTS	130
SEGMENT	∧ (]#	12	403.VE3=	5	2	NG	0F	INPUT	POINTSE	123
8EGMENT	N Ú #	13	40₹,v£₹*	1	3	NO	OF	INPUT	POINTSE	124
SEGMENT	N:0 #	14	HOR,VERE	5	3	NG	0F	INPUT	POINTSE	40
SEGMENT	N0=	15	409,VE3=	3	3	NO	0F	INPUT	POINTSE	6
SEGMENT	NC≡	16	407, 452=	4	3	N0	OF	INPUT	POINTŠa	. 51
SEGMENT	NGE	17	494,754=	5	3	NO	QF	INPUT	POINTŠe	142
SEGMENT	20 E	- 15	-0-,vEsa	5	3	NO	0F	INPUT	POINTSE	132
SEGMENT	∧:0=	19	HOR,VER.	1	4	NO	0F	INPUT	POINTSE	97
SEGMENT	NÛB	20	HUS'AESE	5	4	ND	0F	INPUT	POINTSE	17
SEGMENT	N () 🛢	21	HOR,VERA	3	4	NO	QF.	INPUT	POINTS	2
SEGMENT	NGB	55	40 7 ,v£₹#	4	4	NO	0F	INPUT	POINTSE	76
SEGMENT	∿0 ≢	\$3	HAR,VERE	5	4	NO	QF	INPUT	POINTŠE	141
SEGMENT	NQ #	\$4	HUG, VESE	5	4	NO	0F	INPUT	POINTS:	138
SEGMENT	N:0 =	25	HOR,VEPE	1	٩.	201	9F	INPUT	POINTSE	63
SEGMENT	NQ#	50	403,VES#	5	5	CM	0F	INPUT	POINTSE	9
SEGMENT	NU#	27	403.VE68	3	4	NJ	0F	INPUT	POINTSE	29
SEGMENT	N () •	28	and,vesa	4	5	NO	0F	INPUT	POINTSE	106
SEGMENT	~Q#	23	407,VE7.	5	٩	NO	0F	INPUT	POINTSE	134
SEGMENT	N0.	3	HOP, VERE	5	5	N0	05	INPUT	POINTSE	144
SEGMENT	×ü∎	31	HOR, VERE	1	6	NQ	0F	Input	POINTSE	101
SEGMENT	N() =	32	404,754*	5	6	N 0	0F	INPUT	POINTS	99
SEGNENT	NO.8	33	HOR.VER.	3	A	N 0	QF	INPUT	POINTS	109
SEGMENT	NÚ	34	HOR, VERE	4	6	NO	OF	INPUT	POINTSE	136
SEGMENT	N0*	35	HUS'AESS	- 5	8	. ND	٥F	INPUT	POINTSE	124
SEGMENT	NÜR	36	HUS'AESS	5		N D	0F	INPUT	POINTȘE	132

TIME FOR WRITING SEGMENTS INTO SCRATCH FILE

3.16 MINUTES

1581 GPID HESH POINTS ARE VALUED AS FOLLOWS 1 1039 ARE INTERPOLATED WITH A MEAN OF 904 ARE EDUAL TO INPUT DATA POINTS 438 ARE UNDEFINED BY RADIUS-CHECKING 4 INPUT DATA POINTS

GPIDDING		4.13	MINUTES			• .			
5200.3000	3,223334490	% %	8,03333494	8,00000000	3,38888888	PLOTTER	PLOCK	1	
5002.007770		3.333049							
\$703.078877		3,233033							
5803.039779		9,999999							
8927. 327230		9.993000							
6023.097330		2.299009							
5107.037370		3.303000				•			
8203 UAABAA		9,999996							
6607 027379	· *	000666.5							
7000.000000		3. 333000						•	
			0.00000000	8.20200020	3.03003000	PLOTTER	BLOCK	1	
			0.00000000	3.39399309				1	
			•	• • • • • • •				•	
			10.222402	2.20220200	8,0300008	PLOTTER	BLOCK	1	
-0.12723200E+36		0 0000000	•	• • • • • • • •	••••	PLOTTER		ī	
	5270, 7843 5007, 047776 5007, 047776 507, 047776 507, 047776 607, 047776 607, 047776 607, 047776 607, 047776 7077, 047777 7077, 047777 70777, 0477777 707777 70777777 7077777777777 70777777	5270,3787 500,07737 573,233337 503,07337 503,07337 503,03737 503,03737 503,03737 503,023737 503,023737 503,023737 503,023737 503,023737 503,023737 504,003737 504,003737 504,003737 4,3565791 4,949337 4,5565791	\$2200,3003 3,82332400 3,82332400 \$503,403330 3,82332400 3,823020 \$733,23333 3,823020 3,823020 \$633,233373 3,823020 3,823020 \$633,2333730 3,823020 3,823020 \$623,2033730 3,82000 8,8202 \$123,23370 3,82000 8,2202 \$623,2033730 3,200020 8,200020 \$623,2033730 3,200020 3,200020 \$623,2033730 3,2000200 3,2000200 \$723,2373730 3,20002000 3,20002000 \$723,203,203 3,20002000 3,20002000 \$739999996,002,0131 3,20002000 3,20002000 \$723,274,7373 3,20002000 3,20002000 \$739999996,002,0131 3,200020000 3,200020000 \$72,37,7474 3,700020000 3,200020000 \$72,37,7474 3,700020000 3,200020000 \$72,37,7474 3,700020000 3,200020000 \$72,37,7474 3,700020000 3,200020000 \$73,77474 3,200020000 <	\$270.78%3 3.7378490 3.00000000 0.0000000 \$507.047788 3.000000 0.0000000 0.0000000 \$732.37878 3.00000 0.000000 0.000000 \$833.0778 3.00000 0.000000 0.000000 \$607.07787 3.00000 0.000000 0.000000 \$607.07787 3.00000 0.000000 0.000000 \$607.07787 3.00000 0.000000 0.0000000 \$607.07787 3.00000 0.0000000 0.0000000 \$607.07787 3.000000 0.0000000 0.0000000 \$607.07787 3.0000000 0.0000000 0.0000000 \$00000000 7.00000000 0.00000000 0.00000000000000000000000000000000000	\$270.78%3 3.737849 0.28000000 0.0300000 0.0300000 \$507.047738 0.230000 0.0300000 0.0300000 \$732.238373 0.230000 0.030000 \$607.027373 0.230000 \$607.027373 0.230000 \$607.027373 0.230000 \$607.027373 0.200000 \$607.027373 0.200000 \$607.027373 0.200000 \$607.027373 0.200000 \$607.027373 0.200000 \$607.027373 0.2000000 \$607.027373 0.2000000 \$607.027373 0.2000000 \$607.027373 0.2000000 \$0.0000000 0.2000000 \$0.00000000 0.20000000 \$0.00000000 0.200000000 \$0.00000000000000000000000000000000000	\$270.78%3 3.737849 0.280000000 0.03000000 0.0000000 0.0000000 \$507.047738 0.030000 0.0300000 0.0000000 0.0000000 0.0000000 \$732.238373 0.030000 0.030000 0.0000000 0.0000000 0.0000000 \$607.07738 0.030000 0.030000 0.0000000 0.0000000 \$607.07737 0.0000000 0.0000000 0.0000000 0.0000000 \$607.07737 0.0000000 0.0000000 0.0000000 0.00000000 \$107.07737 0.0000000 0.00000000 0.00000000 0.00000000 \$107.07737 0.0000000 0.00000000 0.00000000 0.00000000 0.000000000 \$107.07737 0.00000000 0.00000000 0.000000000 0.000000000 0.000000000 \$2.39999990000 0.00000000 0.00000000 0.00000000000000000000000000000000000	\$270,78%7 7,777,787 7,777,787 7,777,787 7,777,778 <th 7,778<<="" td=""><td>\$270,38%3 3,23338490 3,0000000 0,0000000 0,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,00000000 9,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,00000000 9,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 607,07378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 7073,07378 3,0000000 3,0000000 3,0000000 3,0000000 PLOTTER BLOCK 9,0000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 9,0000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 9,00000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 12,30-93379 4,3565791 13,0000000 10,0000000 3,00000000 0,000000</td></th>	<td>\$270,38%3 3,23338490 3,0000000 0,0000000 0,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,00000000 9,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,00000000 9,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 607,07378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 7073,07378 3,0000000 3,0000000 3,0000000 3,0000000 PLOTTER BLOCK 9,0000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 9,0000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 9,00000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 12,30-93379 4,3565791 13,0000000 10,0000000 3,00000000 0,000000</td>	\$270,38%3 3,23338490 3,0000000 0,0000000 0,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,00000000 9,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,00000000 9,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 5003,047378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 607,07378 3,0000000 3,0000000 3,0000000 9,0000000 PLOTTER BLOCK 7073,07378 3,0000000 3,0000000 3,0000000 3,0000000 PLOTTER BLOCK 9,0000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 9,0000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 9,00000000 3,00000000 3,00000000 3,00000000 3,00000000 PLOTTER BLOCK 12,30-93379 4,3565791 13,0000000 10,0000000 3,00000000 0,000000

POSTING ON BLOCK 2

TIME FOR POSTING / MESH / TICKS

3,56 MINUTES

CONTOURS ON BLOCK	3								•		
CONTOUR LEVEL :	5242.222000	NO	ÛF	GRID	CELLS	1	. 3	POURCENTAGE	13	8.80	x
CONTOUR LEVEL 1	5692.000000	NO	0F	GRID	CELLS		13	POURCENTAGE	1	8,59	X
CONTOUR LEVEL :	5773.233200	NO	0F	GRID	CELLS	1	48	POURCENTAGE	1	2.86	x
CONTOUR LEVEL :	5570.202000	ND	ÛF	GRID	CELLS	1	250	POURCENTAGE	1	15.47	x
CONTOUR LEVEL :	5987.232830	NO	0F	GRID	CELLS	1	528	POURCENTAGE	1	30.22	X.
CONTOUR LEVEL :	6293.302983	NO	0F	GRID	CELLS	1	278	POURCENTAGE	1	15.26	z
CONTOUR LEVEL .	6193.093900	NO	0F	GRID	CELLS	1	113	POURCENTAGE	1	6.72	x
CONTOUR LEVEL :	6297.202030	ND	0F	GRID	CELLS	I.	53	POURCENTAGE	1	3,15	x
CONTOUR LEVEL :	6573.777770	NB	0₽	GRID	CELLS	1	2	POURCENTAGE	1	0.00	x
CONTOUR LEVEL :	7232.382239	NÖ	0F	GRID	CELLS	1	9	POURCENTAGE	1	0.00	X

TIME FOR CONTOURING

7.00 MINUTES

3.30309000

0.00000000

PLOTTER BLOCK

STOP Stop	0.00007000 07-178-80	3.00000000 39:11:16	9,99999999	9,99999999
•				

AIRMAG N22.30-23.30/E41-42 SCALE 1:1000000

Figure 2.-Total intensity aeromagnetic map of the area around Harrat al Kishb, Kingdom of Saudi Arabia (values in gammas, contour interval 100 gammas).

FILE : DRI:TESTCI.DAT

144,70000 138,28999 139,78999 141,94000 140,81000 141,16000 145,45000 150,92999 146,12000 143,75999 149,21001 155,99001 152,60001 157,92999 161.59000 153,16000 151,34000 147,46001 139,17999 141,60001 145,21001 145,08000 148,20000 151,05000 145,55000 137,02000 147,78000 142,55000 150,11000 159,88000 174,59000 169,83000 148,19000 144,28999 145,15000 141,99001 133,84000 139,49001 144.63000 141,08000 138,73000 136,53000 135,63000 139,23000 143,53000 153,33000 154,92999 165,23000 147,95000 143,20020 141,91000 139,42999 138,23000 130,66000 132.03000 131,63000 132,23000 135,56000 134,56000 138,75999 145,36000 147,36000 150,56000 156,56000 133, 53020 139, 63020 135, 52020 136, 03999 133, 64000 129, 44000 134, 84020 140, 44000 149,14000 145,50000 147,08000 144,00000 151,00000 156,39999 157.30000 161,89999 133.81000 128.09020 127.61700 128.41000 128.61000 130.41000 134.71801 139.61008 148, 50999 154, 31000 149, 98000 152, 11000 150, 00999 148, 41000 145, 50999 144, 00999 127.46000 125.55000 126.56000 131.25999 133.86000 130.56000 135.86000 139.00999 140,71001 149,65000 158,8000 155,03999 149,24001 147,12000 147,83000 148,33000 124,77000 126,47000 136,57001 138,53000 133,61000 131,78999 132.74001 135,94000 137,34000 146,53999 156,14000 163,00999 154,89999 151,45000 147,67999 149,31000 130,92999 129,92999 137,33000 147.23000 142.89000 137.28000 142.80000 138,96001 135,84000 140,94000 145,14000 155,94000 161,66000 153,50000 149,30000 153,86000

47

END OF FILE : DB1:TESTC1.DAT

FILE : TESTC1.CTR -

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DB1:TESTC1.DAT DB1:TESTC1.PNT DU1:BTD. DB1:TESTC1.PLT TEST NO. CI, 7 APR 80, M.DONZEAU PMT (8F10.0/8F10.0) PRNT 3 RDGD 15 9 2 110.0000 2.00000 LEVL 180.0000 TITL SCALE 1:2200 5.905500 6.290111 TOPOGRAPHY. DRAW1 5. 10, 1 DRAW2 -1.000000 STOP

FILE : DRI:CONTUR.DAT

•	
0.1447000E+030.1382900E+730.1397900E+030.1419400E+030.1408100E+030.1411	500E+03 1
3.1454520E+030.1529322E+232.1461220E+232.1437602E+030.1492120E+032.1859	900E+03 1
0.1525070E+030.1579307E+738.1615900E+030.1631600E+03	1
0,1513439E+030,1474677E+737,1391830E+733,1416300E+030,1452130E+030,1453	800E+03 2
0.1482000E+030.1510502E+030.1455500E+030.1370200E+030.1477800E+030.1425	500E+03 2
a,1501100E+030,1598502E+033,1745900E+030,1698302E+03	2
0.1481970E+030.1442977E+037.1451670E+730.1419900E+730.1338400E+430.1394	900F+03 3
9.14819762+030,14279782+034,14510062+330,14199022+330,13663065433,1302	3005-03 3
0.1446300E+030.1412807E+030.1387300E+030.1365300E+030.1366300E+030.1392	3
0.1435300E+030.1533300E+030.1549300E+730.1652300E+03	600E+03 4
0,1479570E+030,1432000E+030,1419100E+030,1394300E+030,1382300E+030,1386	
0,1320320E+030,1316307E+037,1322300E+030,1355600E+030,1345600E+030,1387	500E+03 4
0,1453600E+030.1473600E+030.1505600E+030.1565600E+03	4.0.0 E . 4.3 E
0.1335320E+030.1396307E+237.1355720E+732.1367402E+230.1336422E+032.1294	4002+03 0
0_1348420E+030_1404407E+737,1491407E+730.1455000E+030,1400800E+030,1440	202E+03 5
7_1519070E+030_1564777F+737,1573770E+730,1619000E+03	5
0.133e120E+030 1282922E+232 1276120E+232 1284100E+230 1286120E+032 1324	1005+03 5
0,1347130E+030,1396100E+030,1465100E+030,1543100E+030,1499800E+030,1521	100E+03 6
3.1507130E+030,1494137E+730,1455130E+730,1440100E+03	6
0.1274630E+030.1255607E+037.1255600E+030.1312600E+030.1338600E+030.1305	600E+03 7
0,1358600E+030,1390100E+030,1407100E+030,1496600E+030,1588000E+030,1550	400E+03 7
0,1492420E+030,1471202E+030,1478300E+030,1483300E+03	7
0.12477 JAE+030.12547 77E+03\$,13657 JAE+730.13853 JOE+030.13361 JOE+030.1317	9002+03 8
0.1327400E+030.1359400E+039.1373400E+030.1465400E+030.1561400E+030.1630	100E+03 8
0,1549770E+237.1514507E+732.1476800E+730.1493100E+03	8
0.1309377E+230.1299377E+237.1373320E+230.1472302E+230.1428922E+432.1372	800E+03 9
0.1428030E+030.1389602E+030.1355400E+030.1409403E+030.1451400E+030.1559	4025+03 9
0,14590000000,138900024030,1303400070305400017030,180940017030,140017030,1004	9
0.1616670E+030.1535000E+037.1493720E+730.1538600E+03	•

123123123123123123123123123123

END OF FILE : DB1:CONTUR.DAT

FILE : CONTUR.CTR

DB1:Cn	411P .				
DØ11TES	5101.	PNT			
0811810).				
DØ11TES	STC1.	PLT			
			P# 89.	M.DONZEA	U
РИТ		•			Ŧ
r	276F	13.7/	1.	4E13.7)	
	ZIUL	12.11		4618814	
PRNT			Э		
RÚBD			16	9	· 2
LEVL		118.	0300	2,939300	180.0000
TITL		_			
TOPOGRA	APHY.	gC	ALE 1:	2303	
DRAW1		5.90	5590	5,299111	5.
DRAWE				3389E+038	. 33308-33
\$]0P					

END OF FILE : CONTUR.CTR

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CALCOMP CONTOURING SYSTEM- MODIFIED MAR,1979 37-APR-60 11154:22

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CONTROL CARD FILENAME :	CONTUR, CTR
INPUT DATA FILENAME :	DB1:CONTUR.DAT
PRINTER FILENAME 1	DB1:TESTC1.PNT
OUTPUT GRID FILENAME :	001:010.
PLOTTER FILENAME :	DB1:TESTC1.PLT

TITLE FOR THE PUN : TEST NO. C1. 7 APR 88, M.DONZEAU

FHT	2.32033037 216E13.7/),	7.93479890 4813.7)	7, 3730,9333	0.39499499	9.30330300	3,03833893	PLOTTER BLOCK	1
PRNT	R5459685 B	66666669	8. 37403433	0.00000000	3.20232336	2.03033303	PLOTTER BLOCK	1
30GD	16.000000	0.0777000	2.0300030	3,33333493	8. 400000M	9.999999966	PLOTTER BLOCK	ĩ
TIME FO	DR READING PREGR	10000 DATA	3.	26 MINUTES				
LEVL	112.00000	2. 6777298	197.22020	8.32363084	3.30384848	3.000000000	PLOTTER BLOCK	1
TOPOGRA	А. 5787522 11 ЭНУ. 9САЦЕ 11	2000 R R R S S G . K	9.54949999	5,39999963	9.99959999	2.42999999	PLOTTER BLOCK	1
DRANI	5,9054999	5.2991149	5.9882349	10.000000	1.8380846	3.33034300	PLOTTER BLOCK	1
94145	-1,3035630	20285866.6	20220206.6				PLOTTER BLOCK	1
	_ 1	2 3	4	5	5	7 ರೆ	v	10

1	144,70000	139.29999	139,75999	141,94202	149.81200	141.16000	145,45002	150,92999	146,12000	143,75999
2	151.34330	147 45271	139,17999	141.62001	145,21261	145,23334	148,20062	151.05000	145,55800	137,02000
3	148,19282	144 29999	145.16322	141.99001	133.84000	139,49001	144.63000	141,48040	158.73200	136,53000
۵	147,95722	143.23777	141.91778	139,42999	138,23200	130,55000	132,33000	131.03000	132.23100	135,56000
5	133,53200	130 63227	135,52823	136.03999	133,64000	129,44020	134,84068	140.44040	149,14000	145.50200
6	133.81202	128, 399778	127.61777	120.41000	128.61223	130.41000	134.71001	139.61999	146,52999	154.31000
,	127.46747	125 55772	126.55377	131.25999	133,86200	130,55040	135,86000	139.00999	142,71001	149.55222
8	124,77702	124 47272	135.57321	138,53200	133.61240	131,78999	132.74001	135,94000	137,34000	146,53999
Ģ	130,92999	153 35638	137.33727	147.23707	142.89200	137,28000	142,86600	138,96801	135.84460	140,94000

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	11	12	13	14	15	15
1	149.21701	155,99781	152.60071	157,92999	161,59300	163,15000
2	147.78772	142 55778	152,11077	159 88400	174,59000	169.83040
3	136,63222	139 23337	143,53020	153.33420	154,92999	155,23020
4	134,56747	138 75999	145,36777	147.36807	150,56200	156,56040
5	140.28242	148 37279	151.22228	156,39999	157.32202	161,89999
6	149,98220	152 117 77	150,20999	149.41902	145,50999	144.20999
7	158,80707	192 23999	149.24871	147 12828	147,83220	148,33000
8	156.14707	153 22999	154,89999	151.45000	147,67999	149,31000
9	145.14707	155,94872	151.55222	153,53303	149,30000	153.85020

TIME FOR PUNCHING AND PRINTING

0.14 MINUTES

TIME FOR POSTING / MESH / TICKS

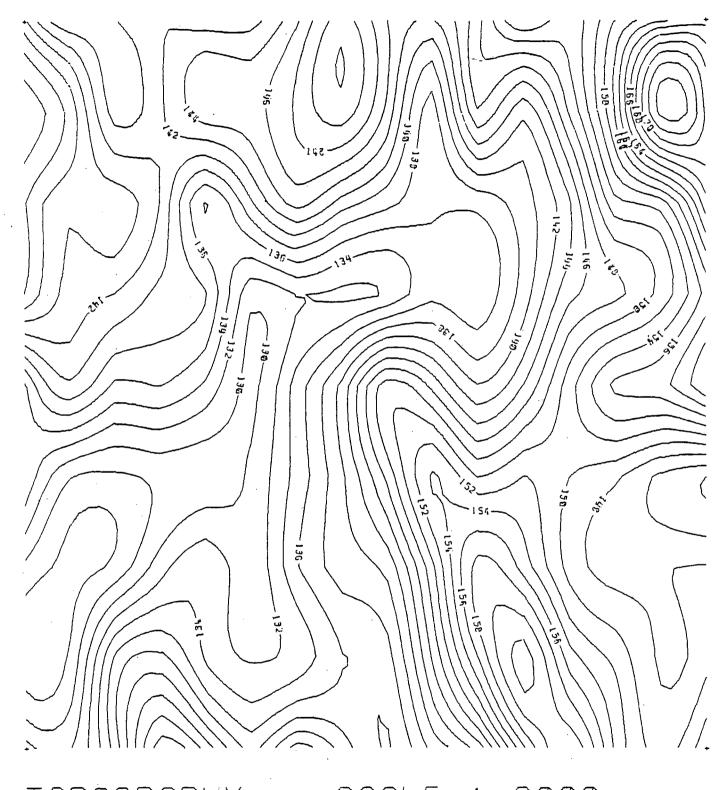
2.00 MINUTES

CONTOURS ON BLOCK	2						
CONTOUP LEVEL :	117.337230	NO OF	GRID	CELLS :	2	POURCENTAGE #	0.00 X
CONTOUR LEVEL	112.000000	NO OF	GRID	CELLS :	3	POURCENTAGE :	0.00 %
CONTOUR LEVEL	114.027720	NO OF	GRID	CELLS :	3	POURCENTAGE 1.	3.80 X
CONTOUR LEVEL :	116.000200	NO OF	GRID	CELLS :	2	POURCENTAGE :	0.00 X
CONTOUR LEVEL :	118.227720	NO 07	GRID	CELLS :	3	POURCENTAGE I	9.20 X
CONTOUR LEVEL :	193.232929	NO OF	GRID	CELLS :	6	POURCENTAGE I	3.00 %
CONTOUR LEVEL :	122.3329.20	NO OF	GRID	CELLS :	а	POURCENTAGE :	0.08 %
CONTOUR LEVEL 1	124.387780	N0 0F	GRID	CELLS I	6	POURCENTAGE :	0,00 X
CONTOUR LEVEL :	126.000000	NO OF	GRID	CELLS :	8	POURCENTAGE I	5,56 %
CONTOUR LEVEL :	128.373700	NO OF	GRID	CELLS I	9	POURCENTAGE :	6,25 %
CONTOUR LEVEL :	138.222700	NO OF	GRID	CELLS #		POURCENTAGE :	11.81 X
CONTOUR LEVEL :	132.020040	NO OF	GRID	CELLS :		POURCENTAGE I	19,44 %
CONTOUR LEVEL 1	134.307799	NO OF	GRID	CELLS I	32	POURCENTAGE I	22.22 X
CONTOUR LEVEL :	136.000000	ND OF	GRID	CELLS :		POURCENTAGE 1	27.78 X
CONTOUR LEVEL :	138.232,00	NO OF	GRID	CELLS I	43	POURCENTAGE :	29,86 X
CONTOUR LEVEL 1	199.999494	NO OF	GRID	CELLS :	••	POURCENTAGE :	28,47 X
CONTOUR LEVEL :	142.042700	NO 0F	GRID	CELLS :		POURCENTAGE :	31,25 X
CONTOUR LEVEL :	184.022200	NO OF		CELLS :	45	POURCENTAGE #	31.25 X
CONTOUR LEVEL :	146,222720	40 OF		CELLS :	42	POURCENTAGE 1	29,17 X
CONTOUR LEVEL :	188.032300	NO OF		CELLS :		POURCENTAGE 1	29 . 17 %
GONTOHR LEVEL :	157.002020	NO OF		CELLS :		POURCENTAGE 1	25,80 X
CONTOUR LEVEL :	125.333299	NO OF		CELLS I		POURCENTAGE 1	22.22 X
CONTOUR LEVEL 1	144.000000			CELLS :		POURCENTAGE L	18.26 X
CONTOUR LEVEL :	156.232300			CELLS :		POURCENTAGE 1	14,58 %
CONTOUR LEVEL :	158.007709	NO OF		CELLS :		POURCENTAGE 1	12.50 X
CONTOUR LEVEL :	163.333300	NO OF		CELLS :		POURCENTAGE :	9.72 X
CONTOUR LEVEL :	145.995690	NO DE		CELLS :		POURCENTAGE 1	5,25 %
. CONTOUR LEVEL :	164.003000	NO 07		CELLS :		POURCENTAGE 1	3,47 X
CONTOUR LEVEL :	146.233900	NO OF		CELLS :		POURCENTAGE 1	2.78 X
CONTOUR LEVEL #	158.003000	NO OF		CELLS :		POURCENTAGE 1	2.78 X
CONTOUR LEVEL :	173.000000	NO OF		CELLS :		POURCENTAGE :	2.78 X
CONTOUR LEVEL :	172.007920	NO OF		CELLS :		POURCENTAGE :	2.78 X
CONTOUR LEVEL :	174.22222	NO OF		CELLS :		POURCENTAGE 1	2.78 X
CONTOUR LEVEL :	126.203020	NO OF		CELLS :		POURCENTAGE :	0.00 X
CONTOUR LEVEL :	178.393000	NO OF		CELLS :		POURCENTAGE 1	0.00 X
CONTOUR LEVEL 1	183.333930	NO OF	GRID	CELLS :	9	POURCENTAGE E	9.88 X

TIME FOR CONTOURING

3.75 MINUTES

	STOP Stop	TIME:	0.09003009 07-4PR-80	7,03070000 11158151	9.69099999	9.99999499	3*983898989	8.03988889	PLOTTER BLOCK	3
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TOPOGRAPHY, SCALE 1:2000

Figure 3.-Topographic map of Muzubiah area, Kingdom of Saudi Arabia (values in meters, contour interval 2 meters).

SOURCE PROGRAM LISTING

The source program listing is not reproduced here as it is quite big. It is stored in the Geophysics section of the U.S. Geological Survey office in Jiddah, and is at the disposal of the people interested in it.

ACKNOWLEDGEMENTS

All the modifications of the CALCOMP version of the program described in this report were made partly by J. Bobillier and J. -P. Veyrier from BRGM/Jiddah, and partly by B. Dixon, L. North, and M. Donzeau from USGS/Jiddah.

REFERENCES

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