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DEC VAX VERSION OF MAGRAY

USERS GUIDE

VERSION 2.1

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## 1.0 INTRODUCTION

MAGRAV is a interactive computer program which aids in the modelling and interpretation of gravity and magnetic anomaly profiles in two and a half dimensions. It is termed two and a half dimensions because it allows the user to describe a body's shape in the plane of the profile but will only allow the user to describe the extent of the body perpendicular to the profile.

MAGRAV was first developed for use on a CDC CYBER 6400 running under NOS by I. Wells of the Bedford Institute of Oceanography in October 1977. It was then modified to run under NOS/BE by Terry Gordon of the C.S.C. in 1978. In 1982 Peter McGrath of the G.S.C. added two and a half dimensions and automatic body contrast adjustment.

Example models using MAGRAV are presented in section 7.5 Interpretation of examples of gravity and magnetic anomalies using MAGRAV of INTERPRETAION OF GRAVITY AND MAGNETIC ANOMALIES FOR NON-SPECIALISTS, orginized by A.K.Goodacre, May 18, 1986.

The present VAX version evolved from a version that John Broome of the G.S.C. had converted to VAX FORTRAN in 1986.

The present version allows the user to:

- 1) input actual gravity and/or magnetic anomalies;
- 2) input the coordinates and associated gravity and magnetic parameters of hypothetical two and a half dimensional bodies;
- 3) compute the anomaly that the hypothetical bodies would generate;
- 4) change coordinates and parameters of the hypothetical bodies either in text mode or graphics mode;
- 5) store the models on disk for later modifications;
- 6) use a variety graphics terminals.

MAGRAV is written in FORTRAN and uses the DATA PLOTTING DPICT/VGL graphics software.

The following is a list of the parameter limits:

maximum number of bodies .....	20
maximum number of body points per body .....	24
maximum number of observations .....	200

## 2.0 GETTING STARTED

MAGRAV is an interactive program. It can be used either in text mode or text/graphics mode depending on the type of terminal that is being used.

At the present time, the following two files must be in the users directory;

MAGRAV.COM  
MAGVGL.EXE

The procedure MAGRAV.COM must be executed so that the proper logicals are set up for the graphics routines. This procedure will also execute the program.

To begin the program enter the command:

@MAGRAV

At this point a few lines of system messages will be displayed. These are unimportant. The first information that the program requires is the type of device that you are using. A device is the type of terminal that you have used to log-on to the computer.

If you are using a text terminal that doesn't have graphics capabilities, enter NONE at this point.

If you are using a graphics terminal but are unsure of the device name the program is expecting or you are unsure that the type of terminal that you are using is supported, enter a ?. This will display a list of device names which are supported. Choose one and enter it when prompted.

If you have chosen a TEK40XX device, you will be asked if it is a CYBERNEX terminal which emulates a TEKTRONICS terminal. Answer yes to this if you are using a CYBERNEX GR4014 terminal. This will allow the program to switch the terminal between text and graphics modes.

Next you will be asked to enter the name of your MODELS FILE. If you have used the program before and wish to add a new model to a existing MODELS FILE or you wish to modify an existing model, enter the name of the file that you had created earlier. Otherwise enter a new file name for your models.

The program will then list the names of the models that are in your MODELS FILE. If it is a new MODELS FILE then no models names will be listed.

You will now be into the main body of the program and the command prompt ENTER OPTION : will be displayed.

### 3.0 BRIEF INSTRUCTIONS FOR FIRST-TIME USERS

#### 3.1 INTRODUCTION

This section briefly describes the steps to set up a basic model. The order of some of the commands is unimportant but it is recommended that you follow these steps until you become familiar with the program.

While the ENTER OPTION : prompt is displayed, the program will only look at the first four characters of any option to determine what you wish to do. Therefore, you may truncate all of the options to four characters.

#### 3.2 SETTING UP A MODEL

1) Give your model a name. Use the option MODEL , then enter a 1 to 10 character name. Note the upper and lower case is important. You will not get the same model if you define it in lower case then try to retrieve it at a later date using upper case.

2) Tell the program what type of modelling that you wish to do; either gravity or magnetics. Enter GRAVity for gravity modelling or enter MAGNetics for magnetic modelling.

3) Set the scale limits to be used for your model, enter SCALE. A list of the present scale settings will be displayed. To change a setting enter the letter that corresponds to the setting that you wish to change. The scale parameters are;

a) Field point minimum value.

If you want your field point observations to start at the edge of the graphics screen enter 0 or enter the offset in kilometers.

b) Field point maximum value.

If you want your field point observations to end at the edge of the graphics screen enter a value that is equal to number of field points minus one, times the field point spacing or enter a larger value.

c) Depth maximum.

This should be a little larger than the expected depths of the bodies.

d) Field point spacing.

Enter the distance between your observations in kilometers. Your observed data must have equal spacing.

e) Number of field points.

Enter the number of field point observations. This must be less than or equal to the field point maximum-minimum/spacing.

f) Anomaly minimum.

This should be a little less than your expected anomaly minimum.

g) Anomaly maximum.

This should be a little larger than your expected anomaly maximum.

h) Anomaly difference minimum.

This is the anomaly minimum scale to be used when you plot the calculated minus observed curve. i.e. when using the DIFFERENCE option. (see section 4.0).

i) Anomaly difference maximum.

This is the anomaly maximum scale to be used when you plot the calculated minus observed curve. i.e. when using the DIFFERENCE option (see section 4.0).

j) X grid spacing.

This is the distance between grid lines in the x direction when the body grid is turned on. This may be turned on with the SUPPRESS option (see section 4.0).

k) Z grid spacing.

This is the distance between grid lines in the z direction when the body grid is turned on. This may be turned on with the SUPPRESS option (see section 4.0).

4) Enter your field point observations if you have any, option OBSERVATION. This is an optional command because it is not necessary to have observations to create a model. If you use this option you will be asked to enter the field point number and its value. The field point number corresponds to the position of the field point. Number one is at the field point minimum value, number two is at the field point minimum plus the field point spacing, etc..

5) Enter your body positions, option BODY.

You may enter the body positions in text mode with this command or you may enter the body positions in graphics mode. If you used this command you will be asked for the body number, the half-strike length and the number of points in the body. Then you will be asked for N number of x,z pairs. Enter the x,z pairs in clockwise order.

6) Enter your body parameters, option PARAMETER .

You will first be asked to enter the body number or 0 to add to all bodies. If you enter 0, then the values you enter will be added to all the bodies. If you enter a body number then you will be asked for the values.

If you are modelling gravity, you will be asked for the density contrast minimum allowable value, the value to use and the maximum allowable value. The minimum and maximum allowable values are used when you use the automatic contrast adjustment option AMPL (see section 4.0) and are the lower and upper bounds over which the contrast can be adjusted.

If you are modelling magnetics you will be asked for the magnetization minimum allowable value, value to use, the maximum allowable value, declination and dip. The magnetization minimum and maximum allowable values are used when you use the automatic contrast adjustment option **AMPL** (see section 4.0) and are the lower and upper bounds over which the contrast can be adjusted.

If you wish to keep the density contrast or the magnetization a constant, then the minimum allowable value and the maximum allowable value should be set equal to value to use.

7) Repeat steps 5 and 6 until all bodies are entered.

8) Compute the hypothetical anomaly, option **ANOMaly** .

9) Enter graphics mode, option **GRAPHics** .

If you are using a text terminal the command will not do anything. If you are using a graphics terminal, then the observed and calculated anomalies, the bodies and the graphics options will be displayed.

10) Once in graphics mode you can use the graphics commands to manipulate your model. See section 5.0 on graphics commands for further information.

11) To save your model on disk use the **WRITE** command.

12) To terminate the program use the **END** command.

#### 4.0 TEXT MODE COMMANDS

- AMPL** Automatic adjustment of the body contrast.  
This command will change all the body contrasts to best fit the observed anomaly. If you wish to keep a body's contrast constant then the minimum allowable value, the maximum allowable value and value to use of the adjustable parameters must be equal. This can be set using the **PARAMeter** command.
- ANOMaly** Calculates the anomaly for a body or all bodies.
- BODY** Creates or deletes a body.  
a) To create a body enter a body number and the number of points. The number of points is equal to the number of vertices. The last point is not equal to the first. If the body already exists **MAGRAV** will ask;  
DUPLICATE BODY. OVERWRITE? (Y,N)  
answer Y to re-enter the body.  
Next, you will be asked for the **HALF-STRIKE LENGTH**. This is the distance perpendicular to the profile, from the centre of the body to the edge of the body; hence 2.5-dimensions. You will now be asked to enter the body points. Enter the X, Z pairs in clockwise order.  
b) To delete a body enter the body number, then enter 0 as the number of points. You then be asked if you want to type the body. If you answer Y, you will get a list of the body points of the body that was deleted.
- COMMENTS** Allows you to enter or change a comment line for the model. The comment may be 1 to 80 characters. To list the comment use the **TCOMment** command.
- CROSSs** When **DRAWing** or **SKETChing** in graphics mode, bodies can be displayed with crosses at each vertex. In some cases the cross will make it easier to identify the vertices. This command is a toggle. If crosses are off entering **CROSSs** will turn them on. If crosses are on entering **CROSSs** will turn them off.
- DELEte** Allows the user to remove a body point. First enter the body number of the body which contains the point to be removed. A list of the body points will be displayed. Then enter the body point number of the point to be removed. To abort the deletion of a point, enter a point value that is greater than the number of points in the body.
- DIFFerence** This command will set the anomaly plot section of the graphics screen to display the difference between the calculated and observed anomalies. The scales of the plot are set with the **SCALE** command and are the **DIFF MIN** and **DIFF MAX** parameters.



**DRAW** One or all bodies are drawn and the plot limits are set as follows:  
X direction, X min = 0, X max = field point maximum.  
Z direction, Z min = 0, Z max = depth maximum.  
If graphics mode is suppressed, this command does nothing.

**DUMP** This command will list all the information about the model. It gives you the option of send the list to the printer.

**END** This command terminates the program.

**FILL** This command will toggle on or off the body filling function in graphics mode. If you are using a colour graphics terminal, the bodies will filled with a solid colour. Otherwise the bodies will be pattern filled. If body filling is off, entering FILL will turn it on. If body filling is on, entering FILL will turn it off.

**GRAPHics** Enter graphics mode. See section 5.0 on graphics commands for further information. If graphics mode is suppressed, this command does nothing.

**GRAVity** Switches modelling type to gravity modelling.

**HALF** Change the HALF-STRIKE LENGTH of a body. The current half-strike length will be displayed and you will be prompted to enter a new half-strike length.

**HELP** Lists a summary of text commands.

**INSErt** Inserts a new body point into a body. You will be asked for the body number of the body for which the point is to be inserted. A list of body points will be displayed. Then you will be asked for the insertion point. The insertion point is the body point number of the point before the new point. All point numbers after the insertion point will be incremented by 1. You will then be asked for the X coordinate, then the Z coordinate.

**LIMIt** This command will find the minimum, maximum, average and rms values of the anomaly. It then will ask you to enter the offset to be subtracted from the observed data. It will also ask for new values for the anomaly scales used in graphics mode.

**MAGNetics** Switches modelling type to magnetics modelling.

**MODEL** Specifies the current model's name. The models name can be 1 to 10 characters. Lower and upper case are important. You can have two models with the same name, one in lower case, the other in upper case.

**OBSERvations** This command adds or modifies the observed values at the field points. The x location of the field point number N is equal to minimum field point location + (N-1) \* the field point spacing. Two sets of observations may be kept: one for gravity and one for magnetics. There are two methods for entering the observed values at the field points, either reading them in from a disk file or entering them directly. You will be prompted to choose which method to use.

If you choose to read them in from a disk file you will be prompted for the file name. The format of the file is one field point number and one observation value per line.

If you choose to enter them directly then the observed field point values are entered by field point number and observed value followed by a return. Up to 200 field points of each type can be entered. When you have finished entering the field point values enter, 0,0 to end. This is the method to use to change an observed value.

**OFFSet** Calculates and sets the offset to be subtracted from the observed data.

**PANOmoly** This command will plot the anomaly but will not calculate it. This is not executed if graphics mode is suppressed. This is handy for viewing the anomaly before it is recalculated with your recent modifications.

**PARAMeters** Replace or add to the parameters of the bodies. If in gravity mode, the density contrast (minimum allowable value, value to use and maximum allowable value) can be replaced. In magnetics mode, the magnetization (minimum allowable value, value to use and maximum allowable value), declination and dip can be replaced. The density contrast and the magnetization each have three parameters, minimum allowable value, value to use and maximum allowable value. The parameter value to use is the value that is used for the calculation of the anomaly. The minimum allowable value and maximum allowable value parameters are used as the lower and upper bounds of the value when the automatic adjustment of body contrasts is used. A constant can be added to the density contrast or magnetization of all the body's by specifying body number 0.

**POINT** Move a body point. You will be asked for the body number of the body which contains the point to be moved. A list of body points will then be displayed. Then you will be asked to enter the body point number of the point to be moved and then the X and Z value for the new location.

**READ** Reads a model from the models file. Use the MODEL command to name the model to be read. Use the TMODEL command to list all the model names in the models file.

## RECOVer

Used to recover a model if the program or computer system crashed, or if you did something that changed your model that you didn't wish to do.

When you use this command, you will get a message telling you how many recoverable models you have. A model is backed-up after every three changes. You enter the number of the backup you wish to get, note that once you recover a model you can not recover a model of a higher backup number.

## SCALE

Sets the scale limits to be used for your model. This is covered in section 3.2 but is repeated here for completeness.

After entering SCALE a list of the present scale settings will be displayed. To change a scale setting enter the letter that corresponds to the setting that you wish to change. The scale parameters are;

a) Field point minimum value.

If you want your field point observations to start at the edge of the graphics screen enter 0 or enter the offset in kilometers.

b) Field point maximum value.

If you want your field point observations to end at the edge of the graphics screen enter the value of the length of the line of observations plus the minimum value or enter a large value.

c) Depth maximum.

This should be a little larger than your expected bodies depths.

d) Field point spacing.

Enter the distance between your observations in kilometers. Your observed data must have equal spacing.

e) Number of field points.

Enter the number of field point observations. This must be less than or equal to the field point maximum - minimum / spacing.

f) Anomaly minimum.

This should be a little less than your expected anomaly minimum.

g) Anomaly maximum.

This should be a little larger than your expected anomaly maximum.

h) Anomaly difference minimum.

This is the anomaly minimum scale to be used when you plot the calculated minus observed curve, i.e. when using the DIFF option.

- i) Anomaly difference maximum.  
This is the anomaly maximum scale to be used when you plot the calculated minus observed curve, i.e. when using the DIFF option.
- j) X grid spacing.  
This is the distance between grid lines in the x direction when the body grid is turned on. This may be turned on with the SUPPress option.
- k) Z grid spacing.  
This is the distance between grid lines in the z direction when the body grid is turned on. This may be turned on with the SUPPress option.

**SKETCh** Change to sketch mode and draw bodies (unless graphics mode is suppressed). Sketch limits are specified with the ZOOM command.

**SUPPress** This command allows you to suppress or to turn on graphics mode. It also allows you to turn on or off the body area grid.

**TANomaly** List the calculated anomalies at each field point for 1 or all bodies.

**TBODY** List the body number, parameters, body point number and X, Z values for 1 or all bodies.

**TCOMments** List the comment line entered by the command COMMENT.

**TMODEls** List the model names on the models file.

**TOBServation** List the observed values at the field points. The field point number, X distance and the observed value are listed.

**TPARameters** List the body parameters for all bodies.

**TSCale** List the scales for the model and whether or not you are in DRAW or SKETCh mode.

**WRITE** Writes the current model to the model's file. The models name is specified with the MODEL command. If the model exists, you will be asked if you want the model to overwrite the model on file. Be sure to name your model or the model will be written with a blank model name.

**ZOOM** Sets the scales for SKETCh mode. This is irrelevant if graphics mode is suppressed. You will be asked for the min X, max X, min Z and max Z.

## 5.0 GRAPHICS MODE COMMANDS

Please note that on some terminals a carriage return may need to be entered after a character has been entered while the graphics cross hairs are being displayed. While other terminals do not require the carriage return. Therefore, for the purposes of this document the term 'enter' will refer to typing a character or typing a character and a carriage return depending on the terminal that you are using.

The term 'any character' refers to any alpha numeric character except X or Q. While using most commands, entering an X will cancel the command and entering an Q will cancel the command and leave graphics mode.

After entering a command, a short bell means the command has executed. A long bell means an error has occurred or the command was canceled.

When in graphics mode, there is a menu of all allowable commands at the bottom of the screen (refer to the sample graphics display in section 7.0). The format of the menu is a letter followed by some text. The letter is the character that you must enter to execute the command described by the text.

The anomaly profiles are displayed at the top of the screen with the observed anomaly profile as a dashed line and the calculated anomaly profile as a continuous line.

The following is a list of the commands and a full description of their use.

KEY	COMMAND	DESCRIPTION
A	ANOMALY	Compute the anomaly for the body or bodies specified. Use: enter A then the body number character that you wish the anomaly be calculated for. If all bodies are to be included, enter 0 or any character. The body number characters are listed in the graphics mode body command description.
B	BODY	Add a body. Use: enter B then move the cross hair to the position of the first point of the body, enter the body number character. Then move the cross hair in a clockwise direction to the second body point, enter the body number character. Continue until all body points are entered, then enter '.' or move the cross hair to the first body point of the next body to be entered then enter its body number character.

The following is a list of the body numbers and the associated body number character.

BODY NUMBER	BODY NUMBER CHARACTER
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	:
11	;
12	<
13	=
14	>
15	?
16	⊙
17	A
18	B
19	C
20	D

- C**      **CROSS**      Toggle body point crosses.  
This command will either draw crosses at the body points or will remove the crosses at the body points.  
Use: enter C
- D**      **DELETE**      Delete a body point.  
Use: enter D then move the cross hair to the position of the body point to be deleted, then enter any character.
- F**      **AUTO ADJUSTMENT  
OF BODY CONTRAST**      Automatic adjustment of body contrast.  
This command will adjust the density or magnetization of the bodies so that a best-fit with the observed data occurs.  
Use: enter F
- G**      **GRAV**      Switch to gravity modelling.  
Use: enter G

I        INSERT                    Insert a body point.  
 Use: enter I then move the cross hair to a body point that is on one side of the body point that you wish to enter, then enter any character. Move the cross hair to the position of the new body point and enter any character. Lastly, move the cross hair to the body point on the other side of the point that was just entered and enter any character.

M        MAG                        Switch to magnetic modelling.  
 Use: enter M

N        REDRAW                        Redraw the graphics screen.  
 Use: enter N

O        OBS DATA OFFSET                Observation data offset adjustment.  
 ADJUSTMENT                      This command will calculate and add a offset constant to the observed data so that modelled and observed anomaly curves will fit more closely.  
 Use: enter O

P        POINT                            Move a body point manually or move one or two points automatically.  
  
 Use #1: enter P then place the cross hair over the body point to be moved, enter any character. Then, move the cross hair to the new position for the body point and enter any character.  
  
 Use #2: enter P then move the cross hair to the body point to be automatically adjusted and then enter A.  
  
 Use #3: enter P then move the cross hair to the first body point to be adjusted and enter any character. Then move the cross hair to the second body point to be automatically adjusted and enter A.

Q        QUIT                            Leave graphics mode and enter text mode.  
 Use: enter Q

R        RECOVER                        Recover latest modelling variables.  
 This command will recover your last modelling variables if the program crashed.  
 Use: enter R

- S SKETCH Sketch the zoom area.  
If you have used the ZOOM command, the area that you specified will be displayed again. To return to the full display use the Y command.  
Use: enter S
- U ANOM DIFF TOGGLE Anomaly difference toggle.  
This command will toggle between plotting the difference of the calculated minus the observed anomalies and plotting the actual calculated and observed anomalies.  
Use: enter U
- V PARAMS Enter or change body parameters.  
This command allows you to modify the body parameters; density for gravity models or magnetization, declination and dip for magnetic models. You may enter the parameters for one body or add a constant to density or magnetization of all bodies.  
Use: enter V and follow the prompts
- W FILL Toggle body filling.  
This command will toggle on or off either the body pattern filling on a monochrome display or the body colour filling on a colour display.  
Use: enter W
- X CANCEL Cancel command in progress.  
If you have entered the wrong command or changed your mind after issuing a command, you may use this command to cancel the issued command. This only applies to commands that require addition information after the initial issuing of the command.  
Use: enter X
- Y DRAW Draw the full area specified by the field point minimum, field point maximum and depth maximum.  
This command will return the graphics display to the entire area specified by the SCALE command. To return to the same zoomed display use the S command.  
Use: enter Y



Z ZOOM

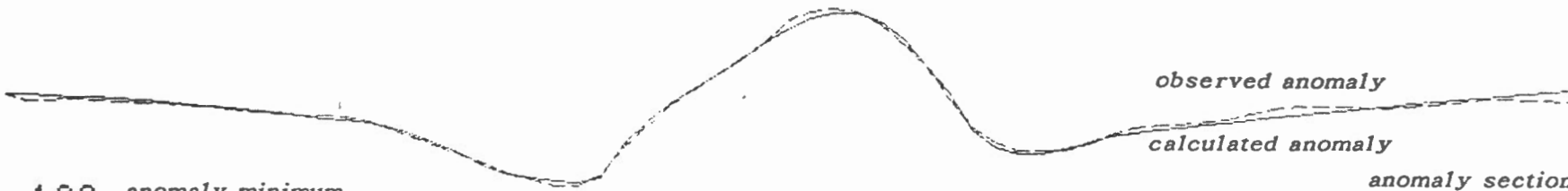
Zoom-in on a smaller area.

Use: enter Z then move the cross hair to the lower left side of the area to be zoomed in on, enter any character. Then move the cross hair to the upper right side of the area and enter any character. To return to the full display use the Y command.

## 6.0 SUMMARY OF TEXT MODE COMMANDS

AMPL - AUTO ADJUSTMENT OF BODY CONTRAST  
ANOM - CALCULATE MODELLED ANOMALY  
BODY - INPUT BODY POINTS  
COMM - INPUT COMMENTS OF MODEL  
CROS - TOGGLE BODY POINT CROSSES  
DELE - DELETE A BODY POINT  
DIFF - SET PLOT TO DIFFERENCE FROM OBSERVED ANOMALY  
DRAW - SET PLOT LIMITS TO FULL AREA  
DUMP - LIST ALL INFORMATION ON MODEL FILE  
END - EXIT FROM PROGRAM  
FILL - TOGGLE BODY FILLING  
GRAP - ENTER GRAPHICS MODE  
GRAV - SWITCH MODEL TYPE TO GRAVITY  
HALF - ENTER A NEW BODY HALF-STRIKE LENGTH  
HELP - LISTS THIS TEXT  
INSE - INSERT A BODY POINT  
LIMI - FINDS MIN & MAX OF OBSERVED ANOMALY & SETS OFFSET  
MAGN - SWITCH MODEL TYPE TO MAGNETICS  
MODE - INPUT MODEL NAME  
OBSE - ENTER OBSERVATIONS  
OFFS - CALCULATE OBSERVATION OFFSET  
PANO - PLOT ANOMALY  
PARA - ENTER BODY PARAMETERS  
POIN - MOVE A BODY POINT  
READ - READ A MODEL FROM DISK  
RECO - RECOVER MODEL AFTER A PROGRAM CRASH  
SCAL - SET SCALES FOR PLOT  
SKET - SET PLOT LIMITS TO ZOOM AREA  
SUPP - GRAPHICS MODE SUPPRESSION TOGGLE  
TANO - LIST ANOMALIES  
TBOD - LIST BODY POINTS  
TCOM - LIST MODEL'S COMMENT  
TMOD - LIST MODELS ON FILE  
TOBS - LIST OBSERVATIONS  
TPAR - LIST BODY'S PARAMETERS  
TSCA - LIST SCALES FOR PLOT  
WRIT - WRITE THE CURRENT MODEL TO DISK  
ZOOM - SET LIMITS FOR SUB AREA

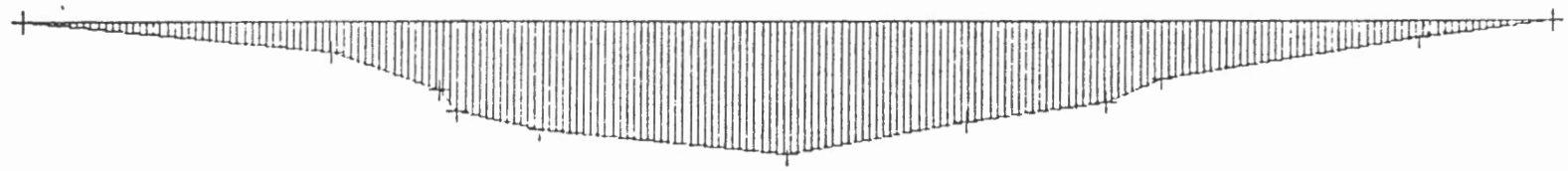
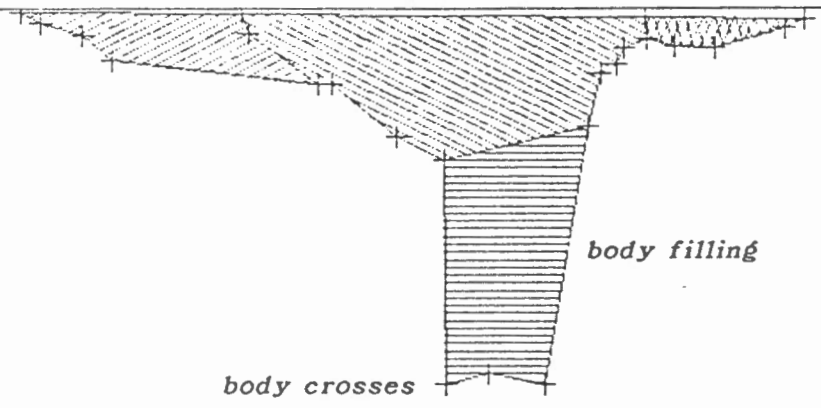
125. anomaly maximum



-100. anomaly minimum

0. field point minimum  
0. depth minimum

field point maximum 340.



body section

60. depth maximum

A-ANOM	B-BODY	C-CROSS	D-DELETE	F-ADJUST CONTRAST
G-GRAY	I-INSERT	M-MAG	N-REDRAW	O-OBS DATA OFFSET
P-POINT	Q-QUIT	R-RECOVER	S-SKETCH	U-ANOM DIFF TOGGLE
V-PARAM	W-FILL	X-CANCEL	Y-DRAW	Z-ZOOM

menu section

Sample gravity profile showing body filling and body crosses.