

2 D I P Documentation

Zonge Data Processing
Two-dimensional Resistivity and IP Modeling
Version 3.20

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2 D I P

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Introduction

2DIP is a finite element program which computes the resistivity and IP responses of two-dimensional models. Models may include both subsurface structure and surface topography on a cross sections up to ninety dipole lengths long and nine dipole lengths deep. Default electrode configurations for dipole-dipole, pole-dipole, or gradient arrays are available, or electrode positions may be specified for arbitrary array geometries. Model responses are calculated as apparent resistivity and IP phase or chargeability for up to 728 data points. Model data are stored in a tabular file format which allows plotting by generic contouring programs.

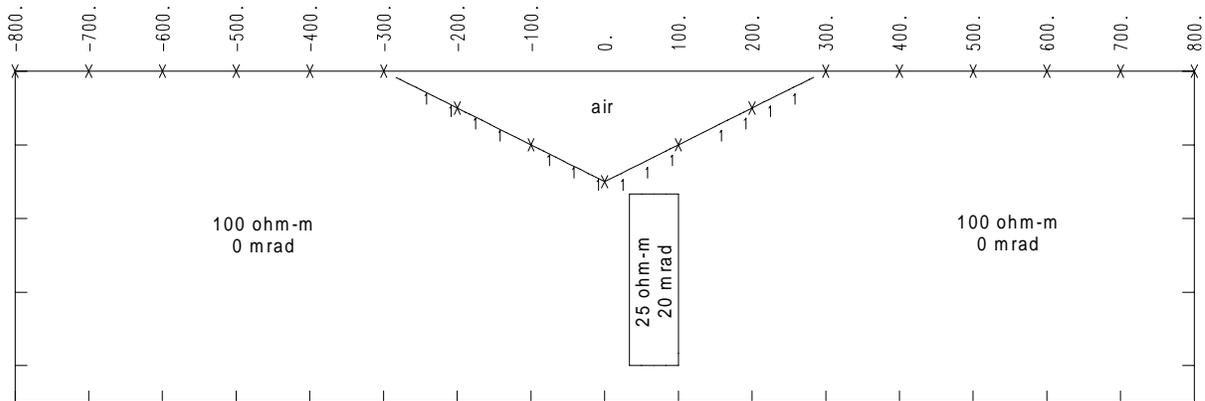


Figure 1: Cross-section of arbitrary two-dimensional geologic model. Up to nine resistivity and IP values may be specified on a cross section up to ninety dipole lengths long and nine dipole lengths deep. Model responses are calculated as apparent resistivity and phase for dipole-dipole, pole-dipole, pole-pole, gradient or arbitrary four-electrode arrays.

Information about 2DIP may be obtained by writing or calling:

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Installation

Minimum Hardware Configuration

The minimum hardware configuration needed to operate 2DIP v3.10 includes:

1. A computer running MS-DOS with 8MB of RAM (16 MB recommended) and a hard disk.
2. A 80386 or higher CPU chip with a math coprocessor.
3. VGA or SVGA graphics with 16 or more colors.

Installation Procedure

2DIP can be installed on one computer at a time. Backup copies of the installed files can be made freely, but they will function only on the computer on which 2DIP is installed. 2DIP can be recalled from one computer for installation on another. 2DIP refers to the two related programs, Q2DIP.EXE and R2DIP.EXE, which provide model editing and model calculations respectively.

To install 2DIP, place the distribution disk in a floppy disk drive and log on to that drive. Then type "INSTALL" and press Enter. You will see a screen title showing the program's name and version number. Below the title block a set of highlighted fields specify the source drive you are installing 2DIP from, usually floppy drive A: or B:, and the target hard drive letter and path in which 2DIP should be installed. It is usually easiest to put 2DIP programs in an existing directory which is already on your computer's MS-DOS path. You can move from field to field on the INSTALL program screen by pressing the Tab key to move forward and Shift+Tab to move backward. To cycle through disk-drive letters, press the space bar or left and right arrow keys. Edit the drive letters and target path to suit your computer's configuration. When you press F10, INSTALL will verify your edited changes and will extract files from #2DIP.EXE to your target directory.

After installation, the S2DIP subdirectory should have the following files:

2DIP program files:

- Q2DIP.EXE - model input and editing program.
- R2DIP.EXE - model evaluation program.
- R2DIPREG.EXE - registration program.
- LF90.FIG - fortran error messages
- GRAPHICS.INI - graphics configuration file.
- GRAPHICS.CHR - graphics font file.

Sample data files:

- DEMO2DIP.2DM - model-parameter file.
- DEMO2DIP.IPD - model-data file.
- DEMO2DIP.MDE - data processing annotation and control file.
- DEMO2DIP.STN - station location and topography file.
- DEMO2DIP.Z2D - ZPLOT-format plot-data file.

Graphics Configuration

GRAPHICS.INI and GRAPHICS.CHR must be somewhere on the MS-DOS path. GRAPHICS.INI holds graphics configuration information. If the line "DISPLAY = 13" is present in GRAPHICS.INI, CSINV will attempt to use SVGA graphics. CSINV will default to VGA graphics if it does not detect SVGA capabilities or if "DISPLAY = 13" is not present in GRAPHICS.INI. On some portable computers with a VGA screen and external-monitor SVGA capabilities, "DISPLAY = 13" has to be deleted from GRAPHICS.INI for normal VGA operation with the built in VGA screen. If you don't get a coherent image on your portable's screen when you attempt to plot a sounding curve with CSINV, delete the line "DISPLAY = 13" from GRAPHICS.INI.

2DIP plots may be saved in HPGL plot files which are given the extension .X??. These HPGL files can be plotted on a HP-compatible pen plotter or utility programs such as FLOT can be used to rasterize them for output on a printer. FLOT reads HPGL files and rasterizes them for printer output.

Recall Procedure

To recall 2DIP back to the distribution disk, place the distribution disk in a floppy-disk drive and log on to that drive, then type "RECALL" and press Enter. RECALL displays a screen with fields for the drive and directory where 2DIP is installed and for the letter of the floppy drive holding the distribution disk. Edit the source drive and path to match your computer's configuration and then press F10 to start the RECALL procedure. RECALL erases Q2DIP.EXE, R2DIP.EXE, INTPRINT.EXE and DEMO2DIP.* from the "recall from" directory. It leaves behind GRAPHICS.INI and GRAPHICS.CHR, two graphics configuration files which may be used by other programs.

Program Use

The two main programs in the 2DIP modeling package are Q2DIP for generating and editing model files and R2DIP for evaluating model files. Q2DIP must be used first to set up a geologic model. Model files DEMO2DIP.2DM and DEMO2DIP.IPD have been provided as an example of program use.

Q2DIP - model-file creation

Model files are generated using Q2DIP.EXE. Typing "Q2DIP" brings up a worksheet with fields specifying the new model's characteristics. Typing "Q2DIP DEMO2DIP" will send Q2DIP directly to the graphical model-editing state described after this section.

Initial Q2DIP model-parameter worksheet:

Model-parameter File: 2DIP_____ .2DM
Model-data File: 2DIP.IPD

Topography File (optional input): _____ .STN

Free-format description of model:

Survey Type: DipoleDipole IP Units mrad

Length: 100.0 m Station Numbers
-----: 100.0
per Dipole

First Station: -800.0 Last Station: 800.0
Minimum Elevation: -300.0 Maximum Elevation: 0.0

Finite element mesh size: 81 by 16 nodes with 6 mesh cells per dipole

Move from field to field with mouse, arrow keys or tab key.
Press ESC key to continue on with program.

Worksheet field entries can be changed by typing over default values or left as is by moving on to the next field. Fields can be edited in sequence by moving from one field to the next using the mouse, arrow keys or tab and shift+tab. Pressing ESC exits the worksheet and Q2DIP continues on to the next step.

"2DIP" is the default name given to a completely new model, although it will almost always be changed to something more specific. To recreate the sample files, edit the model-parameter file name to DEMO2DIP.2DM.

Q2DIP allows the option of reading topographic data from a tabular *.STN file. *.STN files have columns of station number, grid east, grid north and elevation (see file format descriptions). In this case, read topographic information from file DEMO2DIP.STN by entering "DEMO2DIP" in the topography file field.

Three free-format fields save text describing the model. To recreate DEMO2DIP.2DM exactly, type "Valley over conductive, polarizable prism." on the first free-format line and "Dipole dipole demonstration model." on the second.

Default array types may be selected by highlighting the "Survey Type" field and using the space key to cycle through "DipoleDipole", "PoleDipole", "PolePole", "Gradient" or "General". Electrodes are set to default locations for "DipoleDipole", "PoleDipole", "PolePole" or "Gradient" arrays. Choice of a "General" array requires entry of individual electrode locations in a worksheet.

"IP Units" can be cycled through "mrad", "msec" or "PFE" to reflect the frequency-domain or time-domain measurements. IP effects are calculated by perturbing real-valued model resistivities in a PFE-like approximation to IP.

"Dipole Lengths" are specified in units of m, km, ft or kft. 2DIP internally scales all distances to dipole lengths and creates a mesh with five elements per dipole. The length units selected to specify dipole lengths must be the same as units used for *.STN file coordinates and elevations.

"Station Numbers per Dipole" controls the scaling of station numbers relative to dipole lengths. Station numbers should be proportional to distance along line. If available, Q2DIP uses coordinates from *.STN files to associate station numbers with distance along line, capturing station survey irregularities. If a *.STN file is not specified, the ratio between "Dipole Length" and "Stations per Dipole" is used to scale station numbers to distance along line.

"Minimum Elevation" and "Maximum Elevation" control the height of the finite element mesh. 2DIP attempts to keep "Minimum Elevation" at least three dipole lengths below the lowest point on the model's topographic surface. "Cells per dipole" can be any integer between 4 and 8. Using fewer finite-element cells per dipole reduces file size and computational effort. Increasing "cells per dipole" allows more model detail and increased modeling accuracy.

Q2DIP updates related entries whenever an enter, down- or up-arrow key is pressed. Worksheet entries are compared to program limits and the finite-element mesh size is updated.

Q2DIP model-parameter worksheet after editing:

Model-parameter File: DEMO2DIP_____ .2DM
Model-data File: DEMO2DIP.IPD

Topography File (optional input): DEMO2DIP_____ .STN

Free-format description of model:
Valley over conductive, polarizable prism. _____
Dipole dipole demonstration model. _____

Survey Type: DipoleDipole IP Units mrad

Length: 100.0 m Station Numbers
-----: 100.0
per Dipole

First Station: -800.0 Last Station: 800.0
Minimum Elevation: -50.0 Maximum Elevation: 500.0

Finite element mesh size: 97 by 28 nodes with 6 mesh cells per dipole.

Move from field to field with mouse, arrow keys or tab key.
Press ESC key to continue on with program.

Q2DIP follows the model-parameter worksheet with a worksheet specifying up to nine resistivity and IP values:

Model-parameter File: DEMO2DIP_____ .2DM
Model-data File: DEMO2DIP.IPD

Free-format description of model:
Valley over conductive, polarizable prism.
Dipole dipole demonstration model.

Mesh Index	Resistivity (ohm-m)	IP Response (mrad)
1	100.0	0.0
2	25.0	50.0
3	100.0	0.0
4	100.0	0.0
5	100.0	0.0
6	100.0	0.0
7	100.0	0.0
8	100.0	0.0
9	100.0	0.0

Move from field to field with mouse, arrow keys or tab key.
Press ESC key to continue on with program.

Model resistivity and IP fields are given default values of 100 ohm-m and 0 mrad. DEMO2DIP uses two distinct geologic units, mesh cells with a mesh index of 1 are assigned a resistivity of 100 ohm-m and an IP response of 0 mrad, mesh cells with an index of 2 are assigned a resistivity of 25 ohm-m and an IP response of 50 mrad. Model-file names and descriptive text may also be changed in this worksheet.

Again, mouse movement, arrow keys or tab and shift+tab can be used to move from field to field. Q2DIP updates entries whenever an enter, down- or up-arrow key is pressed. Pressing ESC exits the worksheet and Q2DIP continues on to the next step.

After default values are initialized, a model with uniform subsurface resistivity and IP is ready for graphical entry of geologic structure.

Q2DIP - model-file editing

After specification of default values for a new model or after the name of an existing model is entered, Q2DIP draws a cross section of the current model. Each resistivity/IP unit is given a distinct color. Resistivity/IP units are also indicated by integer codes. 0 indicates air, 1 through 9 can be assigned arbitrary resistivities and IP values. Interfaces between units are outlined by solid lines. At a sufficiently detailed scale, dotted lines indicate the size and location of cells in the finite element mesh. Transmitter and receiver electrode locations are marked by small crosses.

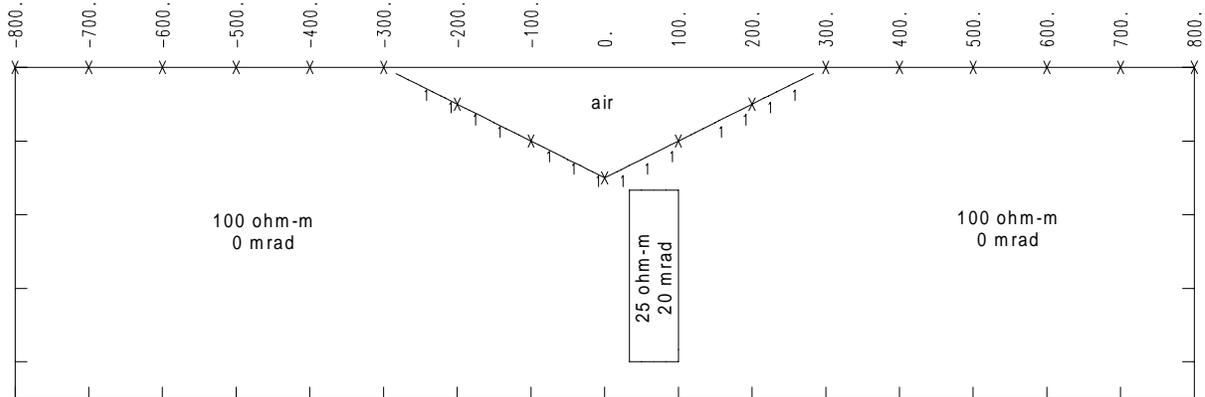


Figure 2: Cross section of current model, in this case the model stored in DEMO2DIP.2DM and DEMO2DIP.IPD. An index of resistivity and IP values below the cross section can be replaced by a list of editing options by pressing F1.

F3 -> edit model parameters

Models can be changed by choosing one of the editing options displayed below the model cross section. Model parameters can be edited by pressing function key F3. Pressing F3 brings a familiar worksheet to the screen. The worksheet shows current model filenames, free-format descriptive text and model resistivity and IP values.

F3 "Edit model parameters" worksheet:

Model-parameter File: DEMO2DIP_____.2DM
Model-data File: DEMO2DIP.IPD

Free-format description of model:
Valley over conductive, polarizable prism._____
Dipole dipole demonstration model._____

Mesh Index	Resistivity (ohm-m)	IP Response (mrad)
1	100.0	0.0
2	25.0	20.0
3	100.0	0.0
4	100.0	0.0
5	100.0	0.0
6	100.0	0.0
7	100.0	0.0
8	100.0	0.0
9	100.0	0.0

Move from field to field with mouse, arrow keys or tab key.
Press ESC key to continue on with program.

You can edit parameter values by moving from field to field with the mouse or arrow keys and by typing over default values. New values are updated whenever up-arrow, down-arrow or enter keys are pressed. Pressing ESC returns you to the model cross-section plot.

Model-file names can be changed editing the first field. Model-parameter and model-data files always have the same name. Text describing the model can be entered in three free-format lines of text. Changing entries in the resistivity and IP fields updates the physical properties associated with integer resistivity codes. Resistivities are given in ohm-meters and IP values are given in mrad, msec or PFE. When you are satisfied with the model parameters, return to the model cross section by pressing ESC.

F4 -> draw body cross-section

Geologic bodies are added to the model cross section by pressing F4. When F4 is selected, a message "Enter RESISTIVITY CODE for body (0-9):" appears below the cross-section. Valid responses are the number keys 0 through 9 to select a resistivity/IP unit, or the ESC key to abandon the drawing procedure and to return to the main menu.

If you select a valid integer resistivity/IP unit index, the next prompt is "Use arrow keys to position cursor and Enter to begin drawing body." A small cursor will appear near the center of the model cross-section. Cursor movement can be controlled by either a mouse or arrow keys. You can move the cursor horizontally by pressing the left and right arrow keys. Pressing the up and down arrow keys gives vertical motion, and to move diagonally, use the Home, End, PgUp, and PgDn keys.

When you have positioned the cursor on the corner of the new geologic feature, press the Enter key. Now a prompt "Use the arrow keys to draw a closed body boundary" appears. You can outline the new feature by moving the cursor around with a mouse or with arrow keys, although arrow keys allow more precise control of cursor movement. As before, diagonal movement is effected with the Home, End, PgUp, and PgDn keys. As you progress around the body, a solid line will mark your path. The body will be completed when you close the boundary by returning to the first corner. You can

abandon the procedure at any time by pressing ESC. If you use ESC, the new feature will not be added to the model. If you complete a closed boundary, the new feature will be added to the model and you will be returned to the main menu.

F5 -> change plot window

The scale of the plot window is controlled by selecting F5 from the main menu. Pressing F5 allows rescaling of the plot window. You have the choice of zooming back by pressing F5 and then F6 or of zooming in by pressing F5 and then F5 again.

F6 = zooming back displays all of the mesh, except for a wide band of elements used as a buffer on the sides and bottom of the finite element mesh. The resistivity pattern is extended through the side buffer elements as horizontal layers and through the bottom buffer elements as vertical dike-like features. Natural boundary conditions are used on the sides and bottom of the mesh.

F5 = zooming forward allows you to select a new plot window. Move the cursor to a corner on the new plot window using the arrow keys. Pick the corner by pressing Enter. Position a second corner of the new plot window next, by using the arrow keys. The new plot window will be outlined by a rubberband box. Pick the second corner by pressing Enter. Pressing ESC at any time aborts rescaling and returns you to the main menu.

F6 -> file current model

To save the current model in a disk file, select F6. The screen will clear and a message reporting "Writing values to file DEMO2DIP" will appear. The actual file names used can be changed using the F3 main-menu selection.

ESC -> stop program execution

Using the Esc key at the main-menu level returns you to MS-DOS.

Partial listing of model-parameter file DEMO2DIP.2DM

Q2DIP produces model-parameter and model-data files which can be evaluated by R2DIP. Model parameters are stored in a ASCII text file with the extension *.2DM. Model-parameter values can be edited directly with a text editor if necessary. A partial listing of the file DEMO2DIP.2DM and an explanation of model parameters follows.

```
&R2DIP
  Header(1)='From Q2DIP v3.10b 10/04/96',
  Array='DipoleDipole',LengthUnits='m',IPUnits='mrad'/
&MESH2D
  DipoleLength=100.,StnPerDipole=100.,StnBeg=-800.,StnEnd=800.,
  RES(1)=1.0000E+2,RERR(1)=0.0,PHZ(1)=0.00,PERR(1)=0.0,
  RES(2)=2.5000E+1,RERR(2)=0.0,PHZ(2)=50.00,PERR(2)=0.0,
  NXNODE= 97,NZNODE=28 /
  -800., -800., 1000.,
  500.0,483.3,466.7,450.0,433.3,416.7,400.0,383.3,366.7,350.0,
  333.3,316.7,300.0,283.3,266.7,250.0,233.3,216.7,200.0,183.3,
  166.7,150.0,133.3,116.7,100.0,83.3,66.7,50.0,
  '11111111111111111111111111111111'
  '11111111111111111111111111111111'
  '11111111111111111111111111111111'
  '11111111111111111111111111111111'
  -783.333, -783.333, 1000.,
  500.0,483.3,466.7,450.0,433.3,416.7,400.0,383.3,366.7,350.0,
  333.3,316.7,300.0,283.3,266.7,250.0,233.3,216.7,200.0,183.3,
  166.7,150.0,133.3,116.7,100.0,83.3,66.7,50.0,
  '11111111111111111111111111111111'
  '11111111111111111111111111111111'
  . . . . .
  . . . . .
  . . . . .
```

Two Fortran namelist blocks occupy the first section of *.2DM files. Namelist parameters can be given in any order between the character strings "&R2DIP" or "\$MESH2D" which mark the beginning of the namelist blocks and "/" which marks their ends.

R2DIP Namelist parameters:

Header - free-format describing model.
Array - survey array (DipoleDipole, PoleDipole, Gradient, General).
LengthUnits - distance units (m, km, ft, kft).
IPUnits - IP-response units (mrad, msec or PFE).

MESH2D Namelist parameters:

DipoleLength - dipole length (LengthUnits).
StnPerDipole - dipole length (station number units).
StnBeg - first station to include in model.
StnEnd - last station to include in model.
Res(*) - model resistivities (ohm-m).
Rerr(*) - used in inversion programs (percent).
Phz(*) - model IP (IPUnits).
Perr(*) - used in inversion programs (IPUnits).
NXNODE - number of node columns in finite-element mesh.
NZNODE - number of node rows in finite-element mesh.

The second section of *.2DM files contains two types of records in an alternating sequence. Records specifying coordinates for a vertical column of mesh nodes sandwich record blocks defining mesh-cell properties.

Vertical columns of mesh nodes are first located horizontally by three values: station number, grid east, and grid north. Station numbers are proportional to distance along line, although variation due to surveying error or slope correction can be accommodated. Grid east and grid north values should be accurate and are given in the same LengthUnits used to specify elevation and DipoleLength. The three horizontal-location values are followed by NZNODE elevation values, one elevation value for every node in the vertical column. 2DIP's finite element mesh allows vertical displacement of mesh nodes, primarily for more accurate modeling of topography. All 3+NZNODE node-location values are read free-format, so spacing and line breaks are not important. Values must be in order and separated by spaces or commas.

Numbers specifying node locations sandwich record blocks specifying cell properties. A group of four lines, each line NZNODE-1 characters long, defines the physical properties of a column of elements. The first line indicates the properties of triangular subcell 1, the second line triangular subcell 2, etc (see figure 3).

The last record in a *.2DM files should be a list of node locations along the edge of the finite-element mesh. There should be a total of NXNODE node-location record blocks and NXNODE-1 cell-property blocks. A mesh can be subdivided by increasing the value of NXNODE and inserting additional node-location and cell-property record blocks in the middle of a *.2DM file.

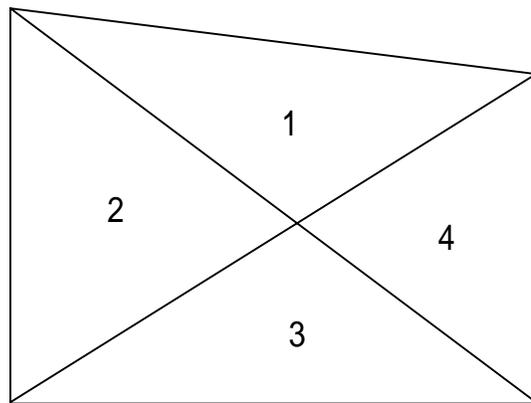


Figure 3: Groups of four triangular subcells, indexed 1 to 4, are combined into trapezoidal elements with vertical sides and possibly sloping top or bottom edges. Individual resistivity and IP properties may be specified for each triangular subcells.

Partial listing of model-data file DEMO2DIP.IPD

Receiver and transmitter electrode locations, optional observed data values, and calculated resistivity and IP values are stored in *.IPD files. The tabular format contains one record per data point. Comment lines, any line with a "!" in the first column, allow file annotation. A partial listing of the file DEMO2DIP.IPD and an explanation of model data follows.

```
"SP1t" "ZP1t" "SRx1" "SRx2" "STx1" "STx2" "ARobs" "ARerr" "APobs" "APerr" "ARmod" "APmod"
"Modeling results from R2DIP v3.10b Date:10/04/96 Time:18:12"
-650,-100,-800,-700,-600,-500,0.0000,0.0,0.0,0.0,99.34,0.0,
-550,-100,-700,-600,-500,-400,0.0000,0.0,0.0,0.0,98.80,0.0,
-600,-150,-800,-700,-500,-400,0.0000,0.0,0.0,0.0,98.66,0.0,
-450,-100,-600,-500,-400,-300,0.0000,0.0,0.0,0.0,94.33,0.0,
-500,-150,-700,-600,-400,-300,0.0000,0.0,0.0,0.0,91.37,-0.1,
-550,-200,-800,-700,-400,-300,0.0000,0.0,0.0,0.0,88.98,-0.1,
-350,-100,-500,-400,-300,-200,0.0000,0.0,0.0,0.0,116.7,0.0,
-400,-150,-600,-500,-300,-200,0.0000,0.0,0.0,0.0,112.9,-0.1,
-450,-200,-700,-600,-300,-200,0.0000,0.0,0.0,0.0,109.3,-0.2,
-500,-250,-800,-700,-300,-200,0.0000,0.0,0.0,0.0,106.8,-0.3,
-250,-100,-400,-300,-200,-100,0.0000,0.0,0.0,0.0,94.28,-0.1,
-300,-150,-500,-400,-200,-100,0.0000,0.0,0.0,0.0,130.9,-0.3,
-350,-200,-600,-500,-200,-100,0.0000,0.0,0.0,0.0,137.1,-0.5,
-400,-250,-700,-600,-200,-100,0.0000,0.0,0.0,0.0,138.4,-0.7,
-450,-300,-800,-700,-200,-100,0.0000,0.0,0.0,0.0,138.4,-0.8,
-150,-100,-300,-200,-100,0,0.0000,0.0,0.0,0.0,93.00,-1.0,
. . . . .
. . . . .
. . . . .
```

Record 1 is a list of column headers indicating the data type in each column. Record 2 is a comment line showing the program name and version, along with the date and time when the file was updated. All remaining records in DEMO2DIP.IPD specify individual dipole-dipole data points.

Column Number: Associated data type:

- 1: location of receiver electrode 1 (station numbers).
- 2: location of receiver electrode 2 (station numbers).
- 3: location of transmitter electrode 1 (station numbers).
- 4: location of transmitter electrode 2 (station numbers).
- 5: observed apparent resistivity (ohm-m).
- 6: observed apparent resistivity error (percent).
- 7: observed apparent IP (IP Units).
- 8: observed apparent IP error (IP Units).
- 9: calculated apparent resistivity (ohm-m).
- 10: calculated apparent IP (IP Units).

R2DIP - model evaluation

Models are evaluated with R2DIP.EXE. To evaluate the example model DEMO2DIP, type "R2DIP DEMO2DIP". Program R2DIP will read the files DEMO2DIP.2DM and DEMO2DIP.IPD, calculate apparent resistivity and IP responses for model DEMO2DIP, and write calculated apparent resistivity and IP values in an updated DEMO2DIP.IPD and new DEMO2DIP.Z2D. With an eye towards batch file operation, R2DIP also creates DEMO2DIP.LOG to save incidental information generated during the program run.

DEMO2DIP.LOG holds a summary record of the model, listing descriptive text, array type and model resistivity and phase. An alphanumeric plot of the model cross section verifies correct mesh input. The cross section is oriented with elevations increasing to the left and station numbers increasing upward. Station number locations for each node column are listed left of the cross section and node elevations are listed below the section.

For actual evaluation, R2DIP adds wide margins to the sides and bottom of the mesh, moving mesh boundaries well away from the central region of interest. Comparisons of R2DIP 100 m dipole-dipole results with data calculated using an image solution over a 200 m wide vertical dike differ by an average of 0.6 percent with 4 cells per dipole length and better than 0.1 percent with 8 cells per dipole length. Pole-dipole, pole-pole and gradient test results using a vertical dike model indicate an average error of about 1 percent.

Modeling results are written into an updated copy of *.IPD and into a *.Z format file with the extension *.Z2D. The Zonge pseudosection contouring program ZPLOT can be used to create black and white plots of modeling results. For the example files, typing "ZPLOT DEMO2DIP.Z2D" produces two HPGL plot files, DEMO2DIP.X01 and DEMO2DIP.X02. *.X01 holds a calculated apparent resistivity pseudosection plot and *.X02 holds a calculated IP phase pseudosection plot.

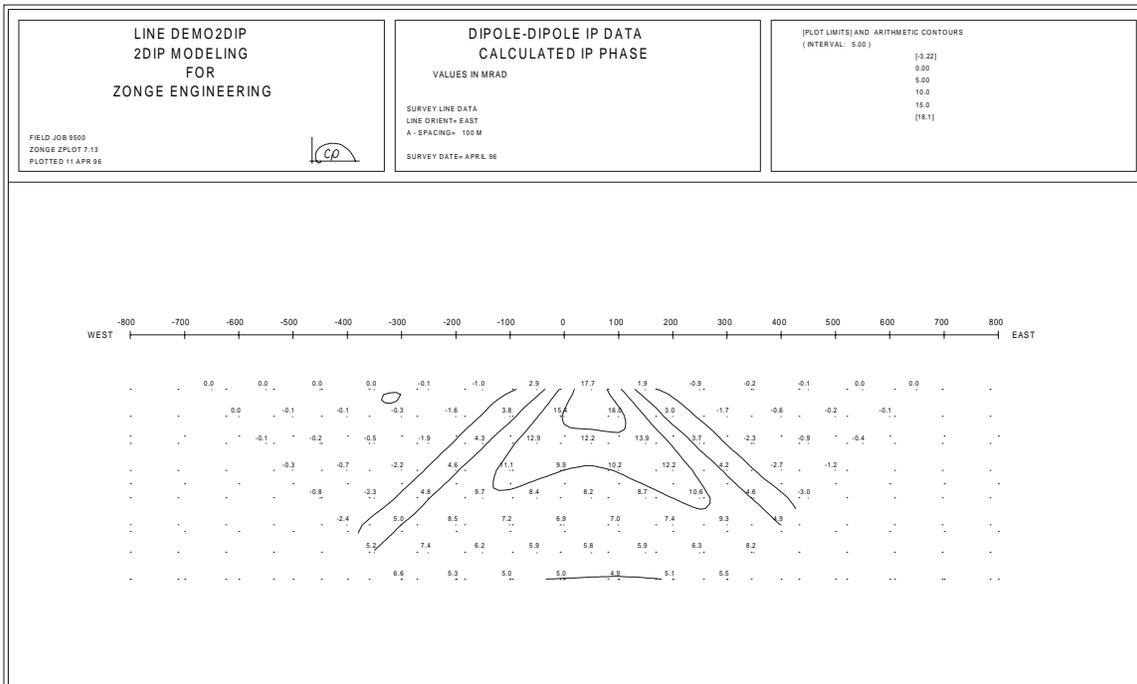
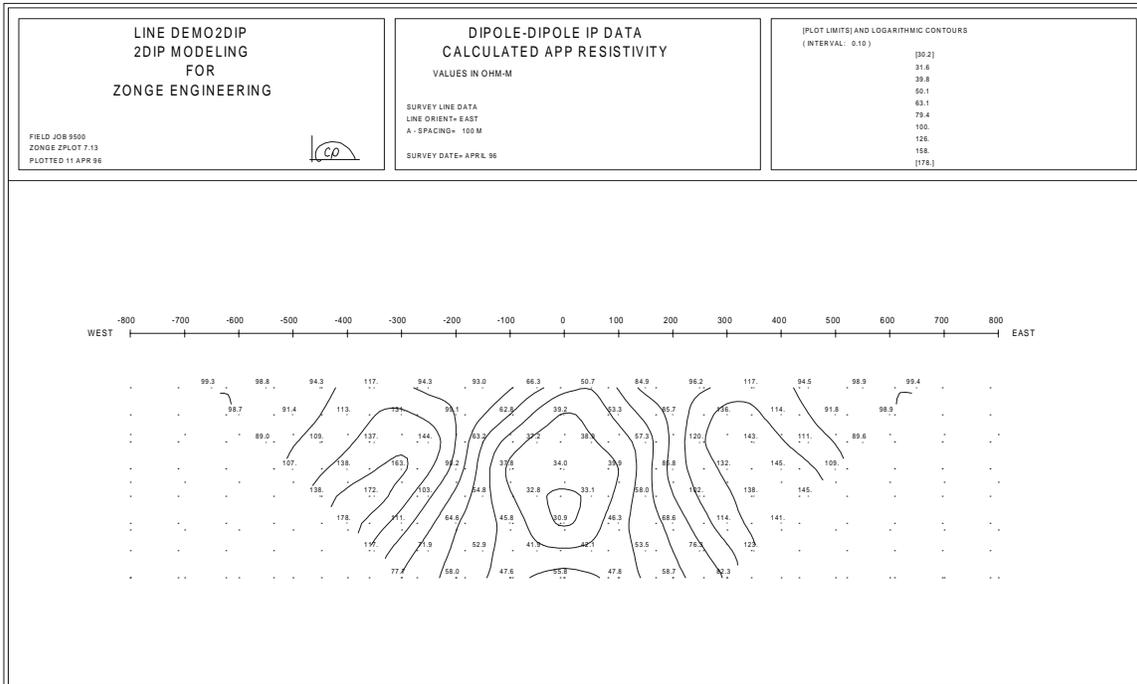


Figure 4: Pseudosections plotted using program ZPLOT and input files DEMO2DIP.MDE plus DEMO2DIP.Z2M. The pseudosections are plotted by typing "ZPLOT DEMO2DIP.Z2D". Note that apparent resistivity (top panel) is much more distorted by topography than is apparent phase. Topographic effects dominate the apparent resistivity anomaly, while the phase anomaly maps the polarizable dike.

References

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Appendix A: File Format Documentation

*.MDE File (Zonge data-processing-control file)

*.MDE files hold annotation and Zonge data-processing-control information. A *.MDE-file consists of one or more MODE LINES, each of which begins with a "\$" in the first column, optionally followed by a program name and colon ":". The name of the mode is followed by an equal sign "=", then the value to assign to the variable. Spaces may be included between elements of the mode line. Spaces in values defined as text will be included as part of the value.

Modeling programs do not define modes for changes of variables, but they may recognize several general mode lines such as those included in the sample. Variables specific to 2DIP may be modified later by editing the namelist definitions in the model-parameter file (*.2DM-file).

*.MDE-file listing:

```
$ CLIENT=Zonge Engineering
$ PROJECT=2DIP Modeling
$ JOBNUMB=9500
$ JOBDATE=April 96
$ JOBLINE=DEMO2DIP
$ BRGLINE=East
$ BRGBACK=West
$ STNLO= -800.0
$ STNHI= 800.0
$ LBLDELT= 100.0
$ STNDELT= 100.0
$ ASPACE= 100m
$ UNITS= m
$ auto=yes
$ zplot:sizeX=1.5
$ zplot:sizeY=0.75
$ zplot:view=y
```

*.MDE-file variables:

CLIENT - Name of company running survey (text).
PROJECT - Project name (text).
JOBNUMB - Job number.
JOBDATE - Date when survey was conducted.
JOBLINE - Line number.
BRGLINE - Forward line bearing (in direction of increasing station numbers).
BRGBACK - Line back bearing (in direction of decreasing station numbers).
STNLO - Low unscaled station number.
STNHI - High unscaled station number.
STNDELT - Unscaled station-number increment. Default: STNDELT=1.0
LBLFRST - First scaled station number corresponding to unscaled STNLO station.
Default: LBLFRST=STNLO
LBLDELT - Scaled station-number increment along axis. Default: LBLDELT=STNDELT
ASPACE - Dipole length (length units).
UNITS - Length units (m, km, ft, kft).
AUTO - yes = batch file processing mode.
ZPLOT: SIZEX - horizontal plot scale (LBLDELT/cm).
ZPLOT: SIZEY - vertical plot scale (data points/cm).
ZPLOT: VIEW - yes = preview plots on screen.

***.STN File (station location coordinates)**

*.STN files hold information about station locations in a simple tabular format. A *.STN file should have at least two records, corresponding to the first and last stations. Additional records may be necessary to trace out topographic changes or curved lines. Modeling programs assume that station numbers represent distance along line. Location coordinates for stations which are not explicitly listed in the *.STN file are calculate by linear interpolation between station numbers. Comment lines preceded by a "!", "\". "/" or "" in column 1 may be inserted anywhere in the file.

Column 1: station numbers. Station numbers can be in any unit, but they should be proportional to distance along line.

Column 2: x coordinate = grid east in LengthUnits (m,km,ft,kft).

Column 3: y coordinate = grid north in LengthUnits (m,km,ft,kft).

Column 4: z coordinate = elevation in LengthUnits (m,km,ft,kft).

*.STN-file listing:

```
"Stn"  "GridE" "GridN" "Elev"  
\ Sample station file for 2DIP.  
-1000 -1000 1000 500  
  -300  -300 1000 500  
   000   000 1000 350  
   300   300 1000 500  
  1000  1000 1000 500
```

***.2DM File (model-parameter file)**

```
&R2DIP
Header(1)='From Q2DIP v3.10d 01/10/96',
Array='DipoleDipole',LengthUnits='m',IPUnits='mrad'/
&MESH2D
DipoleLength=100.,StnPerDipole=100.,StnBeg=-800.,StnEnd=800.,
RES(1)=1.0000E+2,RERR(1)=0.0,PHZ(1)=0.00,PERR(1)=0.0,
RES(2)=2.5000E+1,RERR(2)=0.0,PHZ(2)=50.00,PERR(2)=0.0,
RES(3)=1.0000E+2,RERR(3)=1.0,PHZ(3)=0.00,PERR(3)=0.1,
RES(4)=1.0000E+2,RERR(4)=1.0,PHZ(4)=0.00,PERR(4)=0.1,
RES(5)=1.0000E+2,RERR(5)=1.0,PHZ(5)=0.00,PERR(5)=0.1,
RES(6)=1.0000E+2,RERR(6)=1.0,PHZ(6)=0.00,PERR(6)=0.1,
RES(7)=1.0000E+2,RERR(7)=1.0,PHZ(7)=0.00,PERR(7)=0.1,
RES(8)=1.0000E+2,RERR(8)=1.0,PHZ(8)=0.00,PERR(8)=0.1,
RES(9)=1.0000E+2,RERR(9)=1.0,PHZ(9)=0.00,PERR(9)=0.1,
NXNODE= 97,NZNODE=28 /
-800., -800., 1000.,
500.0,483.3,466.7,450.0,433.3,416.7,400.0,383.3,366.7,350.0,
333.3,316.7,300.0,283.3,266.7,250.0,233.3,216.7,200.0,183.3,
166.7,150.0,133.3,116.7,100.0,83.3,66.7,50.0,
'11111111111111111111111111111111'
'11111111111111111111111111111111'
'11111111111111111111111111111111'
'11111111111111111111111111111111'
-783.333, -783.333, 1000.,
500.0,483.3,466.7,450.0,433.3,416.7,400.0,383.3,366.7,350.0,
333.3,316.7,300.0,283.3,266.7,250.0,233.3,216.7,200.0,183.3,
166.7,150.0,133.3,116.7,100.0,83.3,66.7,50.0,
'11111111111111111111111111111111'
'11111111111111111111111111111111'
'11111111111111111111111111111111'
'11111111111111111111111111111111'
-766.667, -766.667, 1000.,
500.0,483.3,466.7,450.0,433.3,416.7,400.0,383.3,366.7,350.0,
333.3,316.7,300.0,283.3,266.7,250.0,233.3,216.7,200.0,183.3,
166.7,150.0,133.3,116.7,100.0,83.3,66.7,50.0,
'11111111111111111111111111111111'
'11111111111111111111111111111111'
'11111111111111111111111111111111'
. . . . .
. . . . .
. . . . .
```

Two Fortran namelist blocks occupy the first section of *.2DM files. Namelist parameters can be given in any order between the character strings "&R2DIP" or "&MESH2D" which mark the beginning of the namelist blocks and "/" which mark their ends.

R2DIP Namelist parameters:

- Header - free-format describing model.
- Array - survey array type (DipoleDipole, PoleDipole, Gradient, General).
- LengthUnits - length units (m, km, ft or kft).
- IPUnits - IP-response units (mrad, msec or PFE).

MESH2D Namelist parameters:

DipoleLength - dipole length (LengthUnits).
StnPerDipole - dipole length (station number units).
StnBeg - first station to include in model.
StnEnd - last station to include in model.
Res(*) - model resistivities (ohm-m).
Rerr(*) - used in inversion programs (percent).
Phz(*) - model IP (IPUnits).
Perr(*) - used in inversion programs (IPUnits).
NXNODE - number of node columns in finite-element mesh.
NZNODE - number of node rows in finite-element mesh.

The second section of *.2DM files contains two types of records in an alternating sequence. Records specifying coordinates for a vertical column of mesh nodes sandwich record blocks defining mesh-cell properties.

Vertical columns of mesh nodes are first located horizontally by three values: station number, grid east, and grid north. Station numbers are proportional to distance along line, although variation due to surveying error or slope correction can be accommodated. Grid east and grid north values should be accurate and are given in the same LengthUnits used to specify elevation and DipoleLength. The three horizontal-location values are followed by NZNODE elevation values, one elevation value for every node in the vertical column. 2DIP's finite element mesh allows vertical displacement of mesh nodes, primarily for more accurate modeling of topography. All 3+NZNODE node-location values are read free-format, so spacing and line breaks are not important. Values must be in order and separated by spaces or commas.

Numbers specifying node locations sandwich record blocks specifying cell properties. A group of four lines, each line NZNODE-1 characters long, defines the physical properties of a column of elements. The first line indicates the properties of triangular subcell 1, the second triangular subcell 2, etc (see figure 4).

The last record in a *.2DM files should be a list of node locations along the edge of the finite-element mesh. There should be a total of NXNODE node-location record blocks and NXNODE-1 cell-property blocks. A mesh can be subdivided by increasing the value of NXNODE and inserting additional node-location and cell-property record blocks in the middle of a *.2DM file.

***.IPD File (model-data file)**

*.IPD files hold observed and calculated data in a tabular format.
Comment lines beginning with a "!", "\", "/", or """" can be included for annotation.

Partial *.IPD-file listing:

```
"SP1t" "ZP1t" "SRx1" "SRx2" "STx1" "STx2" "ARobs" "ARerr" "APobs" "APerr" "ARmod" "APmod"  
"Modeling results from R2DIP v3.10d Date:01/10/96 Time:13:59"  
-650,-100,-800,-700,-600,-500,0.0000,0.0,0.0,0.0,99.34,0.0,  
-550,-100,-700,-600,-500,-400,0.0000,0.0,0.0,0.0,98.80,0.0,  
-600,-150,-800,-700,-500,-400,0.0000,0.0,0.0,0.0,98.66,0.0,  
-450,-100,-600,-500,-400,-300,0.0000,0.0,0.0,0.0,94.33,0.0,  
-500,-150,-700,-600,-400,-300,0.0000,0.0,0.0,0.0,91.37,-0.1,  
-550,-200,-800,-700,-400,-300,0.0000,0.0,0.0,0.0,88.98,-0.1,  
-350,-100,-500,-400,-300,-200,0.0000,0.0,0.0,0.0,116.7,0.0,  
. . . . .  
. . . . .  
. . . . .
```

Record 1 is a list of column headers indicating the data type in each column. Record 2 is a comment line showing the program name and version along with the date and time when the file was updated. All remaining records in DEMO2DIP.IPD specify individual four-electrode resistivity/IP data points.

- Column Number: Associated variable
- 1: horizontal plot-point coordinate (station numbers).
 - 2: vertical plot-point coordinate (station numbers).
 - 3: location of receiver electrode 1 (station numbers).
 - 4: location of receiver electrode 2 (station numbers).
 - 5: location of transmitter electrode 1 (station numbers).
 - 6: location of transmitter electrode 2 (station numbers).
 - 7: observed apparent resistivity (ohm-m).
 - 8: observed apparent resistivity error (percent).
 - 9: observed apparent IP (IP Units).
 - 10: observed apparent IP error (IP Units).
 - 11: calculated apparent resistivity (ohm-m).
 - 12: calculated apparent IP (IP Units).

***.Z2D File (Zong plotting program ZPLOT *.Z file)**

*.Z files hold data in an (x,y,z) format specialized for the Zong plotting program ZPLOT.

Partial *.Z2D-file listing: ! Modeling results from R2DIP v3.10d

```
1: $ DATE= 01/10/96
2: $ ASPACE= 100.m
3: $ ZPLOT: DATA= N-SP
4: R2DIP v3.10d Contour file.
5: Cl Cn Ce Ns Nd Yl Plot file 1
6: 1 10 0 3 1 0
7: Dipole-Dipole IP Data
8: Calculated App Resistivity
9: values in ohm-m
10: IIxxxxxxxxxYYYYYYYzzzzzzzzzzz AAA
    2 -650. 1. 9.934E+01
    2 -550. 1. 9.880E+01
    2 -600. 2. 9.866E+01
    2 -450. 1. 9.433E+01
    2 -500. 2. 9.137E+01
    2 -550. 3. 8.898E+01
    2 -350. 1. 1.167E+02
    2 -400. 2. 1.129E+02
    2 -450. 3. 1.093E+02
    2 -500. 4. 1.068E+02
      : : : :
      : : : :
99: 9999.00
```

Description of values in sample *.Z file:

Line # Explanation:

- 2: \$ ASPACE= 100.m Keyword specifying dipole length
- 3: \$ ZPLOT: DATA= N-SP Keyword specifying vertical plot axis type
- 4: R2DIP v3.00d Program name and version that generated this file.
- 5: Cl Label for contour type: 0 = linear
1 = logarithmic
2 = pseudo-log

Pseudo-log contours: positive and negative values contoured separately, using $\log_{10}(\text{abs}(\text{value}))$, plus a zero contour.

Cn Label for number of contours per interval.

Ce Label for exponent of the contour interval.
The "interval" is an integer power of ten: $10C_e$

Ns Label for number of significant digits when posting values.
Values: -1, 3, 4, 5. (-1 = free format for small values)

Nd Label for the number of digits after the decimal.

Yl Label for vertical axis: 0 = none

- 1 = linear frequency
- 2 = log frequency
- 3 = linear depth

6: 1 Value of Cl: logarithmic contours

5 Value of Cn: 5 contours per "interval"

0 Value of Ce: interval = 100 = 1

3 Value of Ns: use 3 significant digits for contouring

1 Value of Nd: plot 1 digit after the decimal

1 Value of Yl: linear frequency axis

7-9: Data description for this Plot File. Two to six lines are available, NOT including the first column.
Plot programs may plot these lines as title information.

10: Header line for the data that follows:

II - Command flag:

0 = Skip this line of data.

1 = Omit for contouring, but post the bracketed value.

2 = Use for contouring and post the value (most common).

3 = Label a point or station by plotting a symbol under the X-axis at the X-coordinate.

4 = Use for contouring, post the symbol and not the value.

Used for depth plots where values are interpolated for the bottom of the plot to improve the gridding.

5 = Use to set plot limits, do not contour or post.

Used for depth plots to set zero depth. Used to provide a margin around the data, as for plan maps.

xxxxxxx - X-coordinate, usually station coordinate.

YYYYYYYY - Y-coordinate, not used for Flag = 3

zzzzzzzz - Value to be plotted at X-Y for Flags 1, 2, 4.

AAA - For Flag 1 or 2, ZPLOT posts any characters in the AAA column instead of the value in the zzzzzzzz column.

For Flag 3, ZPLOT plots a symbol below the X-axis at the x-value according to an integer in column AAA. A zero or positive integer refers to symbols in TABLE 1 of the PLOT Manual. A negative integer refers to topographic symbols in the CTOPO Manual.

99: 9999.0 - End-Of-Plot indicator.