

RES3DMOD ver. 2.1

for Windows 95/98/Me/2000/NT

3-D resistivity & IP forward modeling using the finite-difference and finite-element methods

(Wenner, dipole-dipole, pole-pole, pole-dipole,
Schlumberger, rectangular)

by

M.H.LOKE

March 2001

Freeware courtesy of M.H.Loke

Copyright (1999-2001) M.H.Loke

Table of Contents

	Topic	Page No.
1	Introduction	1
2	Computer System Requirements	2
3	Theory	2
4	Program files	3
5	Data file options and model data format	4
6	Edit and display functions	8
7	Modifying the program settings	10
8	Calculating the potential values	11
9	Printing the results	12
	References	12

1 Introduction

This is a Windows based 3-D resistivity and IP modeling program. This program calculates the apparent resistivity values for a survey carried out with a rectangular grid of electrodes (Figure 1) using the finite-difference (Dey and Morrison 1979) or the finite-element (Silvester and Ferrari 1990) method.

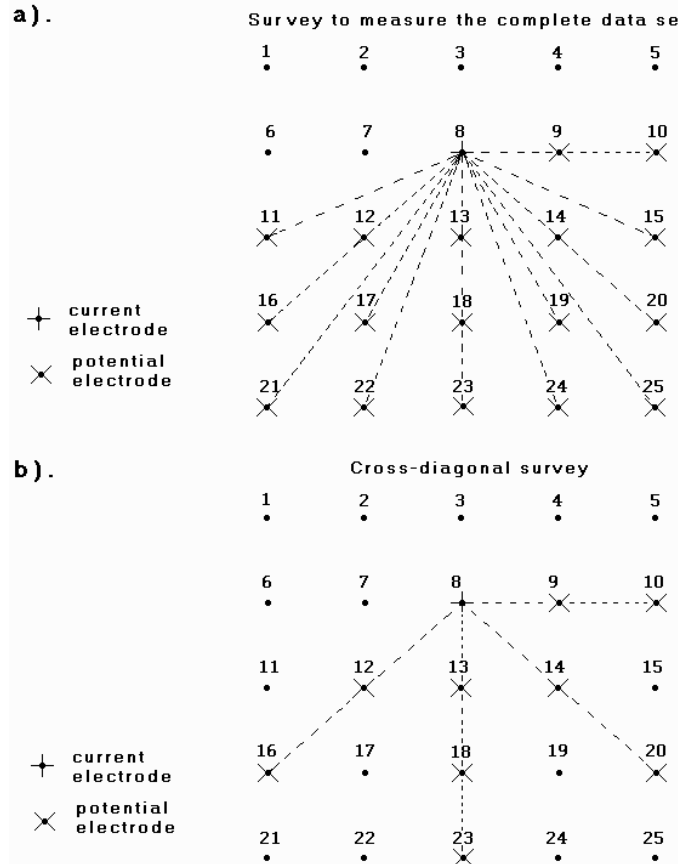


Figure 1. The arrangement of the electrodes in a 3D resistivity imaging survey, and two possible measurement techniques with the pole-pole array.

The maximum survey grid size the program can handle depends on the amount of RAM available. It can handle a survey grid with up to 2500 electrodes (with the finite-difference modelling method) if the computer has at least 128 MB RAM.

2 Computer System Requirements

This program requires the Windows 95/98/Me/2000/NT operating system. It must have at least 32 MB RAM, and preferably at least 64 MB RAM. The hard-disk should have at least 64 Megabytes of free space that the program might need for temporary files. You should also use Windows in the SuperVGA 800x600 or 1024x768 (or even higher) graphics mode with 256 colors. The program will also run with the 16-bit or 24-bit colors modes, but if you encounter problems it is recommended that you switch to the 256 colors (8-bit) mode. To edit the 3-D models on the screen, a sufficiently high resolution graphics mode must be used. If you are still using the standard VGA 640x480 graphics mode, please switch to the 800x600 mode. It is expected that the computer used is a Pentium II or faster system, although the program will also run on the older Pentium and 80486 system.

3 Theory

This program uses the finite-difference method. Figure 2 shows a schematic diagram of the arrangement of the nodes in a 3-D mesh. In practice, the RES3DMOD program uses many more nodes, with 2 nodes between adjacent electrodes and 8 buffer nodes at the sides of the mesh.

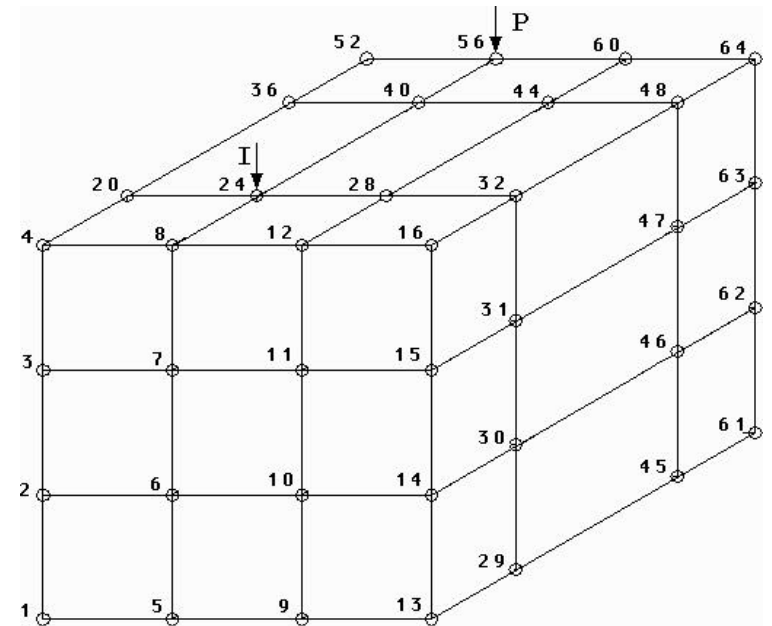


Figure 2. Schematic diagram of 3-D mesh.

To use this program, the user must supply the resistivity value of each cell in the 3-D mesh using an input text file. The relationship between the location of the electrodes and the cells in the 3D mesh is shown in the following diagram.

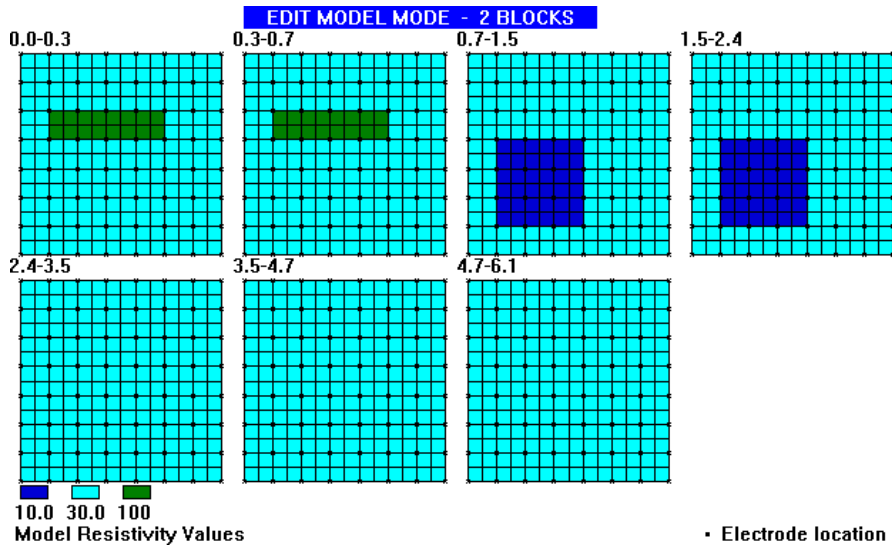


Figure 3. An example 3D model that shows the location of the electrodes.

Note that there are two cells between adjacent electrodes, and the thickness of each layer increases with depth. The resistivities of the cells at the sides and bottom of the central region of model bounded by the grid of electrodes are automatically extended to the sides and bottom of the finite-difference mesh used. If the model has IP values, the IP value for each cell is arranged in a similar manner.

An option to use the finite-element method is also available. However, at present, it is not recommended as it is much slower than the finite-difference method.

4 Program files

The RES3DMOD package comes in a single compressed installation file SETUP.EXE. It is a Windows based installation program that will install the program files.

In Windows 95/98/Me/2000/NT, click Start, and then Settings followed by Control Panel, and then Add/Remove Programs. Then use Browse to navigate to the folder where the SETUP.EXE program is located.

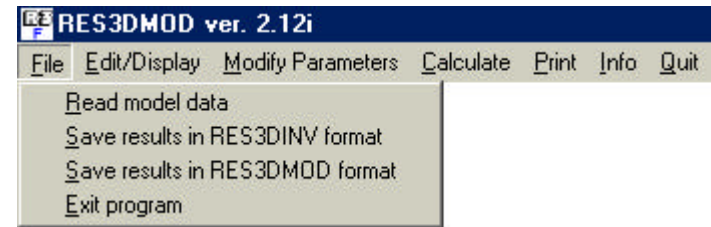
Copyright (1999-2001) M.H.Loike

The RES3DMOD package should have the following files :-

BLOCK8.MOD	Example input model file with a small 8 by 8 survey grid.
BLOCK11.MOD	Example input resistivity model file for a 11 by 11 survey grid.
BLOCK11X.MOD	The above model with the calculated potential values. You can read this file to display the apparent resistivity pseudosections without the need to calculate them.
BLOCK17.MOD	Example input resistivity model file for a 17 by 17 survey grid.
MODELIP.MOD	Example input model with both resistivity and IP. An 11 by 11 survey grid is used.
BLOCK10F.MOD	A model with remote electrodes.
RES3DMOD.EXE	The forward modeling program.
COLOUR.COL	Color configuration file
RES3DMOD.CFG	Configuration file for RES3DMOD
RES3DMOD.CF2	Alternative configuration file for RES3DMOD

5 Data file options and model data format

After starting the program, you can test it by choosing the File option. On selecting the file option, the following menu will be displayed.



Read model data – This option enables you to read in a data file containing the model parameters. As an initial test, select the example file BLOCKS8.MOD. The program uses a finite-difference mesh with an x- or y-spacing that is half the unit electrode spacing. You basically need to specify the resistivity of the sub-blocks within the area covered by the grid of electrodes. As an example of the data format, the contents of the BLOCKS8.MOD file is listed below with a description of the input parameters.

MODELIP.MOD file	Comments
11111111111111111111	Last 2 lines of the model resistivity
11111111111111111111	values.
IP Model Values	This line to show IP values are present
3	Number of IP values
0.10,0.00,0.20	The IP values
LEVEL 1	Following is IP data for layer 1
11111111111111111111	IP of blocks in layer 1
11111111111111111111	The format is the same as that
11111111111111111111	used for the model resistivity values.
11111111111111111111	The number of layers must be the same
11112222211111111111	as that used for the resistivity model.

This model shows interesting “anomaly inversion” effects in both the apparent resistivity and apparent IP values.

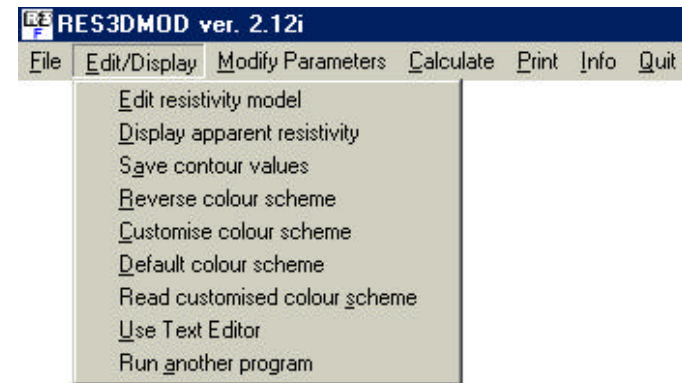
Note that the model IP values are given as V/V values, and not mV/V values. If you use chargeability values of greater than or equals to 1, the program will assume that they are given in the mV/V unit, and it will divide the values by 1000 to convert them into V/V values.

Save results in RES3DINV format – After calculating the potential values, you can save the apparent resistivity values into the format used by the RES3DINV inversion program.

Save results in RES3DMOD format – After calculating the potential values, you can save the model parameters, as well as the calculated potential values into the format used by this program. This saves you some time in calculating the potential values in future for the same model. This is particularly useful if the model has a very large grid.

6 Edit and display functions

These are a number of functions that enable you to edit the model and to display the apparent resistivity values. On selecting this option on the main menu bar, the following list of options will be displayed.



Edit resistivity model – This option will display the input model in grid form (Figure 3). By using the mouse, you can change the resistivity values of the cells. Click ‘Help’ in the Edit Model Mode to see the mouse and keys to use.

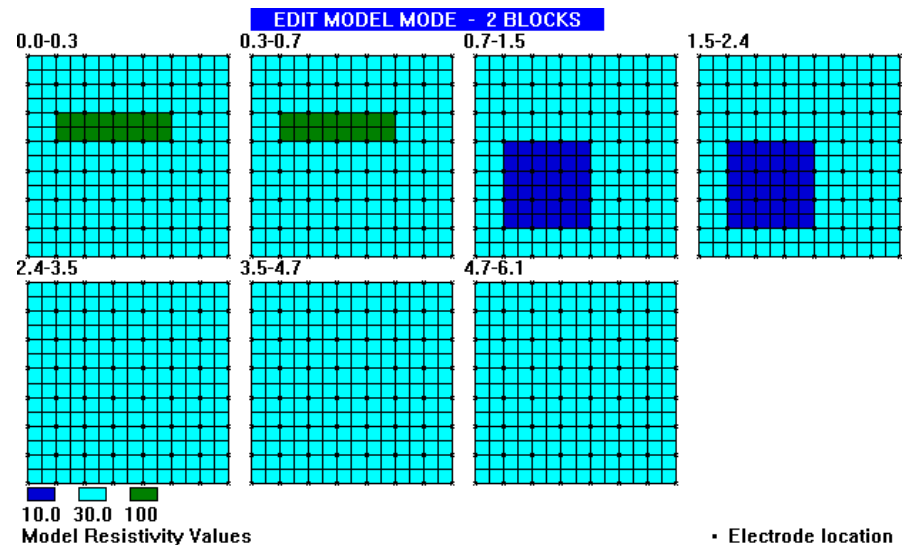


Figure 3. An example 3D model that shows the location of the electrodes.

Display apparent resistivity – This option enables you to display the apparent resistivity values in the form of vertical or horizontal pseudosections. The following dialog box will be displayed when you select this option.

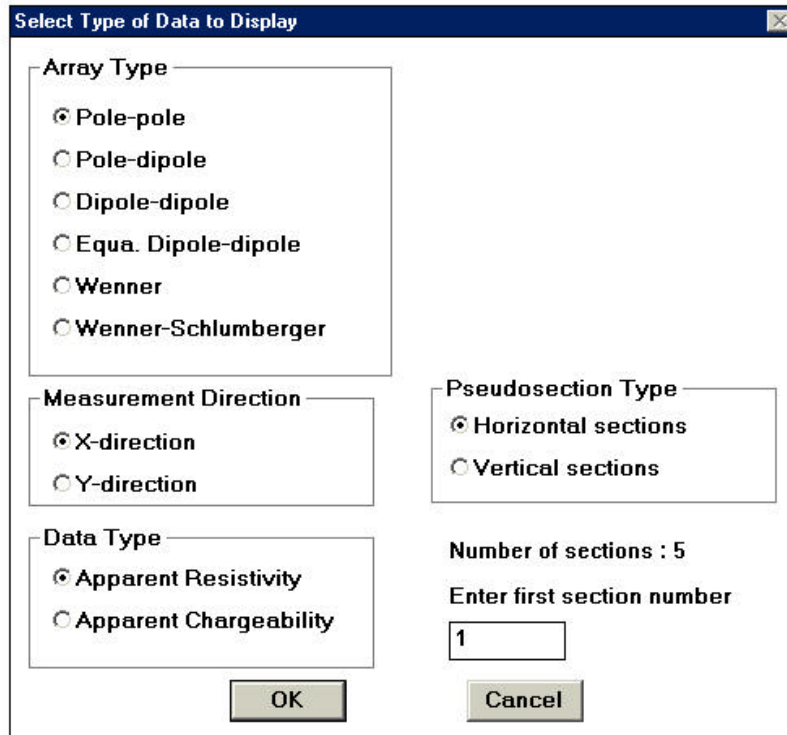


Figure 4. Dialog box showing the different options for displaying the apparent resistivity values.

In this option, you can select the array type, the measurement direction of the apparent resistivity values to be displayed, the choice of horizontal or vertical pseudosections, and the apparent resistivity or IP values.

Reverse colour scheme - Normally the program uses a colour scheme where blue is used for the low resistivity and red for the high resistivity values. This option allows use to reverse the colour scheme so that blue is used for the high resistivity values and red for the low resistivity values.

Save contour values – This option saves the values used to draw the contours in the pseudo and model sections into a file. This is useful when you want to use the same contour values in different displays.

Default colour scheme - This will reset the colour scheme used for colouring the sections to a default system used by the program.

Customise colour scheme - This enables the user to change the colours used for the sections.

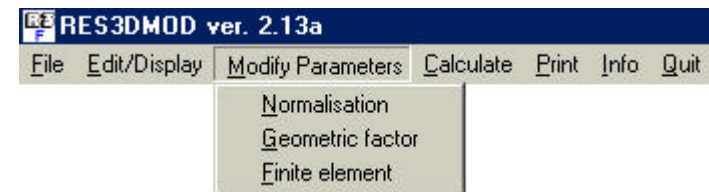
Read customise colour scheme - You can change the colour scheme to a set of customise colours that was earlier saved in a disk file.

Use Text Editor - When you select this option, the text editor (by default NOTEPAD) will start up. To return to the RES2DINV program, you must first exit from the text editor program.

Run another program - This option enables you to run another program. It is mainly intended for cases where the program had not been installed and thus not in the list of programs recorded in the Windows Start and Program option.

7 Modifying the program settings

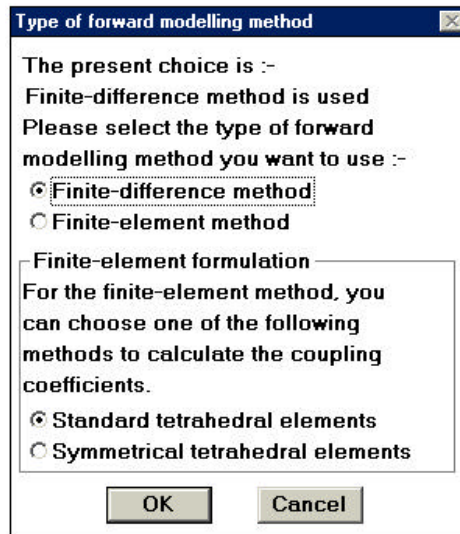
You can change the setting used by the program by selecting the 'Modify Parameters' option on the main menu bar. When you select this option, the following menu list will be displayed.



Normalisation –The potential values calculated for your model is normalised by using the potential values for a homogenous earth model. You can disable this normalization procedure in this option. By default, the normalisation procedure is used.

Geometric factor – This option is only relevant for the pole-pole and pole-dipole arrays where the location(s) of the remote electrode(s) are given in the model file. In this case, you can choose to use the geometric factor for the ideal pole-pole or pole-dipole array, or the true geometric factor by taking into consideration the locations of the remote electrodes, when calculating the apparent resistivity values.

Finite element – When you select this option, the following dialog box is displayed.



Firstly, you can choose to use either the finite-difference or finite-element method to calculate the apparent resistivity values. By default, the program uses the finite-difference method that is much faster. For the finite-element method, you can choose to use standard tetrahedral elements (Silvester and Ferrari 1990), or a modified symmetrical formulation with tetrahedral elements.

8 Calculating the potential values

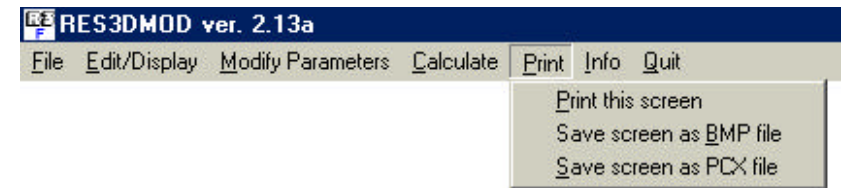
When you are ready to calculate the potential values for your model, just click the 'Calculate' option on the main menu bar. The calculation will take a few seconds to tens of minutes depending on the speed of your computer processor and the grid size of your model. For each electrode position, the program calculates the potential at all other electrodes due to a current electrode at that position. Thus

Copyright (1999-2001) M.H.Loke

once the potential values have been calculated, the apparent resistivity due to any array can be determined without the need to recalculate the potential values. You only need to recalculate the potential values if you change the resistivity of the cells in the model.

9 Printing the results

When you select this option, the following menu will be displayed.



This option enables you to save the screen image as a BMP or PCX graphics file, or make a direct printout with a printer by using the Windows Paintbrush program. After the program has completed drawing the model or pseudosection, click the Print option. This will display options to save the screen as a BMP file, a PCX file or to call up the PaintBrush program to print the file. If you need to print the screen image together with some text, it might be more convenient to save the screen image as a BMP or PCX file. You can later insert the picture directly into the document if the word processor, such as Microsoft Word for Windows or Lotus Amipro or WordPerfect, allows you to import graphics files.

References

- Dey, A. and Morrison, H.F., 1979. Resistivity modelling for arbitrary shaped two-dimensional structures. *Geophysical Prospecting*, 27, 1020-1036.
- Silvester P.P. and Ferrari R.L., 1990. *Finite elements for electrical engineers* (2nd. ed.) . Cambridge University Press.