

RES3DINVx64 - 3D RESISTIVITY & IP INVERSION software for Windows XP/Vista/7/8/10
Uses the smoothness constrained Gauss-Newton least-squares optimization method
Supports on land and underwater surveys. Supports smooth and sharp contrasts inversion
Supports multi-core CPUs. Supports up to 200000 electrode positions (RES3DINVx64 Professional)
Supports electrodes at arbitrary positions and IP inversion using the complex resistivity method.

In areas with complex structures, there is no substitute for a fully 3D survey. The arrays supported include the pole-pole, pole-dipole, inline dipole-dipole, equatorial dipole-dipole and Wenner-Schlumberger and non-conventional arrays.

The RES3DINV program uses the smoothness-constrained least-squares inversion technique to produce a 3D model of the subsurface from the apparent resistivity data. The RES3DINVx64 Basic program supports up to 8 GB RAM, while RES3DINVx64 Professional supports up to 192 GB RAM. The data inversion takes less than a minute for small surveys with 100 electrodes in a flat area, to about an hour for extremely large surveys with 3000 electrodes in rugged terrain.

The program will automatically choose the optimum inversion parameters for a data set. However, the parameters that affect the inversion process can be modified by the user. The inversion settings can be optimized for areas where the subsurface resistivity varies in a smooth manner, or optimized for areas with sharp boundaries. Topographic effects can be incorporated into the model by using a distorted finite-element grid such that the surface of the grid matches the topography.

An example of the results obtained from an electrical imaging survey in an area with complex geology is shown in Figure 1. This survey was carried out in Southern Sweden over a closed sludge deposit using the pole-pole array (Dahlin *et al.* 2002). A survey grid with 21 by 17 electrodes was used. The former sludge ponds containing highly contaminated ground water show up as low resistivity zones in the top two layers. This was confirmed by chemical analysis of samples. The low resistivity areas in the bottom layer are due to saline water from a nearby sea.

The results from a 3D resistivity and IP survey over a copper and gold porphyry prospect in Southeast Asia is in Figure 2 displayed by a 3D Virtual Reality Modeling program to show selected regions of the model. The survey area covers a 5000 by 5000 meters grid. The main targets are regions with high IP values over 20 and 30 mV/V.

RES3DINVx64 supports data collected with electrodes at arbitrary positions that do not fit into a simple rectangular grid. This situation frequently occurs because of physical obstructions such that straight surveys lines cannot be used, or the data is collated from surveys over different periods with lines in different directions (Rucker *et al.* 2010). It also supports IP inversion using the complex resistivity method (Kenma *et al.* 2000), calculation of the model resolution, and outputs the results in Voxler and Paraview formats.

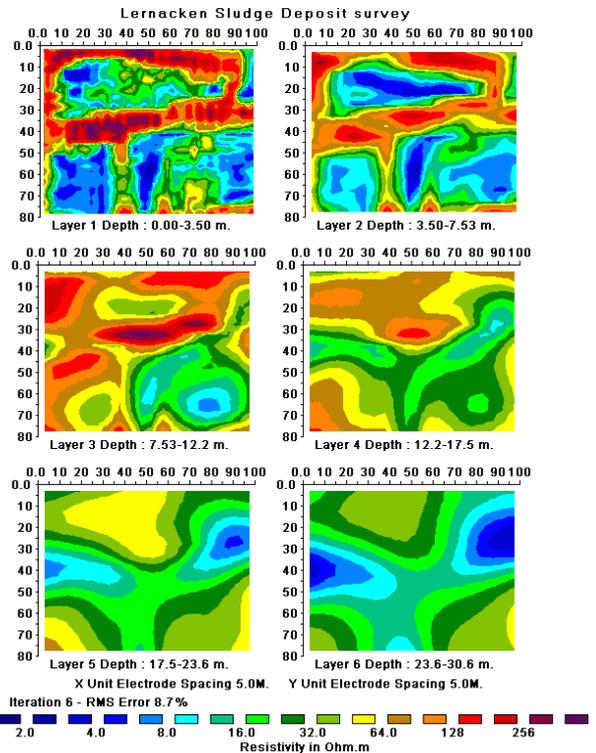


Figure 1. The 3D model obtained from the inversion of the Lernacken Sludge deposit survey data set. The model is shown in the form of horizontal slices through the earth.

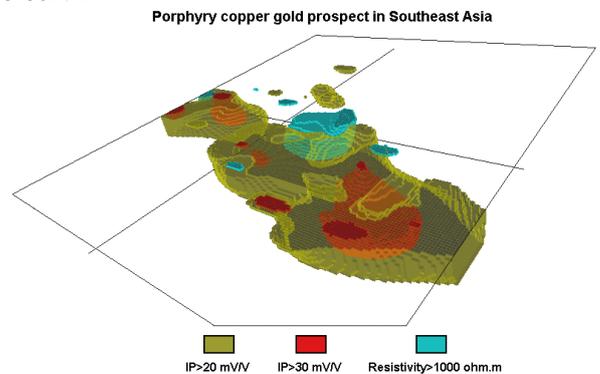


Figure 2. 3D view from the southeast of the resistivity and IP model from a survey over a copper and gold porphyry prospect in Southeast Asia.

References

Dahlin, T., Bernstone, C. and Loke, M.H., 2002. A 3-D resistivity investigation of a contaminated site at Lernacken, Sweden. *Geophysics*, 67, 1692-1700.
 Kenma, A., Binley, A., Ramirez, A. and Daily, W., 2000. Complex resistivity tomography for environmental applications. *Chemical Engineering Journal*, 77, 11-18.
 Rucker, D.F., Loke, M.H., Levitt, M.T. and Noonan, G.E., 2010. Electrical resistivity characterization of an industrial site using long electrodes. *Geophysics*, 75, WA95-WA104.

Summary of RES3DINVx64 features

1. Support for conventional arrays such as Wenner, Wenner-Schlumberger, dipole-dipole, pole-dipole, pole-pole, multiple-gradient, and non-conventional arrays using almost any electrodes arrangement such as the offset pole-dipole array.
2. Handles data from surveys carried out on the ground surface, cross-boreholes, aquatic surveys with floating or bottom electrodes. Support for long electrodes consisting of vertical metal pipes.
3. Handles 3-D data sets with electrodes arranged in a rectangular grid, as well as in arbitrary positions. Data sets, particularly from mineral exploration surveys, that have survey lines with different directions and spacings can be processed using the arbitrary electrode data format.
4. Inversion of IP data using the complex resistivity method.
5. Supports data sets with up to 175,000 readings and 16,000 electrode positions on PCs with 8 GB RAM. Handles data sets with up to 700,000 readings and 200,000 electrode positions on PCs with 128 GB RAM.
6. Support parallel processing for up to 64 CPU cores for multi-core and multi-CPU PCs.
7. Many inversion techniques for different geological settings and survey configurations. This includes smooth (L2) and blocky (L1) inversion options. Topographic modeling using the finite-element method.
8. Output of results in commonly used Voxler and Paraview formats.
9. Most resistivity-meter instruments have software conversion routine to convert field data sets into the data format used by this program.
10. Use of very fast numerical routines. Data sets that take days (hours) to process with some other commercial or academic 3-D software codes take hours (minutes) with this program. As an example, the inversion of a data set with about 9,400 electrode positions and 147,000 data points with topography took about 1.3 hours on PC with an Intel i7 6950X CPU and 128 GB RAM giving a model with 73,600 cells.

Differences between RES3DINVx64 Basic and Professional

The version of RES3DINVx64 that the user is allowed to use depends on the license the USB dongle supplied with the software has. The main differences between the two versions are as follows.

- 1). Res3dinvx64 Basic is limited to 8 GB RAM memory space while Res3dinvx64 Professional can access up to 192GB RAM.
- 2). Only Res3dinvx64 Professional supports 3-D time-lapse inversion. The Basic version does not support this type of data.
- 3). Res3dinvx64 Basic is limited to a finite-difference/element mesh model with a maximum of 1 million nodes. In Res3dinvx64 the maximum mesh size depends on the computer RAM. With 128GB, it supports up to about 10 million nodes.

RES3DINVx64 Basic is probably sufficient for medium size surveys with up to about a thousand electrode positions. RES3DINVx64 Professional is recommended for more complex survey arrangements (particularly for mineral exploration) with very large surveys grids with several thousand electrode positions and tens of thousands of data points and model cells, or for time-lapse surveys. Both versions support non-rectangular survey layouts using the arbitrary electrodes data format.