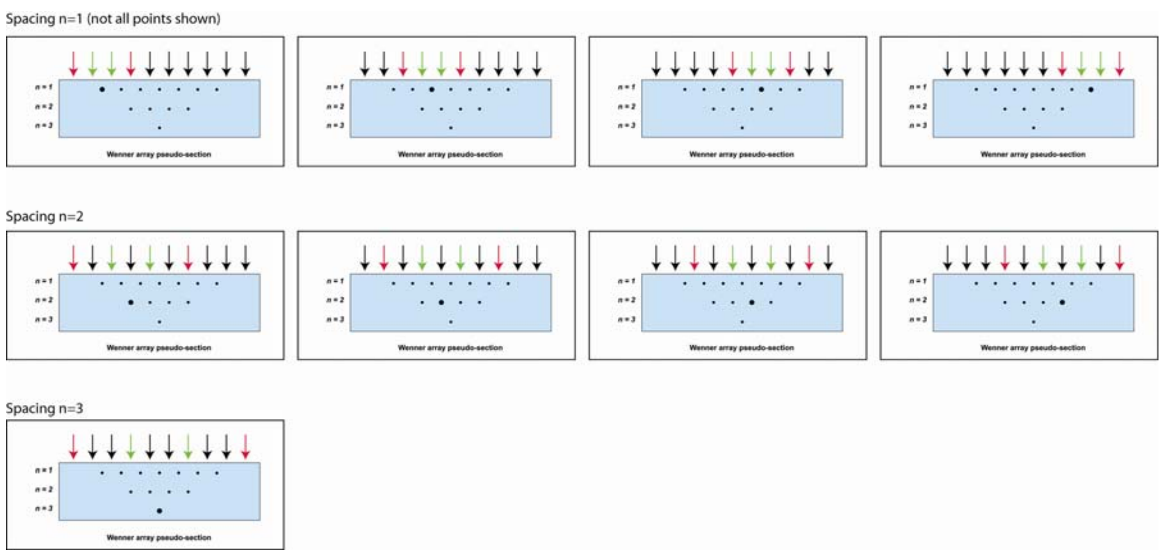
325 C6 Apparent resistivity of a 2-D resistivity model

C6.1 Pseudosection display for a Wenner array

In previous section we saw that **sounding** can determine the variation of resistivity as a function of depth at one point. **Profiling** with an array of fixed *a*-spacing can determine horizontal variations in resistivity along a profile.

To image realistic 2-D resistivity structures, profiling and sounding must be combined. This is the implemented in most modern DC resistivity surveys, with an array of electrodes.



Using an automated cable, each electrode can be activated as a current (**red**) or potential (**green**) electrode. The first row shows a traverse with n=1 spacing. This gives information about resistivity variations close to the surface. The apparent resistivity is plotted in the pseudosection at point in the centre of the 4-electrode array, and at a depth that corresponds to the electrode spacing (the large black dot).

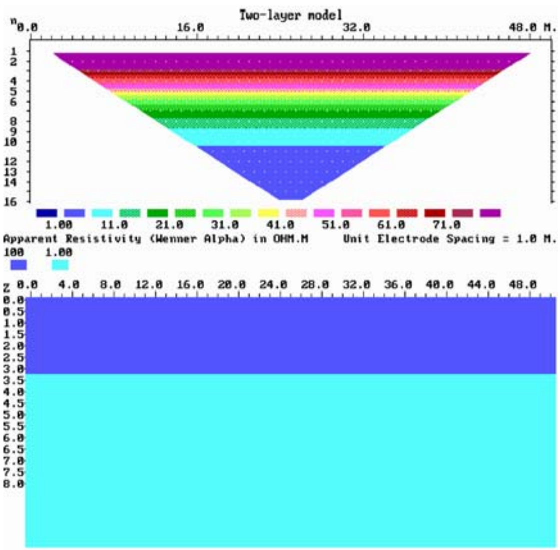
The second row shows a traverse with n=2, giving information about resistivity at greater depth. The larger size of the n=2 array restricts the number of horizontal data points, hence the triangular shape of the pseudosection.

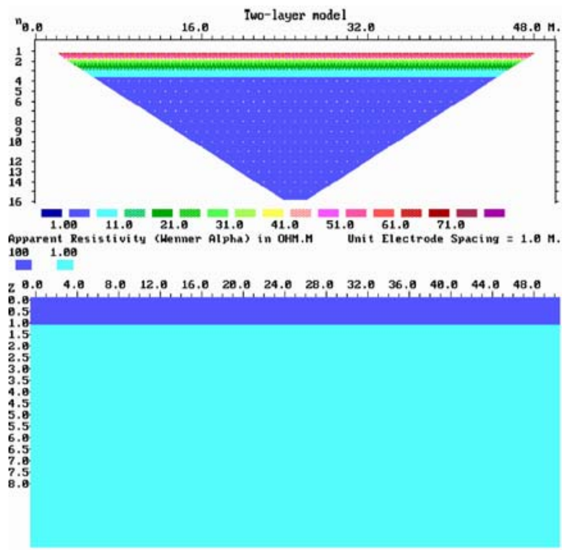
Note that one reason that the pseudosection is “pseudo”, is that it does not give a measure of true depth. Depth increases with a-spacing, but the relationship is not usually **linear**. The true depth must be determined by subsequent data analysis.

However, as we will se below, the pseudosection can give a **general impression** of how resistivity varies beneath the electrode array.

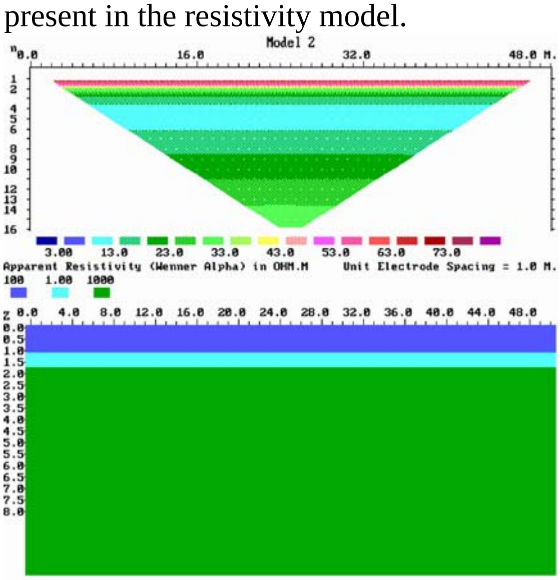
C6.2 Wenner pseudosections of some simple 2-D resistivity models

The following figures were generated using RES2DMOD, a widely used software package developed by Dr. M.H. Loke that can be downloaded for free from http://www.geoelectrical.com/download.html. In the following figures an array of 48 electrodes, 1 m apart was used. Note that the pseudosection (upper panel) and model (lower panel) use different colour scales.

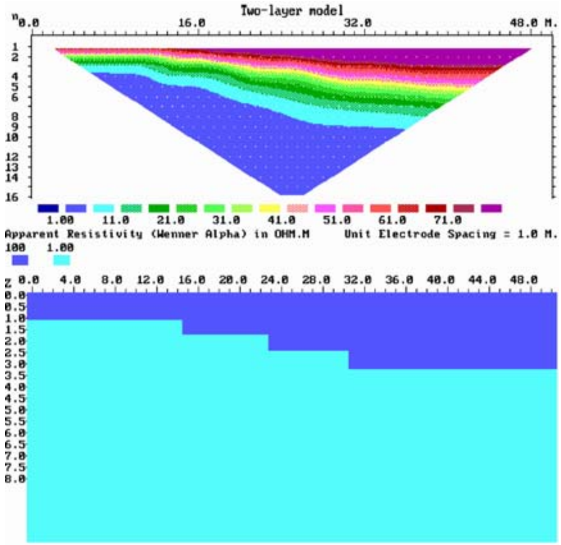




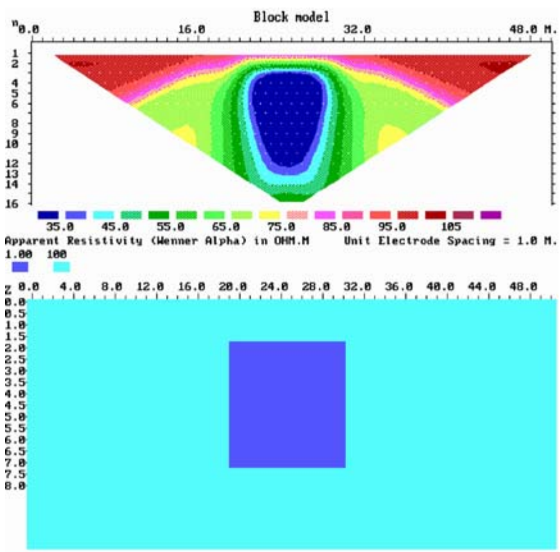
(1) In the first example, consider a 100 ohm-m surface layer that overlies a 1 ohm-m halfspace. When the layer is 3 m thick (left), the lower layer becomes obvious in the pseudosection at approximately n = 10. When the layer is just 1 m thick, the lower layer can be detected at n=4. Note that the pseudosection correctly defines the horizontal layer present in the resistivity model.



(2) This model shows a 3-layer model, and we could verify the results by using the MATLAB code described in C5.4. Note that the pseudosection shows a decrease in resistivity (n=1 to n=5) and then an increase (n=6 to n=16). The array is not really large enough to fully sample the lowest layer (1000 ohm-m).



(3) This example shows a dipping interface. Note that the pseudosection gives a good impression of this geometry, and even shows a hint of the steps.



(4) In this 2-D example, a conductive 1 ohm-m prism is embedded in a 100 ohm-m halfspace. The pseudosection correctly identifies the location of the top of the conductor.

However note that the shape is distorted with the wedge shaped region of low resistivity on each side of the prism. This illustrates another aspect of pseudosections which is the fact that the shape can be distorted.

In summary, pseudosections give a good impression of the subsurface resistivity structure. However pseudosections are pseudo for two reasons:

(1) True depth not known

(2) Shapes are distorted

Inversion of DC resistivity data with RES2DINV

A 2-D resistivity model can be derived from a pseudosection using trial-and-error forward modeling or a formal inversion algorithm. RES2DINV is a widely used software package that can be purchased from www.geometrics.com. The following examples of using RES2DINV are used with the permission of Dr. M.H. Loke and can be found in:

M.H. Loke, Electrical imaging surveys for environmental and engineering studies: A practical guide to 2-D and 3-D surveys, 2000. This can be downloaded at: www.geoelectrical.com in the section "Free software and notes".

Example 1: Synthetic inversion of Wenner array data generated by RES2DMOD

This procedure gives an objective test of an inversion algorithm, since we know what the answer should be. The black lines in (b) and (c) show the features present in the original resistivity model.

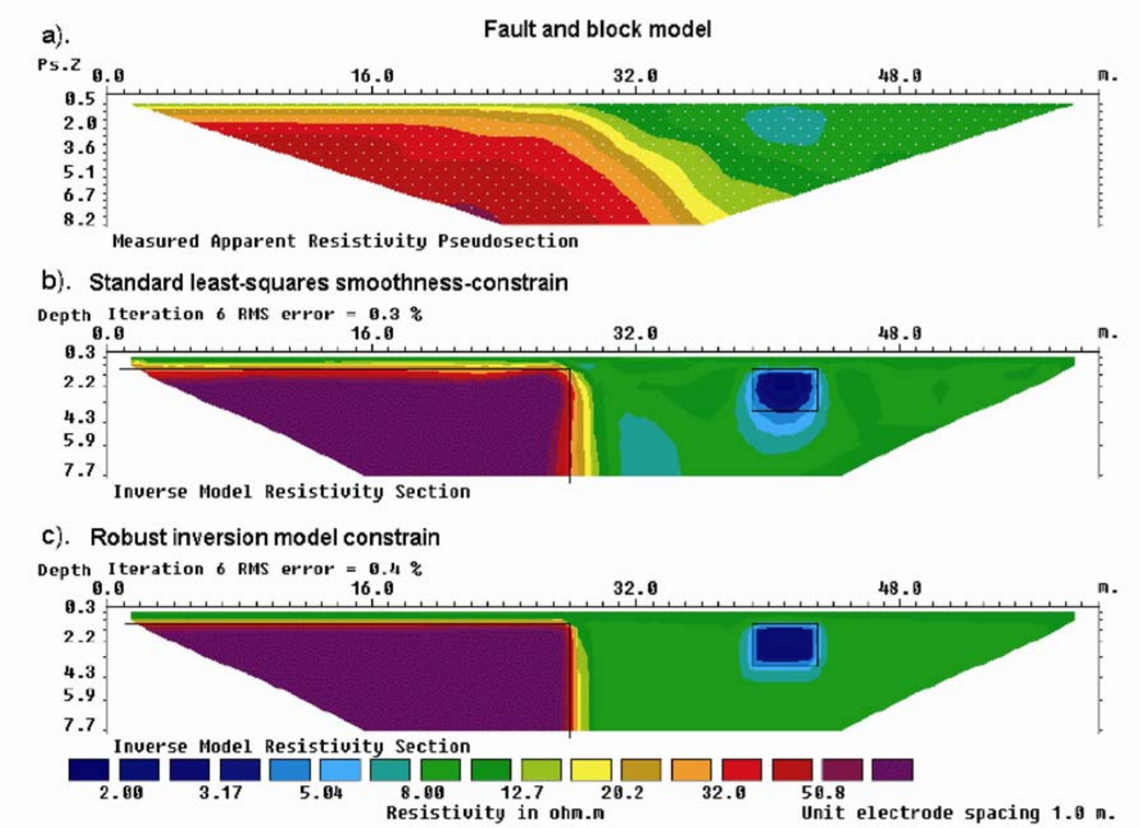


Figure 13. Example of inversion results using the smoothness-constrain and robust inversion model constrains. (a) Apparent resistivity pseudosection (Wenner array) for a synthetic test model with a faulted block (100 ohm.m) in the bottom-left side and a small rectangular block (2 ohm.m) on the right side with a surrounding medium of 10 ohm.m. The inversion models produced by (b) the conventional least-squares smoothness-constrained method and (c) the robust inversion method.

Example 2: Agriculture (Denmark)

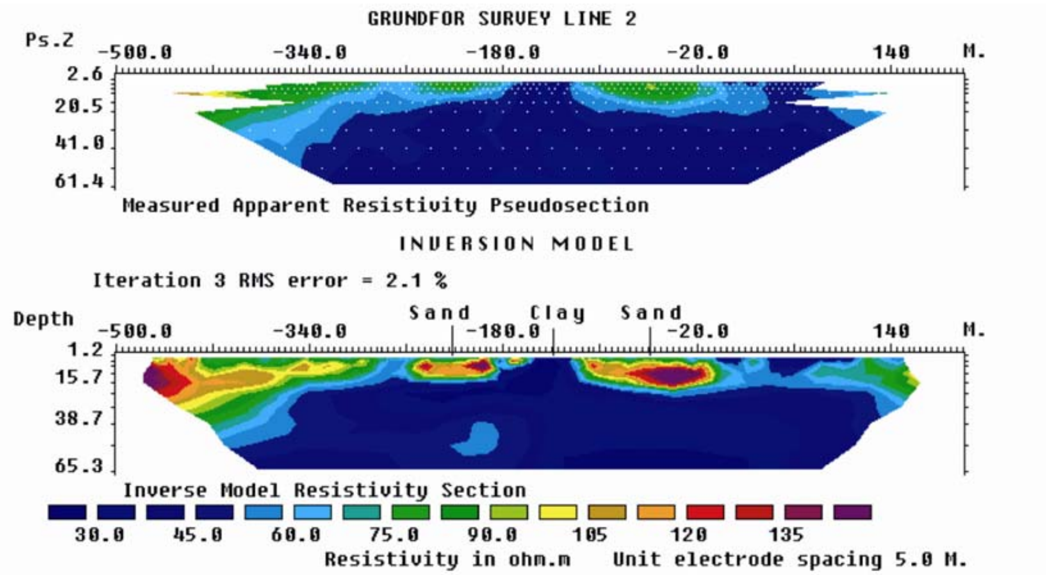


Figure 16. (a) The apparent resistivity pseudosection for the Grundfor Line 2 survey with (b) the interpretation model section.

Example 3: Dike (Sweden)

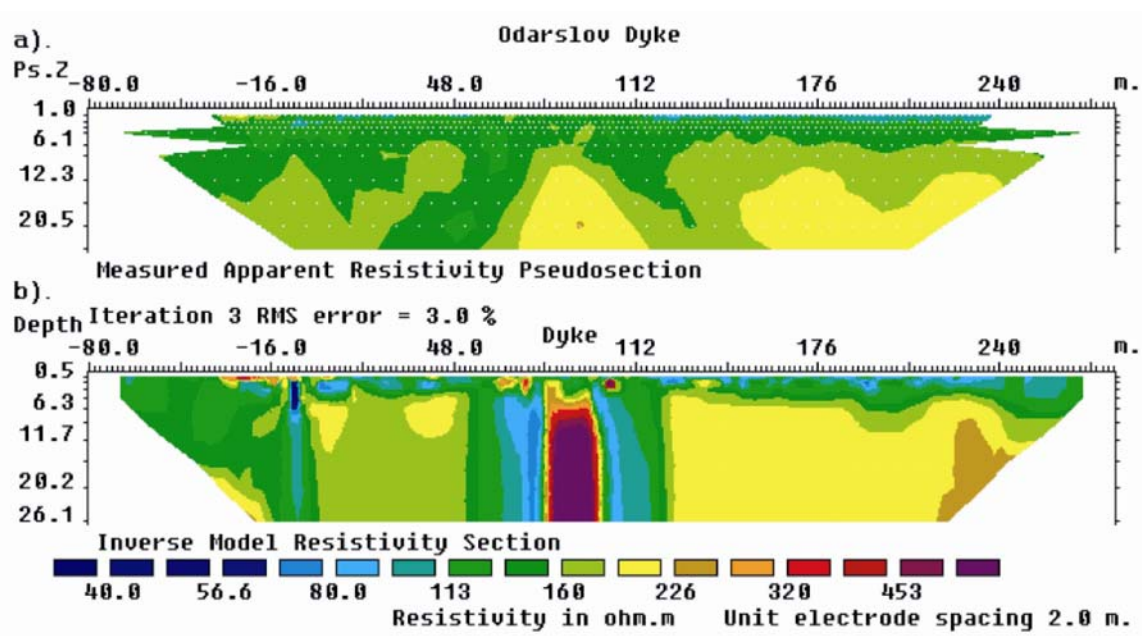
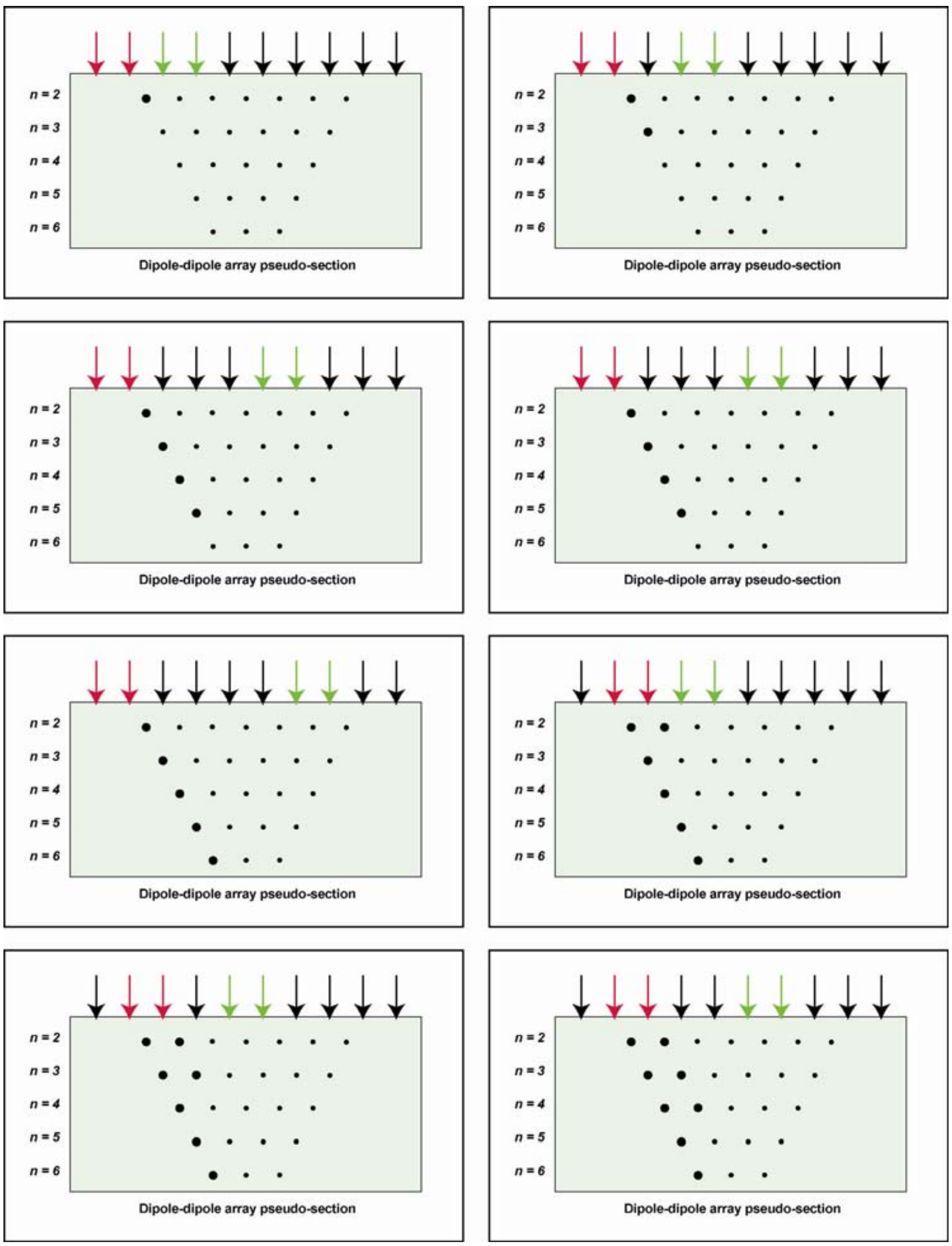


Figure 17. The observed apparent resistivity pseudosection for the Odarslov dyke survey together with an inversion model.

C6.3 Pseudosection for Dipole-dipole array

An alternative electrode configuration can used in array studies as shown below. It can be shown that this can be more sensitive to certain geometries in the subsurface. However, **large currents** are needed to make reliable measurements, since most current is localized between the two current electrodes (red).

The dipole-dipole method can also be used for deep DC resistivity exploration. This is because cables are not needed to connect the current electrodes (a transmitter) and the potential electrodes (a receiver). However, a large power source such as a generator is needed to get data with offsets of several kilometers.



MJU 2005