Adding topography to Res2DInv datasets

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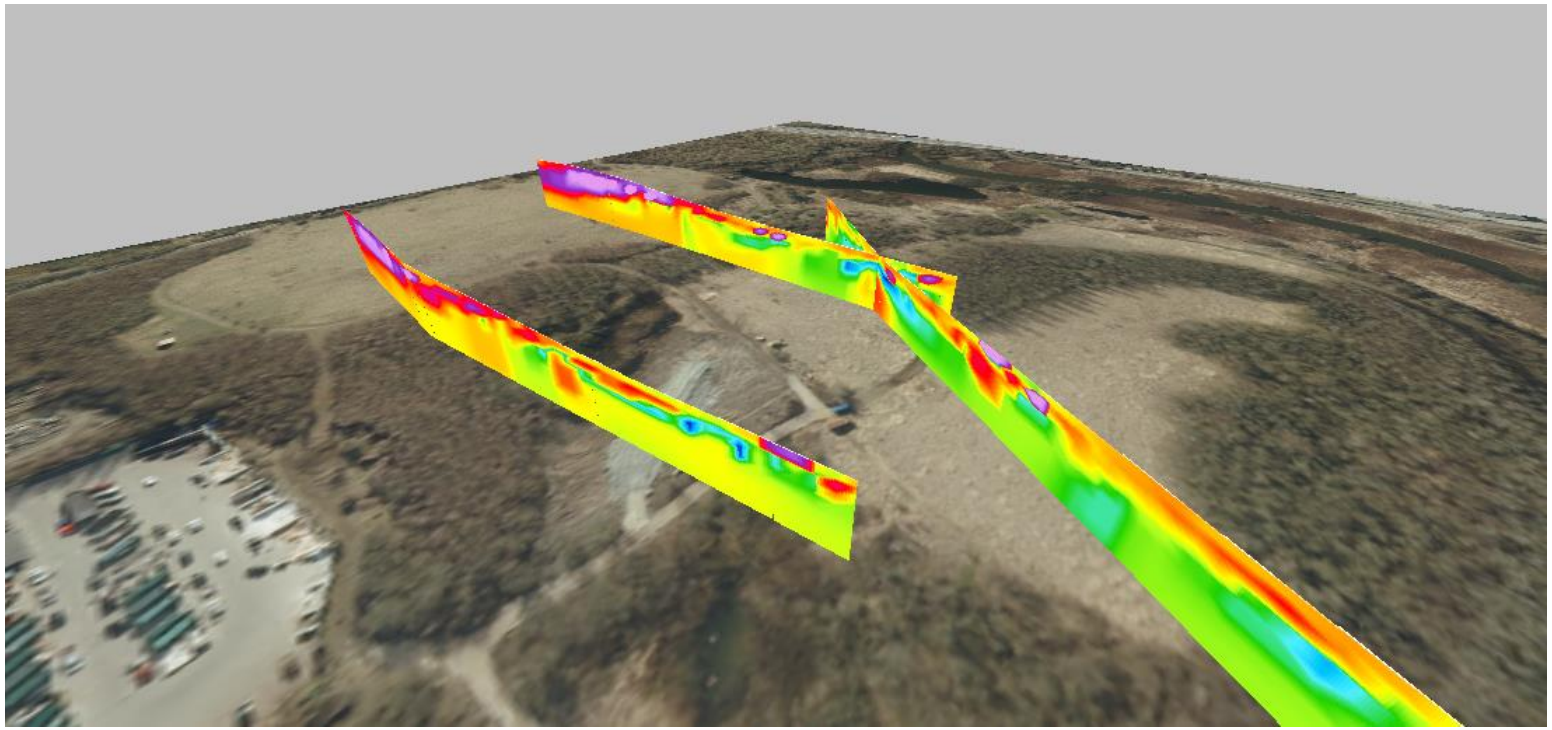
AGS Aarhus GeoSoftware

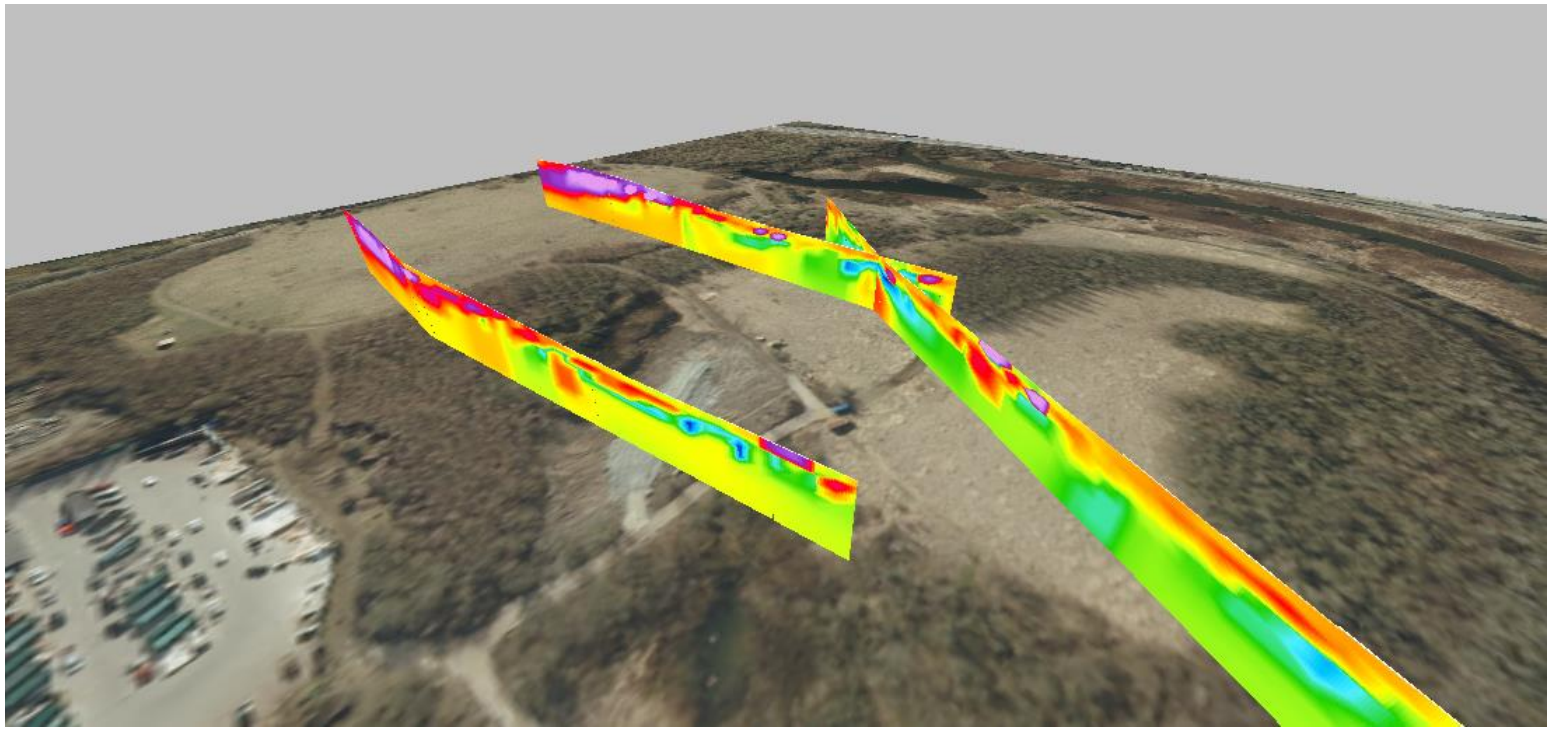
Program

- Motivation
- How to add topography to the .dat files
- Different options for topographical modelling
- Visualizing and exporting inversion results with topography



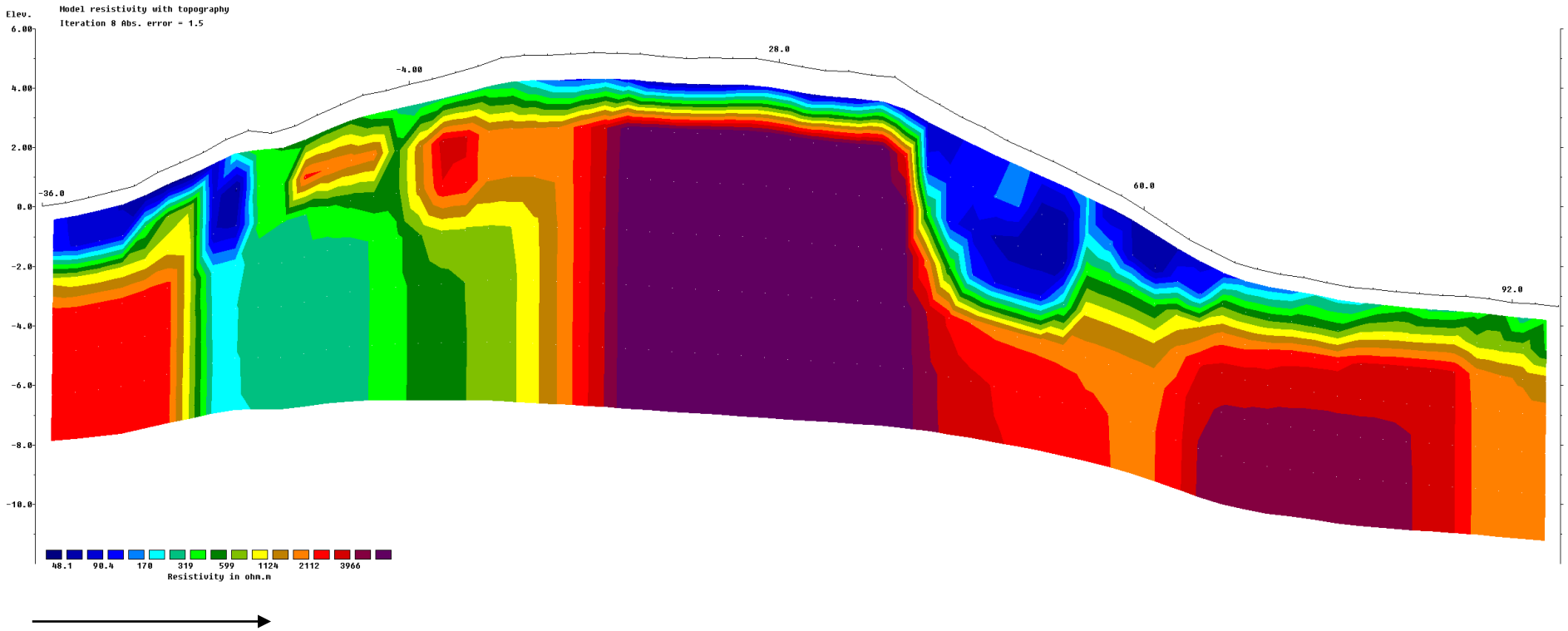
Why add topography?

- **The topography is fully modelled in the forward response -> More accurate inversion results**
- **More accurate and easier to understand visualizations**
- **Easier interpretation**



Coordinate systems

Elevation/Z-coordinates



Profile distances/X-coordinates

Two options !
Ground distances: what you will measure with a tape measure on the ground

True horizontal distances: What you would measure on a map without accounting for topography

Dat-file with no topography

Note the flag for type of profile distance

Header lines

Data lines

```
 1  General array format example
 2  1.0
 3  11
 4  0
 5  Type of measurement (0=app. resistivity,1=resistance)
 6   0
 7  407
 8  1
 9  0
10  4       0.00 0.00       3.00 0.00       1.00 0.00       2.00 0.00      10.158
11  4       1.00 0.00       4.00 0.00       2.00 0.00       3.00 0.00      10.168
12  4       2.00 0.00       5.00 0.00       3.00 0.00       4.00 0.00      10.184
13  4       3.00 0.00       6.00 0.00       4.00 0.00       5.00 0.00      10.225
14  4       4.00 0.00       7.00 0.00       5.00 0.00       6.00 0.00      10.337
15  4       5.00 0.00       8.00 0.00       6.00 0.00       7.00 0.00      10.708
16  4       6.00 0.00       9.00 0.00       7.00 0.00       8.00 0.00      11.668
17  4       7.00 0.00      10.00 0.00       8.00 0.00       9.00 0.00      12.542
18  4       8.00 0.00      11.00 0.00       9.00 0.00      10.00 0.00      12.871
19  4       9.00 0.00      12.00 0.00      10.00 0.00      11.00 0.00      13.238
20  4      10.00 0.00      13.00 0.00      11.00 0.00      12.00 0.00      13.342
410 4      21.00 0.00      20.00 0.00      27.00 0.00      28.00 0.00       3.422
411 4      22.00 0.00      21.00 0.00      28.00 0.00      29.00 0.00       7.834
412 4      23.00 0.00      22.00 0.00      29.00 0.00      30.00 0.00       7.977
413 4      24.00 0.00      23.00 0.00      30.00 0.00      31.00 0.00       7.343
414 4      25.00 0.00      24.00 0.00      31.00 0.00      32.00 0.00       5.907
415 4      26.00 0.00      25.00 0.00      32.00 0.00      33.00 0.00       3.974
416 4      27.00 0.00      26.00 0.00      33.00 0.00      34.00 0.00       6.765
417 0
```

Comment/title line

Unit electrode distance

Array type (General array)

Array sub-type (unspecified)

Header

Measurement type indication

Number of data points

Format of x-coordiantes (1 for true horizontal distances, 2 for ground distances)

Flag for IP data

Number of electrodes, x and z coordinates of C_1, C_2, P_1 and P_2 electrodes, apparent resistivity or resistance

End all files wit a zero

2 types of .dat files

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Index based

```
Blocks
   1.00
2
2124
1
0
      0.50        1.00       13.03
      1.50        1.00       13.17
      2.50        1.00       12.88
      3.50        1.00       13.05
      4.50        1.00       13.00
      5.50        1.00       12.98
      6.50        1.00       13.27
      7.50        1.00       13.31
      8.50        1.00       14.97
      9.50        1.00       18.32
     10.50        1.00       18.16
     11.50        1.00       14.80
     12.50        1.00       13.30
     13.50        1.00       13.12
     14.50        1.00       12.90
```

General array

```
General array format example
1.0
11
0
Type of measurement (0=app. resistivity,1=resistance)
 0
407
1
0
4       0.00 0.00       3.00 0.00       1.00 0.00       2.00 0.00       10.158
4       1.00 0.00       4.00 0.00       2.00 0.00       3.00 0.00       10.168
4       2.00 0.00       5.00 0.00       3.00 0.00       4.00 0.00       10.184
4       3.00 0.00       6.00 0.00       4.00 0.00       5.00 0.00       10.225
4       4.00 0.00       7.00 0.00       5.00 0.00       6.00 0.00       10.337
4       5.00 0.00       8.00 0.00       6.00 0.00       7.00 0.00       10.708
4       6.00 0.00       9.00 0.00       7.00 0.00       8.00 0.00       11.668
4       7.00 0.00      10.00 0.00       8.00 0.00       9.00 0.00       12.542
4       8.00 0.00      11.00 0.00       9.00 0.00      10.00 0.00       12.871
4       9.00 0.00      12.00 0.00      10.00 0.00      11.00 0.00       13.238
4      10.00 0.00      13.00 0.00      11.00 0.00      12.00 0.00       13.342
4      11.00 0.00      14.00 0.00      12.00 0.00      13.00 0.00       13.231
```

Index based .dat file with topography

```
342     72.0     12.0  1033.0
343     74.0     12.0  1091.0
344     76.0     12.0  1160.0
345     78.0     12.0  1680.0
346  2
347  67
348  -36,0.044
349  -34,0.134
350  -32,0.311
351  -30,0.503
352  -28,0.712
410  88,-3.008
411  90,-3.096
412  92,-3.207
413  94,-3.27
414  96,-3.34
415   1
416  0
417  0
```

Last 3 data lines

Flag for topography, 1 for true horizontal distances, 2 for surface distances

Number of topography data points

Topography data: profile distances, elevation

Topography data point coinciding with first electrode

End of file

NOTE: In the index based format profile distances must always be along the ground in the data lines, regardless of what is chosen in the topography section!

General array .dat file with topography

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In separate list:

```
355 4   56.00000  0   92.00000  0   68.00000  0   80.00000  0 1091.00000
356 4   58.00000  0   94.00000  0   70.00000  0   82.00000  0 1160.00000
357 4   60.00000  0   96.00000  0   72.00000  0   84.00000  0 1680.00000
358 Topography in separate list
359 2
360 24
361 -36,0.044
362 -34,0.134
363 -32,0.311
364 -30,0.503
365 -28,0.712
366 -26,1.161
367 -24,1.492
368 -22,1.833
369 -20,2.269
370 -18,2.578
371 -16,2.483
372 -14,2.714
373 -12,3.088
374 -10,3.443
375 -8,3.758
376 -6,3.924
377 -4,4.122
378 -2,4.306
379 0,4.526
380 2,4.747
381 4,5.028
382 6,5.104
383 8,5.111
384 10,5.138
385  1
386 0
```

Last 3 data lines

Header for topography

1 for true horizontal, 2 for surface distances

Number of topography points

Topography data: x-coordinates, elevation

Topography data point coinciding with first electrode

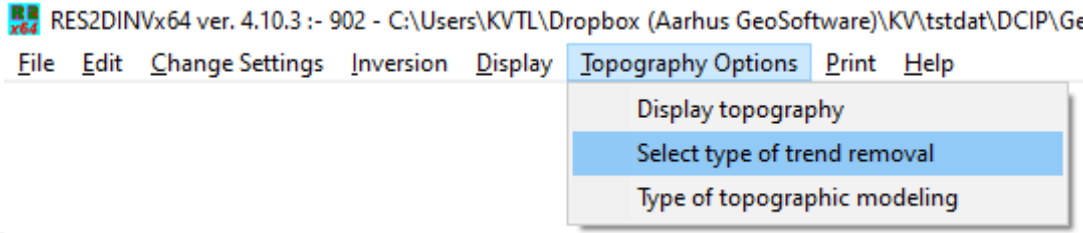
End of file

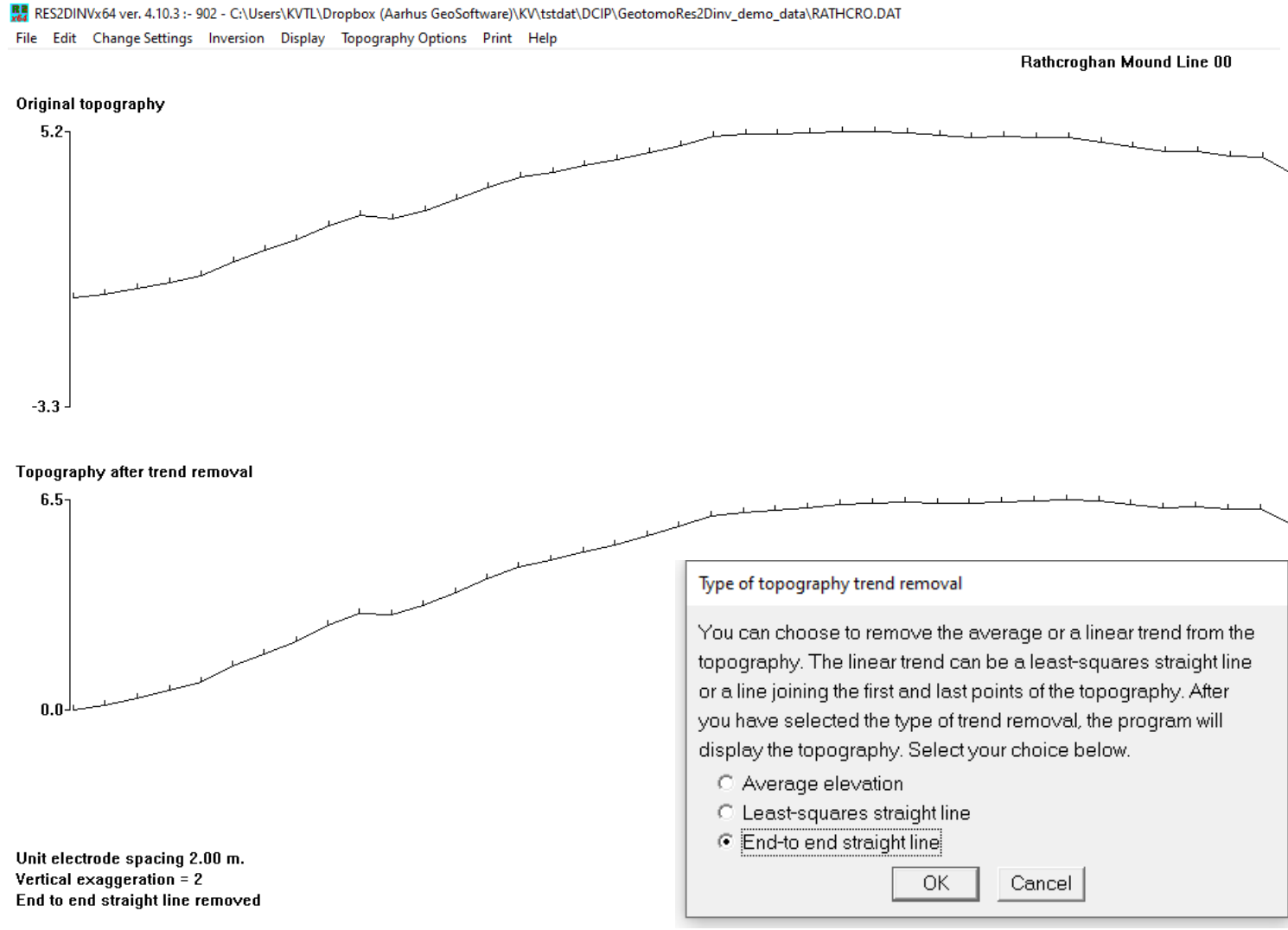
In data lines, as z coordinates:

```
1  General array format with topography example
2  1.0
3  11
4  0
5  Type of measurement (0=app. resistivity,1=resistance)
6   0
7  407
8  1
9  0
10 4       0.00 1.78       3.00 1.68       1.00 1.93       2.00 1.89 10.158
11 4       1.00 1.93       4.00 1.32       2.00 1.89       3.00 1.68 10.168
12 4       2.00 1.89       5.00 1.32       3.00 1.68       4.00 1.32 10.184
13 4       3.00 1.68       6.00 0.31       4.00 1.32       5.00 1.32 10.225
14 4       4.00 1.32       7.00 0.48       5.00 1.32       6.00 0.31 10.337
15 4       5.00 1.32       8.00 0.83       6.00 0.31       7.00 0.48 10.708
16 4       6.00 0.31       9.00 1.31       7.00 0.48       8.00 0.83 11.668
17 4       7.00 0.48      10.00 1.78       8.00 0.83       9.00 1.31 12.542
18 4       8.00 0.83      11.00 1.93       9.00 1.31      10.00 1.78 12.871
19 4       9.00 1.31      12.00 1.89      10.00 1.78      11.00 1.93 13.238
20 4      10.00 1.78      13.00 1.68      11.00 1.93      12.00 1.89 13.342
21 4      11.00 1.93      14.00 1.32      12.00 1.89      13.00 1.68 13.231
22 4      12.00 1.89      15.00 1.32      13.00 1.68      14.00 1.32 12.855
23 4      13.00 1.68      16.00 0.31      14.00 1.32      15.00 1.32 12.511
24 4      14.00 1.32      17.00 0.48      15.00 1.32      16.00 0.31 11.598
25 4      15.00 1.32      18.00 0.83      16.00 0.31      17.00 0.48 10.471
26 4      16.00 0.31      19.00 1.31      17.00 0.48      18.00 0.83  9.203
```

NOTE: Topography in separate list overrules topography in data lines!

Topographical modelling options





Topographical modelling options

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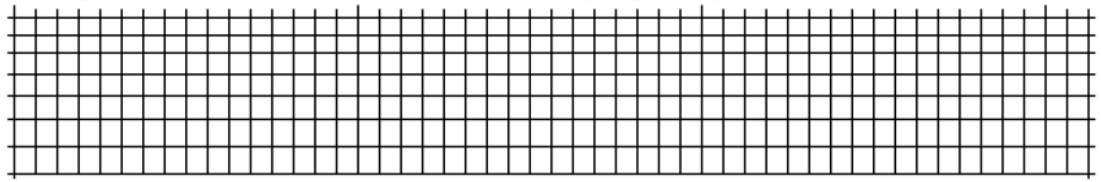
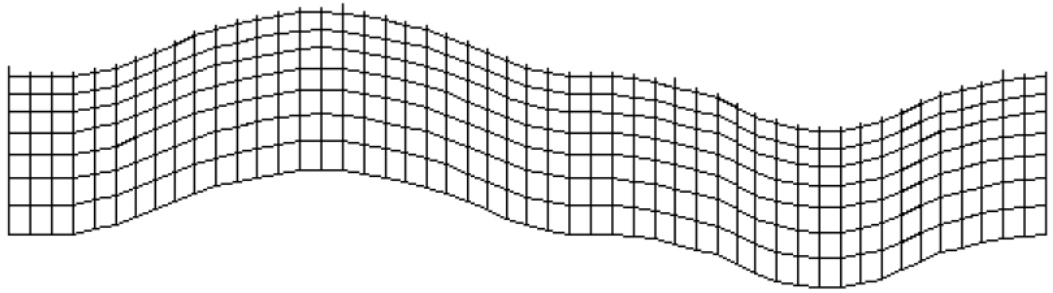
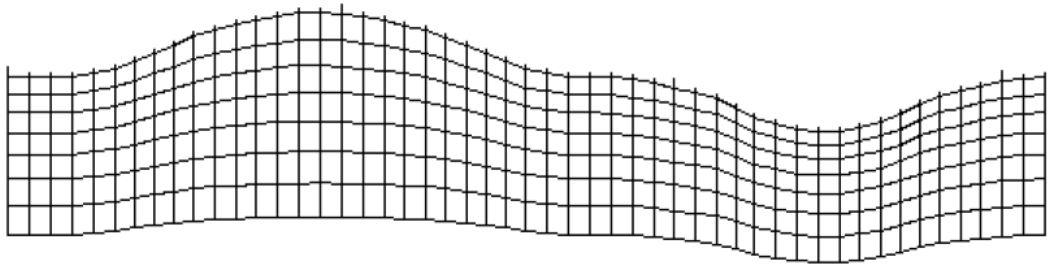
a). Arrangement of model blocks without topography

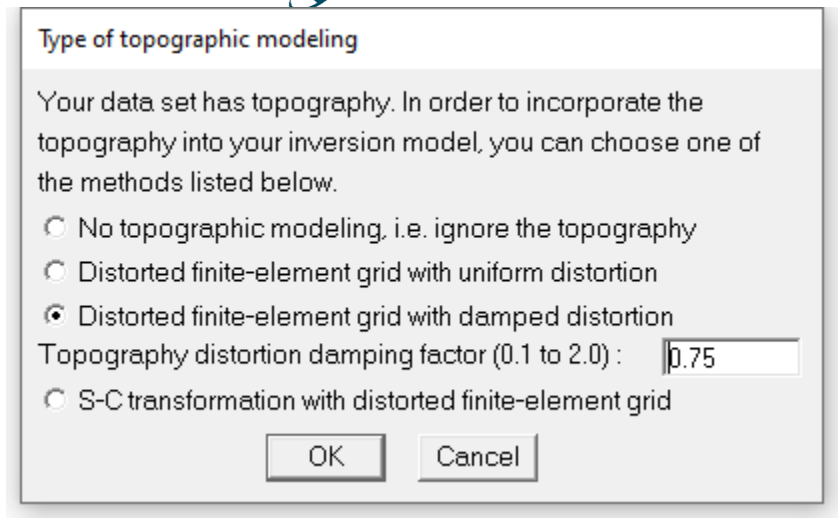


b). Arrangement of model blocks with a uniformly distorted grid

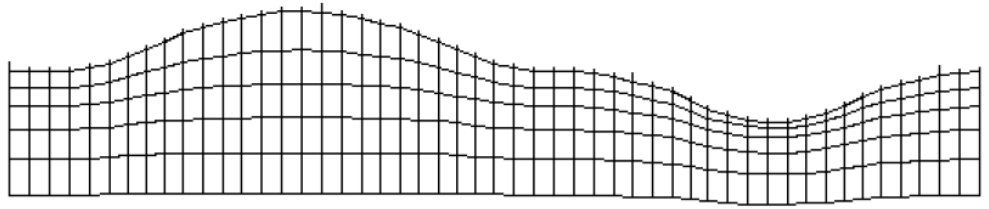


c). Arrangement of model blocks with a moderately damped distorted grid

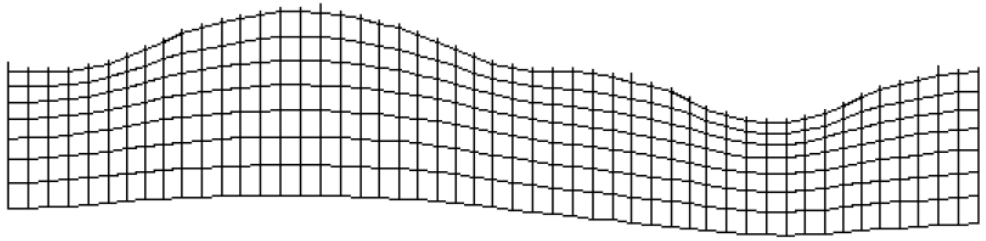




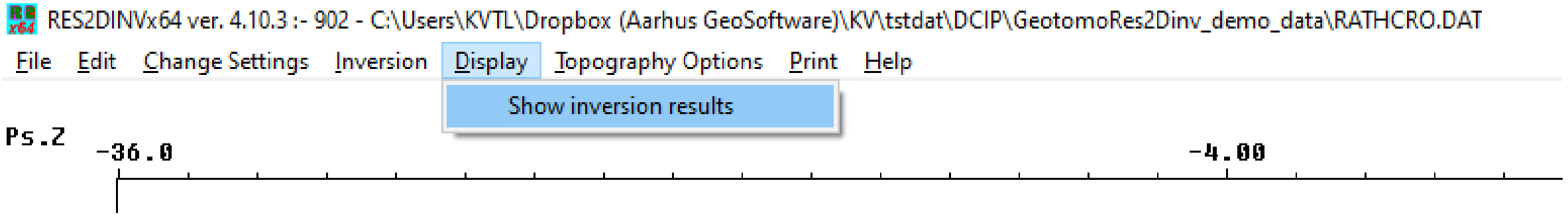
d). Arrangement of model blocks with a highly damped distorted grid



e). Arrangement of model blocks with the inverse Schwartz-Christoffel transformation



Visualizing and exporting inversion results with topography



Visualizing and exporting inversion results with topography

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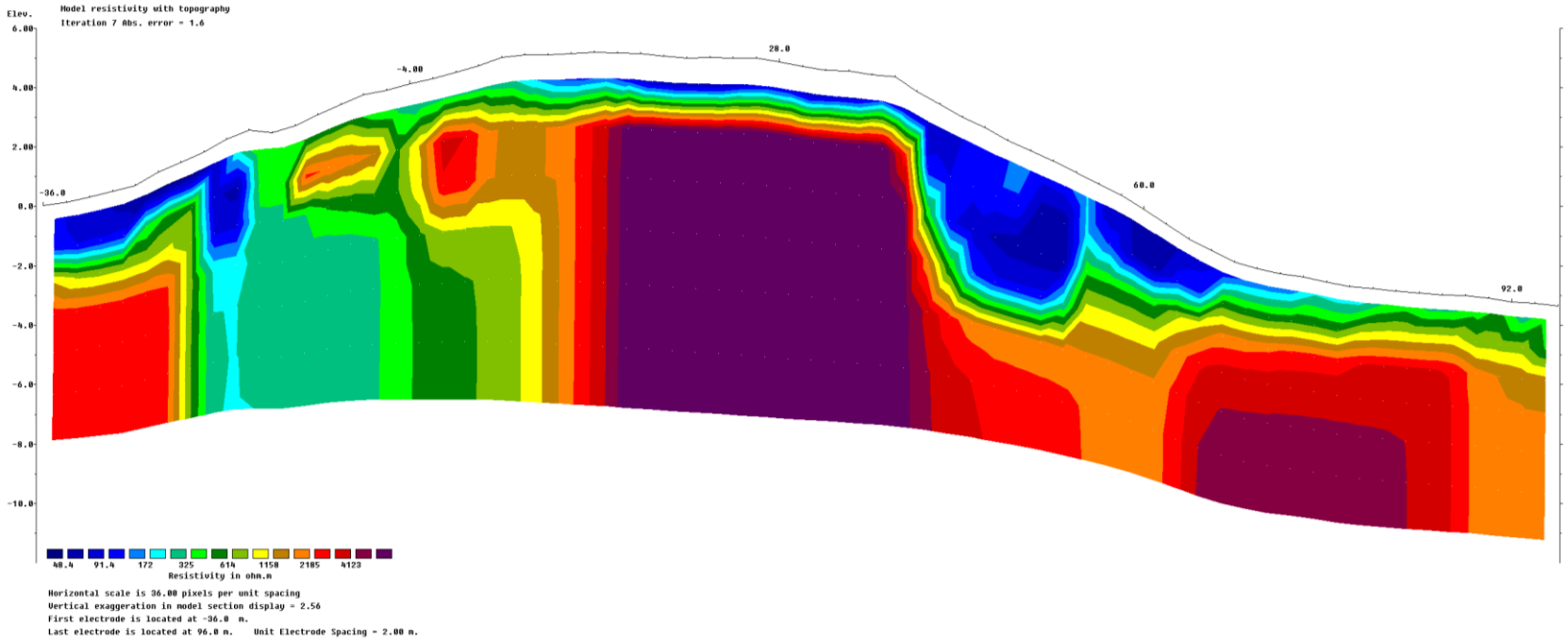
RES2DINVx64 ver. 4.10.3 :- 902 : Display Sections Window - C:\Users\KVTL\Dropbox (Aarhus GeoSoftware)\KV\tstdat\DCIP\GeotomoRes2Dinv_demo_data\Rathcro.inv

File | Display sections | Change display settings | Edit data | Print | Exit

- Model display
  - Display data and model sections
  - Include topography in model display
  - Choose resistivity or IP display
  - Save contour values
- Sensitivity displays
- Time-lapse displays
- Display region of investigation

Rat
Ele
We
No
Tot
Position of mid-point of array is given.
339 78.000 12.000 1680.0
Electrode locations are -36.00 and -32.00.
Minimum and maximum electrode locations are -36.00 and 96.00.
Minimum and maximum electrode locations are -36.0 and 96.0.
Line length is 132.0.
Minimum electrode spacing is 2.0.
Sorting data points.
Number of data levels is 6.
Number of electrodes is 67.
Reading inversion results.
The model has 7 layers and 462 blocks.
Iteration 1 : RMS error 18.84.
Iteration 2 : Abs. error 8.71.
Iteration 3 : Abs. error 5.89.
Iteration 4 : Abs. error 2.61.
Iteration 5 : Abs. error 1.92.
Iteration 6 : Abs. error 1.70.
Iteration 7 : Abs. error 1.60.
Iteration 8 : Abs. error 1.54.
Reference resisivity used is 399.323
Topographical data present in inversion file.
Damped topography was incorporated into inversion model.
Blocks sensitivity information present.
Average sensitivity is 1.175.
Inversion constraints information present.



Visualizing and exporting inversion results with topography

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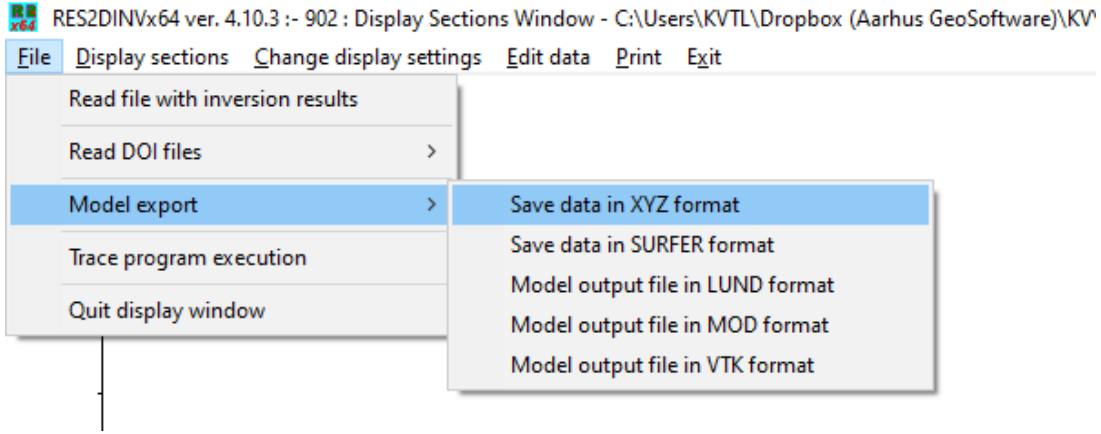
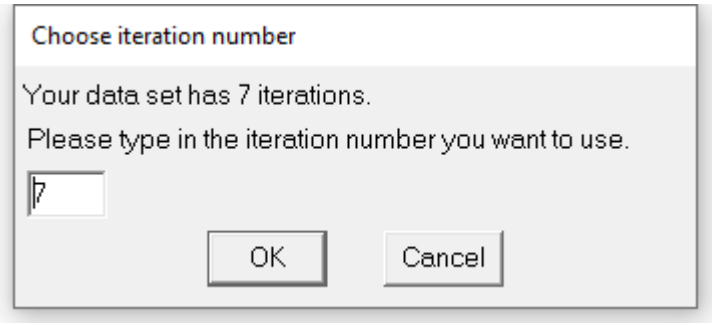
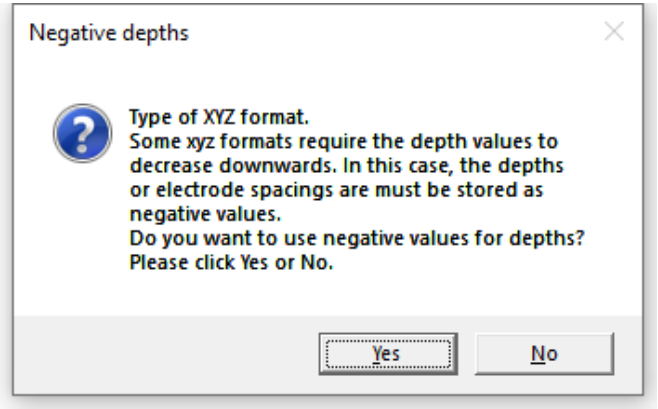
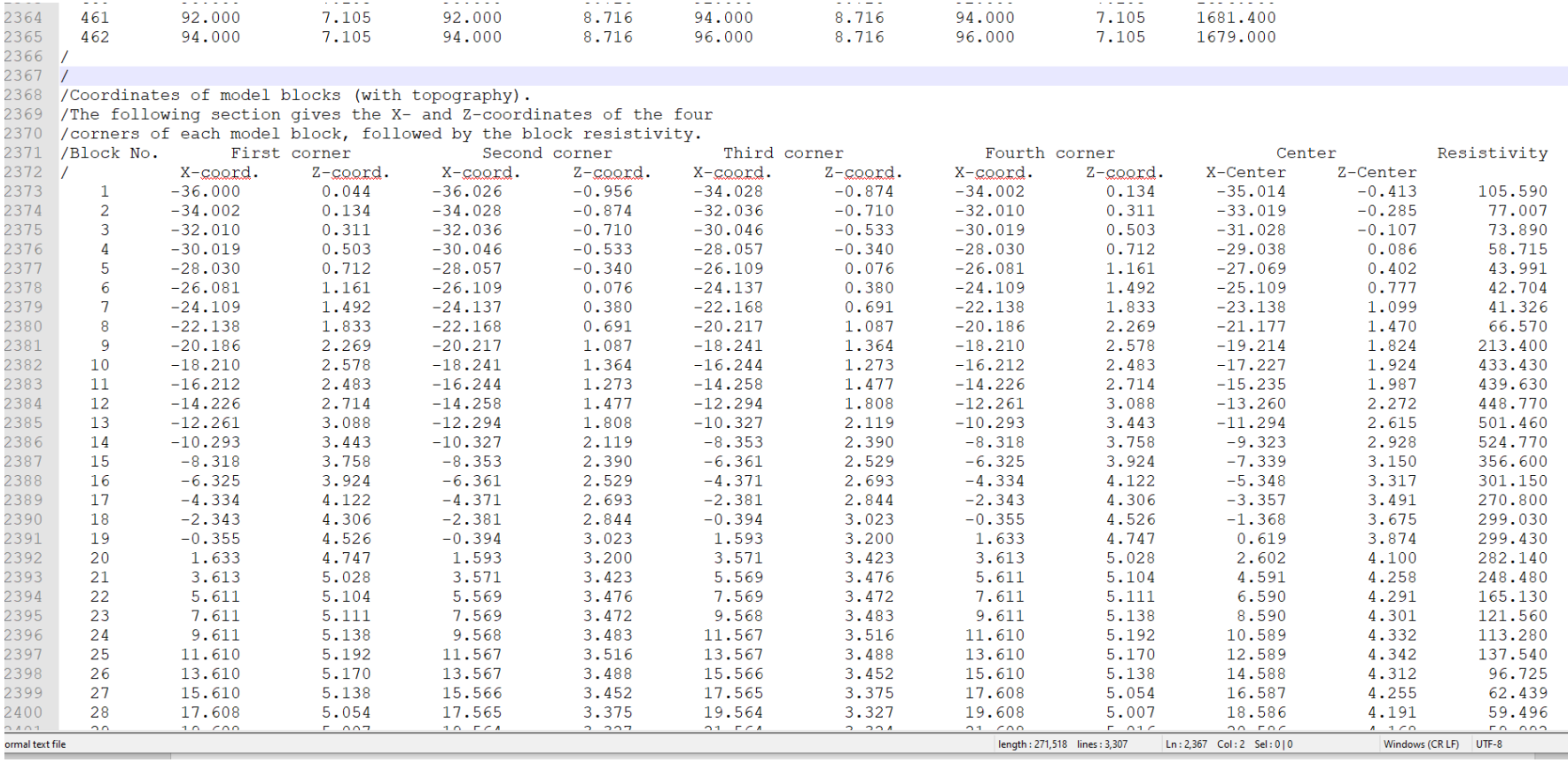


- **8th data "block" is a good basis for further visualizations**







```
  461       92.000        7.105       92.000        8.716       94.000        8.716       94.000        7.105      1681.400
  462       94.000        7.105       94.000        8.716       96.000        8.716       96.000        7.105      1679.000
/
/
/Coordinates of model blocks (with topography).
/The following section gives the X- and Z-coordinates of the four
/corners of each model block, followed by the block resistivity.
/Block No.       First corner            Second corner           Third corner            Fourth corner                Center          Resistivity
/            X-coord.     Z-coord.     X-coord.     Z-coord.     X-coord.     Z-coord.     X-coord.     Z-coord.     X-Center     Z-Center
    1      -36.000        0.044      -36.026       -0.956      -34.028       -0.874      -34.002        0.134      -35.014       -0.413      105.590
    2      -34.002        0.134      -34.028       -0.874      -32.036       -0.710      -32.010        0.311      -33.019       -0.285       77.007
    3      -32.010        0.311      -32.036       -0.710      -30.046       -0.533      -30.019        0.503      -31.028       -0.107       73.890
    4      -30.019        0.503      -30.046       -0.533      -28.057       -0.340      -28.030        0.712      -29.038        0.086       58.715
    5      -28.030        0.712      -28.057       -0.340      -26.109        0.076      -26.081        1.161      -27.069        0.402       43.991
    6      -26.081        1.161      -26.109        0.076      -24.137        0.380      -24.109        1.492      -25.109        0.777       42.704
    7      -24.109        1.492      -24.137        0.380      -22.168        0.691      -22.138        1.833      -23.138        1.099       41.326
    8      -22.138        1.833      -22.168        0.691      -20.217        1.087      -20.186        2.269      -21.177        1.470       66.570
    9      -20.186        2.269      -20.217        1.087      -18.241        1.364      -18.210        2.578      -19.214        1.824      213.400
   10      -18.210        2.578      -18.241        1.364      -16.244        1.273      -16.212        2.483      -17.227        1.924      433.430
   11      -16.212        2.483      -16.244        1.273      -14.258        1.477      -14.226        2.714      -15.235        1.987      439.630
   12      -14.226        2.714      -14.258        1.477      -12.294        1.808      -12.261        3.088      -13.260        2.272      448.770
   13      -12.261        3.088      -12.294        1.808      -10.327        2.119      -10.293        3.443      -11.294        2.615      501.460
   14      -10.293        3.443      -10.327        2.119       -8.353        2.390       -8.318        3.758       -9.323        2.928      524.770
   15       -8.318        3.758       -8.353        2.390       -6.361        2.529       -6.325        3.924       -7.339        3.150      356.600
   16       -6.325        3.924       -6.361        2.529       -4.371        2.693       -4.334        4.122       -5.348        3.317      301.150
   17       -4.334        4.122       -4.371        2.693       -2.381        2.844       -2.343        4.306       -3.357        3.491      270.800
   18       -2.343        4.306       -2.381        2.844       -0.394        3.023       -0.355        4.526       -1.368        3.675      299.030
   19       -0.355        4.526       -0.394        3.023        1.593        3.200        1.633        4.747        0.619        3.874      299.430
   20        1.633        4.747        1.593        3.200        3.571        3.423        3.613        5.028        2.602        4.100      282.140
   21        3.613        5.028        3.571        3.423        5.569        3.476        5.611        5.104        4.591        4.258      248.480
   22        5.611        5.104        5.569        3.476        7.569        3.472        7.611        5.111        6.590        4.291      165.130
   23        7.611        5.111        7.569        3.472        9.568        3.483        9.611        5.138        8.590        4.301      121.560
   24        9.611        5.138        9.568        3.483       11.567        3.516       11.610        5.192       10.589        4.332      113.280
   25       11.610        5.192       11.567        3.516       13.567        3.488       13.610        5.170       12.589        4.342      137.540
   26       13.610        5.170       13.567        3.488       15.566        3.452       15.610        5.138       14.588        4.312       96.725
   27       15.610        5.138       15.566        3.452       17.565        3.375       17.608        5.054       16.587        4.255       62.439
   28       17.608        5.054       17.565        3.375       19.564        3.327       19.608        5.007       18.586        4.191       59.496
```

Visualizing and exporting inversion results with topography

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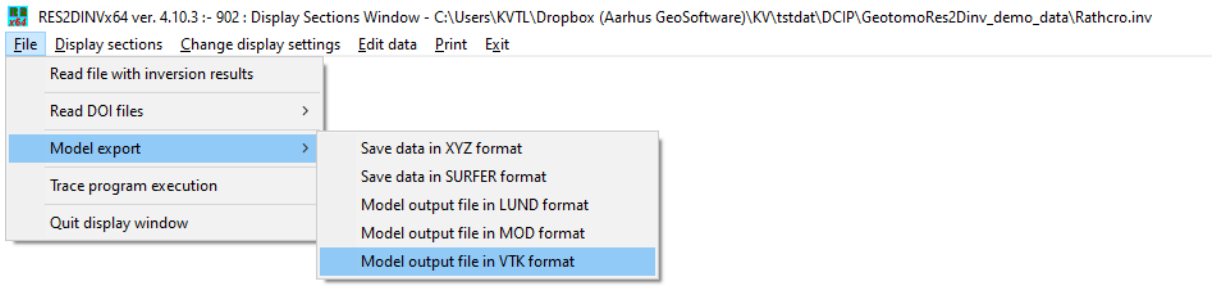

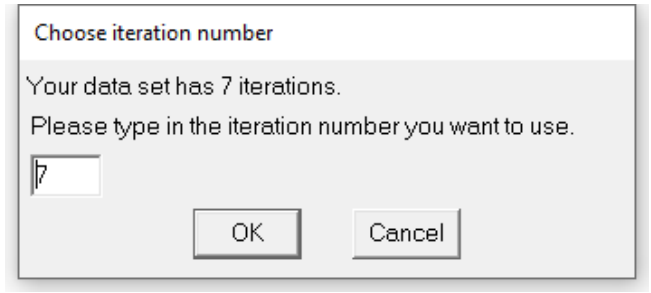

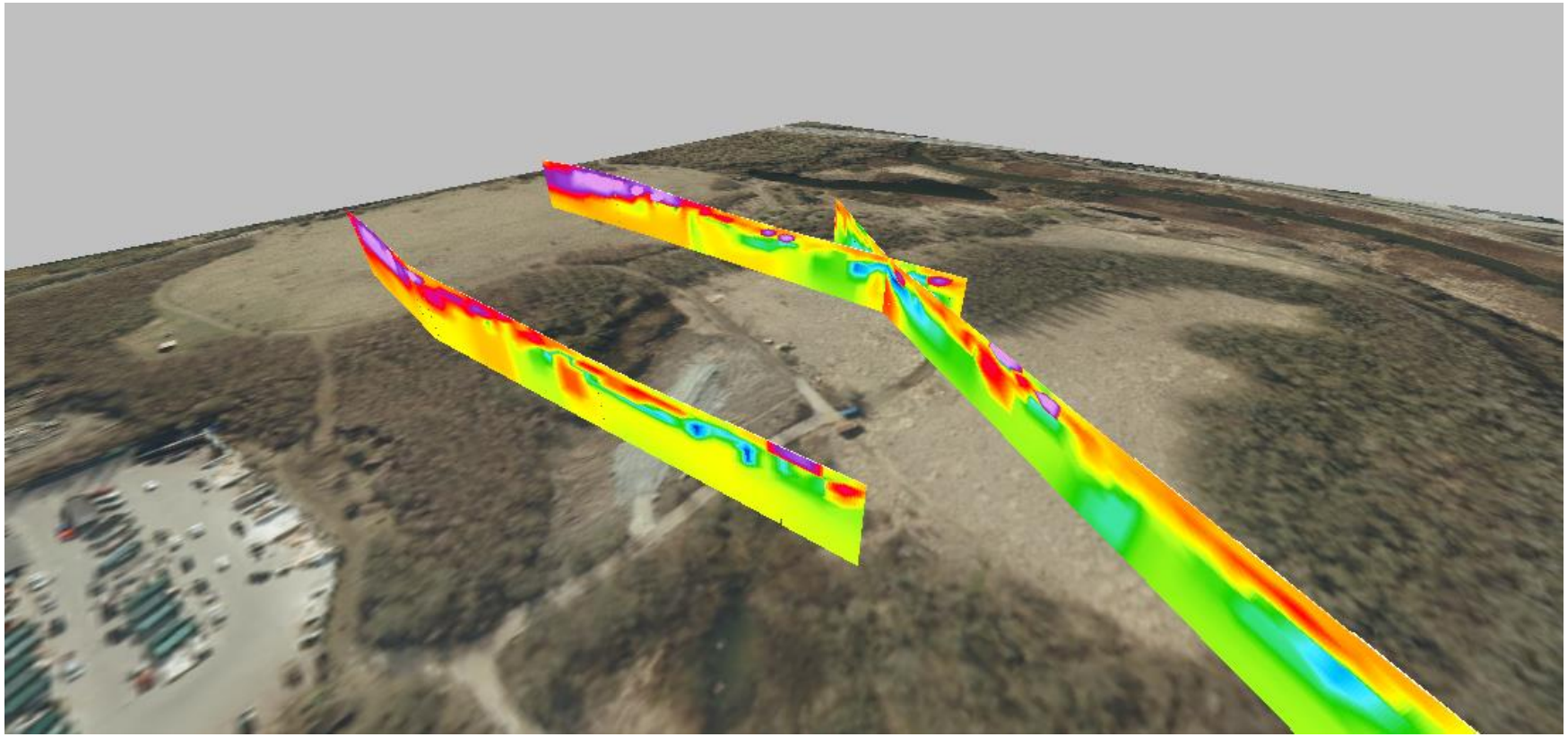

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Thank you for listening!