

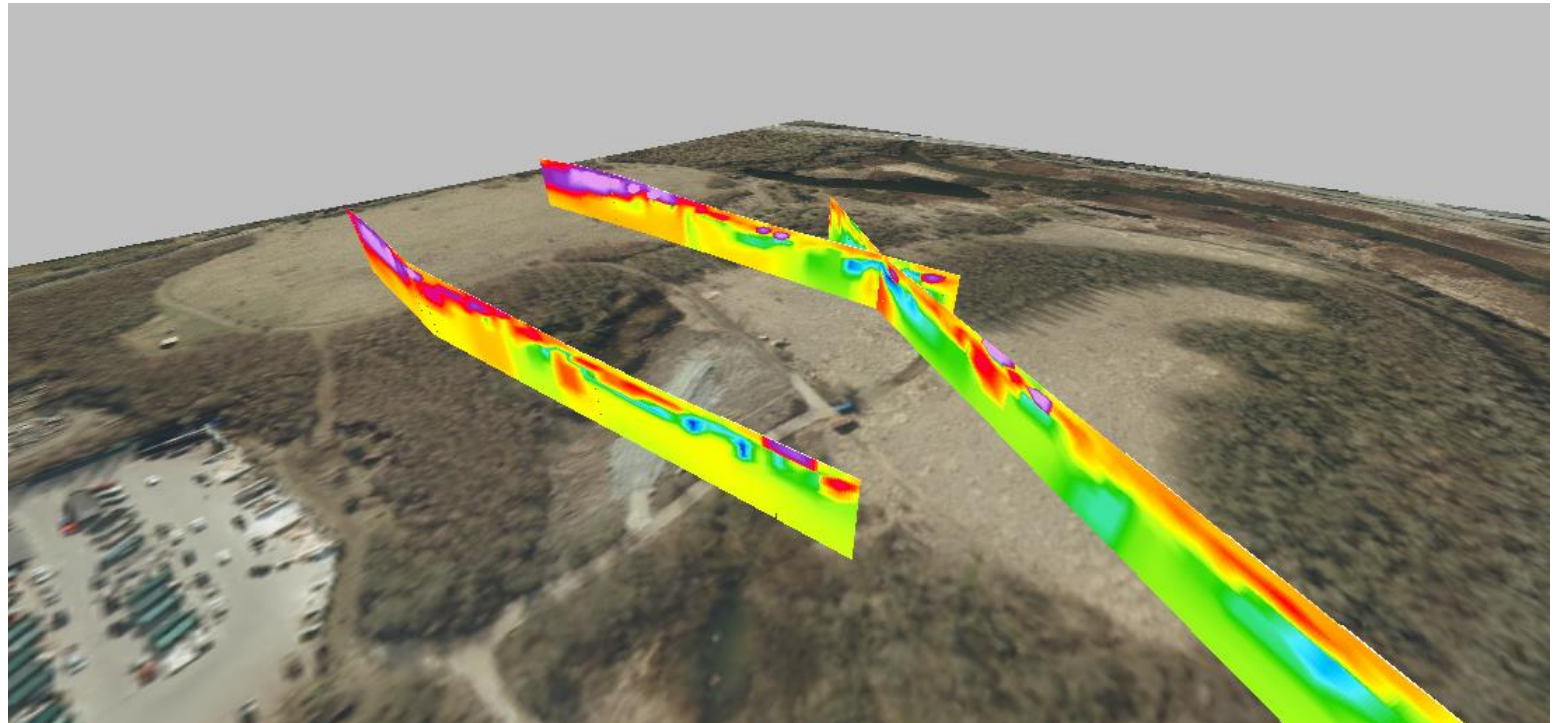
Adding topography to Res2DInv datasets

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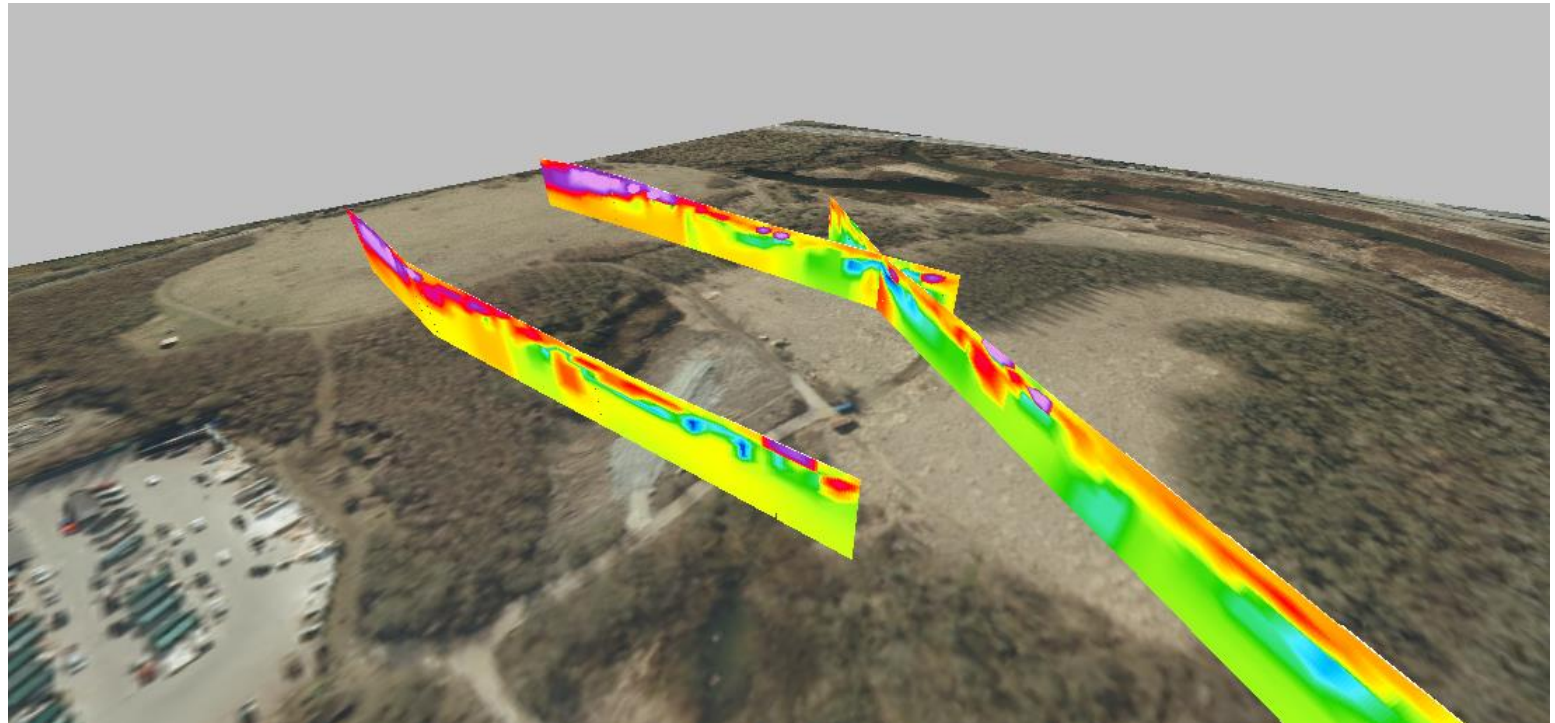
Program

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

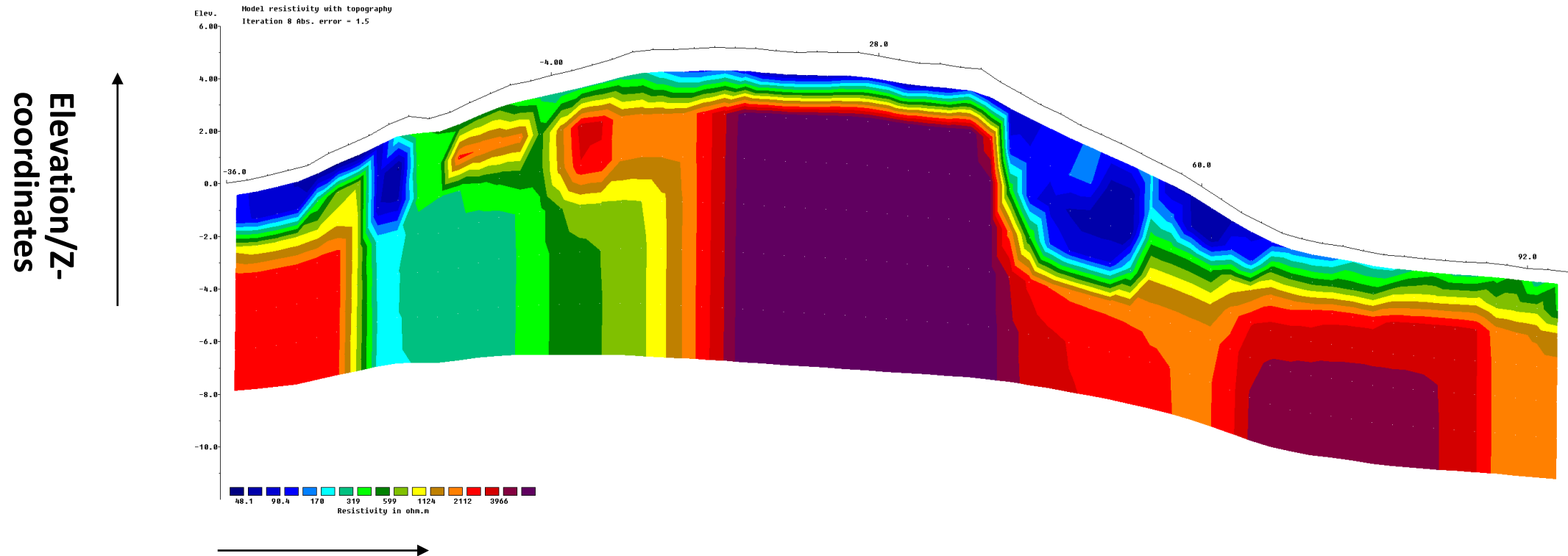


Why add topography?

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



Coordinate systems



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	1	General array format example										Comment/title line	
	2	1.0	Unit electrode distance										
	3	11	Array type (General array)										
	4	0	Array sub-type (unspecified)										
	5	Type of measurement (0=app. resistivity,1=resistance)											Header
	6	0	Measurement type indication										
	7	407	Number of data points										
	8	1	Format of x-coordinates (1 for true horizontal distances, 2 for ground distances)										
	9	0	Flag for IP data										
Data lines	10	4	0.00	0.00	3.00	0.00	1.00	0.00	2.00	0.00	10.158	Number of electrodes, x and z coordinates of C ₁ , C ₂ , P ₁ and P ₂ electrodes, apparent resistivity or resistance	
	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		
	21	4	11.00	0.00	14.00	0.00	12.00	0.00	13.00	0.00	13.331		
	22	4	12.00	0.00	15.00	0.00	13.00	0.00	14.00	0.00	13.331		
	23	4	13.00	0.00	16.00	0.00	14.00	0.00	15.00	0.00	13.331		
	24	4	14.00	0.00	17.00	0.00	15.00	0.00	16.00	0.00	13.331		
	25	4	15.00	0.00	18.00	0.00	16.00	0.00	17.00	0.00	13.331		
	26	4	16.00	0.00	19.00	0.00	17.00	0.00	18.00	0.00	13.331		
	27	4	17.00	0.00	20.00	0.00	18.00	0.00	19.00	0.00	13.331		
	28	4	18.00	0.00	21.00	0.00	19.00	0.00	20.00	0.00	13.331		
	29	4	19.00	0.00	22.00	0.00	20.00	0.00	21.00	0.00	13.331		
30	4	20.00	0.00	23.00	0.00	21.00	0.00	22.00	0.00	13.331			
31	4	21.00	0.00	24.00	0.00	22.00	0.00	23.00	0.00	13.331			
32	4	22.00	0.00	25.00	0.00	23.00	0.00	24.00	0.00	13.331			
33	4	23.00	0.00	26.00	0.00	24.00	0.00	25.00	0.00	13.331			
34	4	24.00	0.00	27.00	0.00	25.00	0.00	26.00	0.00	13.331			
35	4	25.00	0.00	28.00	0.00	26.00	0.00	27.00	0.00	13.331			
36	4	26.00	0.00	29.00	0.00	27.00	0.00	28.00	0.00	13.331			
37	4	27.00	0.00	30.00	0.00	28.00	0.00	29.00	0.00	13.331			
38	4	28.00	0.00	31.00	0.00	29.00	0.00	30.00	0.00	13.331			
39	4	29.00	0.00	32.00	0.00	30.00	0.00	31.00	0.00	13.331			
40	4	30.00	0.00	33.00	0.00	31.00	0.00	32.00	0.00	13.331			
41	4	31.00	0.00	34.00	0.00	32.00	0.00	33.00	0.00	13.331			
42	4	32.00	0.00	35.00	0.00	33.00	0.00	34.00	0.00	13.331			
43	4	33.00	0.00	36.00	0.00	34.00	0.00	35.00	0.00	13.331			
44	4	34.00	0.00	37.00	0.00	35.00	0.00	36.00	0.00	13.331			
45	4	35.00	0.00	38.00	0.00	36.00	0.00	37.00	0.00	13.331			
46	4	36.00	0.00	39.00	0.00	37.00	0.00	38.00	0.00	13.331			
47	0	End all files wit a zero											

2 types of .dat files

Index based

```
1 Blocks
2 1.00
3 2
4 2124
5 1
6 0
7 0.50 1.00 13.03
8 1.50 1.00 13.17
9 2.50 1.00 12.88
10 3.50 1.00 13.05
11 4.50 1.00 13.00
12 5.50 1.00 12.98
13 6.50 1.00 13.27
14 7.50 1.00 13.31
15 8.50 1.00 14.97
16 9.50 1.00 18.32
17 10.50 1.00 18.16
18 11.50 1.00 14.80
19 12.50 1.00 13.30
20 13.50 1.00 13.12
21 14.50 1.00 12.90
```

General array

```
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
21 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 } Last 3 data lines
346  2  Flag for topography, 1 for true horizontal distances, 2 for surface distances
347  67 Number of topography data points
348 -36,0.044
349 -34,0.134
350 -32,0.311
351 -30,0.503
352 -28,0.712
    }
    } Topography data: profile distances, elevation
410  88,-3.008
411  90,-3.096
412  92,-3.207
413  94,-3.27
414  96,-3.34
415  1 Topography data point coinciding with first electrode
416  0 End of file
417  0
```

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

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 } Last 3 data lines
357 4 60.00000 0 96.00000 0 72.00000 0 84.00000 0 1680.00000 }
358 Topography in separate list Header for topography
359 2 1 for true horizontal, 2 for surface distances
360 24 Number of topography points
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 Topography data point coinciding with first electrode
386 0 End of file
```

Topography data: x-coordinates, elevation

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
27 4 17.00 1.31 20.00 1.78 18.00 0.83 19.00 1.31 8.368
```

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

Topographical modelling options

RES2DINVx64 ver. 4.10.3 :- 902 - C:\Users\KVTL\Dropbox (Aarhus GeoSoftware)\KV\tststat\DCIP\GeotomoRes2Dinv_demo_data\RATHCRO.DAT

File Edit Change Settings Inversion Display Topography Options Print Help

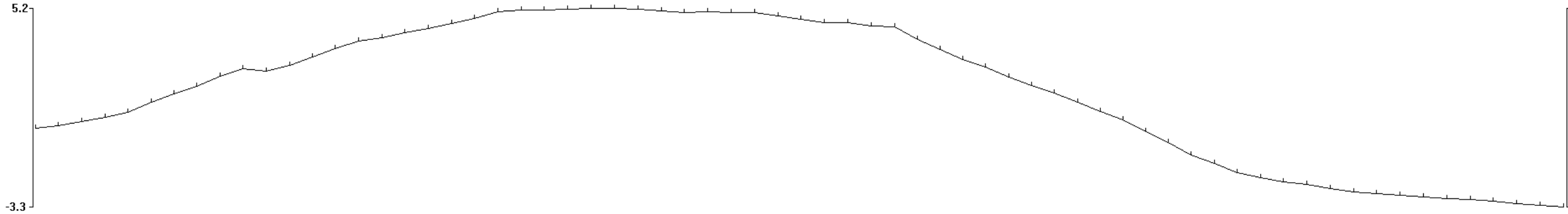
Display topography

Select type of trend removal

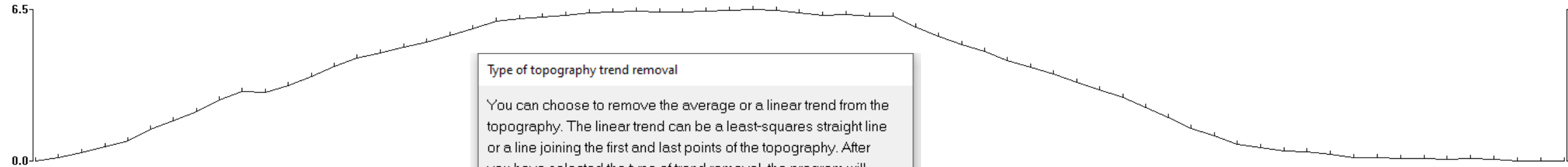
Type of topographic modeling

Rathcroghan Mound Line 00

Original topography



Topography after trend removal



Type of topography trend removal

You can choose to remove the average or a linear trend from the topography. The linear trend can be a least-squares straight line or a line joining the first and last points of the topography. After you have selected the type of trend removal, the program will display the topography. Select your choice below.

- ☐ Average elevation
- ☐ Least-squares straight line
- ☒ End-to end straight line

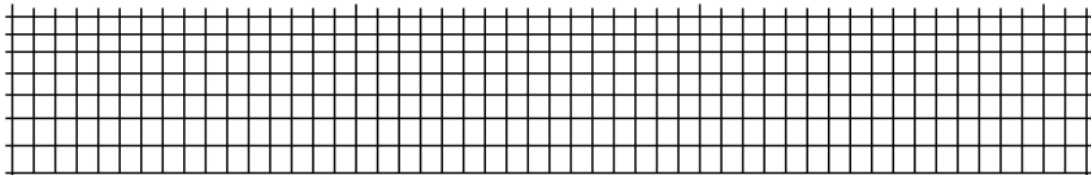
OK

Cancel

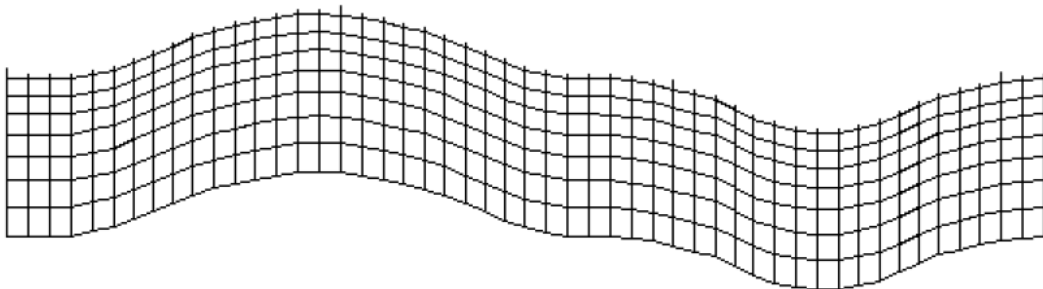
Unit electrode spacing 2.00 m.
Vertical exaggeration = 2
End to end straight line removed

Topographical modelling options

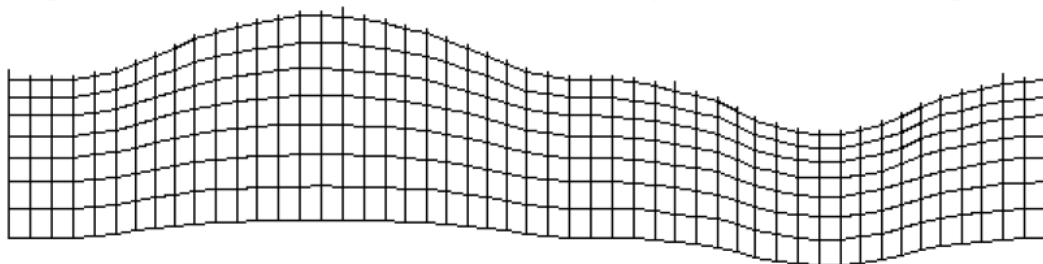
a). Arrangement of model blocks without topography



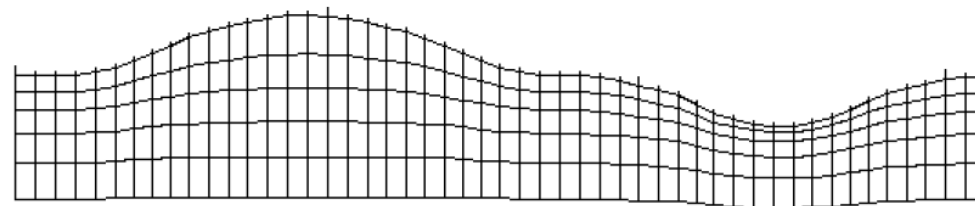
b). Arrangement of model blocks with a uniformly distorted grid



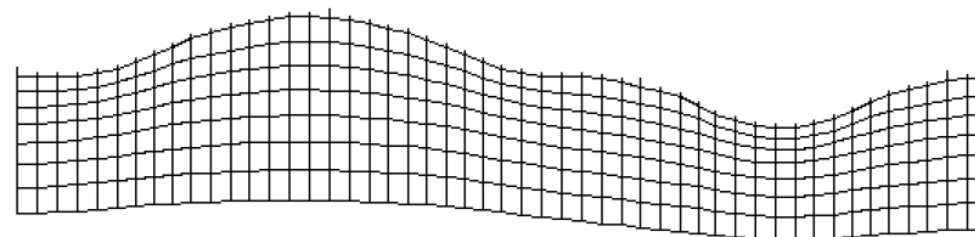
c). Arrangement of model blocks with a moderately damped distorted grid



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



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



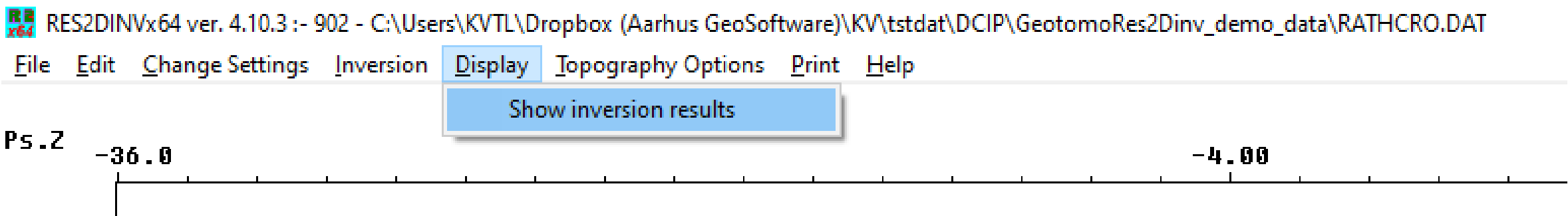
Type of topographic modeling

Your data set has topography. In order to incorporate the topography into your inversion model, you can choose one of the methods listed below.

- ☐ No topographic modeling, i.e. ignore the topography
- ☐ Distorted finite-element grid with uniform distortion
- ☒ Distorted finite-element grid with damped distortion
- ☐ S-C transformation with distorted finite-element grid

Topography distortion damping factor (0.1 to 2.0) :

Visualizing and exporting inversion results with topography



Visualizing and exporting inversion results with topography

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

File Display sections Change display settings Edit data Print Exit

Model display >

Sensitivity displays >

Time-lapse displays >

Display region of investigation

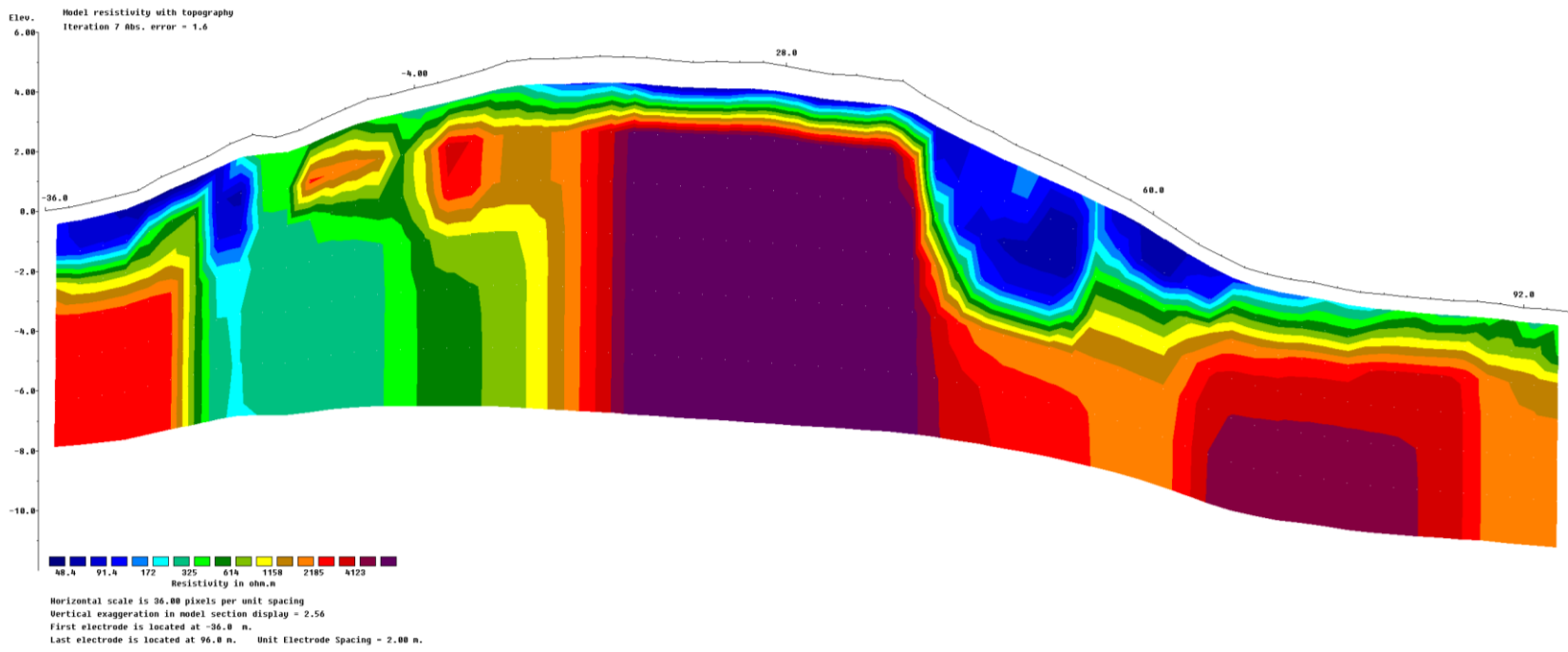
Display data and model sections

Include topography in model display

Choose resistivity or IP display

Save contour values

Position of mid-point of array is given.
339 78.000 12.000 1680.0
Electrode locations are -36.00 and 96.00.
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 resistivity 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

- 8th data “block” is a good basis for further visualizations

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

File Display sections Change display settings Edit data Print Exit

Read file with inversion results

Read DOI files >

Model export >

Trace program execution

Quit display window

Save data in XYZ format

Save data in SURFER format

Model output file in LUND format

Model output file in MOD format

Model output file in VTK format

Choose iteration number

Your data set has 7 iterations.

Please type in the iteration number you want to use.

OK Cancel

Negative depths

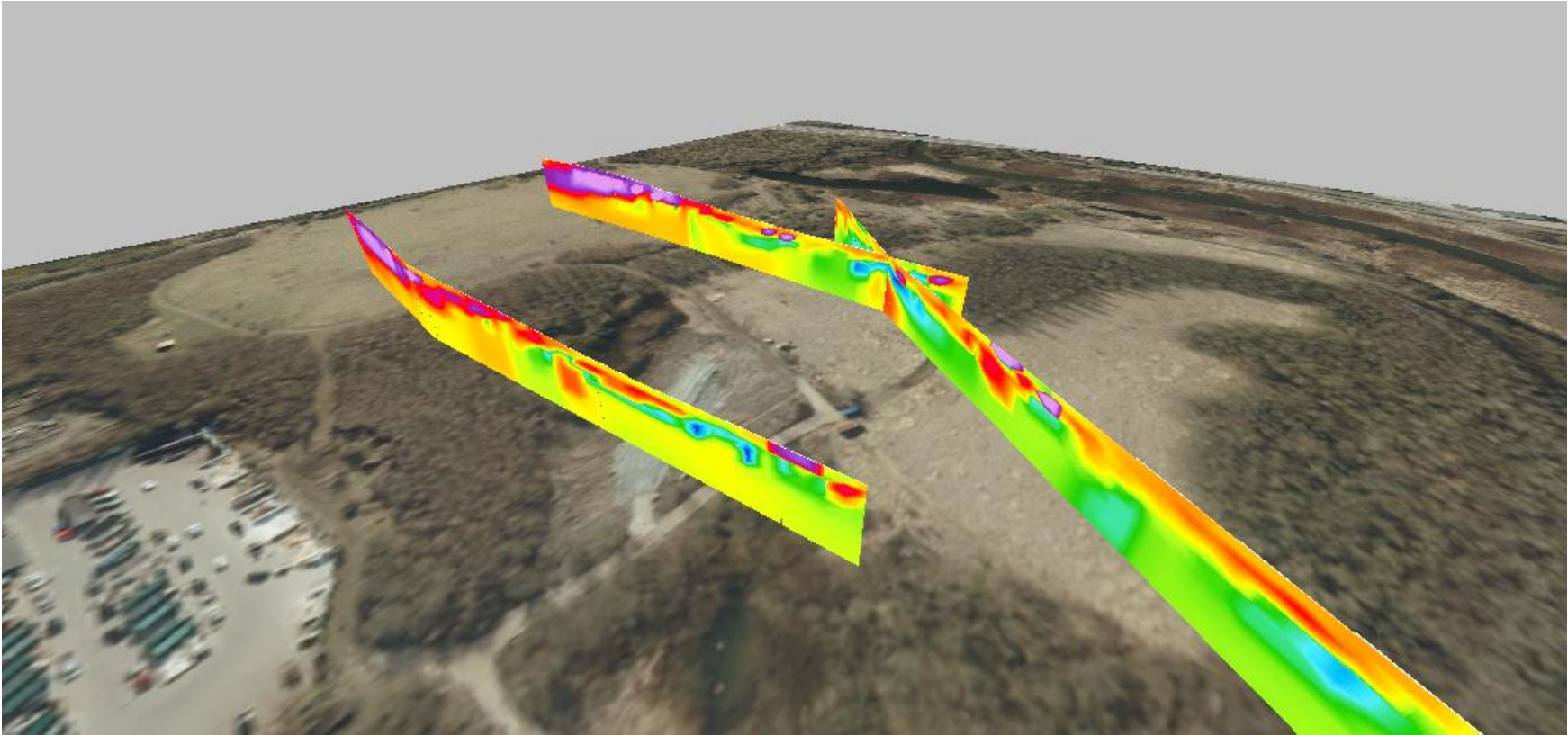
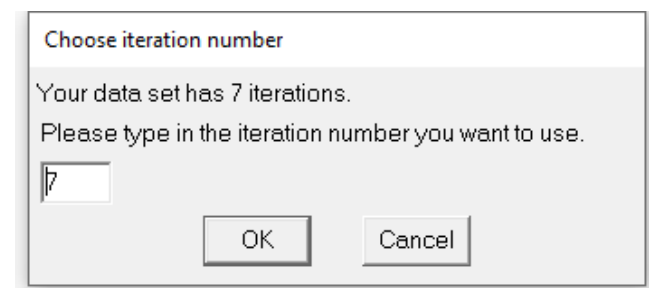
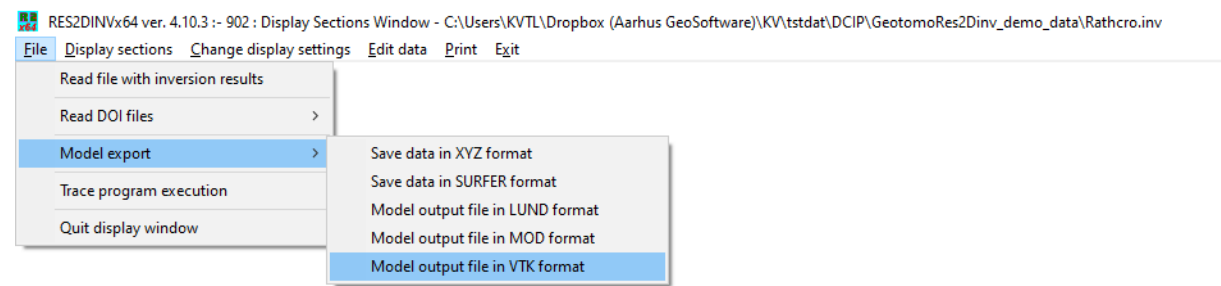
Type of XYZ format.
Some xyz formats require the depth values to decrease downwards. In this case, the depths or electrode spacings are must be stored as negative values.
Do you want to use negative values for depths?
Please click Yes or No.

Yes No

2364	461	92.000	7.105	92.000	8.716	94.000	8.716	94.000	7.105	1681.400
2365	462	94.000	7.105	94.000	8.716	96.000	8.716	96.000	7.105	1679.000
2366										
2367										
2368	/Coordinates of model blocks (with topography).									
2369	/The following section gives the X- and Z-coordinates of the four									
2370	/corners of each model block, followed by the block resistivity.									
2371	/Block No.	First corner		Second corner		Third corner		Fourth corner		Center
2372		X-coord.	Z-coord.	X-coord.	Z-coord.	X-coord.	Z-coord.	X-coord.	Z-coord.	X-Center
2373	1	-36.000	0.044	-36.026	-0.956	-34.028	-0.874	-34.002	0.134	-35.014
2374	2	-34.002	0.134	-34.028	-0.874	-32.036	-0.710	-32.010	0.311	-33.019
2375	3	-32.010	0.311	-32.036	-0.710	-30.046	-0.533	-30.019	0.503	-31.028
2376	4	-30.019	0.503	-30.046	-0.533	-28.057	-0.340	-28.030	0.712	-29.038
2377	5	-28.030	0.712	-28.057	-0.340	-26.109	0.076	-26.081	1.161	-27.069
2378	6	-26.081	1.161	-26.109	0.076	-24.137	0.380	-24.109	1.492	-25.109
2379	7	-24.109	1.492	-24.137	0.380	-22.168	0.691	-22.138	1.833	-23.138
2380	8	-22.138	1.833	-22.168	0.691	-20.217	1.087	-20.186	2.269	-21.177
2381	9	-20.186	2.269	-20.217	1.087	-18.241	1.364	-18.210	2.578	-19.214
2382	10	-18.210	2.578	-18.241	1.364	-16.244	1.273	-16.212	2.483	-17.227
2383	11	-16.212	2.483	-16.244	1.273	-14.258	1.477	-14.226	2.714	-15.235
2384	12	-14.226	2.714	-14.258	1.477	-12.294	1.808	-12.261	3.088	-13.260
2385	13	-12.261	3.088	-12.294	1.808	-10.327	2.119	-10.293	3.443	-11.294
2386	14	-10.293	3.443	-10.327	2.119	-8.353	2.390	-8.318	3.758	-9.323
2387	15	-8.318	3.758	-8.353	2.390	-6.361	2.529	-6.325	3.924	-7.339
2388	16	-6.325	3.924	-6.361	2.529	-4.371	2.693	-4.334	4.122	-5.348
2389	17	-4.334	4.122	-4.371	2.693	-2.381	2.844	-2.343	4.306	-3.357
2390	18	-2.343	4.306	-2.381	2.844	-0.394	3.023	-0.355	4.526	-1.368
2391	19	-0.355	4.526	-0.394	3.023	1.593	3.200	1.633	4.747	0.619
2392	20	1.633	4.747	1.593	3.200	3.571	3.423	3.613	5.028	2.602
2393	21	3.613	5.028	3.571	3.423	5.569	3.476	5.611	5.104	4.591
2394	22	5.611	5.104	5.569	3.476	7.569	3.472	7.611	5.111	6.590
2395	23	7.611	5.111	7.569	3.472	9.568	3.483	9.611	5.138	8.590
2396	24	9.611	5.138	9.568	3.483	11.567	3.516	11.610	5.192	10.589
2397	25	11.610	5.192	11.567	3.516	13.567	3.488	13.610	5.170	12.589
2398	26	13.610	5.170	13.567	3.488	15.566	3.452	15.610	5.138	14.588
2399	27	15.610	5.138	15.566	3.452	17.565	3.375	17.608	5.054	16.587
2400	28	17.608	5.054	17.565	3.375	19.564	3.327	19.608	5.007	18.586
2401	29	19.564	5.007	19.564	3.327	21.564	3.224	21.608	5.016	20.586

normal text file length : 271,518 lines : 3,307 Ln : 2,367 Col : 2 Sel : 0 | 0 Windows (CR LF) UTF-8

Visualizing and exporting inversion results with topography



Thank you for listening!