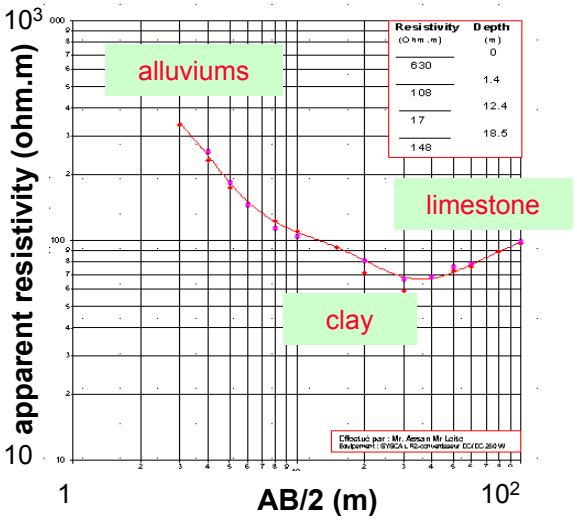
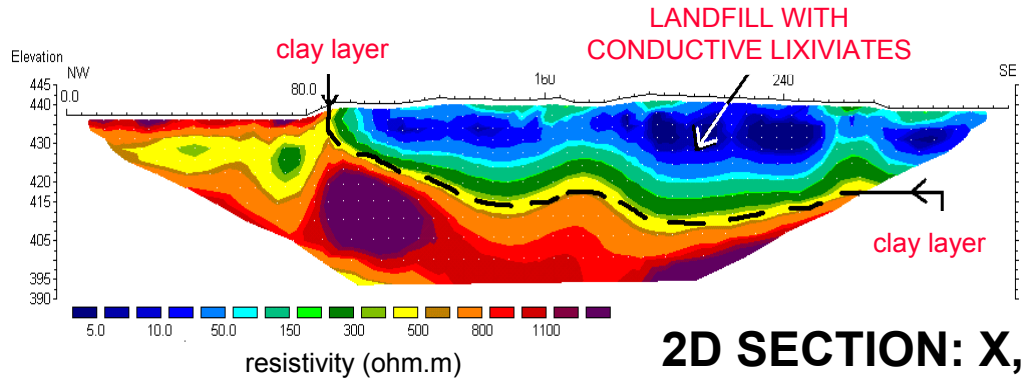
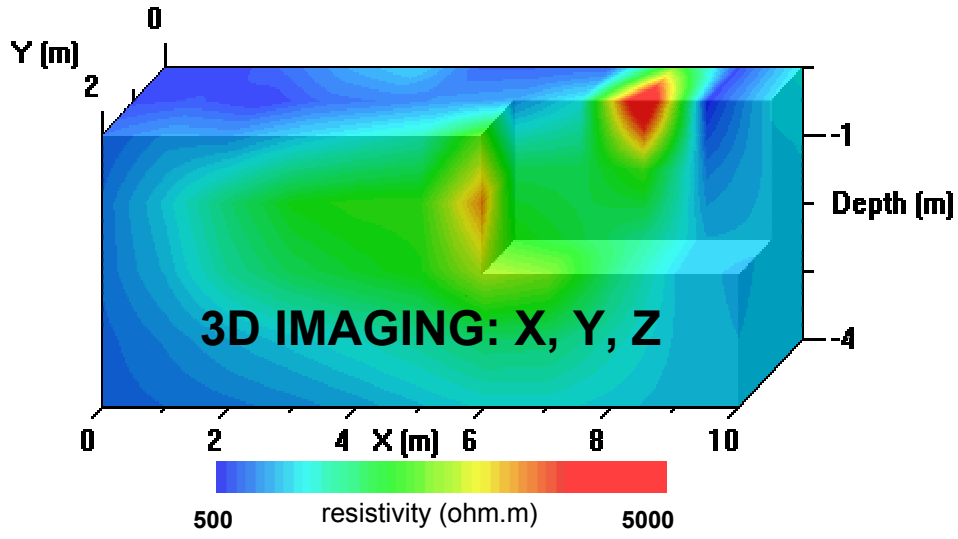
INTRODUCTION GUIDE TO 3D RESISTIVITY IMAGING



1D SOUNDING: Z



2D SECTION: X, Z



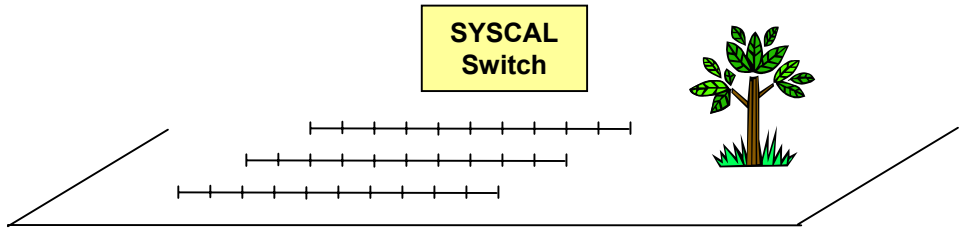
3D IMAGING: X, Y, Z

IRIS instruments

SURFACE AND HOLE 3D RESISTIVITY IMAGING

3D IMAGING FROM THE SURFACE

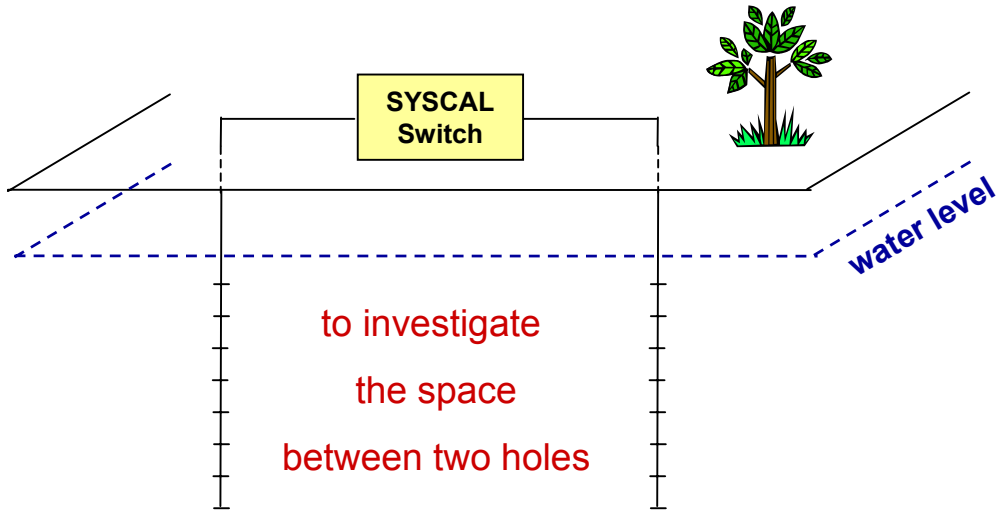
(with surface cables)



to investigate the underground from the surface

3D IMAGING BETWEEN TWO HOLES

(with borehole cables)



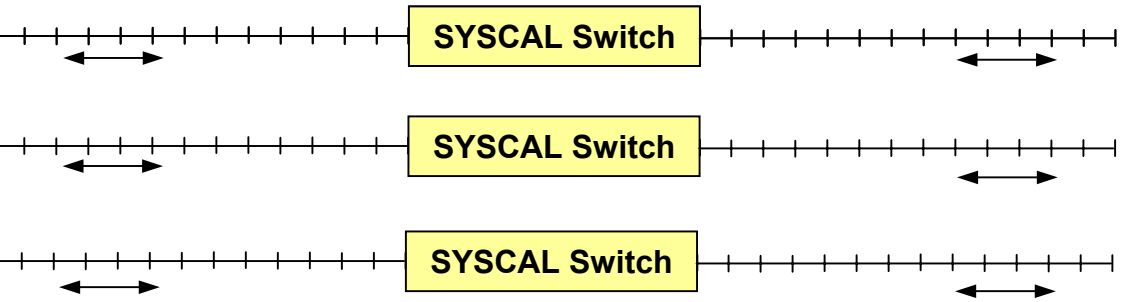
(the electrodes have to be placed under the water level)

Combinations of surface and borehole electrodes can also be used

IRIS instruments

SIMPLIFIED AND TRUE 3D RESISTIVITY IMAGING

1) SIMPLIFIED 3D IMAGING: 2D DATA ACQUISITION, 3D INVERSION



2D SECTION # 1

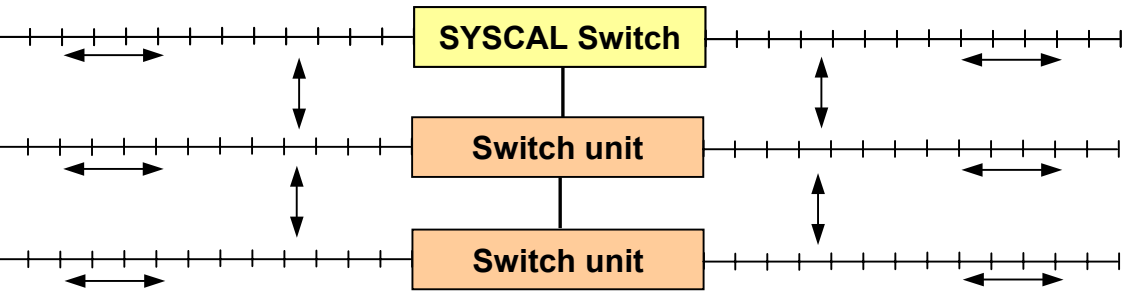
then

2D SECTION # 2

then

2D SECTION # 3

2) TRUE 3D IMAGING: 3D DATA ACQUISITION, 3D INVERSION



3D ACQUISITION:
sections # 1, 2 and 3,
+ readings with current electrodes & potential electrodes located in different lines, for a better investigation of the structures in the perpendicular direction

3D INVERSION SOFTWARE
(Res3Dinv)

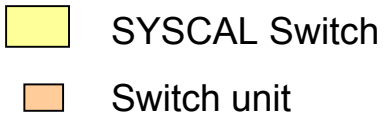
SYSCAL Switch = *Transmitter + Receiver + Switch*

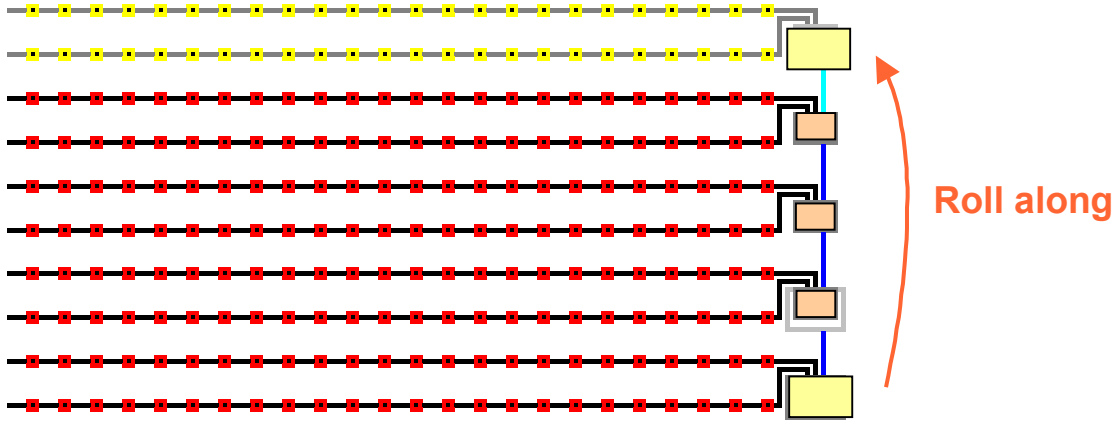
Switch unit = *Switch*

IRIS instruments

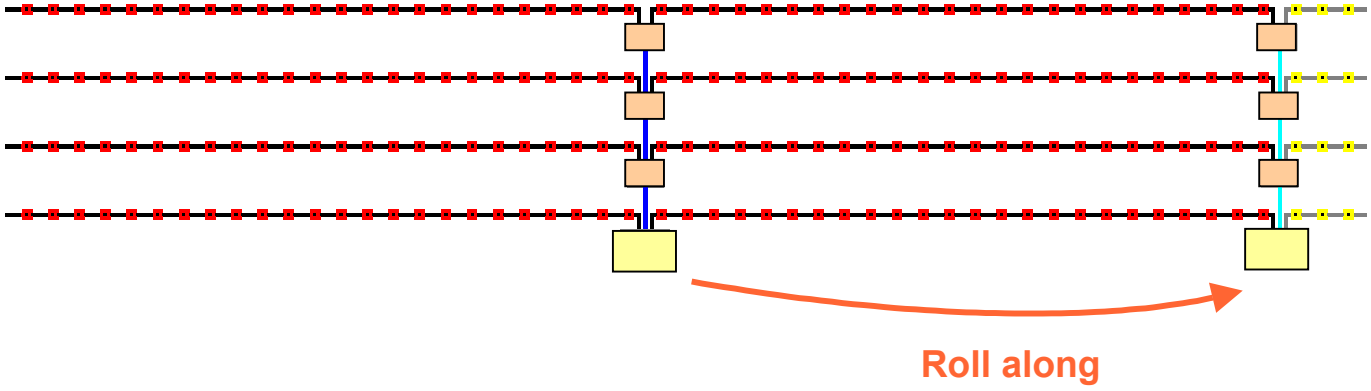
SKETCH OF A 3D RESISTIVITY IMAGING SURVEY with one « SYSCAL Switch » and three « Switch units »

« SQUARE TYPE » CONFIGURATION



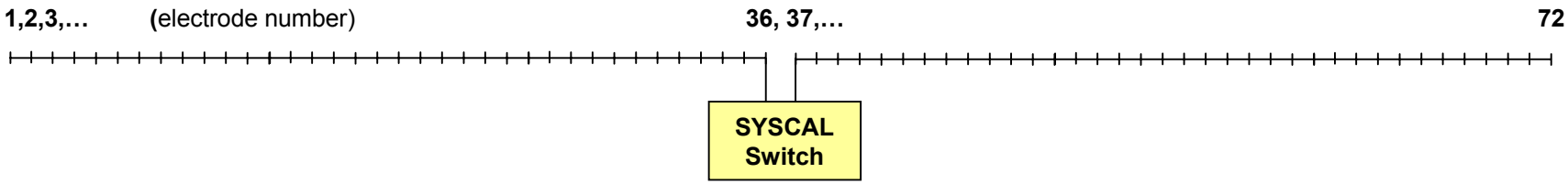


« RECTANGLE TYPE » CONFIGURATION

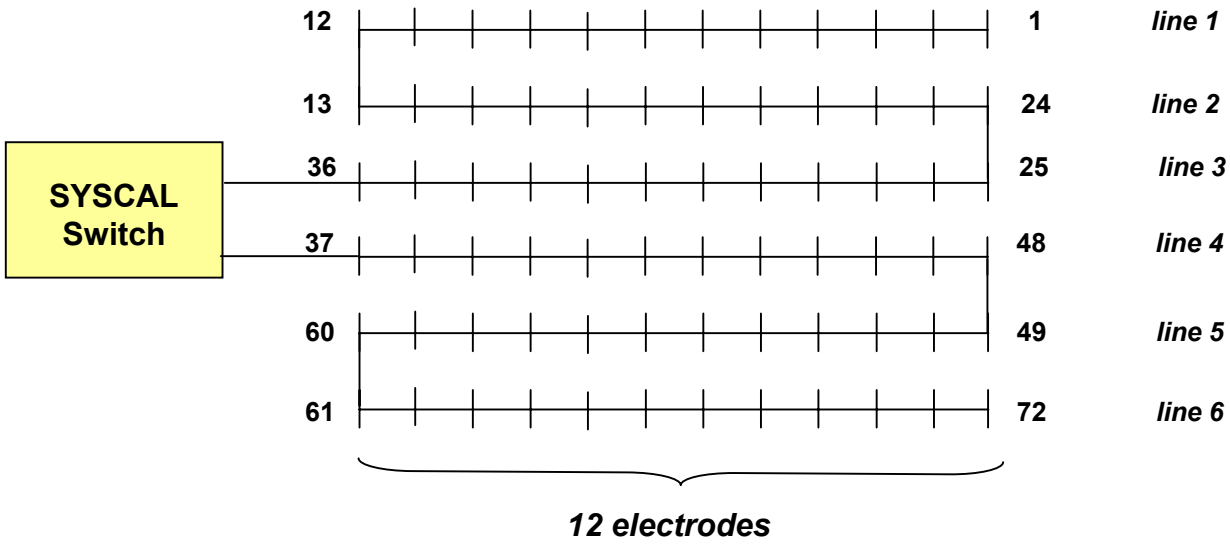


SKETCH OF A 3D RESISTIVITY IMAGING SURVEY with a « SYSCAL Switch » and 72 electrodes

2D CONFIGURATION FOR A ONE LINE SURVEY, WITH 72 ELECTRODES



3D CONFIGURATION FOR A 6 LINE SURVEY, WITH 12 ELECTRODES / LINE

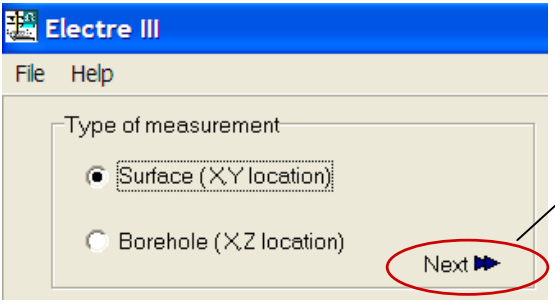


6 lines x 12 electrodes
=
72 ELECTRODES

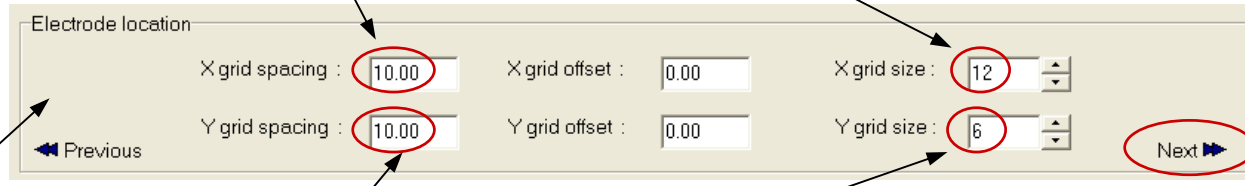
IRIS instruments

CREATION OF 3D SEQUENCES FOR 72 ELECTRODES with ELECTRE III software

INTRODUCE THE ELECTRODE COORDINATES WITH THE AUTOMATIC NUMBERING PROCEDURE



10m spacing between electrodes, 12 electrodes per line (X direction)



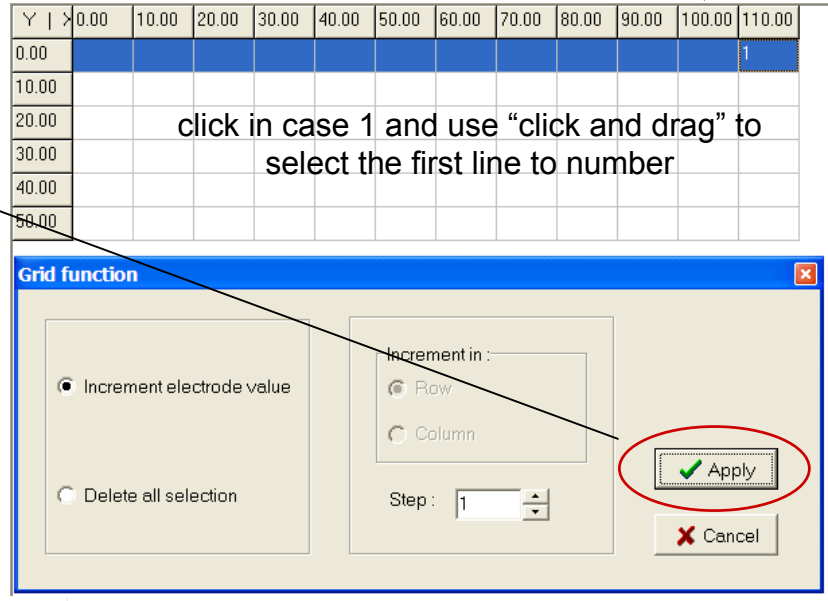
10m separation between lines, 6 lines, (Y direction)

Y | X	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00
0.00	12	11	10	9	8	7	6	5	4	3	2	1
10.00												
20.00												
30.00												
40.00												
50.00												

repeat the operation for all the other lines to number

Y | X	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00
0.00	12	11	10	9	8	7	6	5	4	3	2	1
10.00	13	14	15	16	17	18	19	20	21	22	23	24
20.00	36	35	34	33	32	31	30	29	28	27	26	25
30.00	37	38	39	40	41	42	43	44	45	46	47	48
40.00	60	59	58	57	56	55	54	53	52	51	50	49
50.00	61	62	63	64	65	66	67	68	69	70	71	72

Next



continue on next page

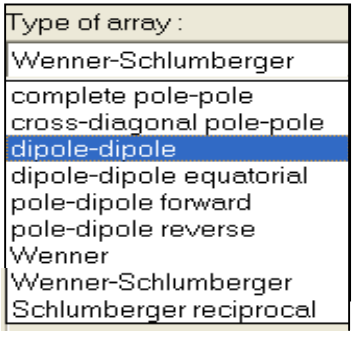
CREATION OF 3D SEQUENCES FOR 72 ELECTRODES

CHOOSE THE ELECTRODE ARRAY(S) FOR THE 3D RESISTIVITY IMAGING

3D = MANY ELECTRODES,
HIGH RESOLUTION REQUIRED

3D = ACQUISITION TIME
USUALLY < FIELD SET UP TIME
(ELECTRODES & CABLES, …)

→ USE SEVERAL SEQUENCES CORRESPONDING TO VARIOUS ELECTRODE ARRAYS, SO AS TO HELP THE INVERSION SOFTWARE, IN THE DELINEATION OF THE STRUCTURES



rank (1 : best)	**penetration depth** (in % of line length)	**lateral resolution**	**signal amplitude**	**field set up** (# of far electrodes)
1	Pole Pole (90%)	Dipole Dipole	Pole Pole	Wen Schlumb (0)
2	Pole Dipole (35%)	Pole Dipole	Wen Schlumb	Dipole Dipole (0)
3	Wen Schlumb (20%)	Wen Schlumb	Pole DIpole	Pole Dipole (1)
4	Dipole Dipole (20%)	Pole Pole	Dipole Dipole	Pole Pole (2)

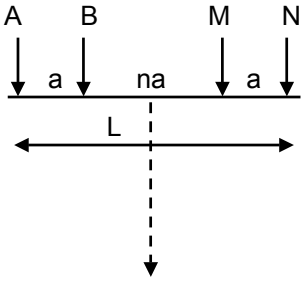
with the **SYSCAL Pro SWITCH**
ELECTRE III optimizes the sequences
for enabling the SYSCAL to *simultaneously* measure
as many readings as possible,
for reducing the acquisition time
(for Wen and Wen Schlum, use the Schlum reciprocal)

ONCE AN ELECTRODE ARRAY HAS BEEN SELECTED, THE PROGRAM AUTOMATICALLY GENERATES A SEQUENCE WHICH INCLUDES ALL THE POSSIBLE COMBINATIONS OF THIS ELECTRODE ARRAY,
IN THE X AND Y DIRECTIONS

IRIS instruments

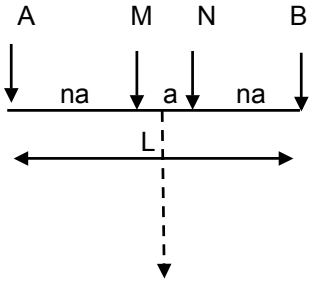
DEFINITION OF MOST USUAL ELECTRODE ARRAYS

Dipole Dipole



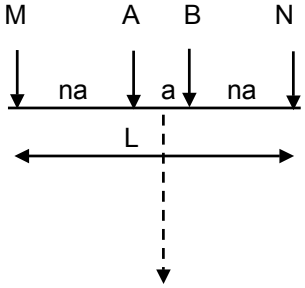
depth: **about 0.2** x **L**

Wenner-Schlu



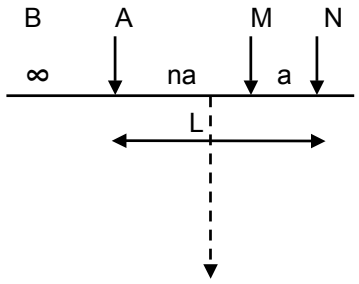
depth: **about 0.2** x **L**

Schlum reciprocal



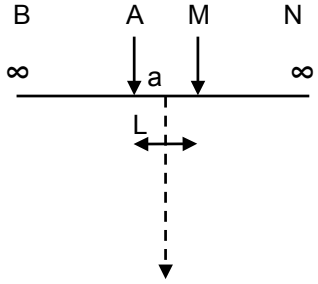
depth: **about 0.2** x **L**

Pole Dipole



depth: **about 0.35** x **L**

Pole Pole



depth: **about 0.9** x **L**

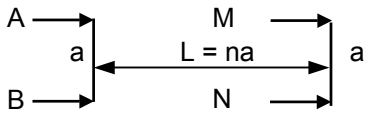
note: the electrode(s) at infinity must be placed at a distance of about 5 to 10 times the maximum line length of the array (L)

Type of array :
Wenner-Schlumberger
complete pole-pole
cross-diagonal pole-pole
dipole-dipole
dipole-dipole equatorial
pole-dipole forward
pole-dipole reverse
Wenner
Wenner-Schlumberger
Schlumberger reciprocal

rank (1 : best)	**penetration depth** (in % of line length)	**lateral resolution**	**signal amplitude**	**field set up** (# of far electrodes)
1	Pole Pole (90%)	Dipole Dipole	Pole Pole	Wen Schlumb (0)
2	Pole Dipole (35%)	Pole Dipole	Wen Schlumb	Dipole Dipole (0)
3	Wen Schlumb (20%)	Wen Schlumb	Pole DIpole	Pole Dipole (1)
4	Dipole Dipole (20%)	Pole Pole	Dipole Dipole	Pole Pole (2)

Equatorial Dipole DIpole

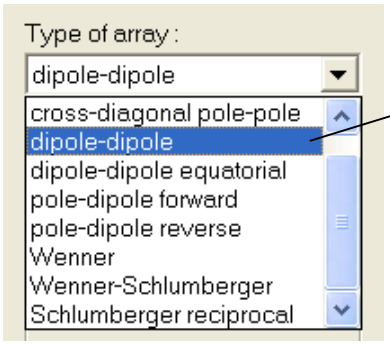
depth: **about 0.4** x **L**



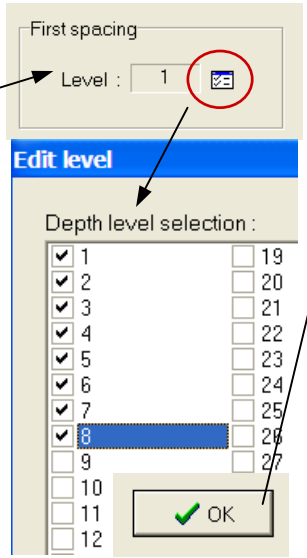
CREATION OF 3D SEQUENCES FOR 72 ELECTRODES

CREATE THE SEQUENCE OF READINGS WITH THE AUTOMATIC GENERATION PROCEDURE

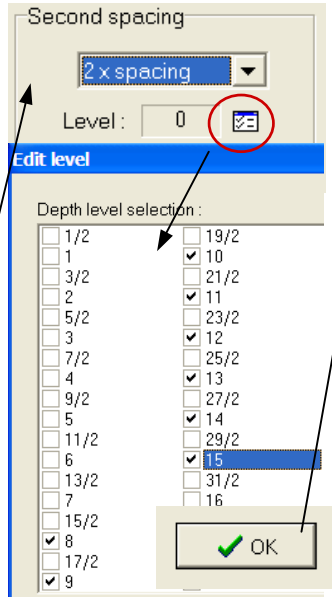
select the electrode array



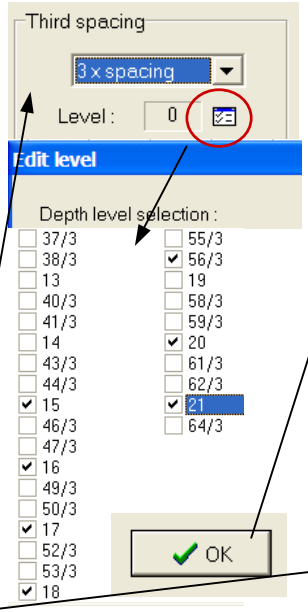
select the levels for the spacing «a»



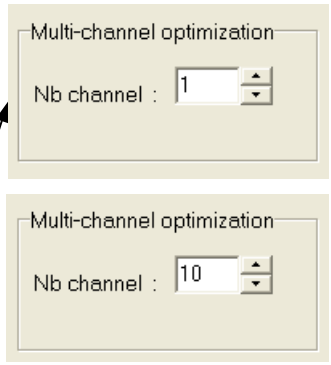
select the levels for the spacing «2a»

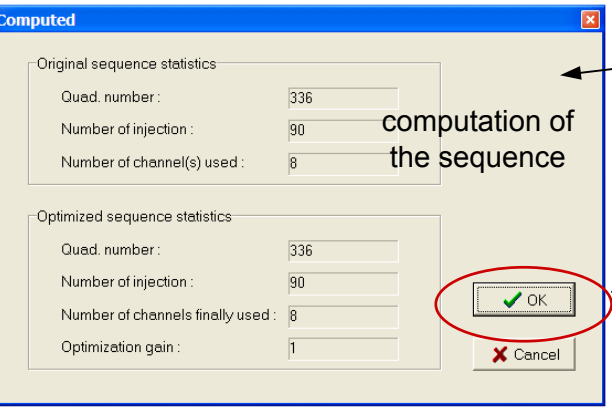


select the levels for the spacing «3a»

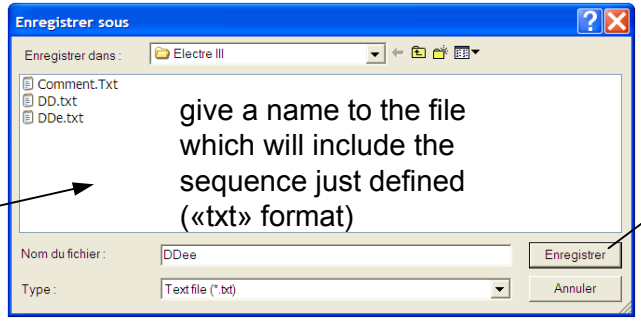


select the number of channels measured simultaneously (1 for SYSCAL Jr, R1+, R2, 10 for SYSCAL Pro)

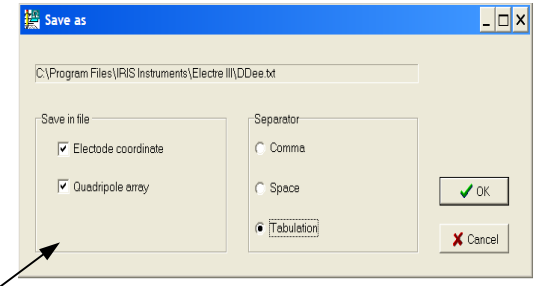




computation of the sequence



give a name to the file which will include the sequence just defined («txt» format)



then, with ELECTRE II:
- press OPEN button to open the «txt» file
- save it as a «sqx» file (file menu),
- transfer it into the SYSCAL memory

FIELD DATA ACQUISITION WITH SYSCAL Switch

FIELD SET UP:

- dig the electrodes and connect them to the cables; connect the SYSCAL Switch to the cables

- select the **sequence** to apply

- check the batteries

-check the electrode ground resistance

- control **the quality** of the future readings by fixing the “stack min”, “stack max”, and “quality factor” (standard deviation) parameters

- run the selected sequence

ACQUISITION TIME FOR A SEQUENCE OF **1000 READINGS**	**RESISTIVITY** (5 stacks, 0.5s ON time)	**RESISTIVITY & IP** (15 stacks, 2s ON & OFF times)
SYSCAL R1 Plus Switch (1 channel measurement)	**1 hour**	**12 hours**
SYSCAL Pro Switch (10 channel measurement)	**8 minutes**	**1 hour ½**

SYSCAL R1 Plus Switch, 24, 48, 72

600V, 200W, 2.5A

SYSCAL Pro Switch, 48, 72, 96

800V, 250W, 2.5A

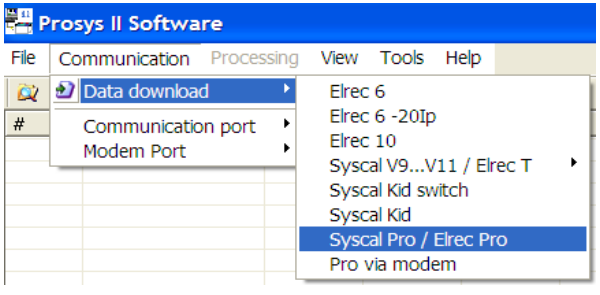
SWITCH Pro unit

(48, 72, 96 extension)

PROCESSING 3D DATA WITH PROSYS II SOFTWARE

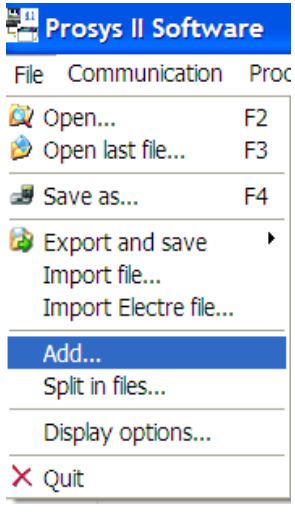
DATA TRANSFER TO PC

- ***Connect serial or USB link*** (SYSCAL to PC)
- ***Run PROSYS II*** software: communication, data download, SYSCAL type, & follow PC indications
- ***Give a name*** to the new global file data (.bin file)



MERGING FILES

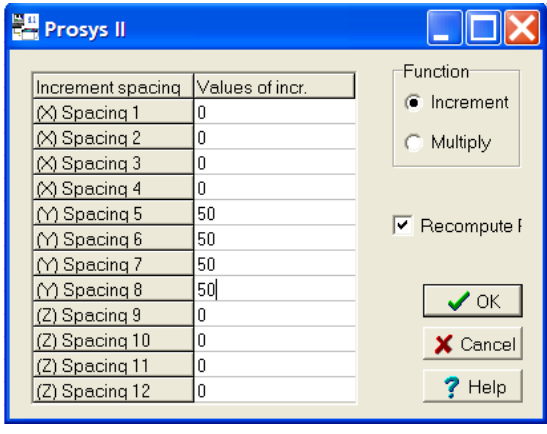
When various data files successively acquired on the same site and have to be interpreted together, they have first to be merged with the PROSYS II software: **Open** "file 1", **Add** "file 2", **Add** "file 3", **Save as,** and give a name to the file which will include all the data ("file 123")

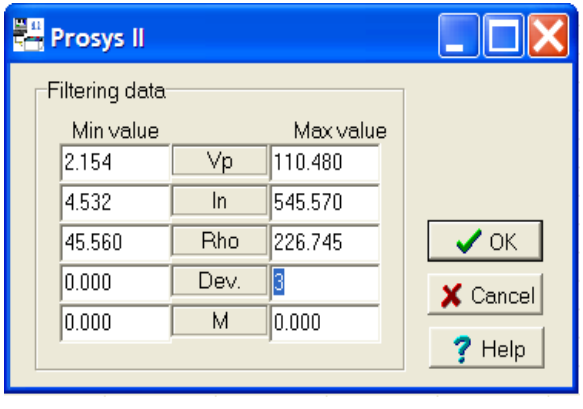


FILE 1 + FILE 2 + FILE 3 → **FILE 123**

MODIFY SPACING

If the spacing (like the line number Y of a profile) has to be changed, go to **"file / processing / modify spacing"** and key in the proper value (Y) for the A, B, M, N electrodes (spacings 5, 6, 7, 8) of all the readings of this file



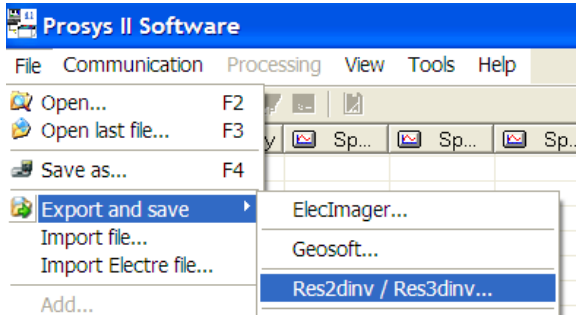


FILTERING THE DATA

By using the **"processing / filtering"** function, it is possible to devalidate the noisy readings for which the standard deviation is greater than a given value (3% for example).

EXPORT TO RES3Dinv

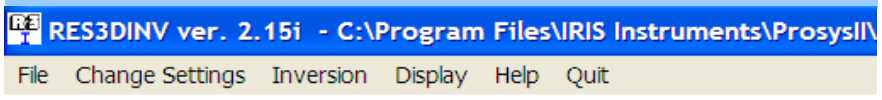
Once the «.bin» data file has been processed with PROSYS II, export them towards RES3dinv, and give a name to this new file («.dat» file)



INTERPRETING 3D DATA WITH RES3Dinv SOFTWARE

BASIC OPERATING PROCEDURE OF THE RES3Dinv SOFTWARE

RES3Dinv MAIN MENU



CHANGE THE COLOUR SCALE

- click on “display / show inversion results”, then on «display sections / display data and model sections”

- modify the **scale of the colours** (the resistivity limits for the 16 colours, or the colours themselves)

- store the new colour scale with the “file / store colour scale” function

HOW TO INVERT THE DATA ?

Introduce the data file (.dat) : “file / read data file”, OK

Run the inversion: “inversion / least square inversion”

Display the results: “display / display results / display inversion model”

Select the type of display: “*sections*” (horizontal sections, at various depths) or “*slices*” (vertical slices, along various lines): *see examples on the next two slides*

EXPORT TO 3D VISUALIZATION PROGRAMS

Use the function **“file / export”** to make the RES3Dinv inversion result file compatible with the following 3D visualization software programs:

-**Slicer Dicer**

- **Rockware**

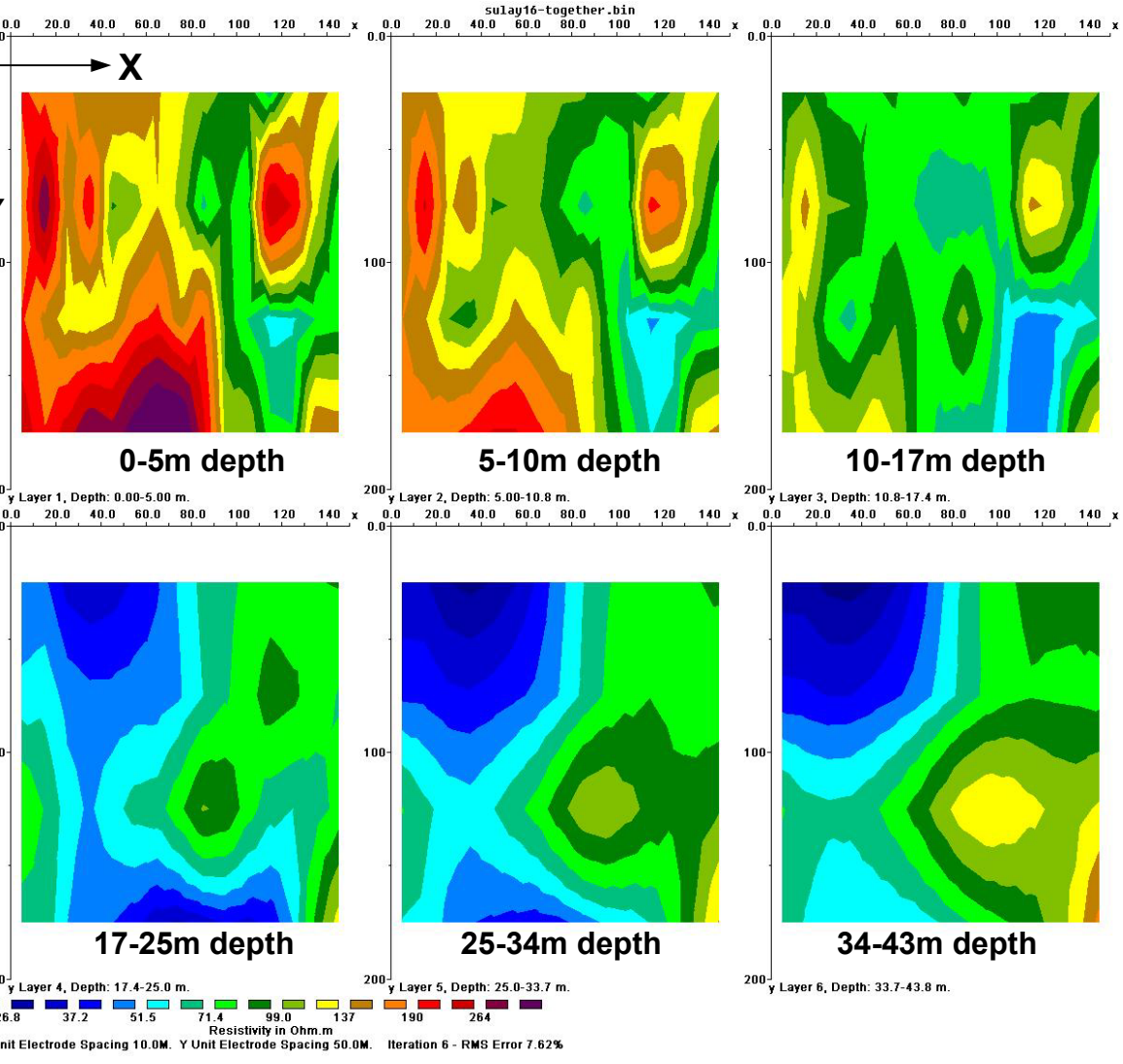
These programs visualize the inversion model in 3D, for a better understanding of the volumes of the various structures detected

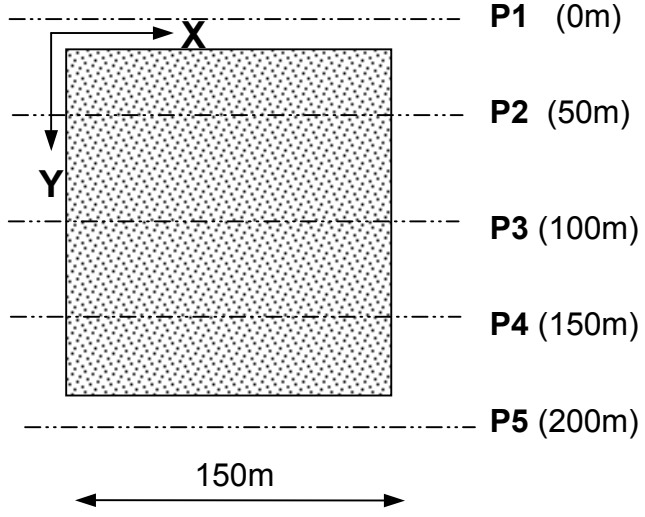
see an example on third next slide

IRIS instruments

INTERPRETING 3D DATA WITH RES3Dinv SOFTWARE

REPRESENTATION OF THE RESULTS IN HORIZONTAL SECTIONS AT VARIOUS DEPTHS



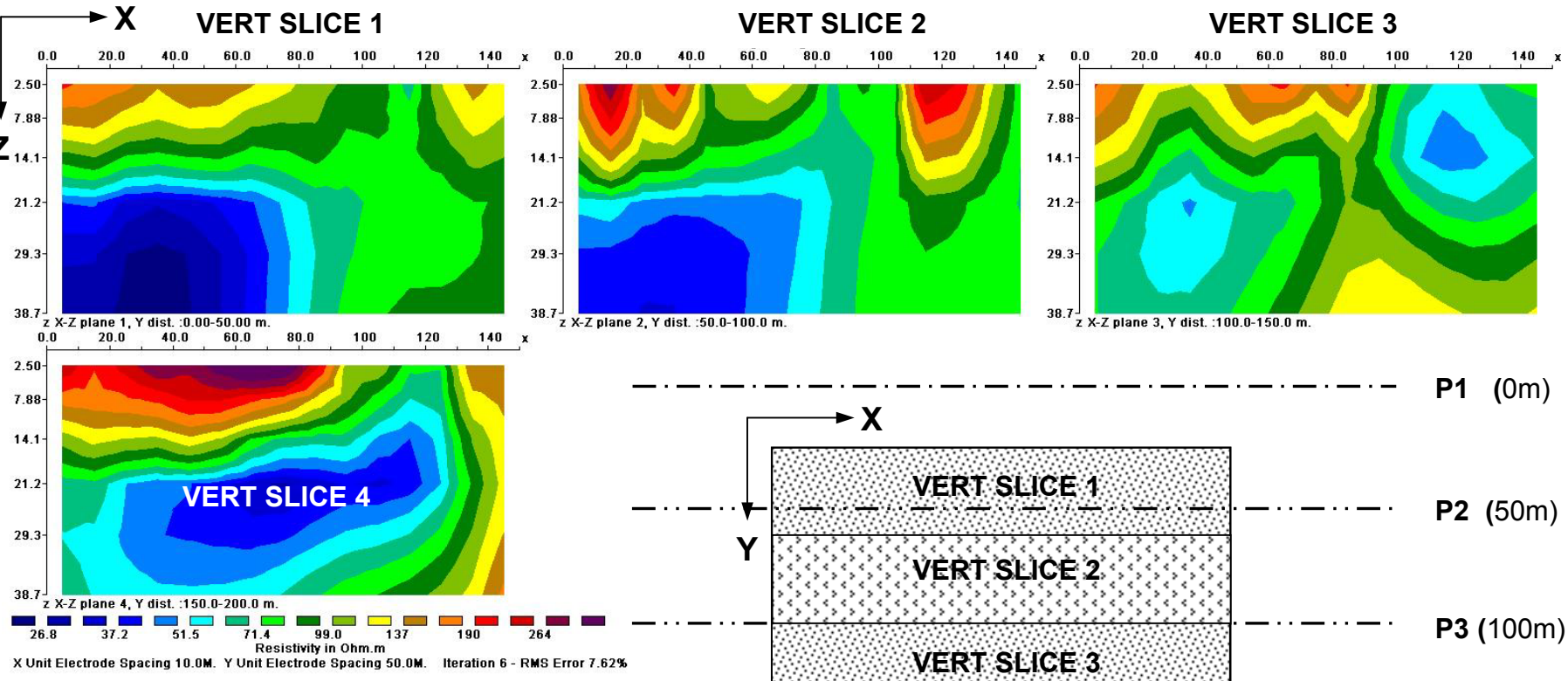


5 PROFILES (P1 to P5)
with 16 electrodes at 10m spacing,
Wenner Schlumberger array

IRIS instruments

INTERPRETING 3D DATA WITH RES3Dinv SOFTWARE

REPRESENTATION OF THE RESULTS IN VERTICAL SLICES, ALONG VARIOUS LINES

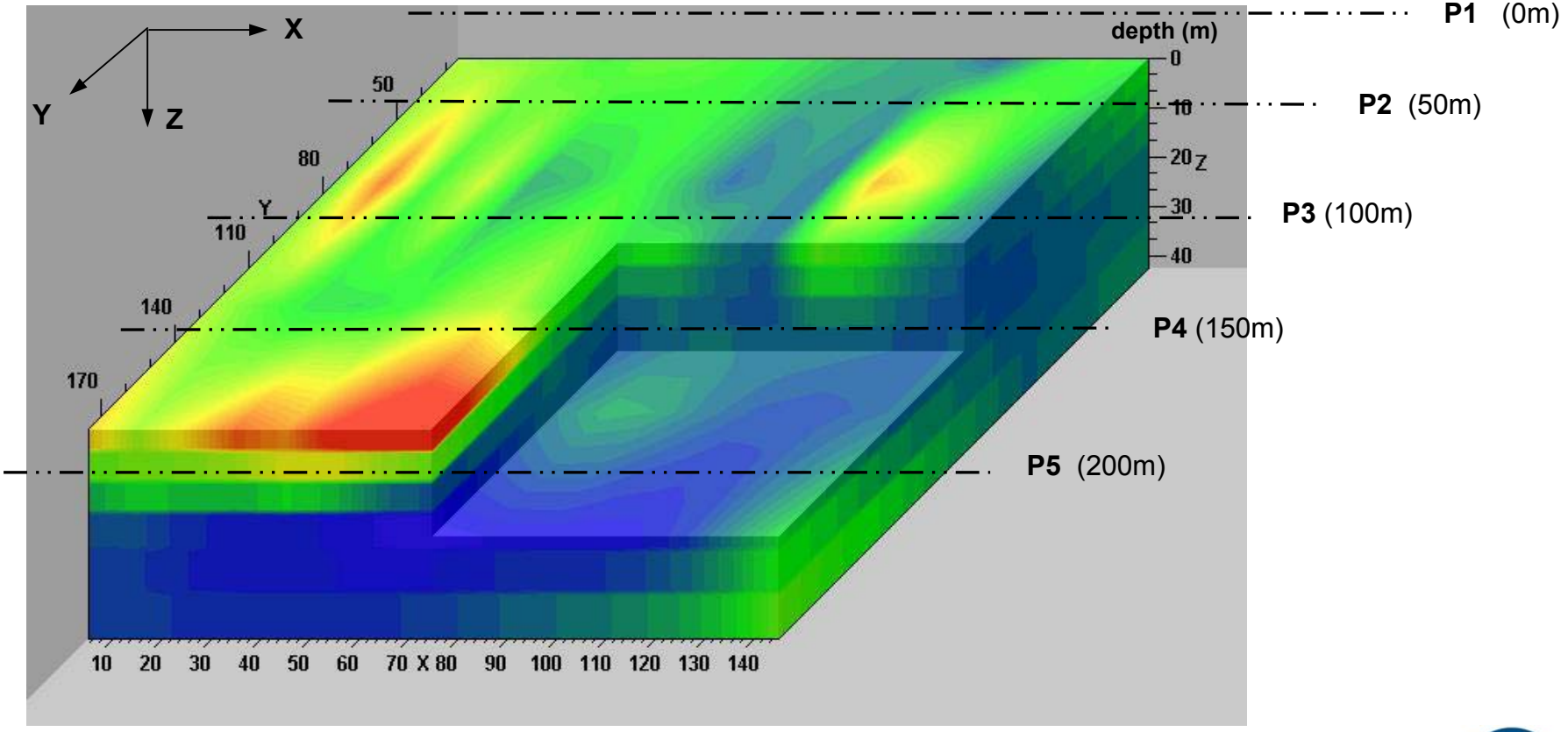


5 PROFILES (P1 to P5)
with 16 electrodes at 10m spacing,
Wenner Schlumberger array

IRIS instruments

PLOTTING 3D VOLUMES WITH SLICER / DICER PROGRAM

REPRESENTATION OF THE INVERSION RESULTS IN VOLUMES



RESISTIVITY values, in ohm.m

5 PROFILES (P1 to P5)
with 16 electrodes at 10m spacing,
Wenner Schlumberger array

IRIS instruments