Editting and Modelling IP datasets
ASEG IP Workshop

IP processing and QC – from amps in the ground to an Inversion input.

2016

Presented by:
Jeremy Barrett

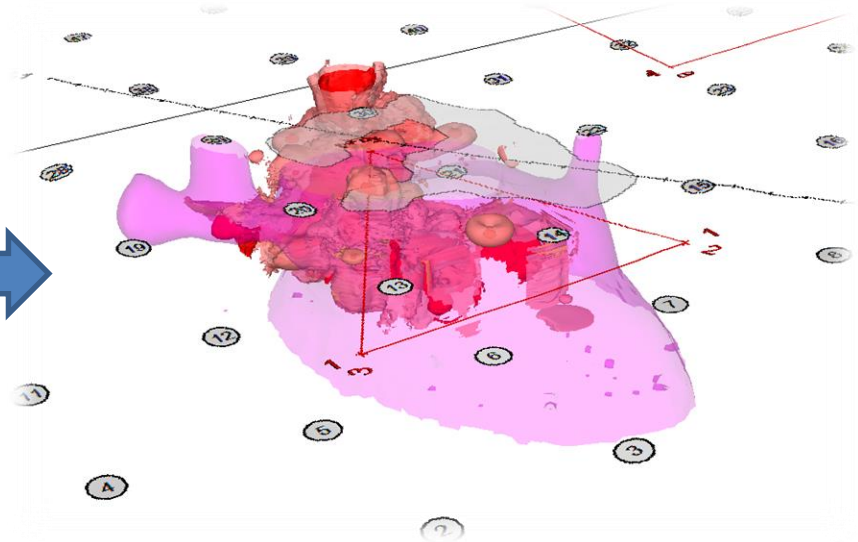
SOUTHERNROCK
GEOPHYSICS

The aim of editting this data

The aim of editting this dataset was to ensure that data used in subsequent interpretation (including inversion modelling) is valid.

- If error information is incorporated into the interpretation scheme then errors must adequately express the accuracy of the data value.
- If error information is not incorporated, or is poorly representative of the accuracy, then data whose uncertainty excedes reasonable limits of error in the interpretation scheme should be removed.

	AReserrEx	MEx	MerrEx	chdEx
6350	0.123621	8.2954	0.058848	
1500	0.104588	3.0799	0.114151	
2400	0.048580	14.0219	0.046967	
2020	0.025073	10.4671	0.019575	
9180	0.024951	17.5716	0.018937	
2060	0.022161	12.8621	0.015029	
4400	0.020134	14.1406	0.012184	
8590	0.024081	9.5291	0.011595	
0450	0.049050	24.6499	0.084317	
0010	0.104228	27.2846	0.108181	
9420	0.034452	12.8026	0.031954	
4340	0.021140	19.0805	0.014280	
2960	0.019671	14.8374	0.010142	
9120	0.019243	20.4479	0.010154	
5440	0.030313	15.4555	0.009878	
3630	0.059655	26.9690	0.057335	
1440	0.132209	28.7547	0.144562	
3580	0.109330	14.4839	0.115574	



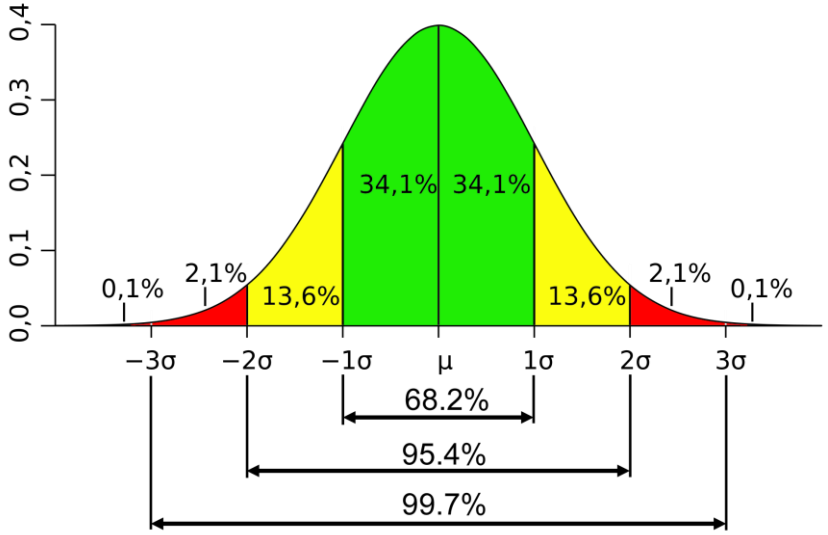
Types of error # 1

Random error:

is an error in measurement caused by factors which vary from one measurement to another.

Random errors often have a Gaussian normal distribution allowing the use of statistical methods to analyze the data.

- The mean *or median* average of a number of measurements of the same quantity will provide the best estimate of that quantity, and the standard deviation of the measurements shows the accuracy of the estimate.
- The standard error of the mean is the ***standard deviation/sqrt(n)***, where ***n*** is the number of measurements.

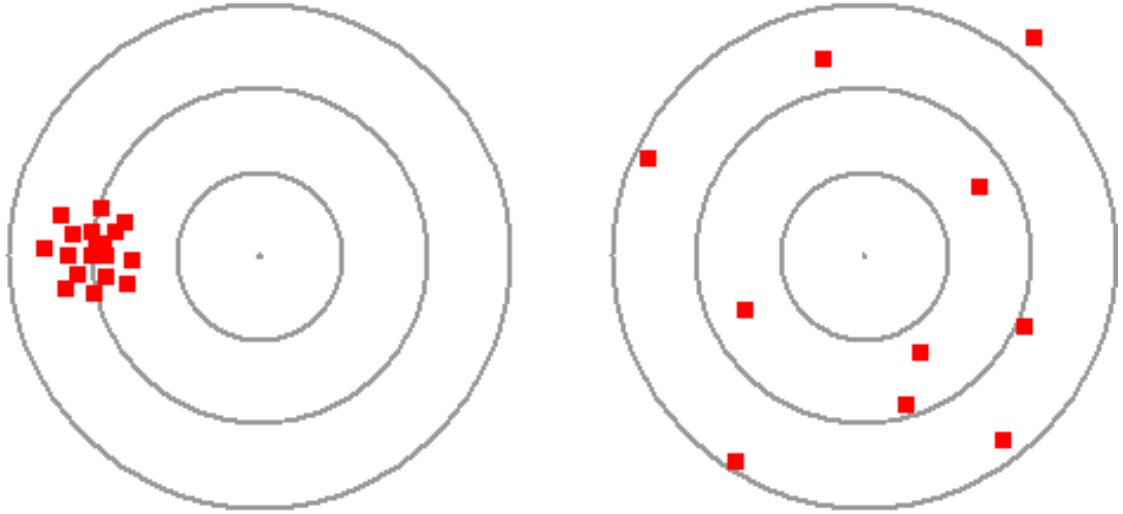


Types of error # 2

Systematic error:

an error having a non-zero mean, so that its effect is not reduced when observations are averaged.

Systematic errors cause a bias in the measured value which is not reduced by stacking and averaging. The standard deviation or SEM of the measurements does not represent the accuracy of the estimate.



Systematic Error Random Error

Examples of sources of different types of error

Random error:

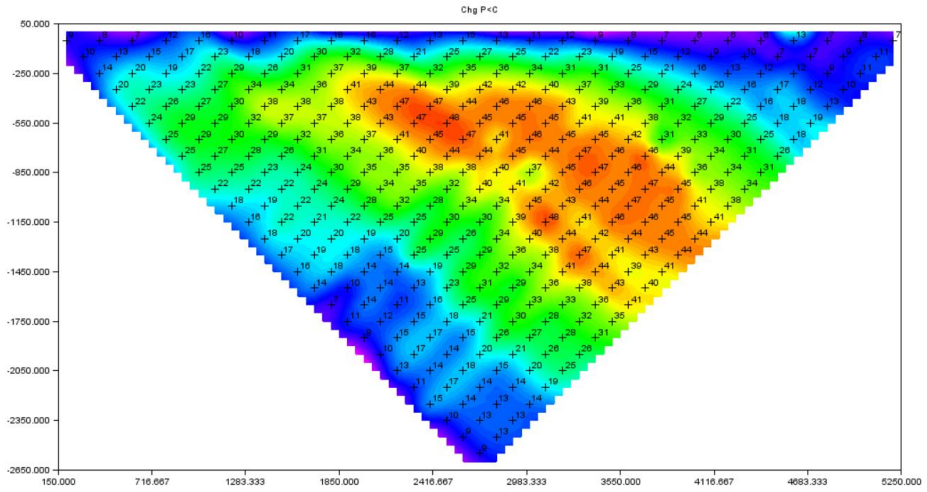
- Telluric noise
- Electrode noise
- Noise generated by movement of cables (wind)

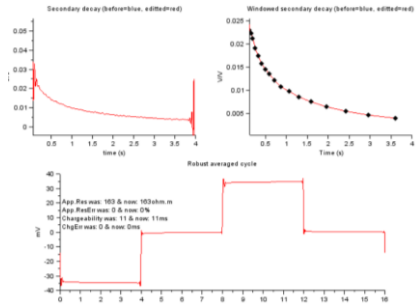
Systematic error:

- Installation errors (cables incorrectly connected, electrodes poorly grounded, poorly insulated cables with leakage, location errors)
- Instrument problems, calibration, synchronicity, etc.
- inductive electromagnetic coupling

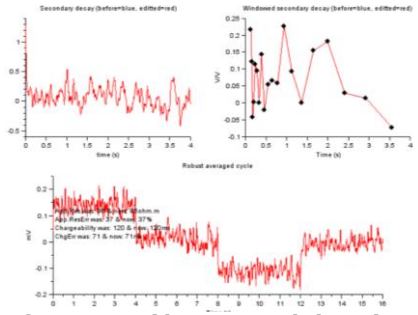
- ***Telluric and electrode noise (relatively low frequency components)***
- ***Inappropriate data processing (erroneous Telluric Cancellation for example)***

Recognition of good and bad data

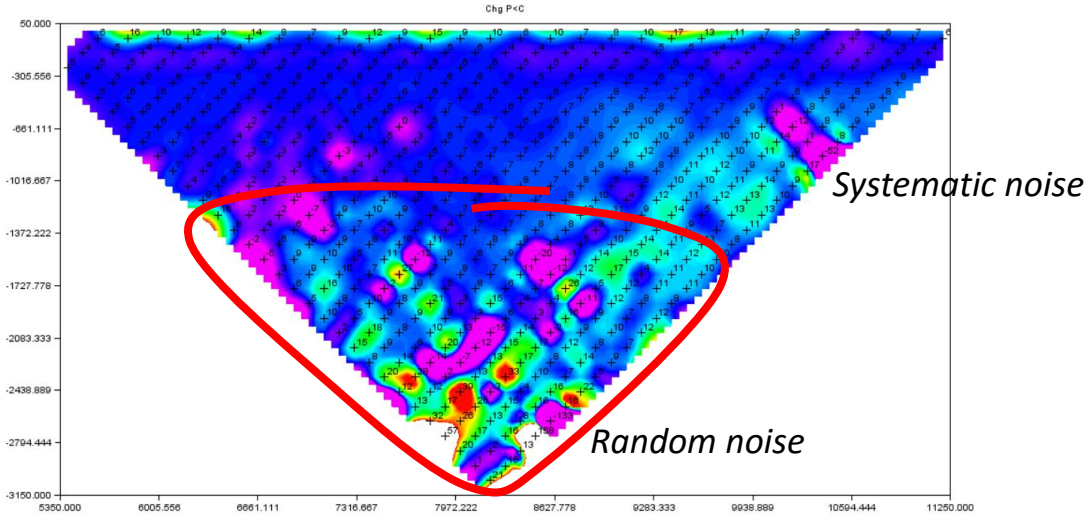




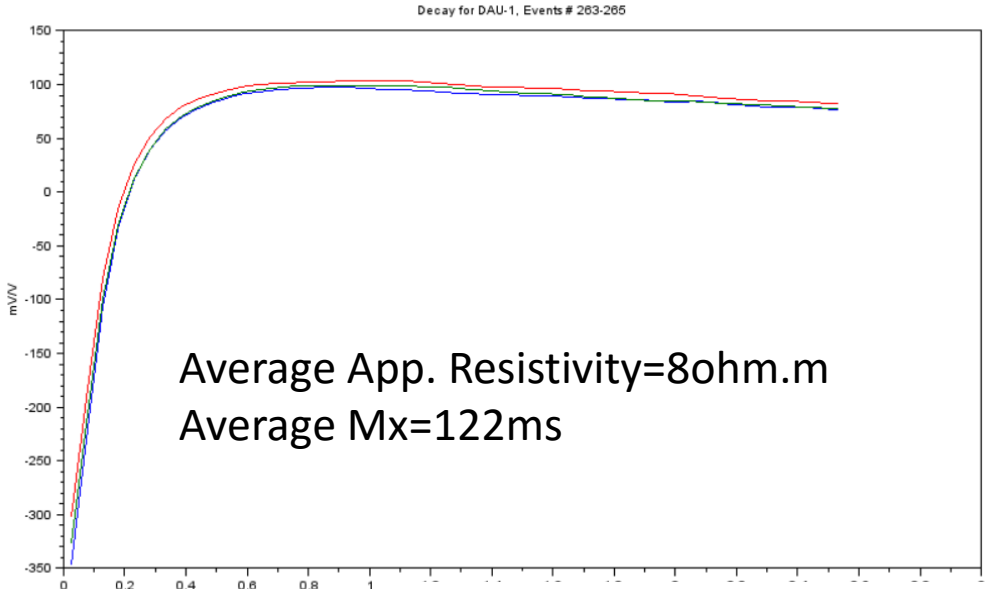
Generally good looking data with just few points that look a bit "noisy"

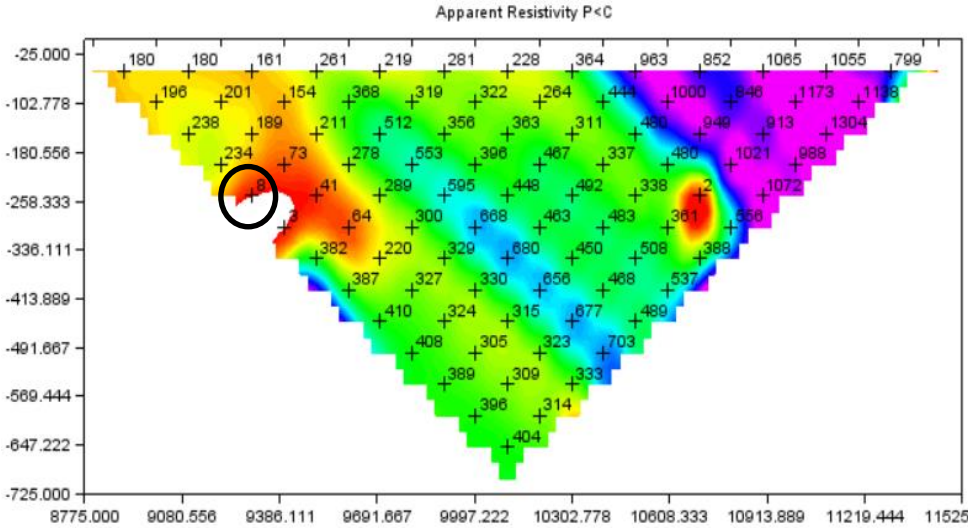


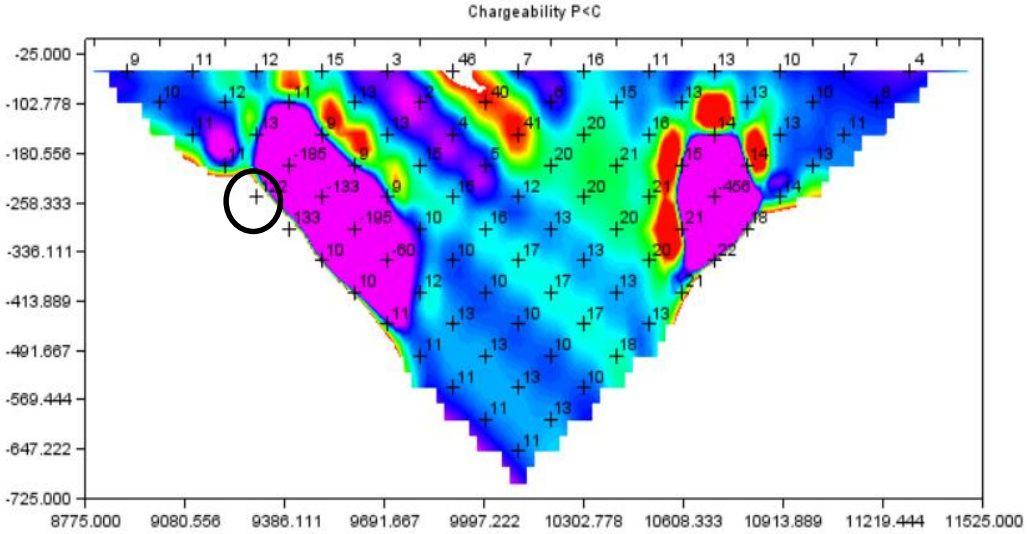
Generally good looking data to n=10 or so, but "deeper" data is noisy (in a generally random-looking manner).



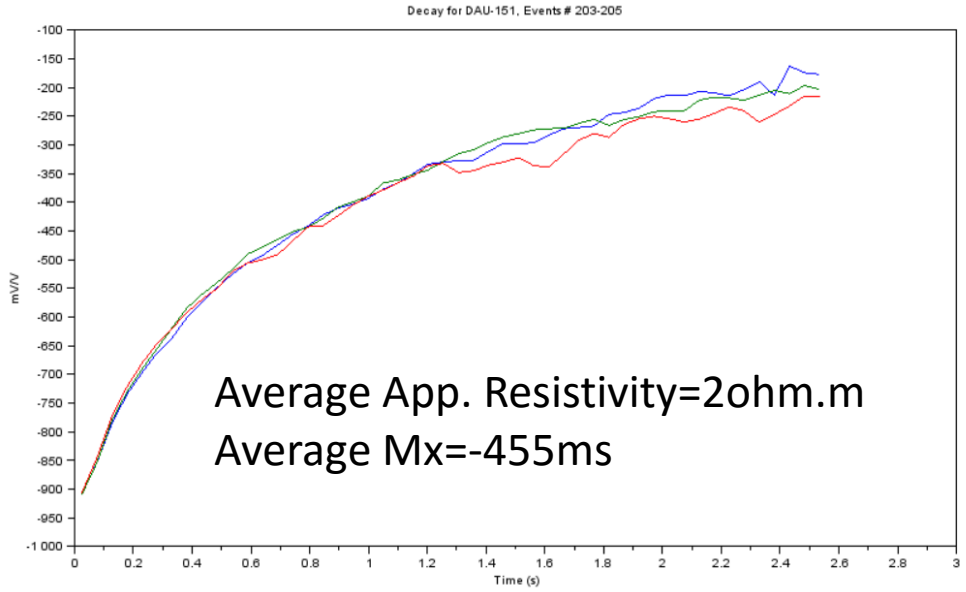
From test dataset
DAU-1, Events # 263-265

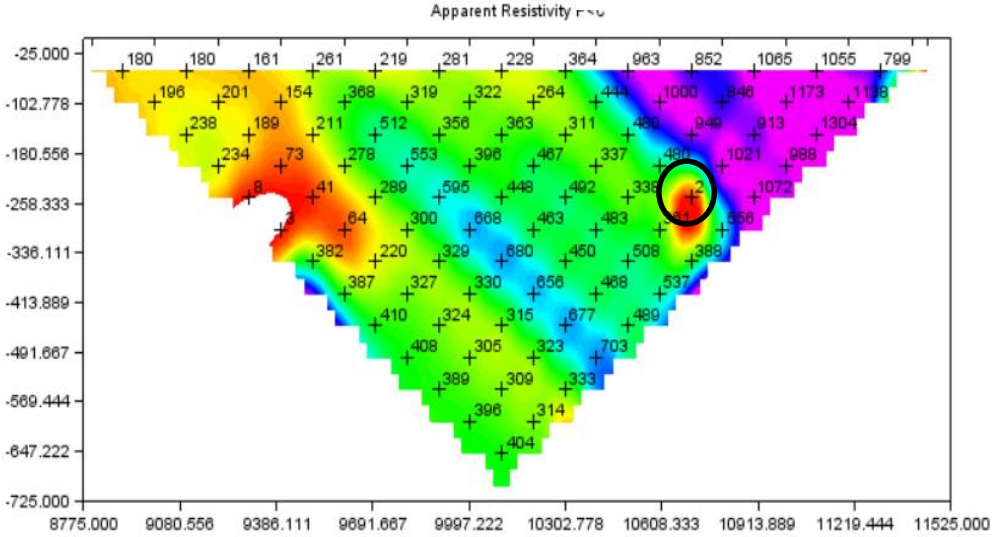


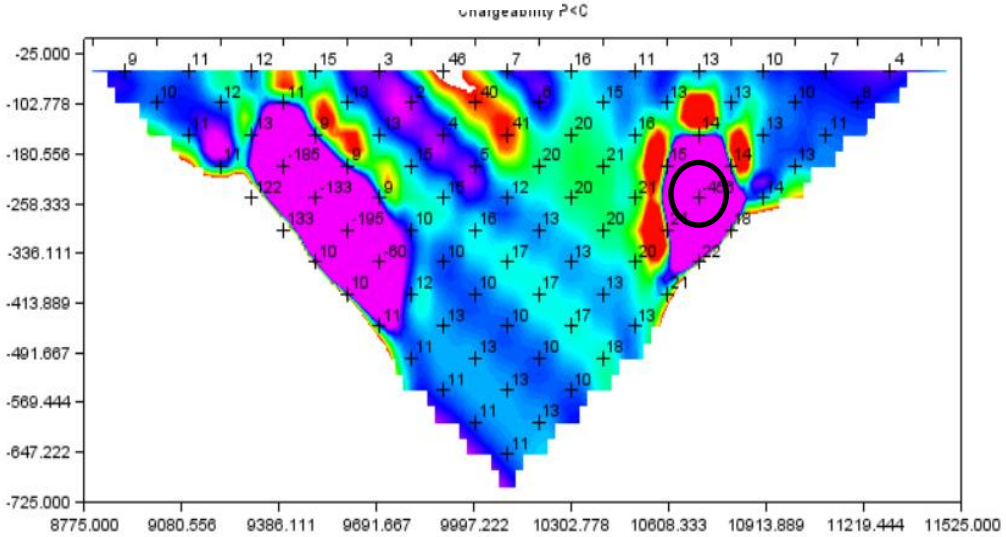




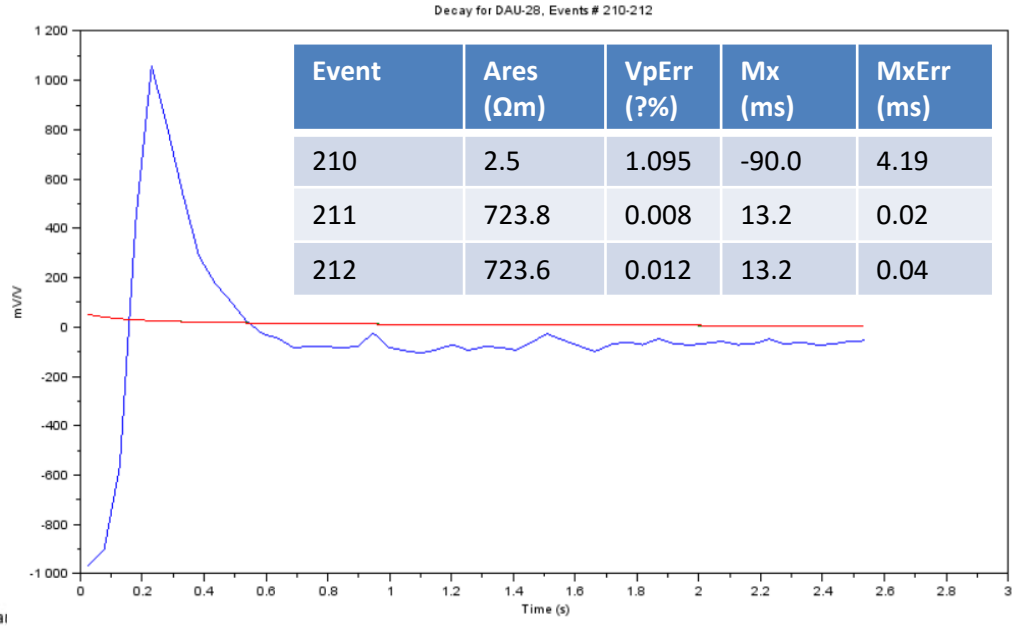
From test dataset
DAU-151, Events # 203-205



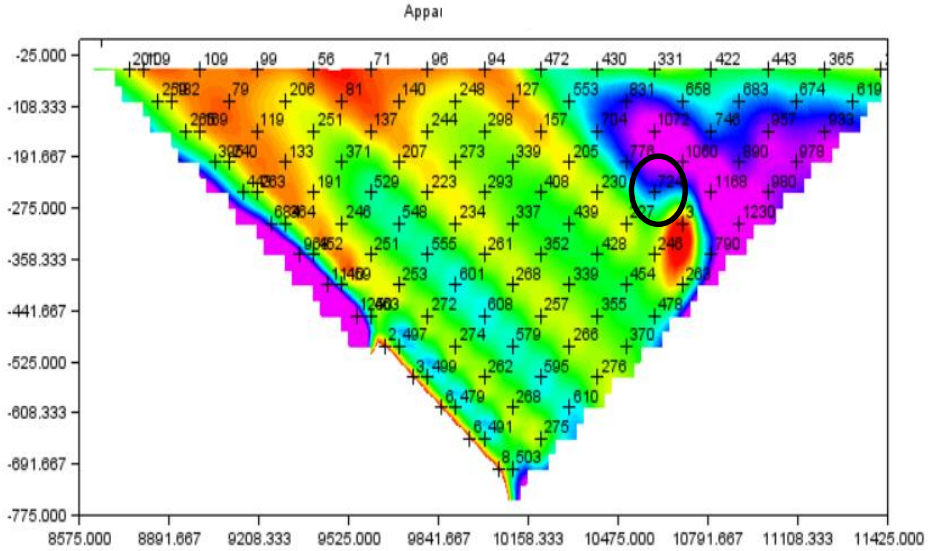


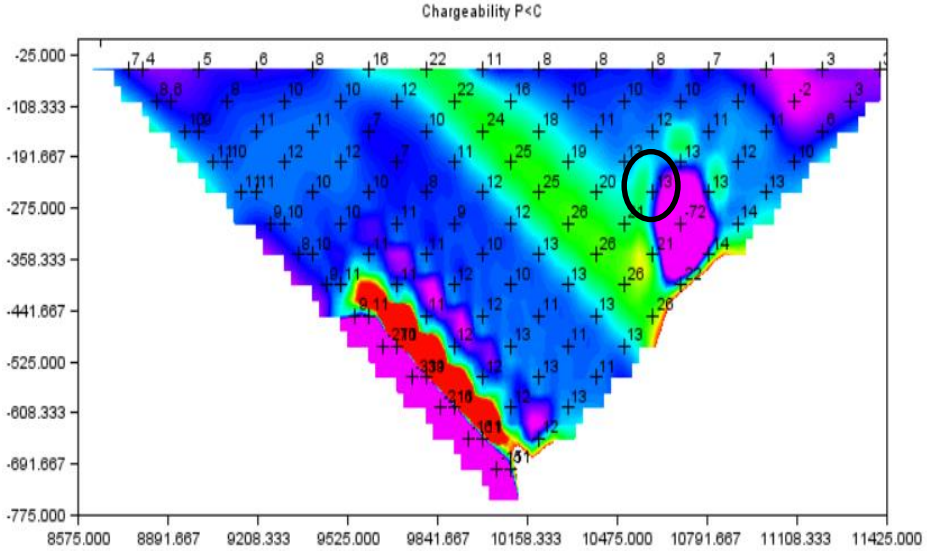


From test dataset
DAU-28, Events # 210-212

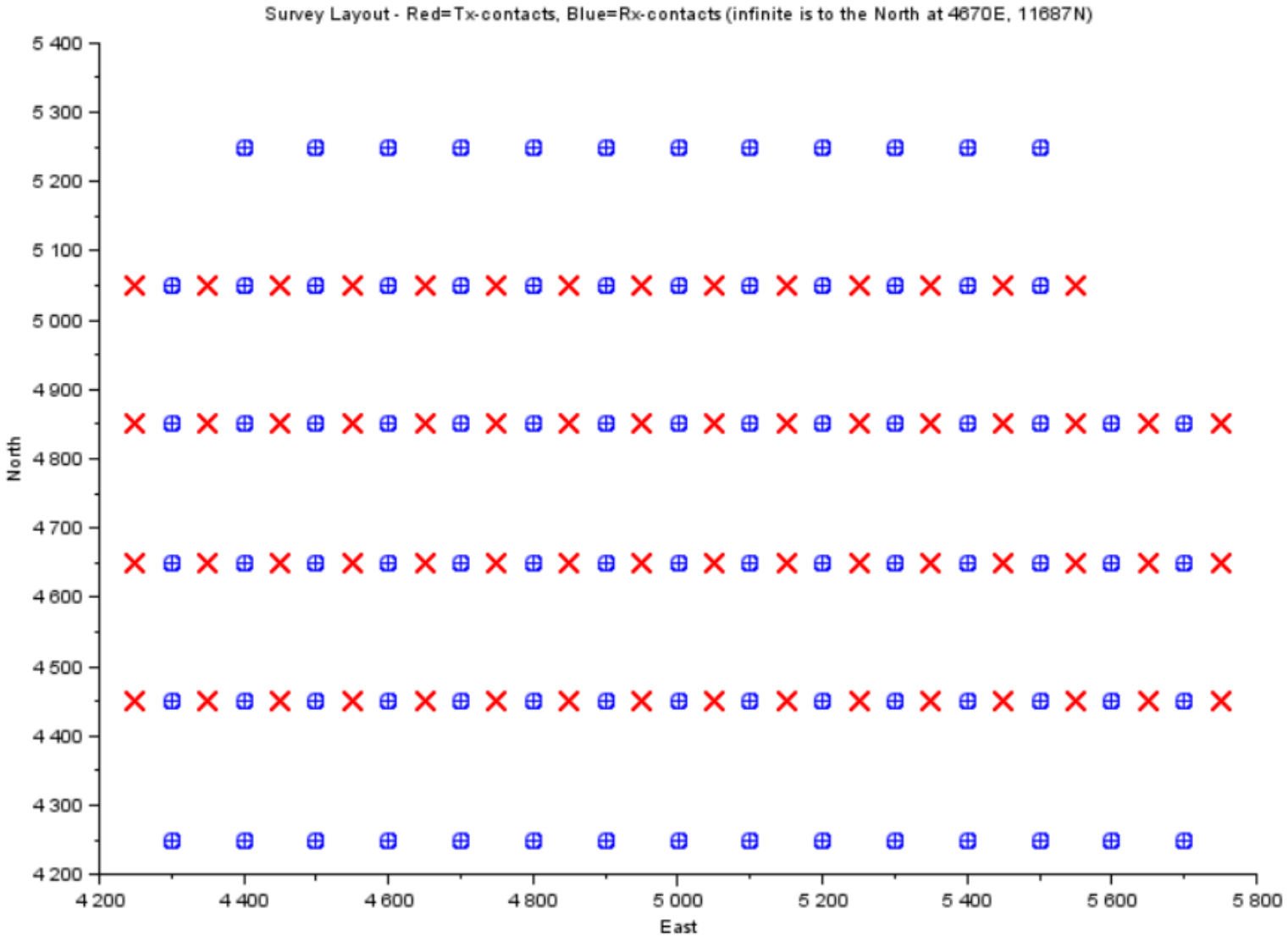


Event	Ares (Ωm)	VpErr (?%)	Mx (ms)	MxErr (ms)
210	2.5	1.095	-90.0	4.19
211	723.8	0.008	13.2	0.02
212	723.6	0.012	13.2	0.04

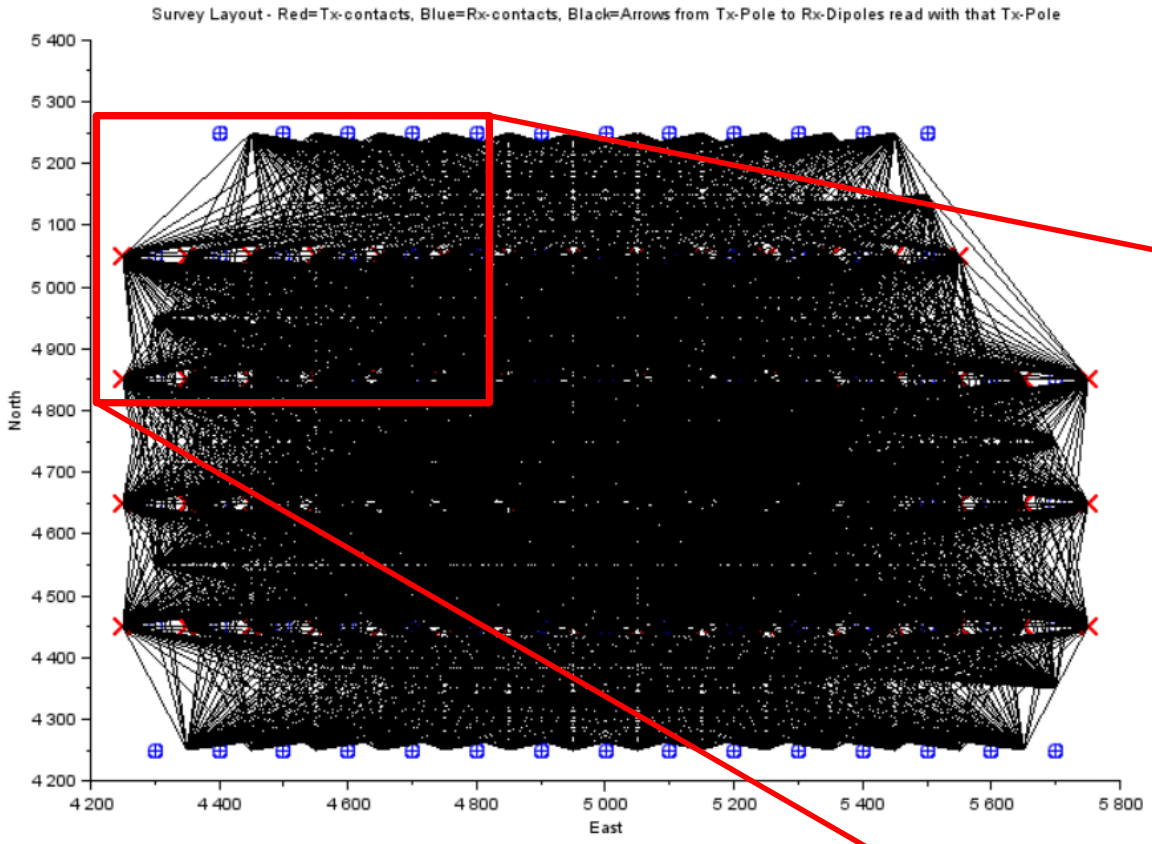


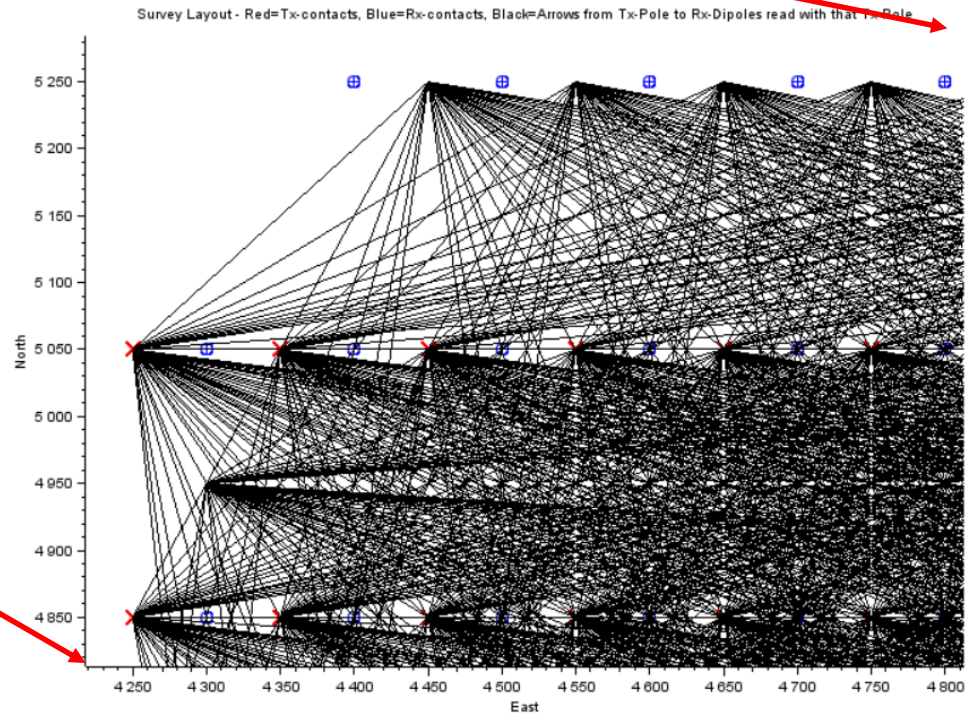


Test dataset - Survey Layout



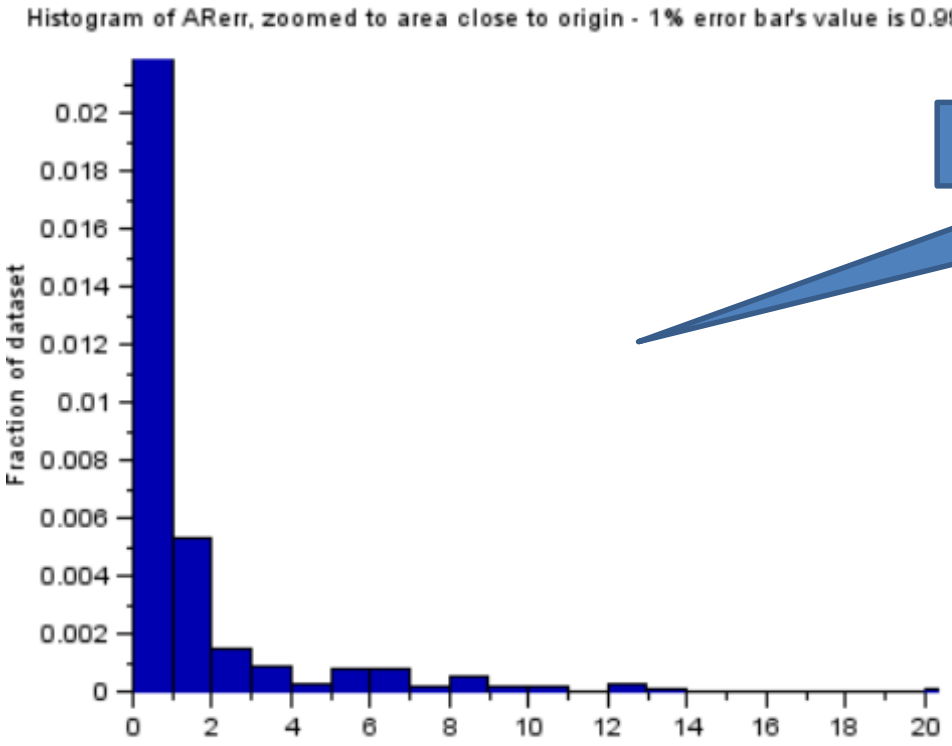
Test dataset - Survey Layout





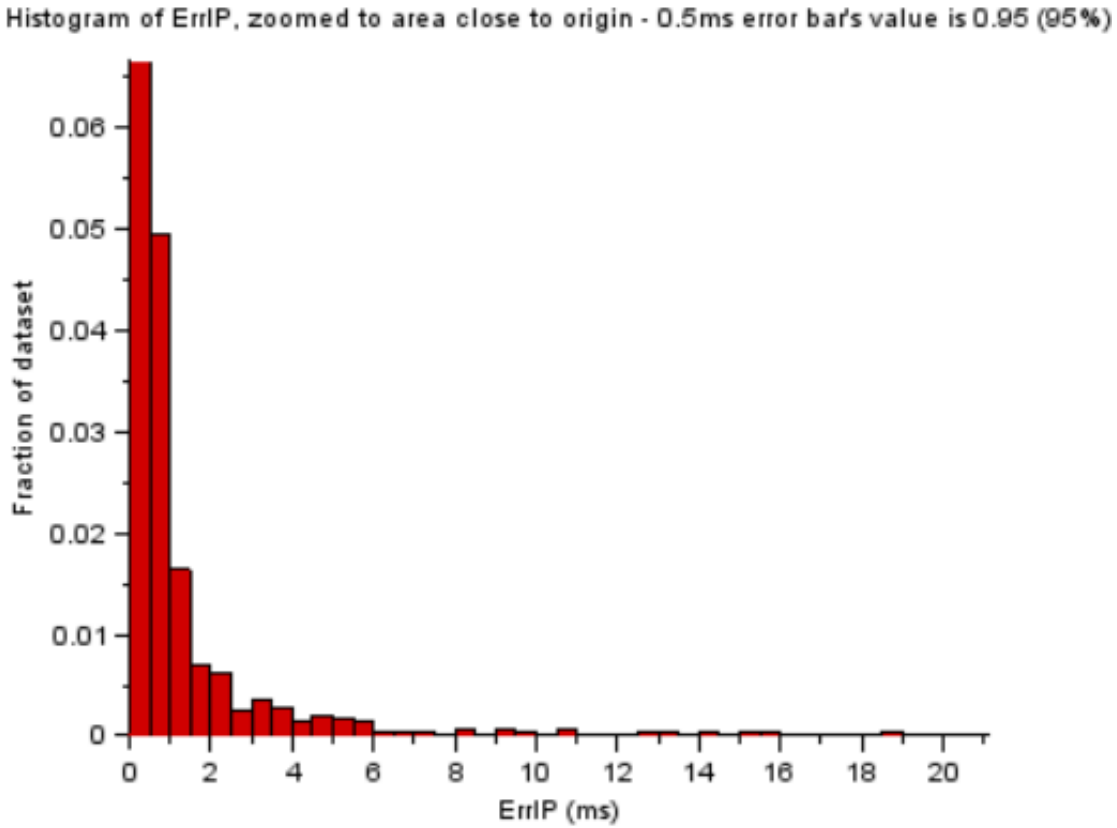
Total of 4896 Tx-Rx pairs,
with 10,510 data values

Reported intra-stack error distributions



For Apparent Resistivity (99% of data < 1% error)

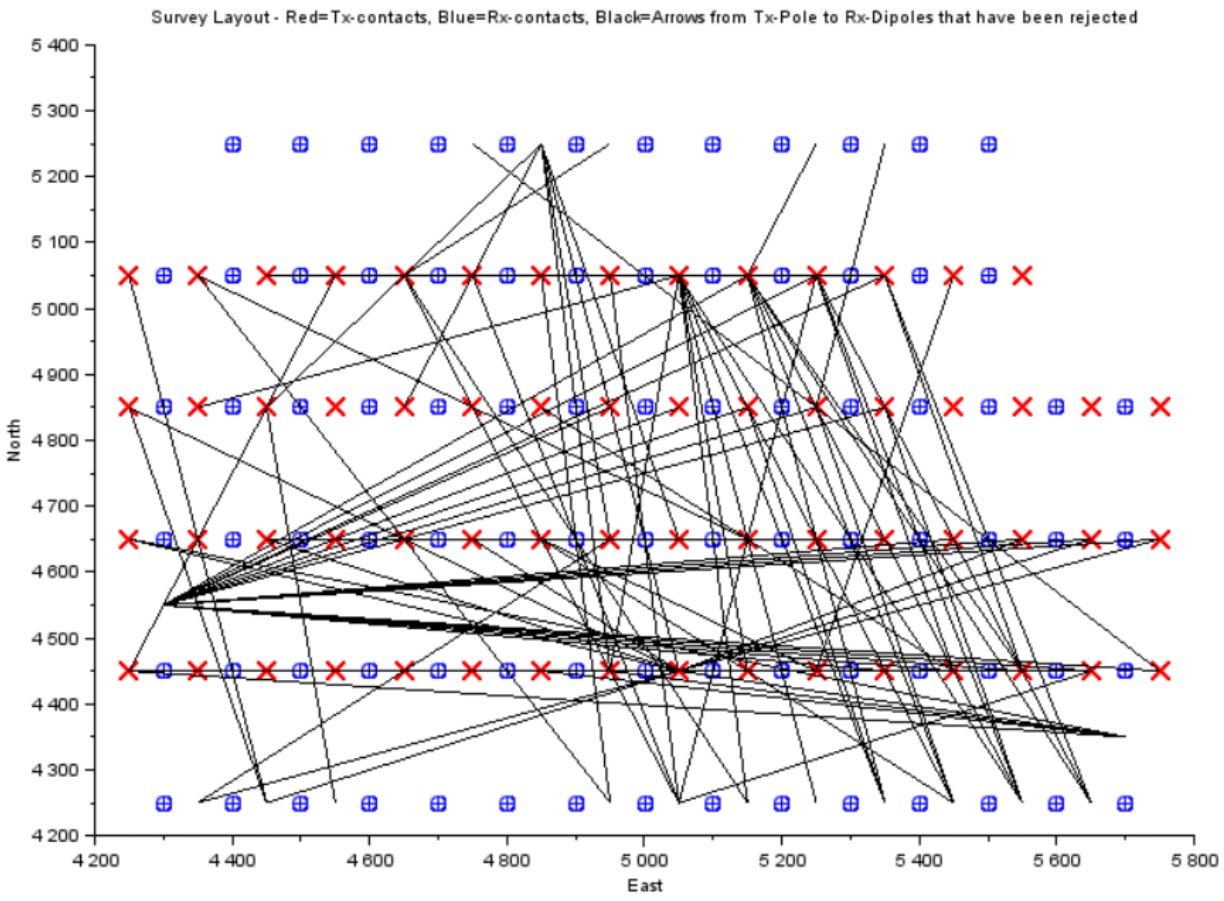
For Chargeability (95% of data < 0.5ms error)



Removal of data with large errors

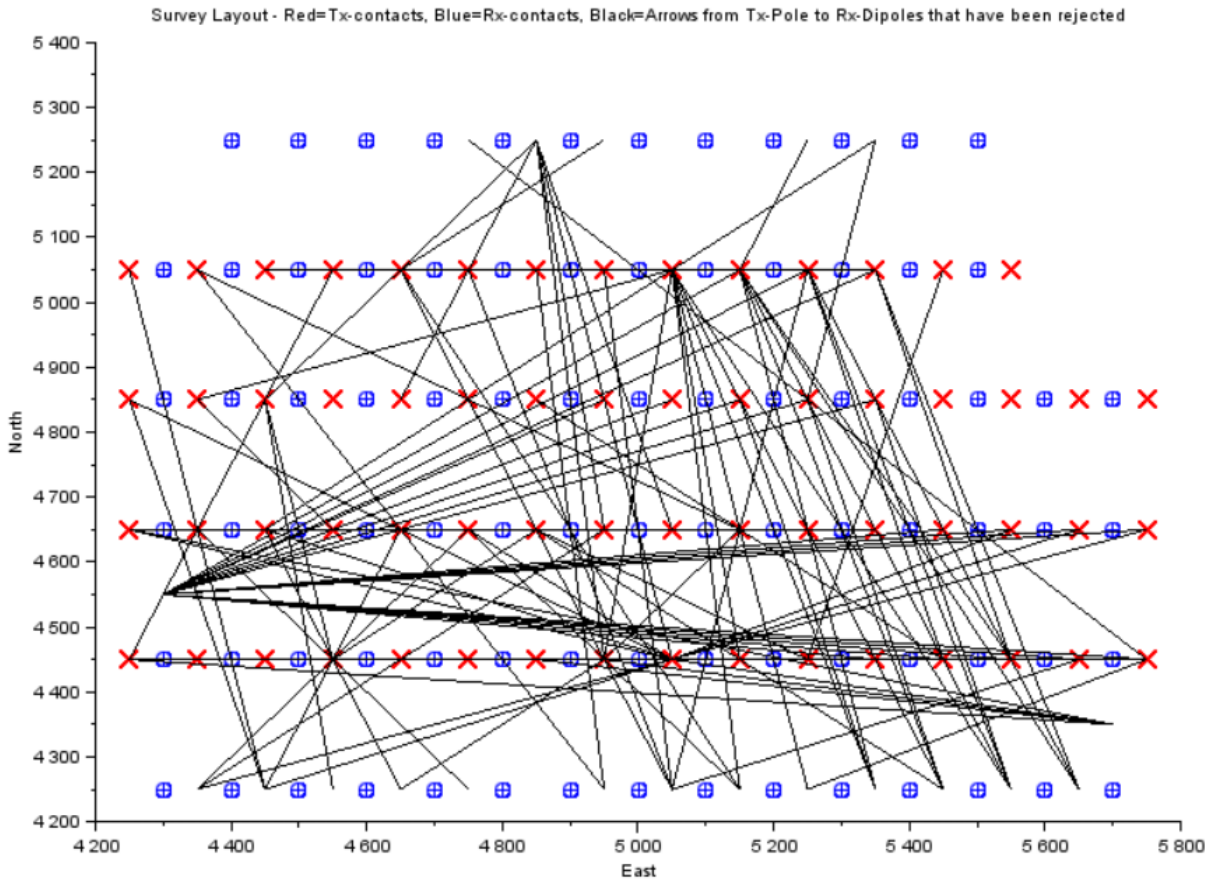
Removal of data with ARerr > 3% (0.1% of the data) or IPerr > 2.5ms (0.5% of the data)

- resulted in the removal of just 158 of the total of 10510 data points in the DAT file.
- These correspond to the following Tx-Rx “traces”. Some Rx-dipoles are seen to show poorer quality data perhaps due to poor contacts.

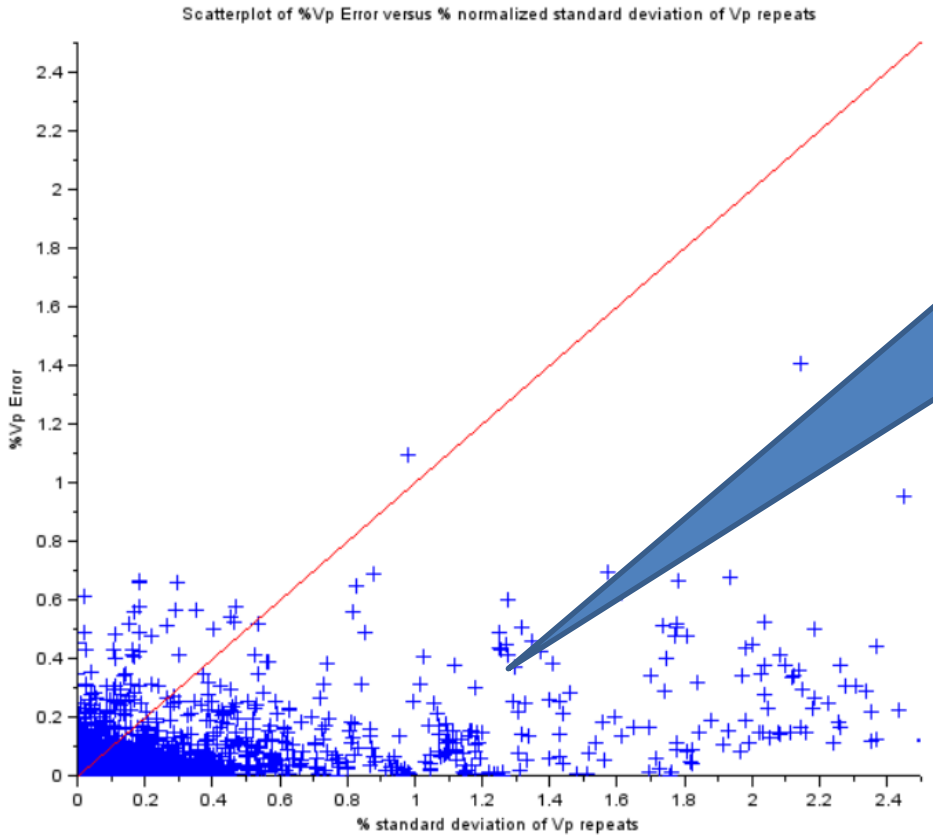


Removal of unusually noisy stacks from multiple repeats

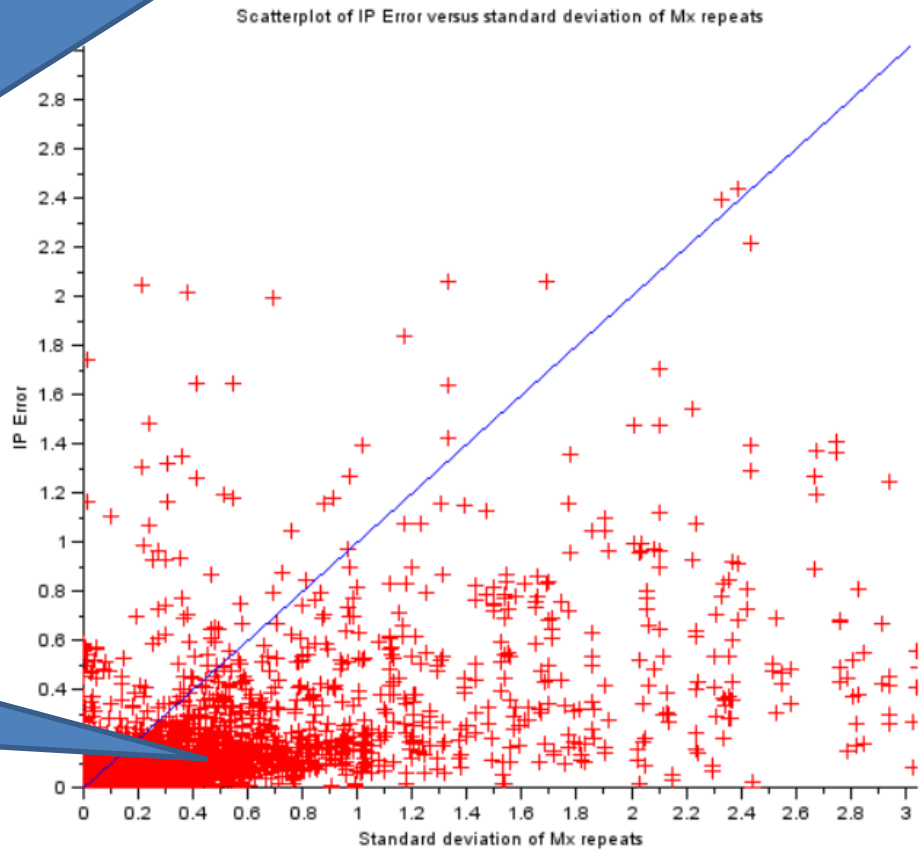
Removal of stacks of data which has an error greater than 10-times the median error of its associated set of repeat stacks. This removes unusually noisy stacks from repeated measurements although in practise it only removes 32 additional data points from this dataset.



Intra-stack versus Inter-stack errors



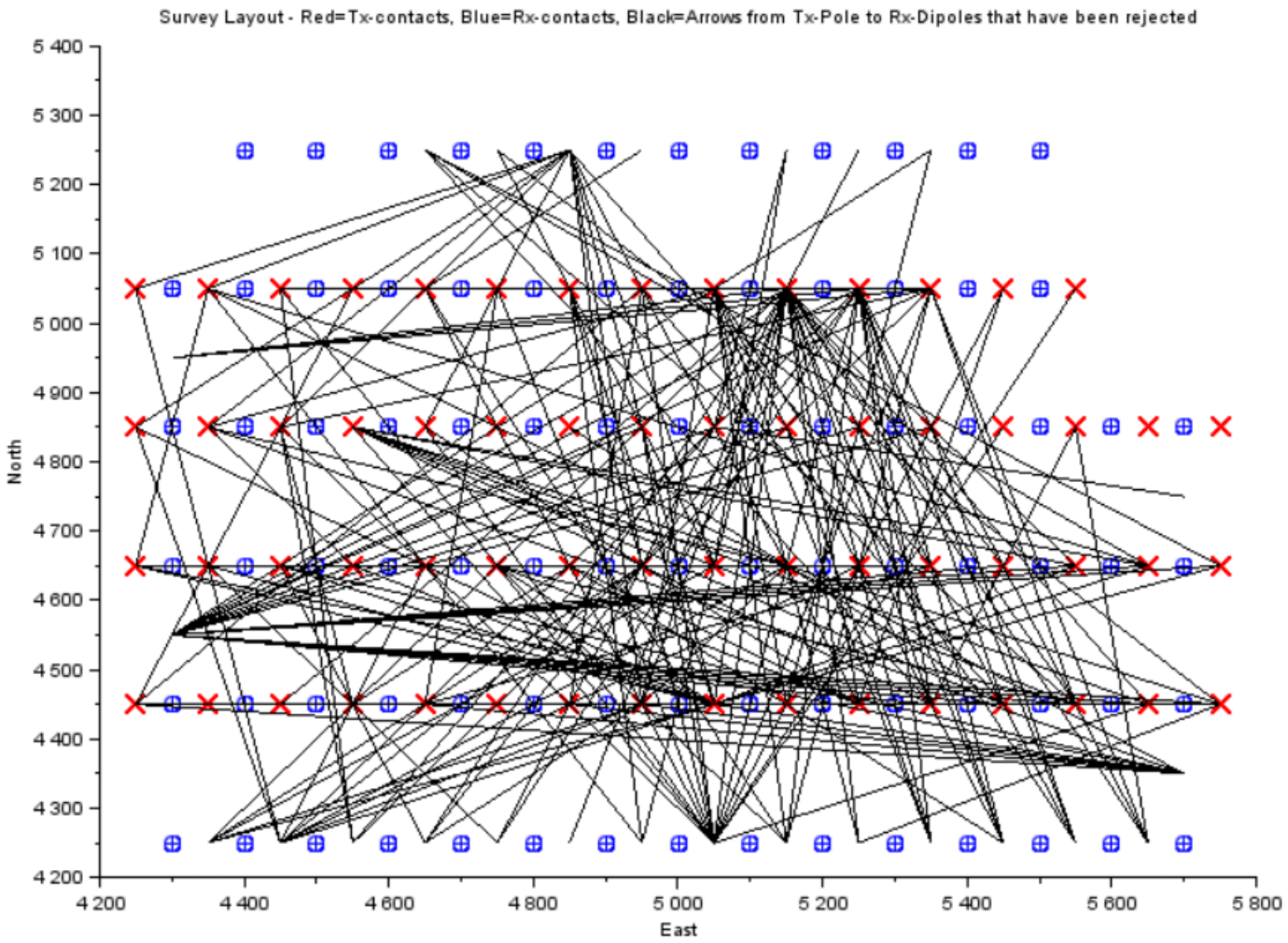
The majority of data points lie beneath the line which represents equal intra- and inter-stack errors for App.Resistivity



Again, the majority of data points lie beneath the line which represents equal intra- and inter-stack errors for Chargeability. A point beneath this line means that the error indicated by the value assigned to that point is less than the standard deviation of the repeats of that measurement.

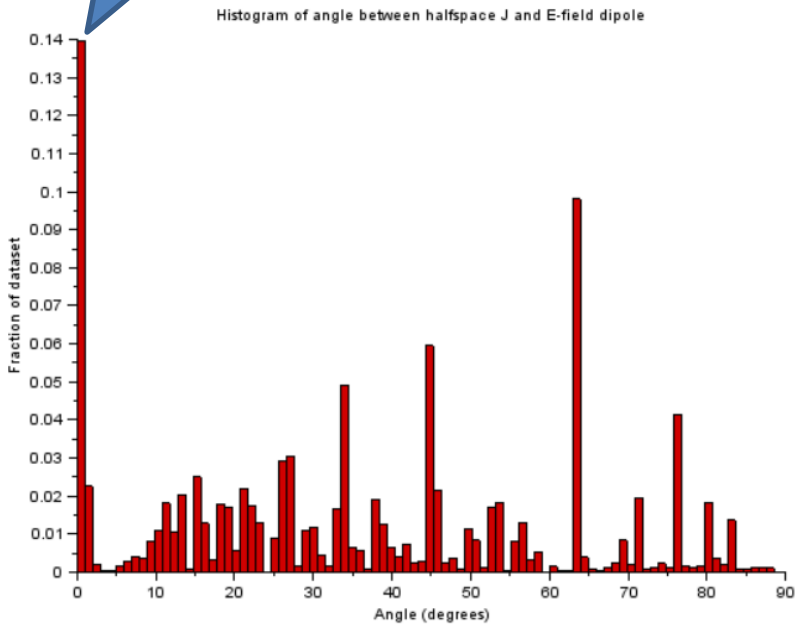
Removal of data on the basis of inter-stack statistics

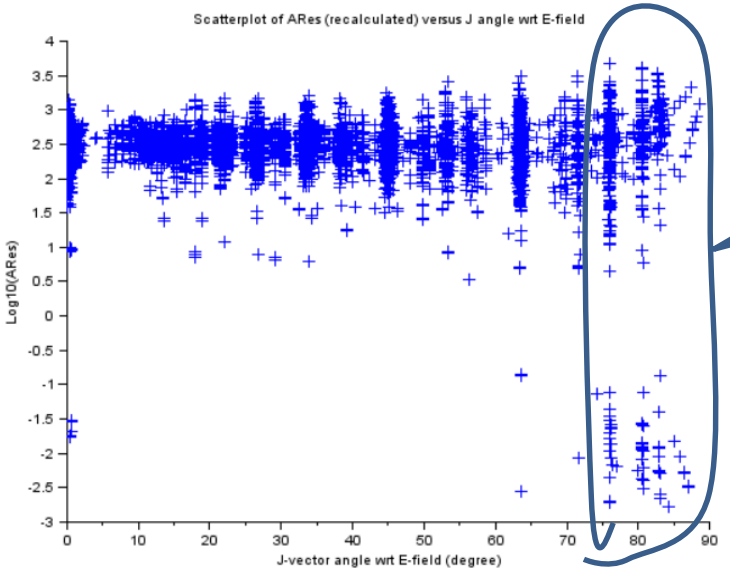
Removal of data whose repeats have a standard deviation >3% for App.Resistivity or 2.5ms for Chargeability resulted in the removal of 260 additional data points leaving 10009 data points



1st quadrant azimuth difference (angle of incidence) between J-vector and E-field dipoles

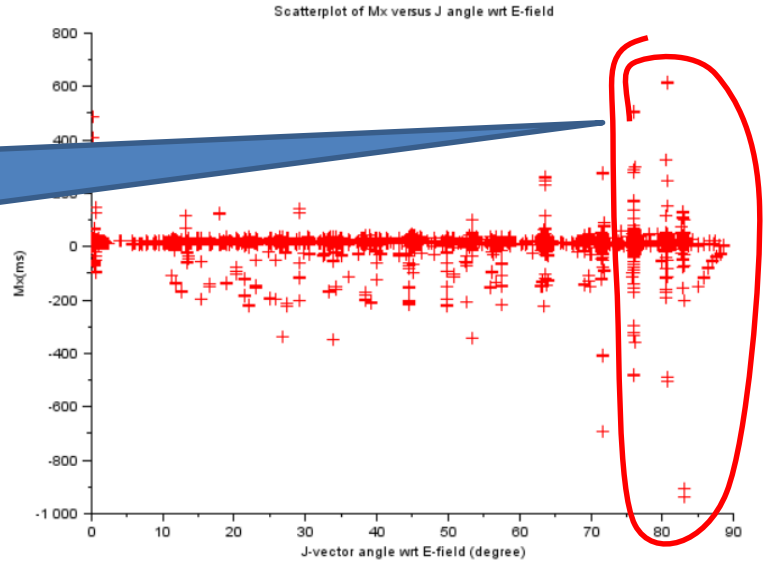
About 14% of data points have “collinear” Tx-pole and Rx-dipole (on one line)
Only approx. Because the J-field azimuth uses the “infinite” Tx which is not really infinitely distant





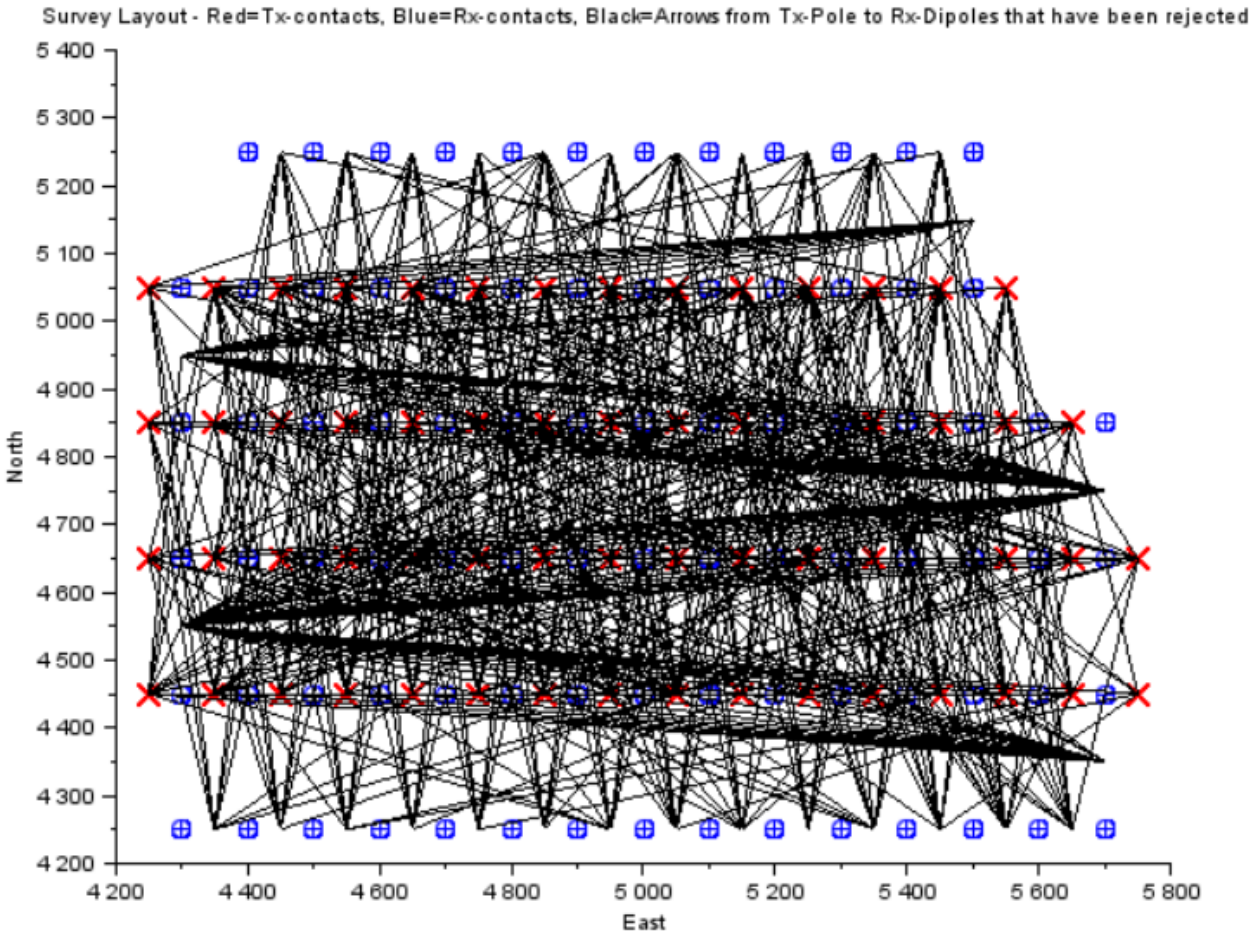
Above 75° angle of incidence between J and E-field dipole the spread of App. Resistivity values increases notably

Above 75° angle of incidence between J and E-field dipole the spread of Chargeability values increases dramatically



Removal of (near) null-coupled E-field data

Removal of data with angle of incidence of J to E-field dipole >75° results in removal of 875 data points leaving 9134 data points



Median Averaging of repeats

Median average repeat readings to give 4143 datapoints (unique Tx-Rx geometries)

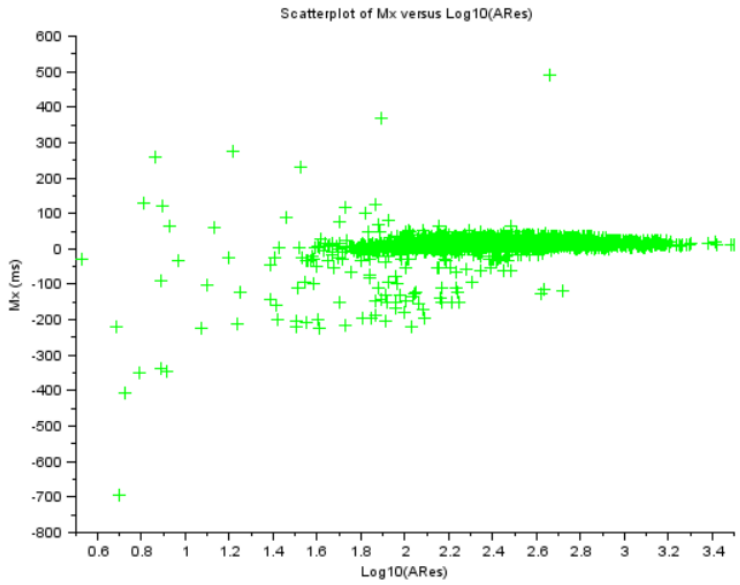
Min ARes = -355Ωm
Max Ares = 3162Ωm
Median Ares = 282Ωm

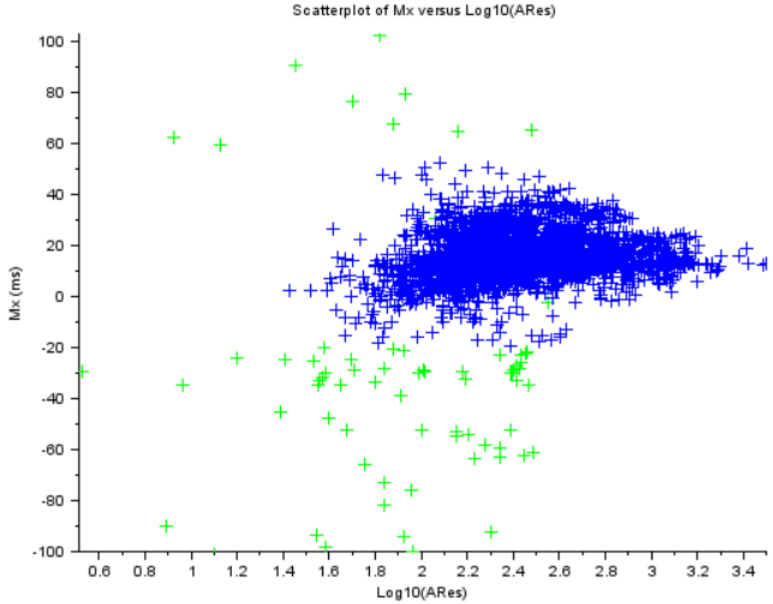
Min Chg= -693ms
Max Chg= 489ms
Median Chg = 14ms

After removal of all (6) negative apparent resistivity data, we are left with 4137 data points.

Then remove all (127) chargeability values either <-20 or >60ms.

Leaving 4010 data points

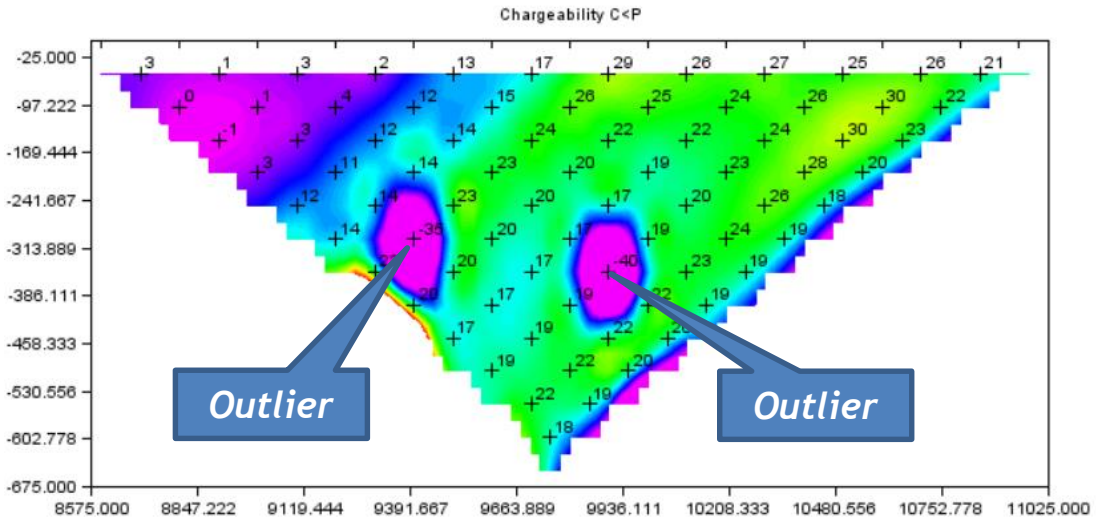


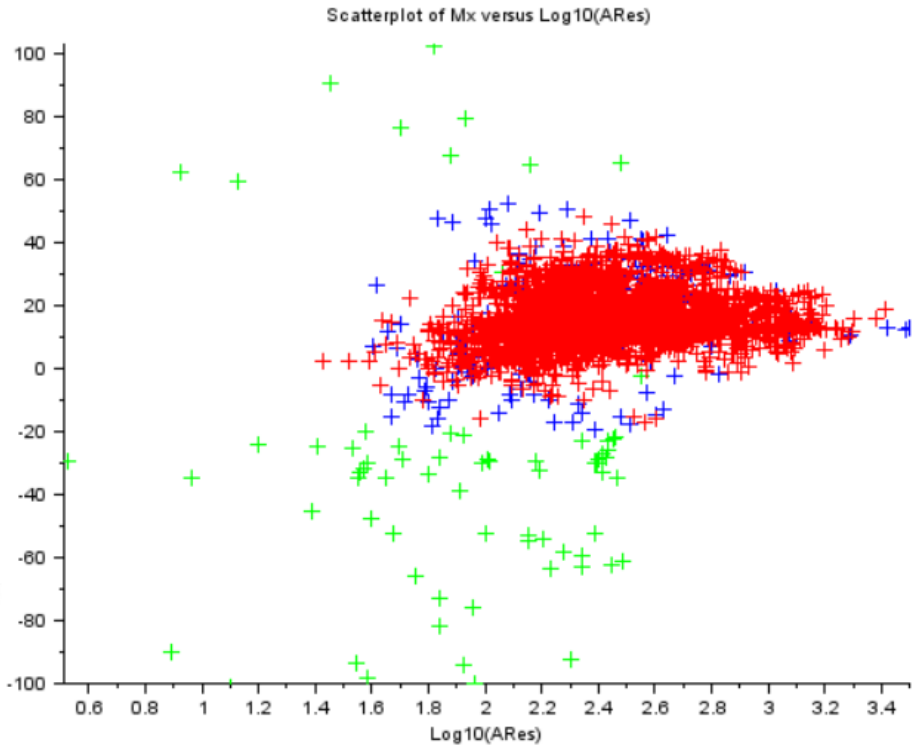


Removal of outliers in spatial sense

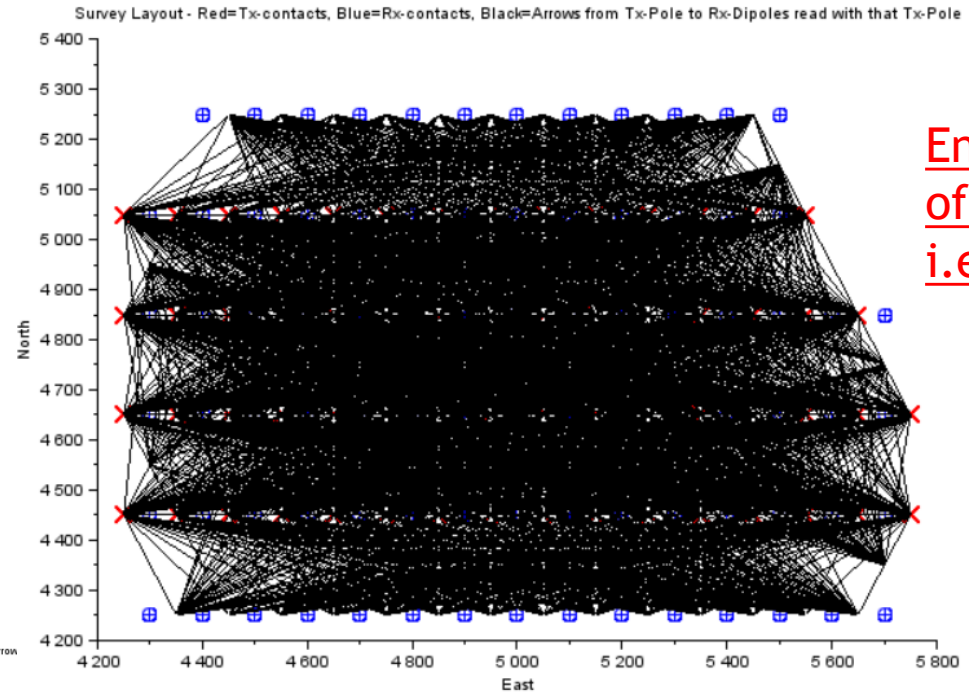
Removal of App.Resistivity and/or Chargeability values which are outliers (1.5 times the interquartile range) within groupings of 10 data points which most closely plot together in 3D pseudo-space (like a pseudosection but in 3D with aerial location weighted toward the receiver dipole to better represent the sensitivity of a Pole-Dipole array)

This removed an additional 230 data points, leaving 3780 “valid” data points (red in figure below-right)



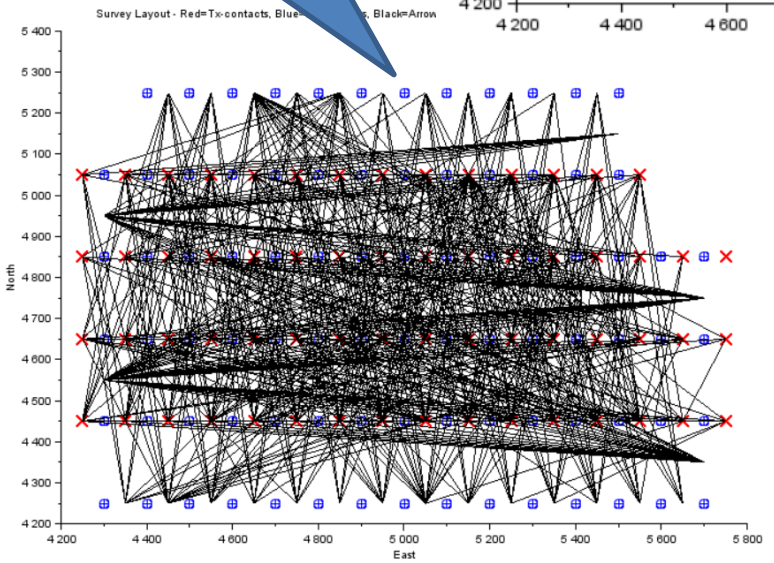


End result of semi-objective data editting

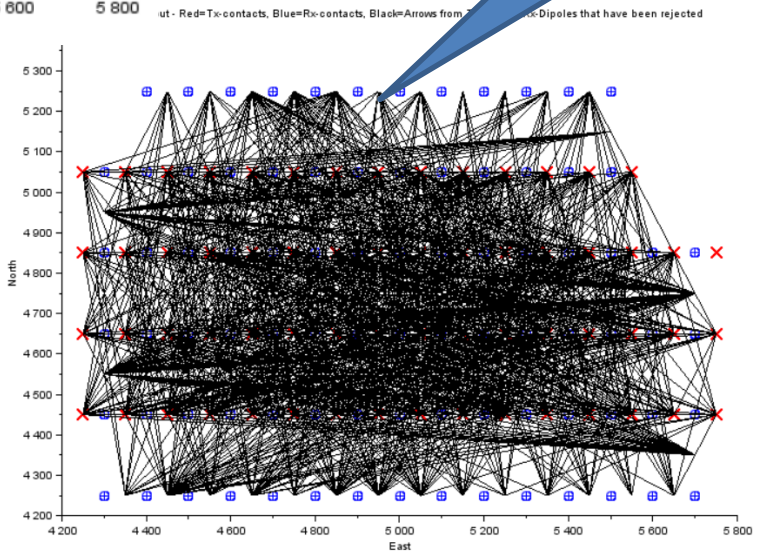


End result of editting was 3780 of a total of 4896 Tx-Rx pairs i.e. removal of 23% of the data.

Removed Tx-Rx traces for App. Resisivity

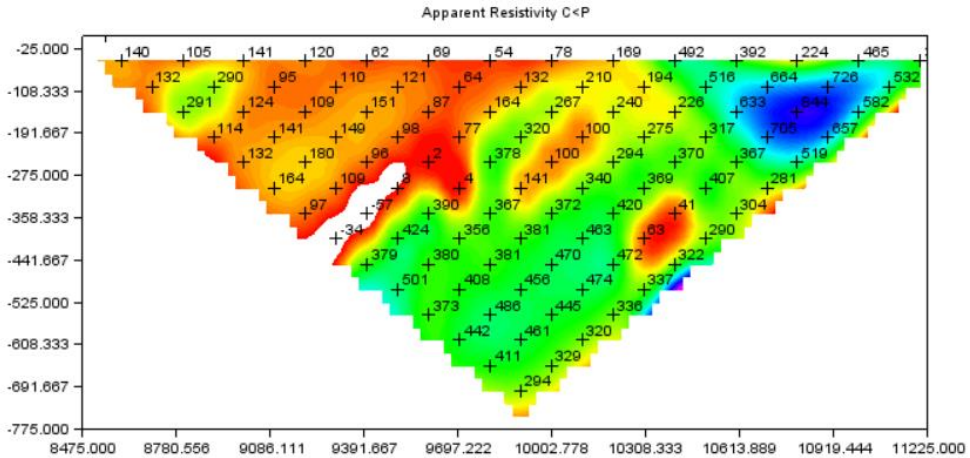


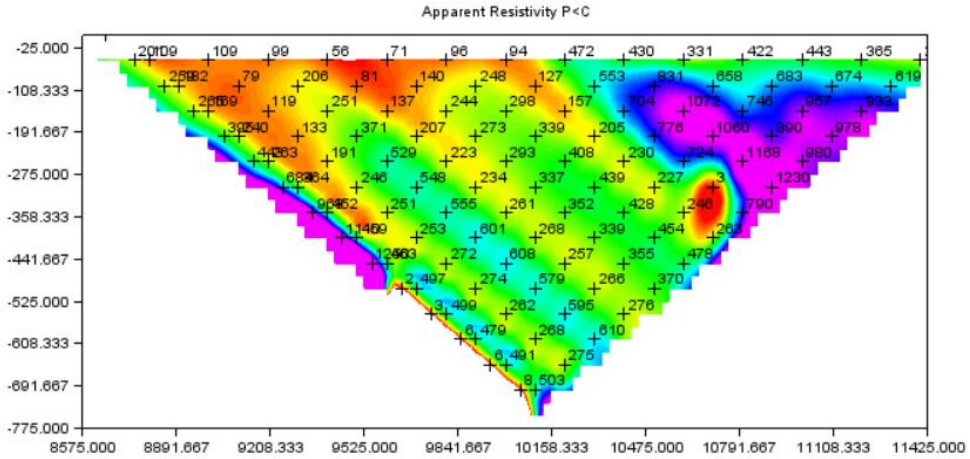
Removed Tx-Rx traces for Chargeability



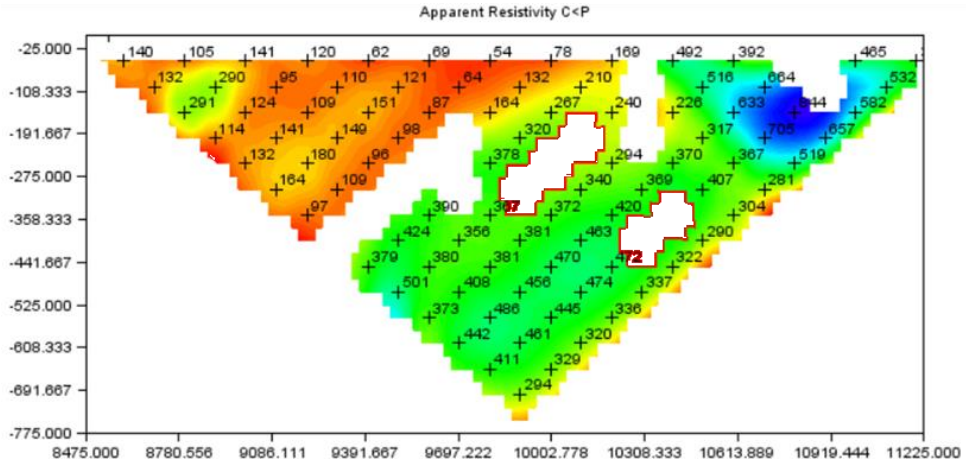
Before and after semi-objective editting
Tx=4450 Rx=4450
Apparent Resistivity Pseudosections

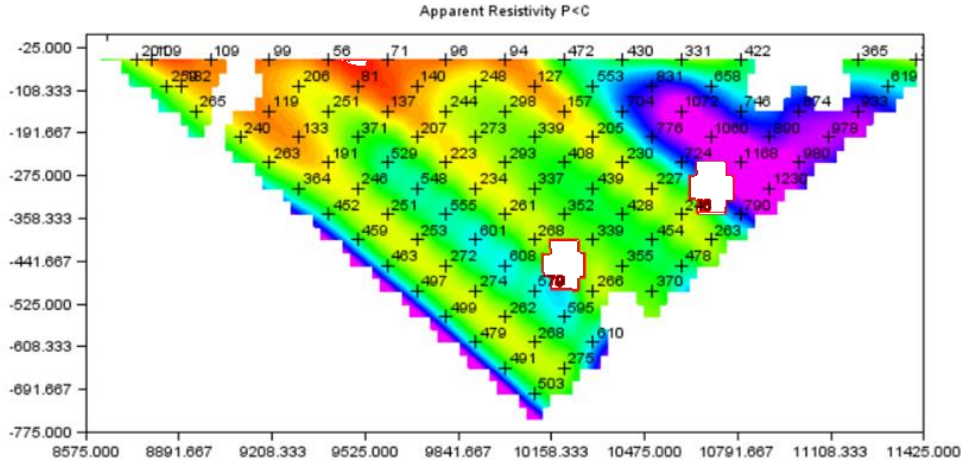
Raw data





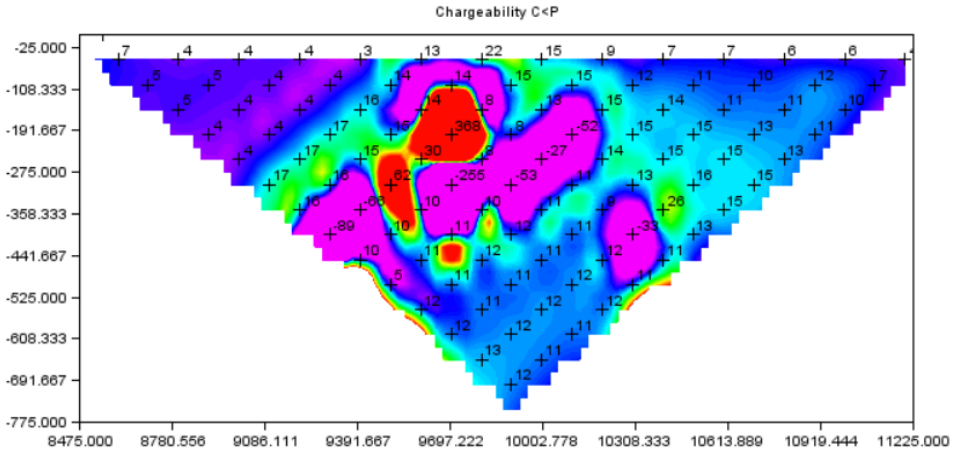
Editted data

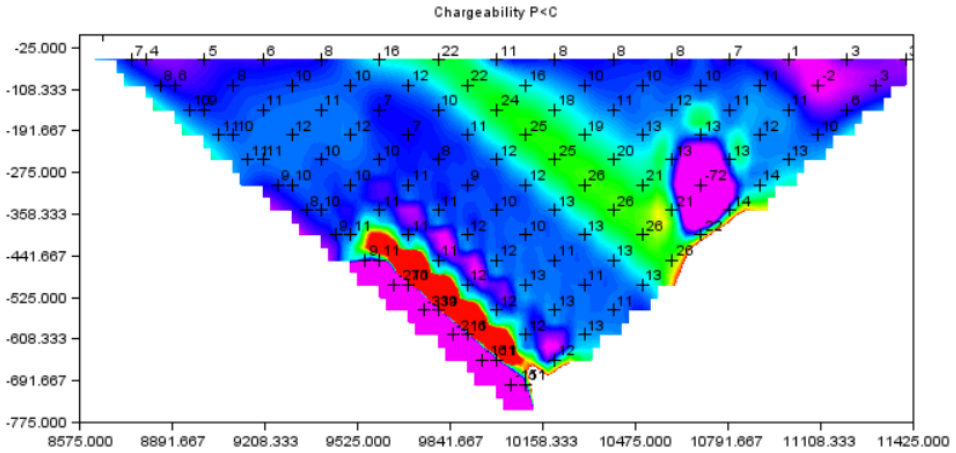




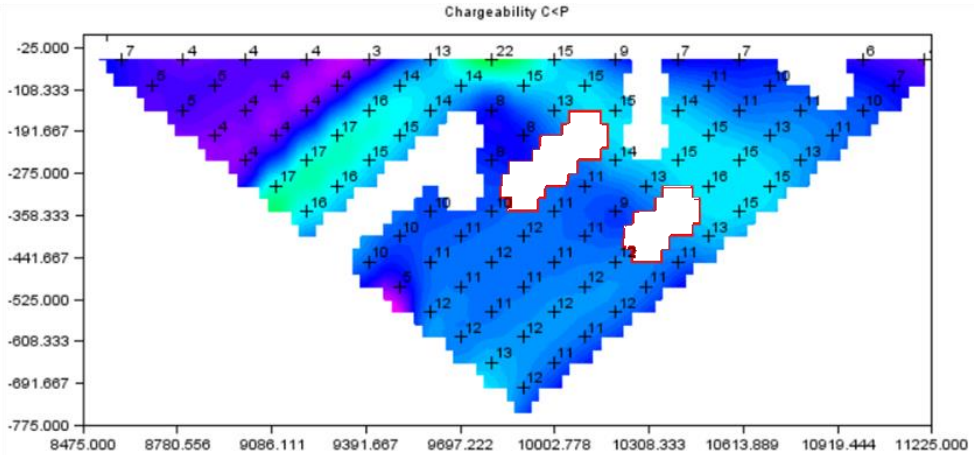
Before and after semi-objective editting
Tx=4450 Rx=4450
Chargeability Pseudosections

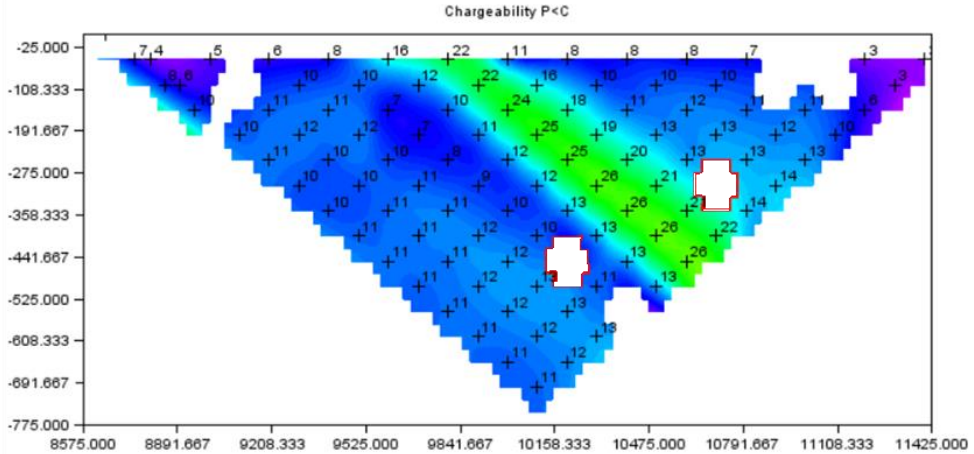
Raw data





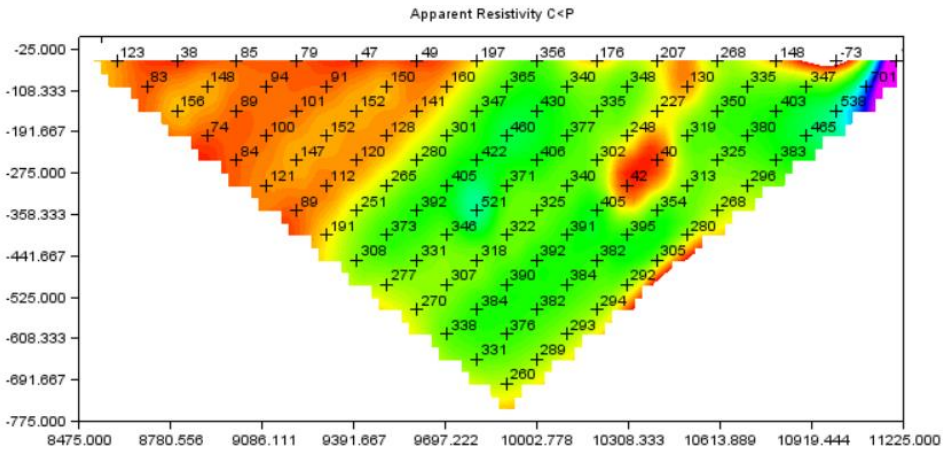
Editted data

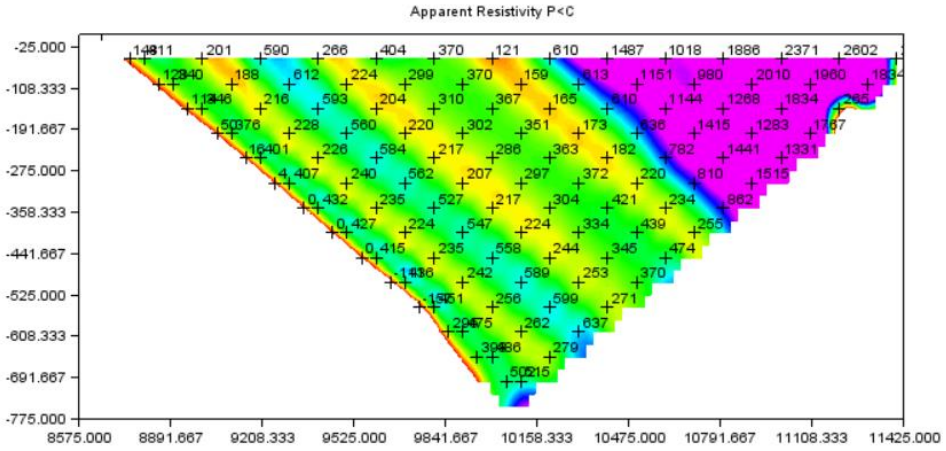




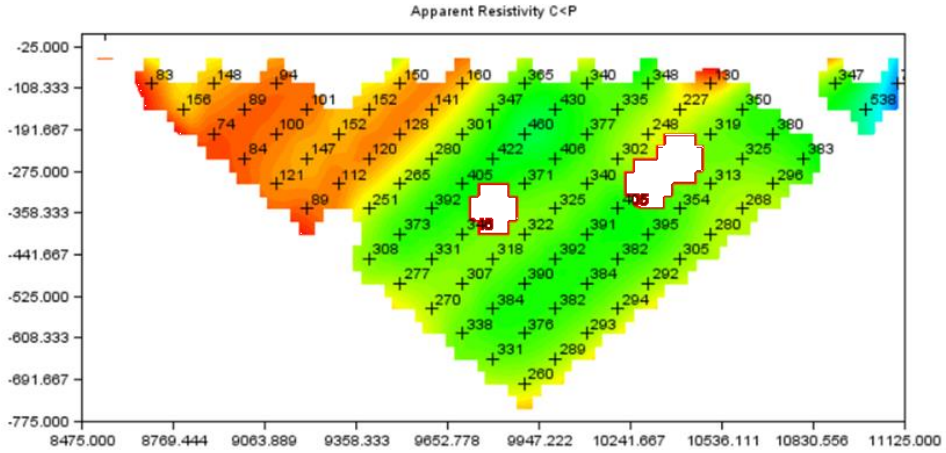
Before and after semi-objective editting
Tx=4850 Rx=4450
Apparent Resistivity Pseudosections

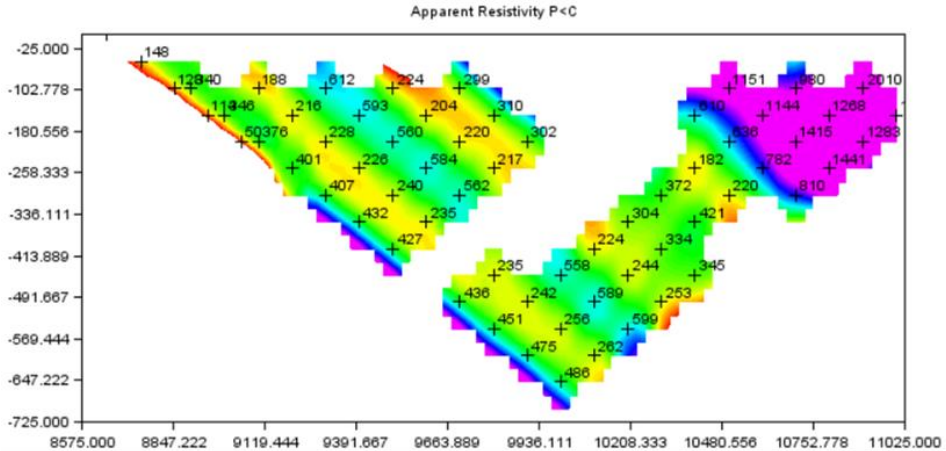
Raw data





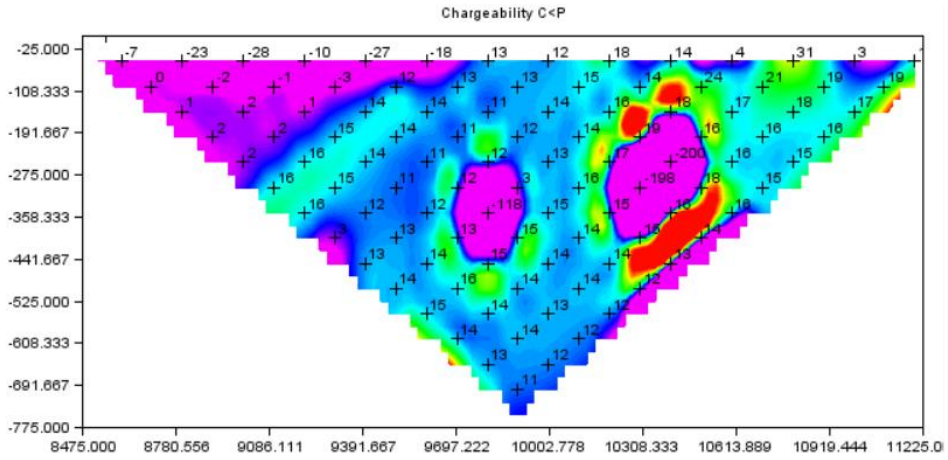
Editted data



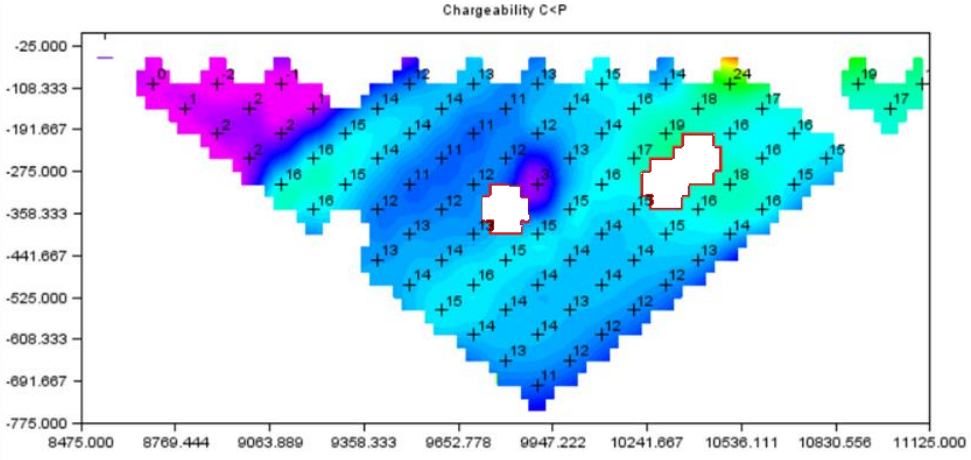


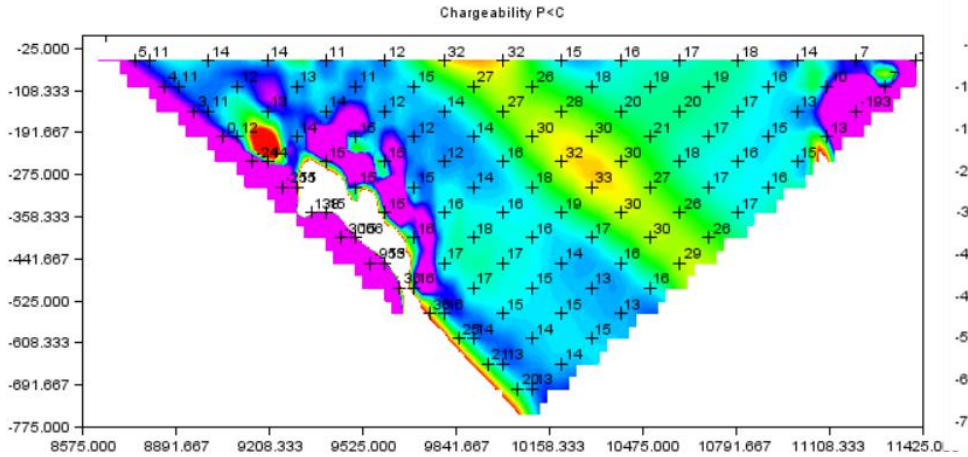
Before and after semi-objective editting
Tx=4850 Rx=4450
Chargeability Pseudosections

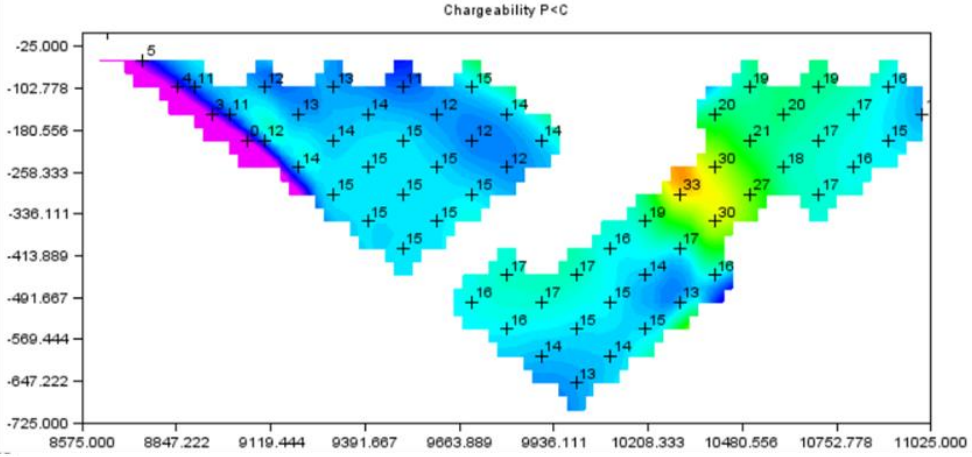
Raw data



Editted data







RES3DINV - 3D Inversion

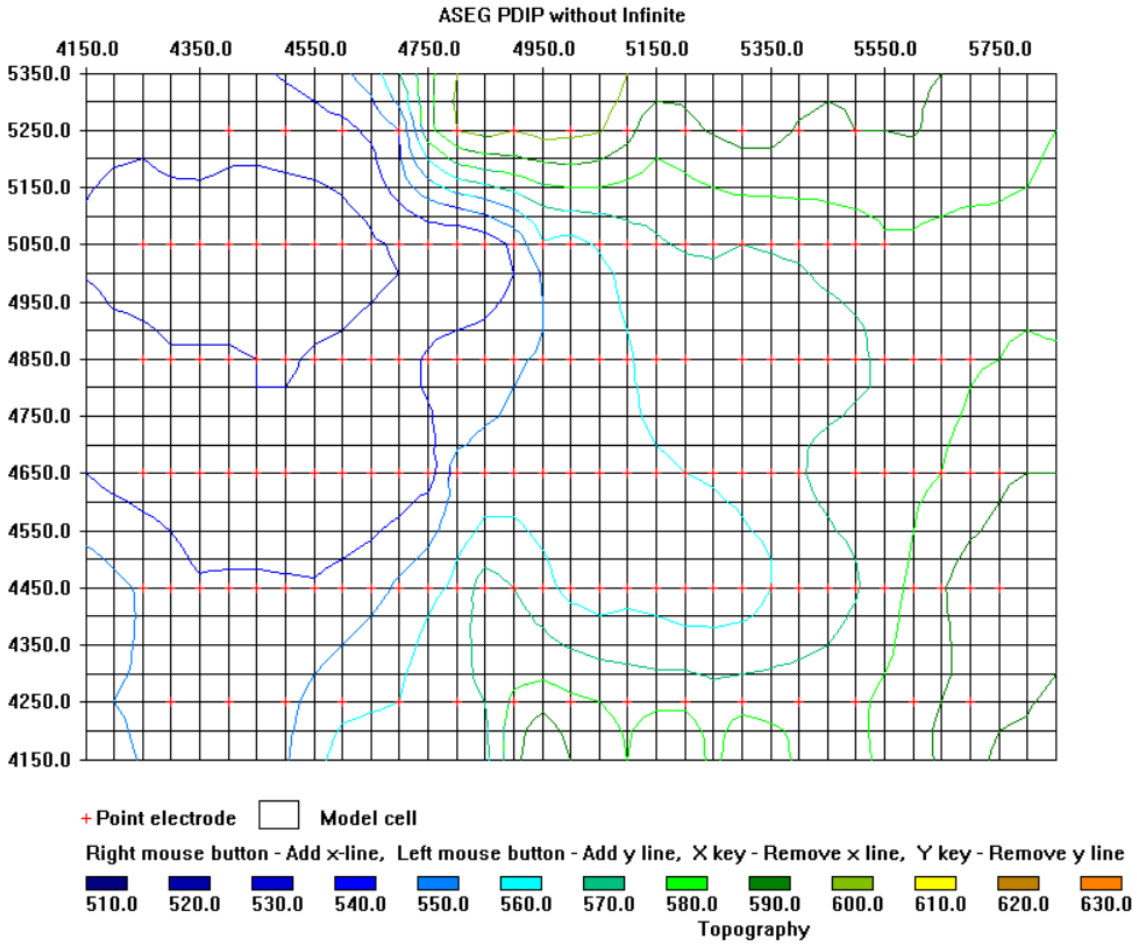
11 layers in model with a 50m x 50m mesh of model cells for a total of 8976 model blocks, with 4 nodes between electrodes

Inversion Parameters

Minimum and maximum depths of investigation are 25.0 and 535.9
Number of layers is 11.
Depth of last layer is 456.83 to 547.86.
Number of model blocks is 8976.
Number of data points is 3662.

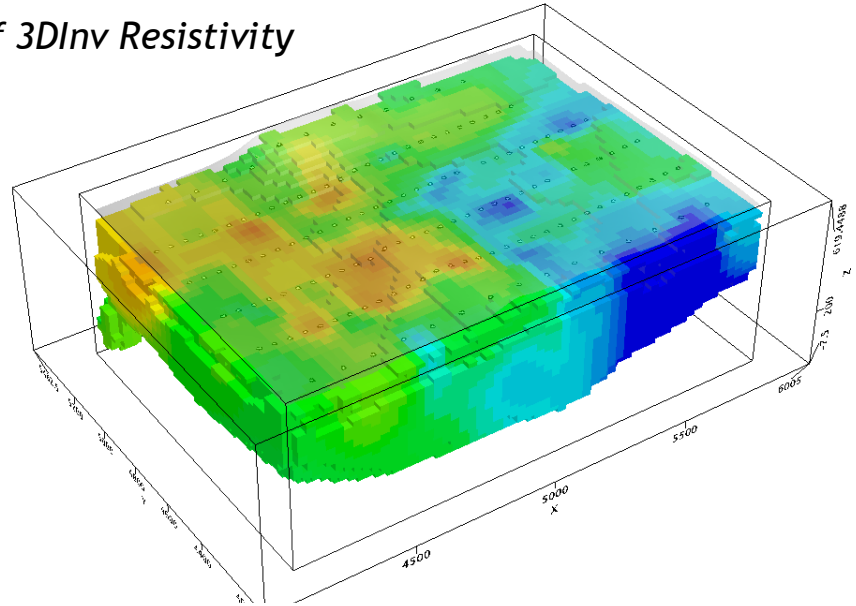
Modify depths to layers

Layer	New Depth	Present Depth	Layer	New Depth	Present Depth
1	22.5	22.5	21		None
2	48.4	48.4	22		None
3	78.1	78.1	23		None
4	112.4	112.4	24		None
5	151.7	151.7	25		None
6	197.0	197.0	26		None
7	249.0	249.0	27		None
8	308.9	308.9	28		None
9	377.7	377.7	29		None
10	456.8	456.8	30		None
11	547.9	547.9	31		None

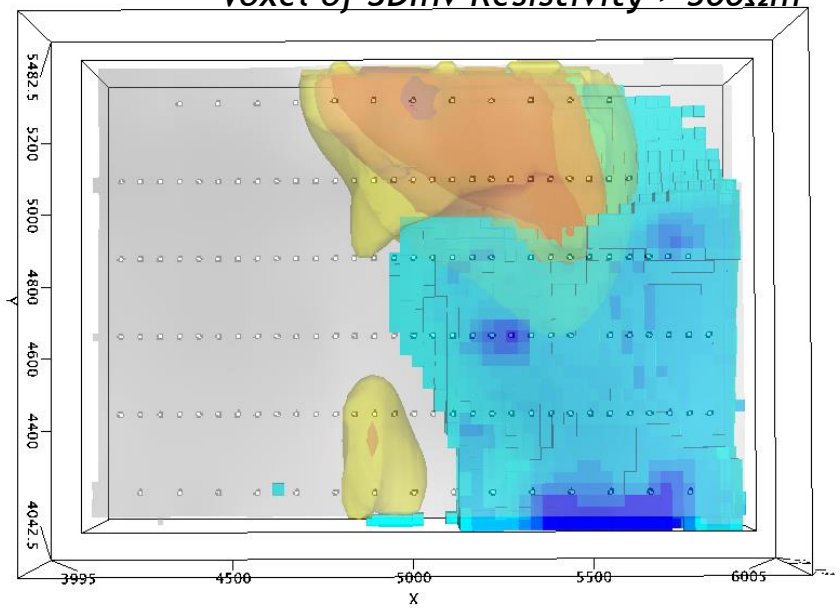


3D Inversion Model results

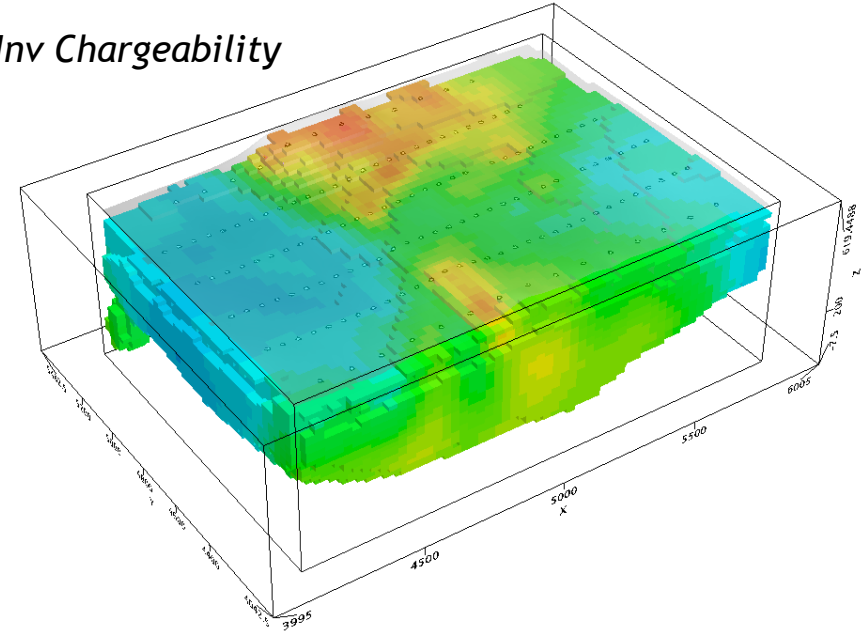
Voxel of 3DInv Resistivity



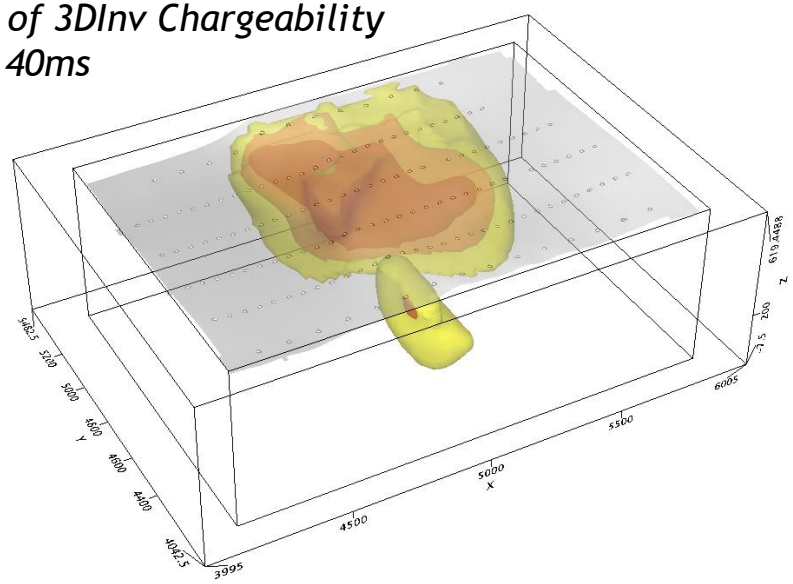
Voxel of 3DInv Resistivity > 500Ωm



Voxel of 3DInv Chargeability

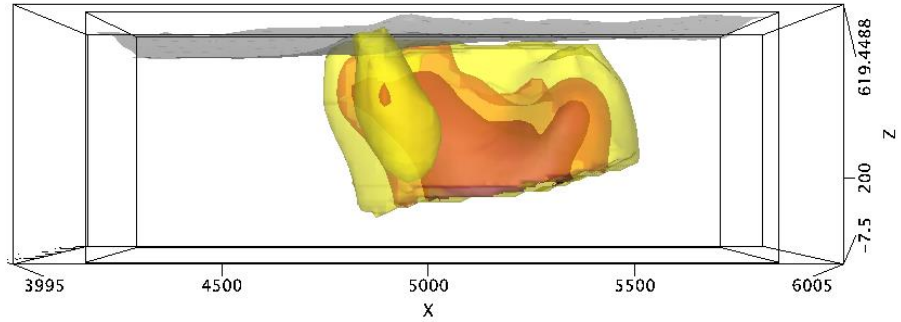


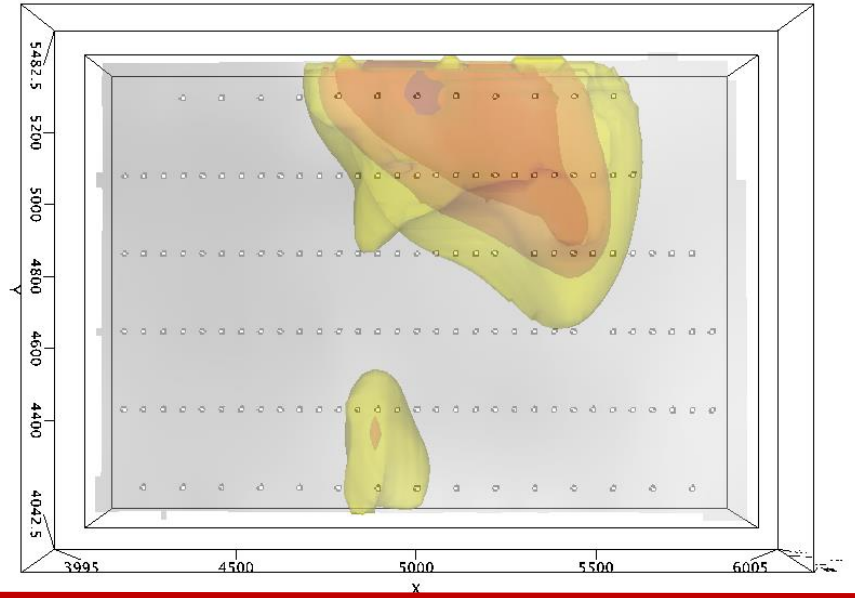
Iso-surfaces of 3DInv Chargeability @ 20, 30, & 40ms



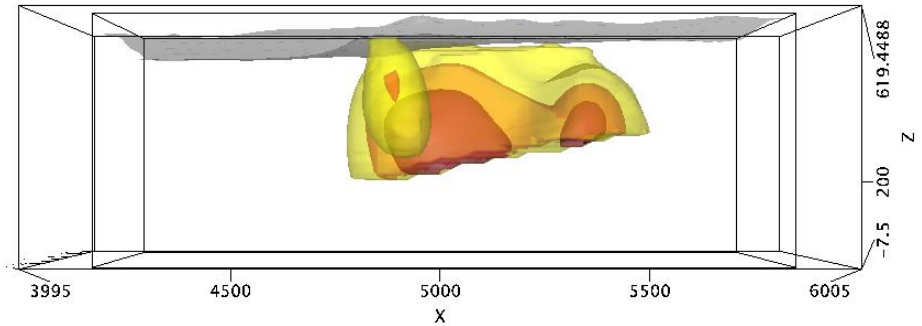
3D Inversion Model results

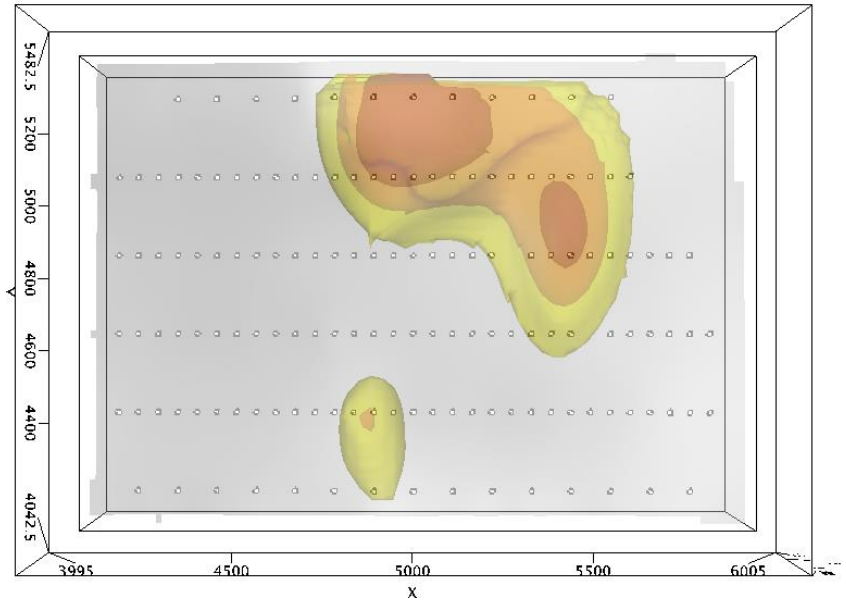
3DInv Chargeability isosurfaces at 20, 30, & 40ms
Using all accepted data (3780 Tx-Rx pairs)





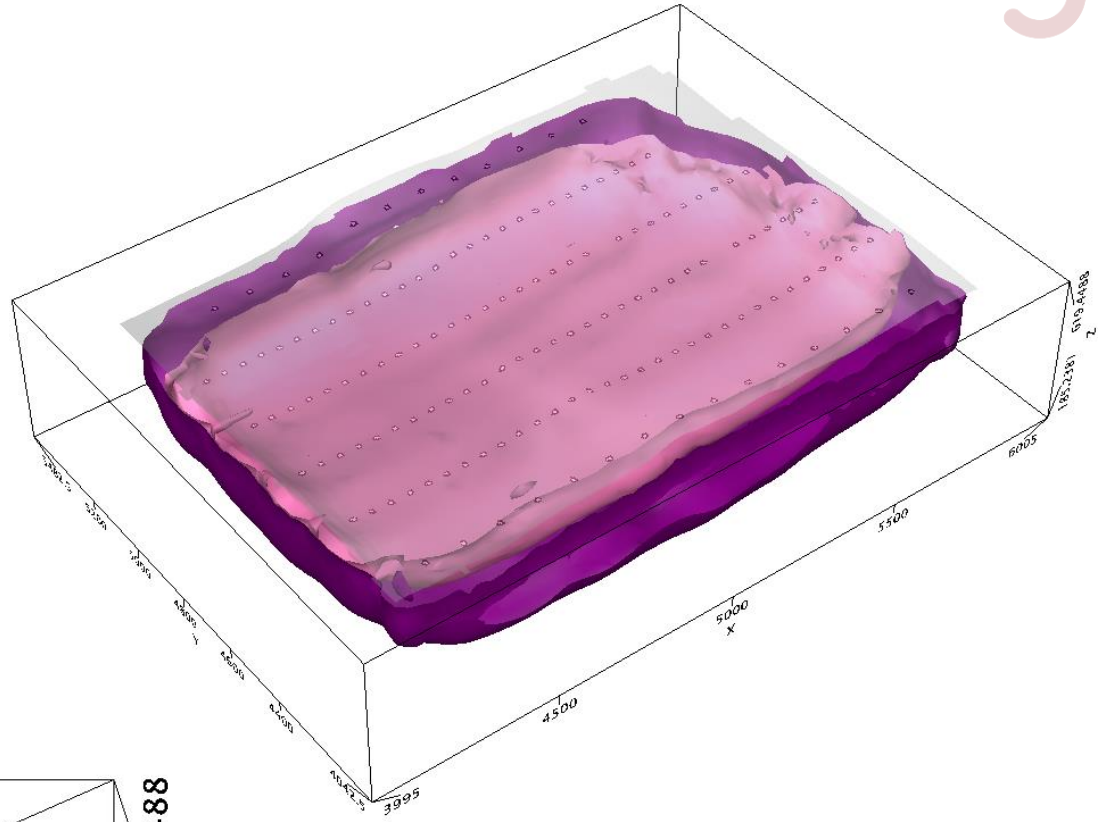
3DInv Chargeability isosurfaces at 20, 30, & 40ms
Using in-line (2D) data only (698 Tx-Rx pairs)



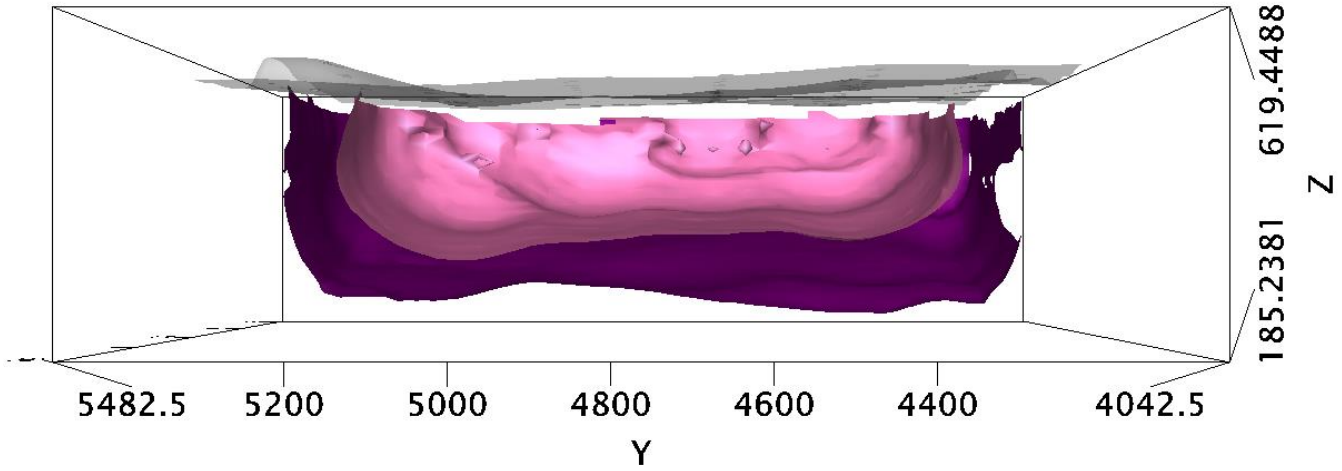


3D Inversion Model results

Isosurface of 3D inversion "Model Resolution / Volume Index" at a value of 5 for all accepted data (dark purple) and only in-line (2D) data (light magenta)

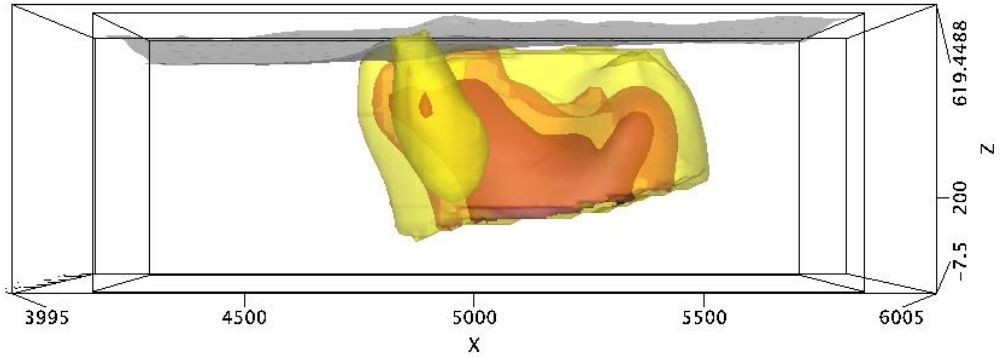


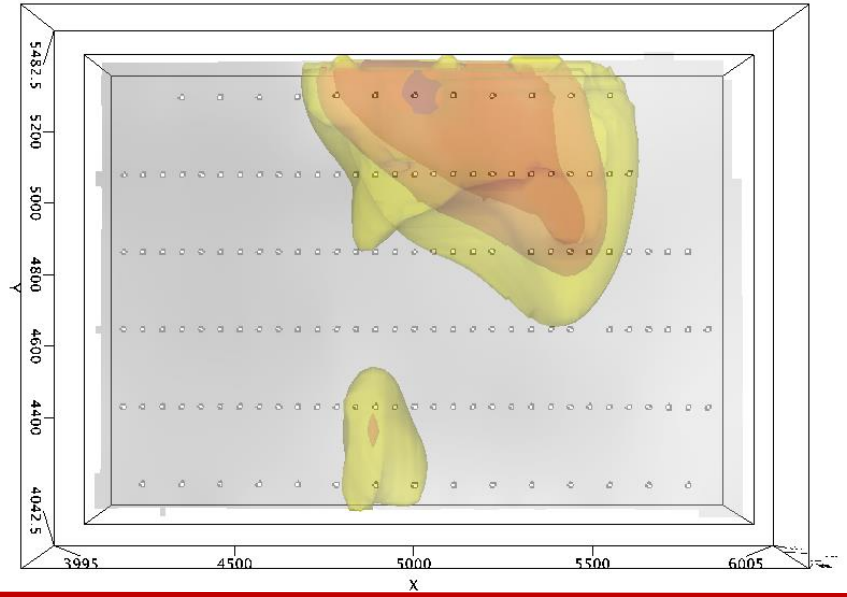
As above cut through at X=5000



3D Inversion Model results

3DInv Chargeability isosurfaces at 20, 30, & 40ms
Using all accepted data (3780 Tx-Rx pairs)





3DInv Chargeability isosurfaces at 20, 30, & 40ms
Using uneditted data (4896 Tx-Rx pairs)