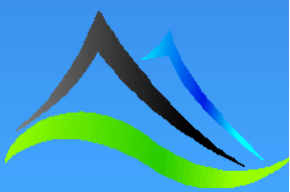
Introduction – The Effect of Dip

The following slides display the chargeability and resistivity results for the previously mentioned array designs on three manto-style mineralisation zones.

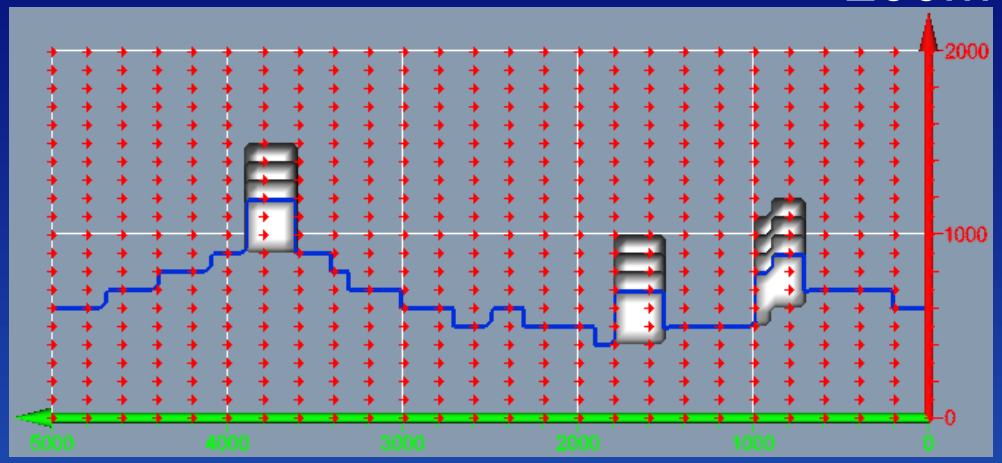
The top of the three zones have been kept in a constant horizontal position with a comparison of two different fault dip angles being made. These two dip angles are 80º and 70º.

Fault 80^{o} dip.

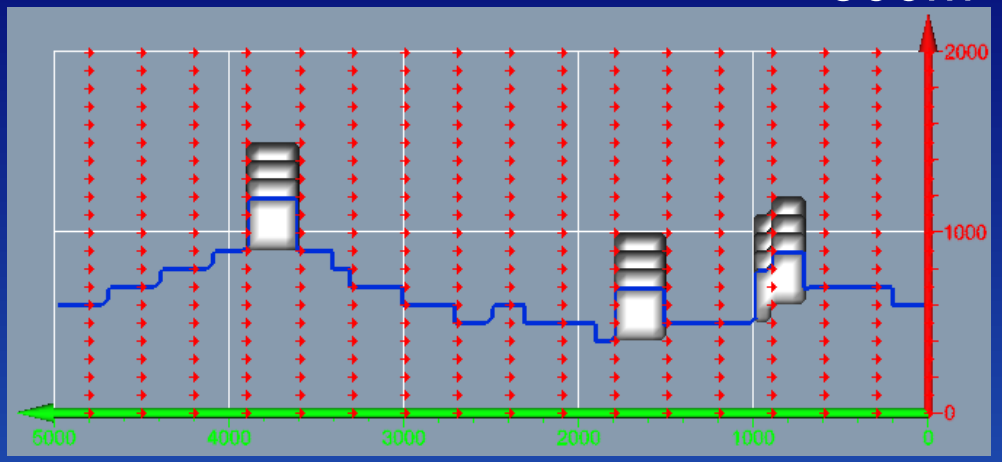


2D Dipole-Dipole with variable line spacing

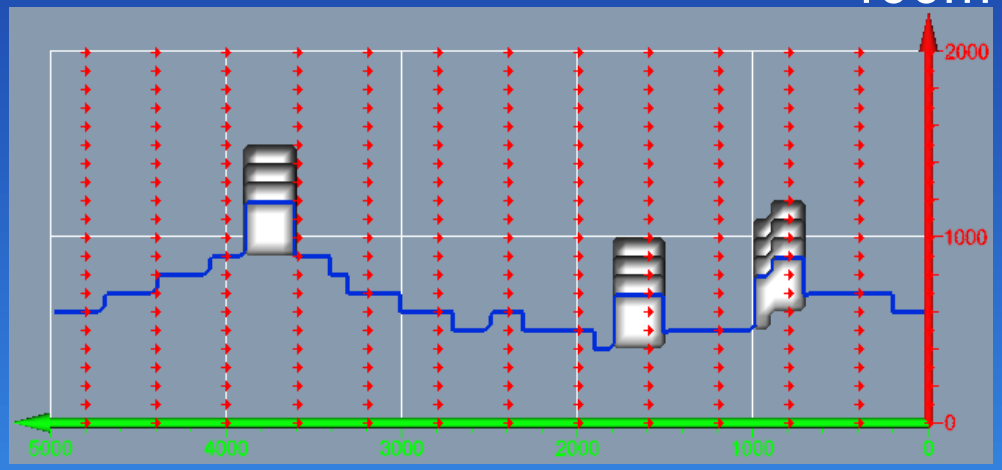
200m



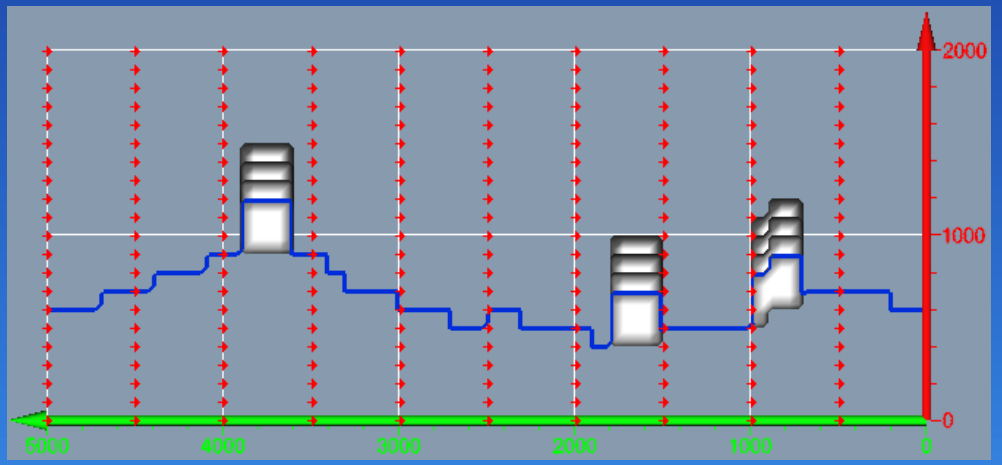
300m



400m



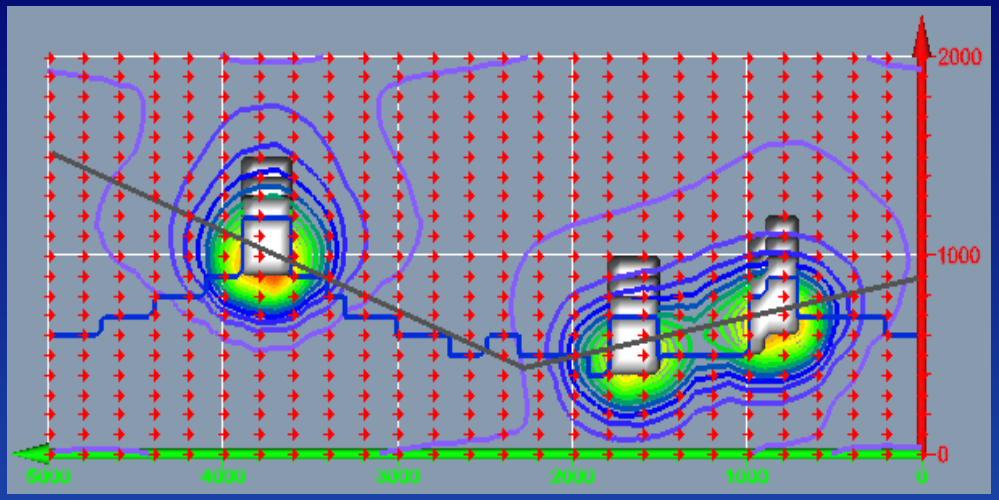
500m

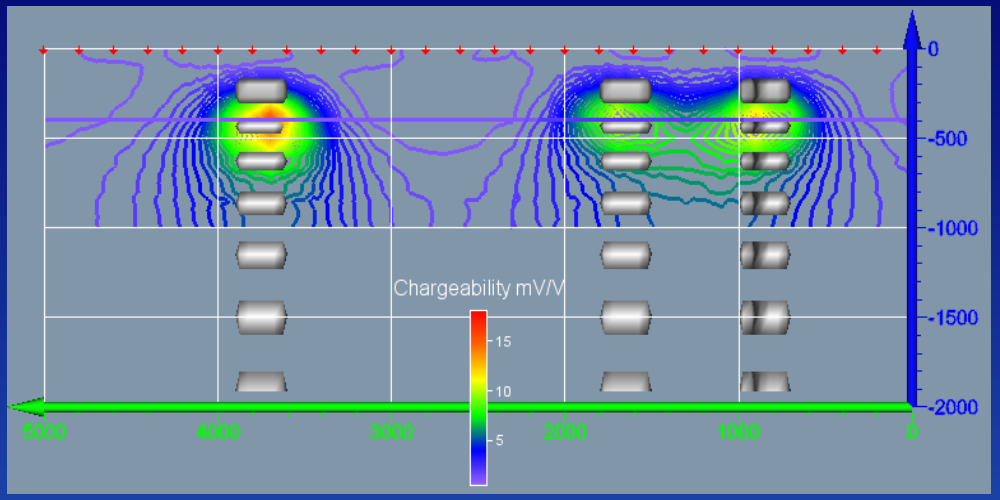


- 100m electrodes and 100m dipoles.
- 200m, 300m, 400m and 500m line spacing.
- Full line of 20 dipoles active each reading.

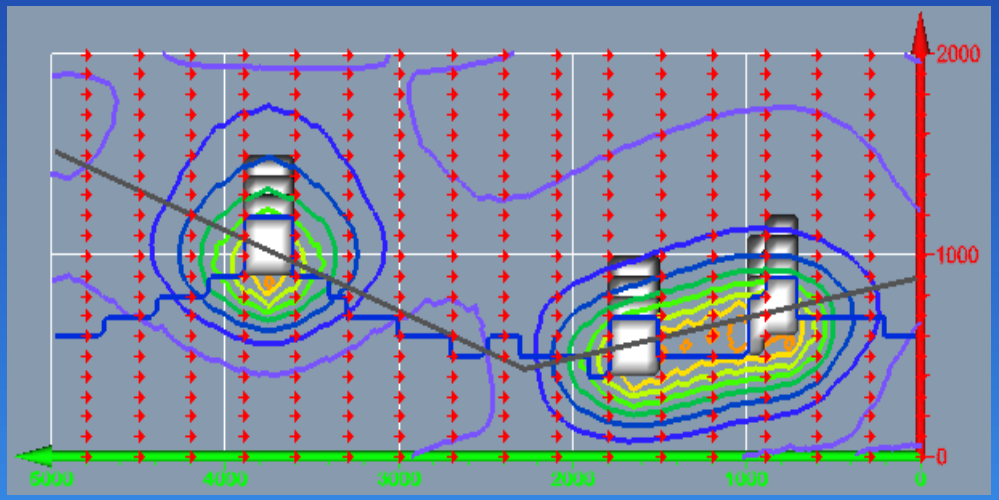
2DDD

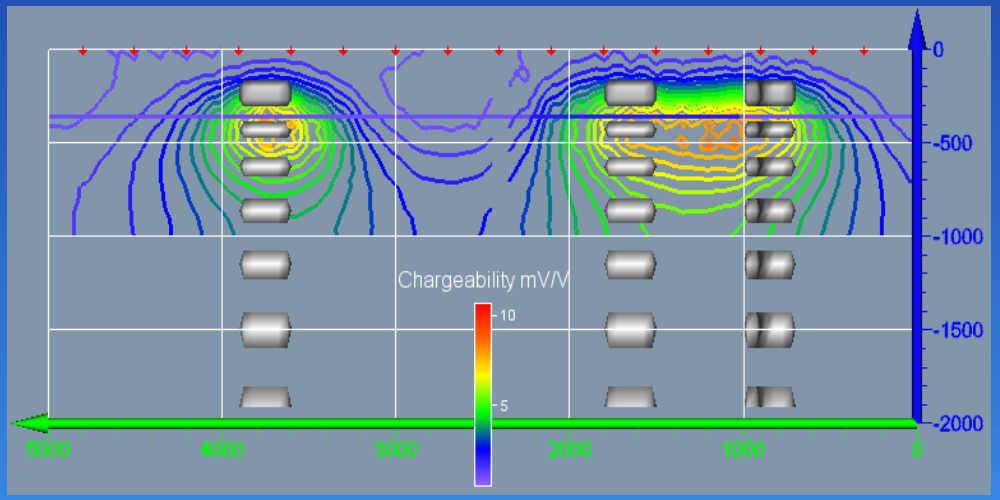
200m Chargeability





300m Chargeability



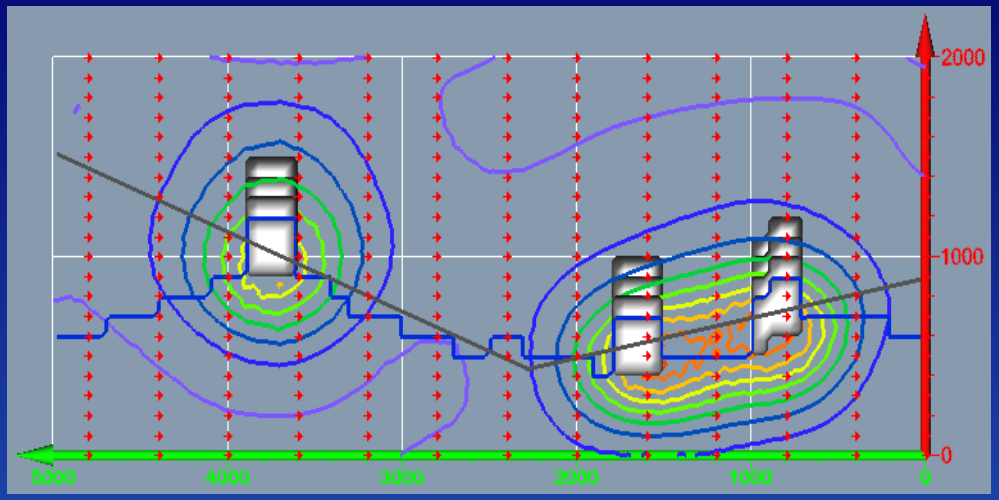


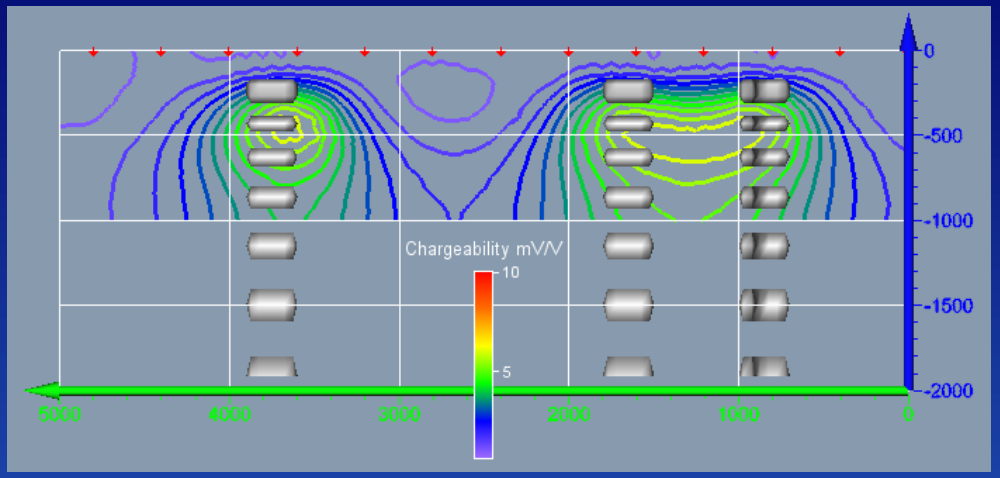
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

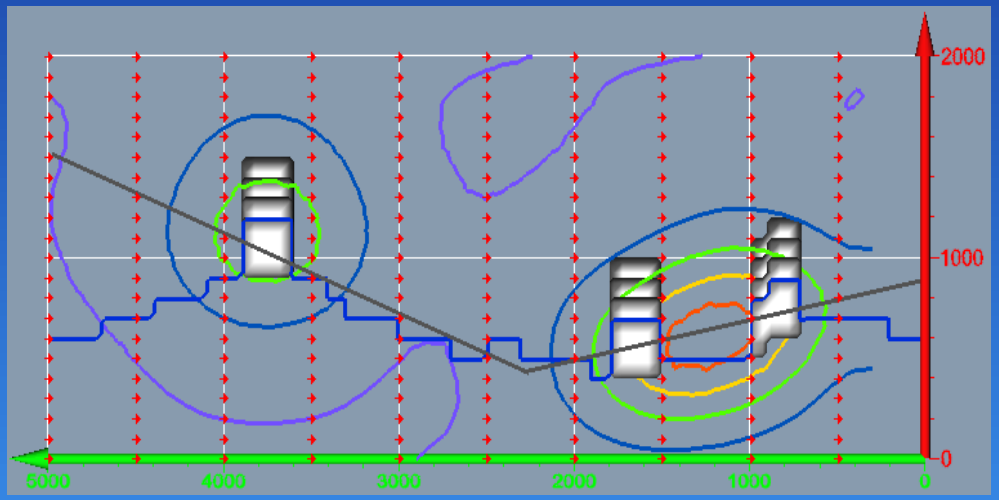
2DDD

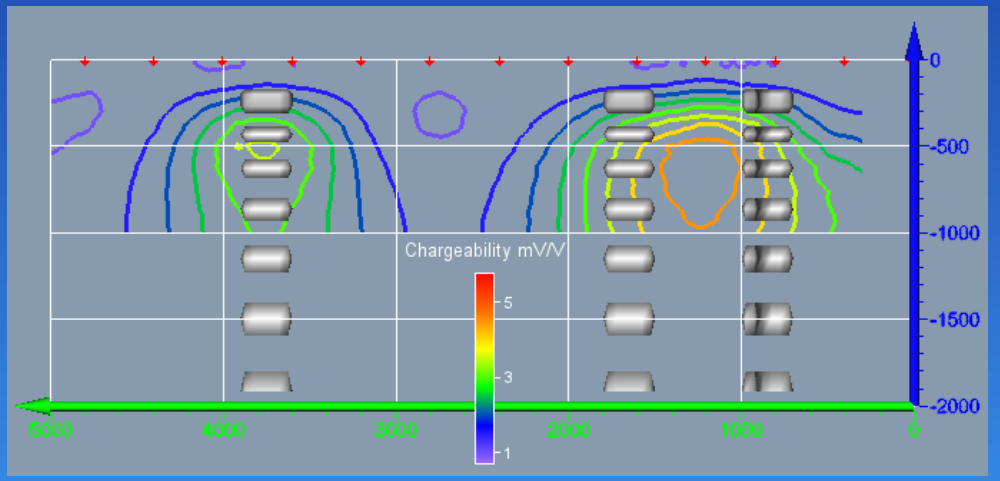
400m Chargeability





500m Chargeability



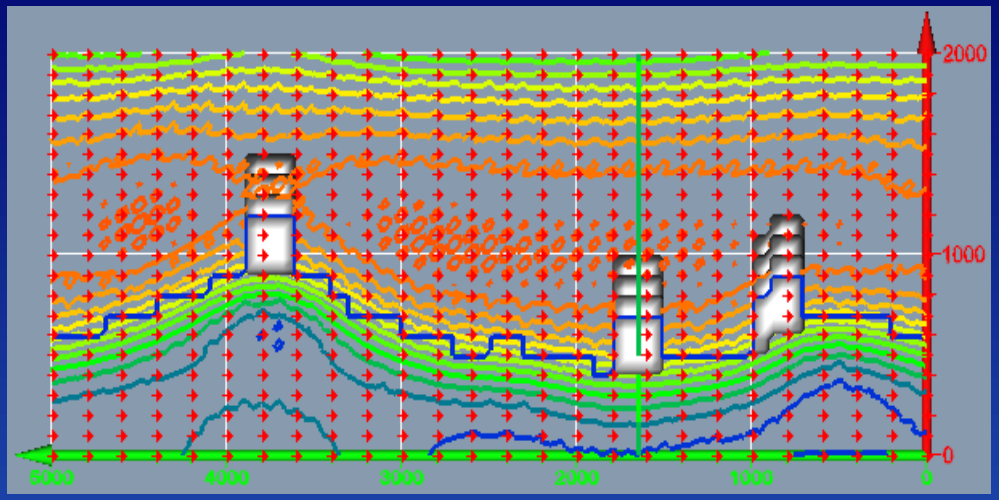


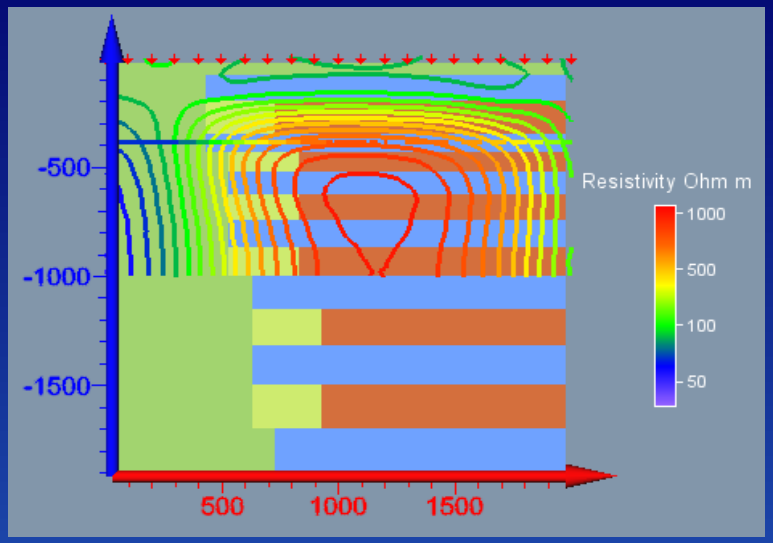
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

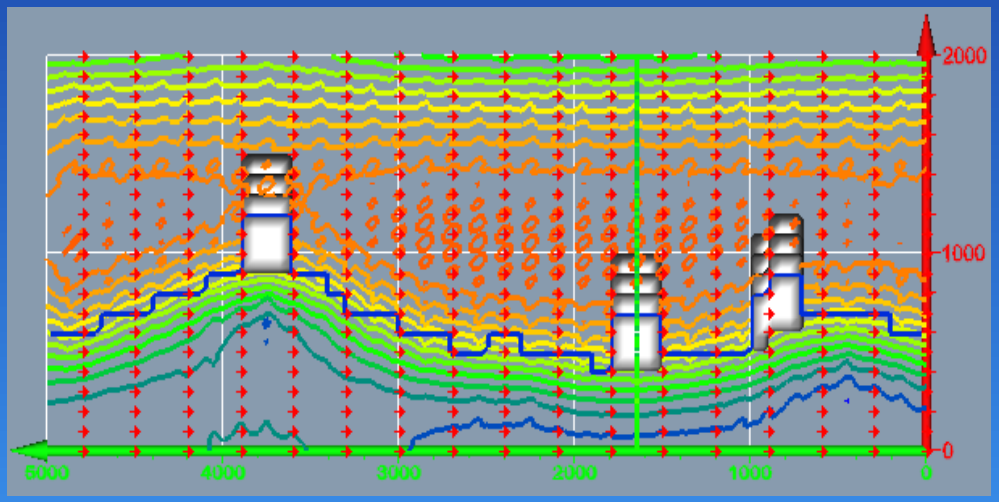
2DDD

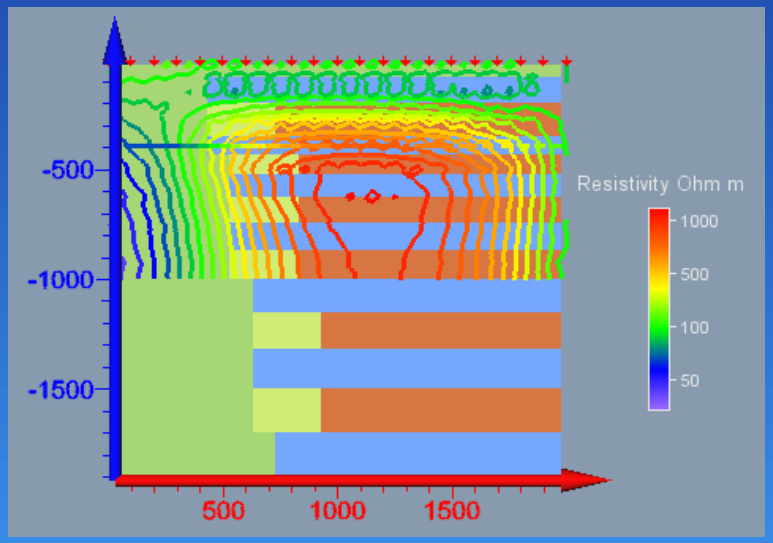
200m Resistivity





300m Resistivity



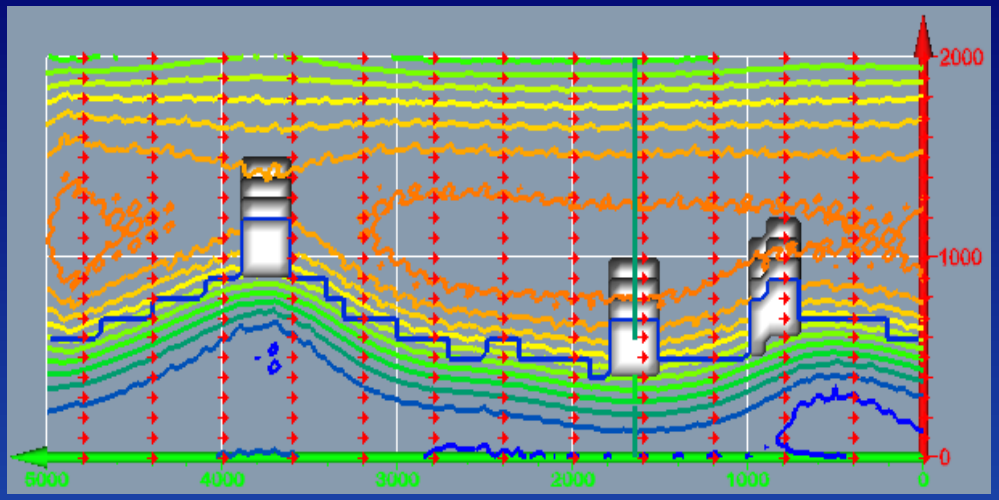


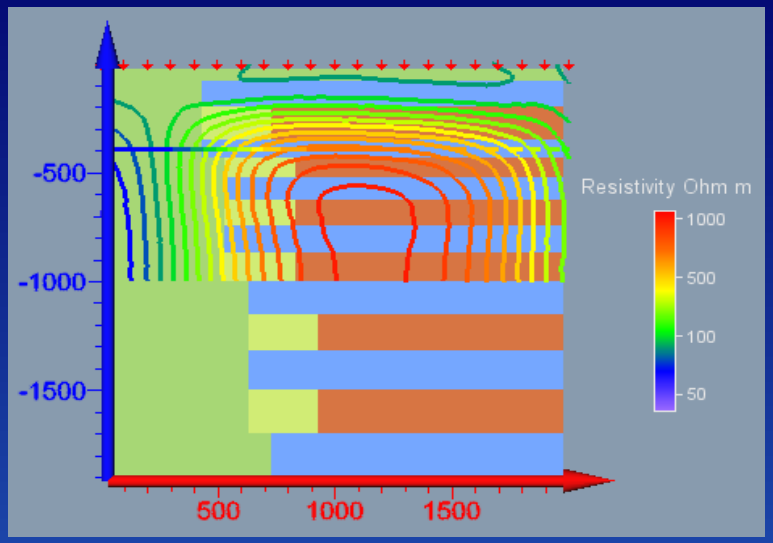
Plan view of contour slice at -400m

Cross section through the middle of the chargeable centre body

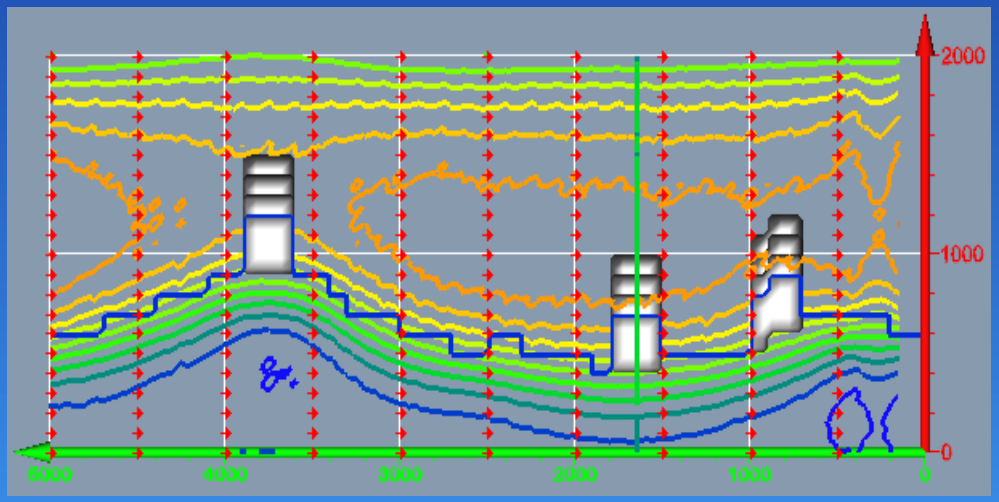
2DDD

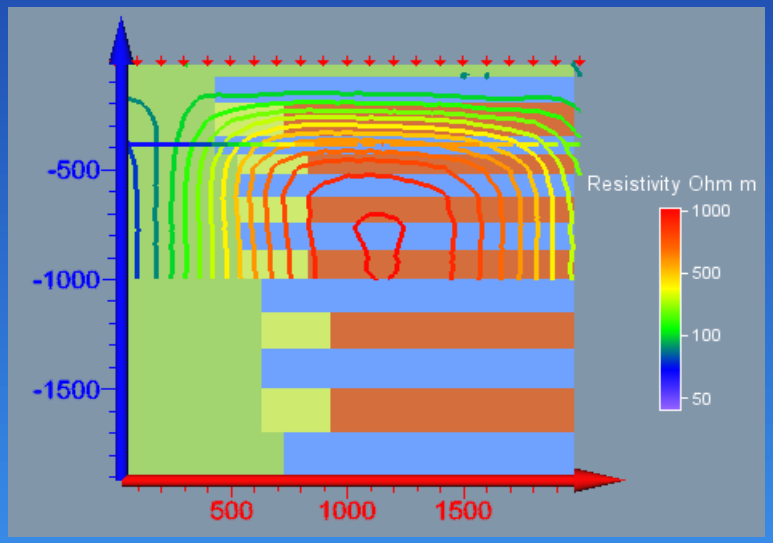
400m Resistivity





500m Resistivity

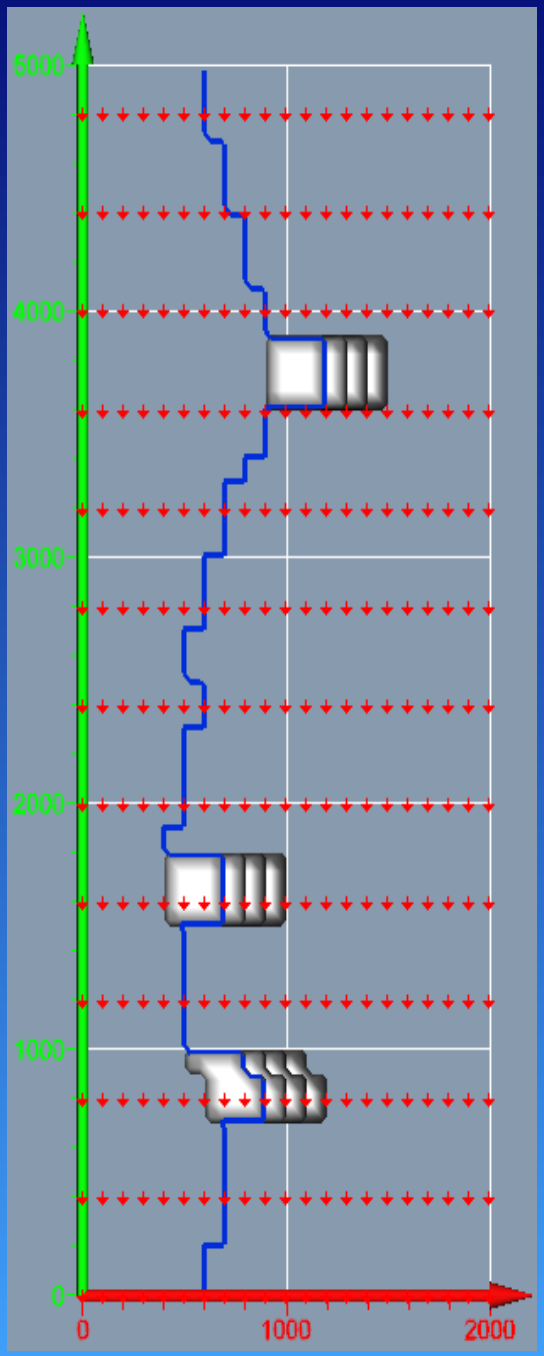




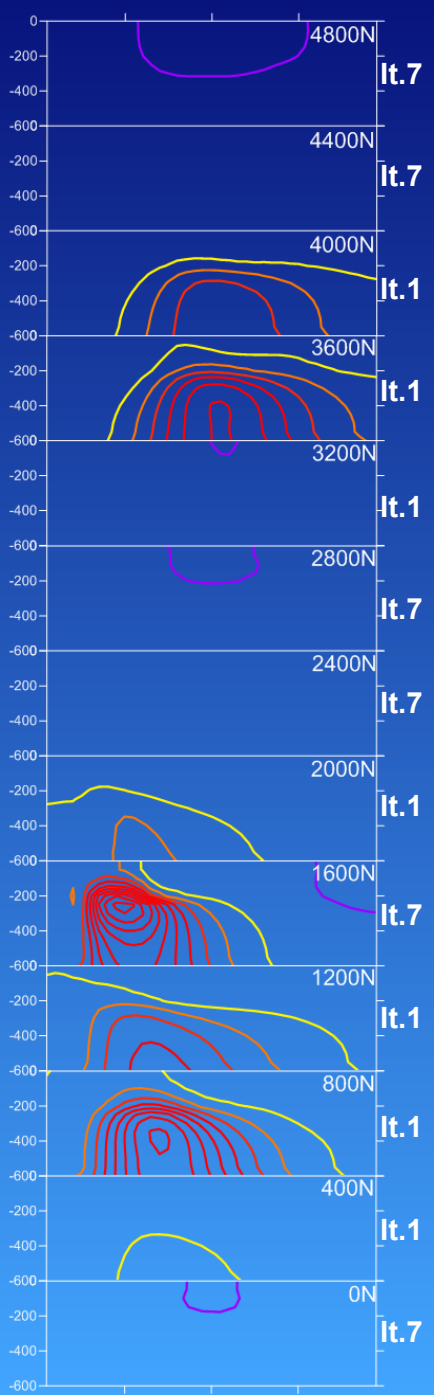
Plan view of contour slice at -400m

Cross section through the middle of the chargeable centre body

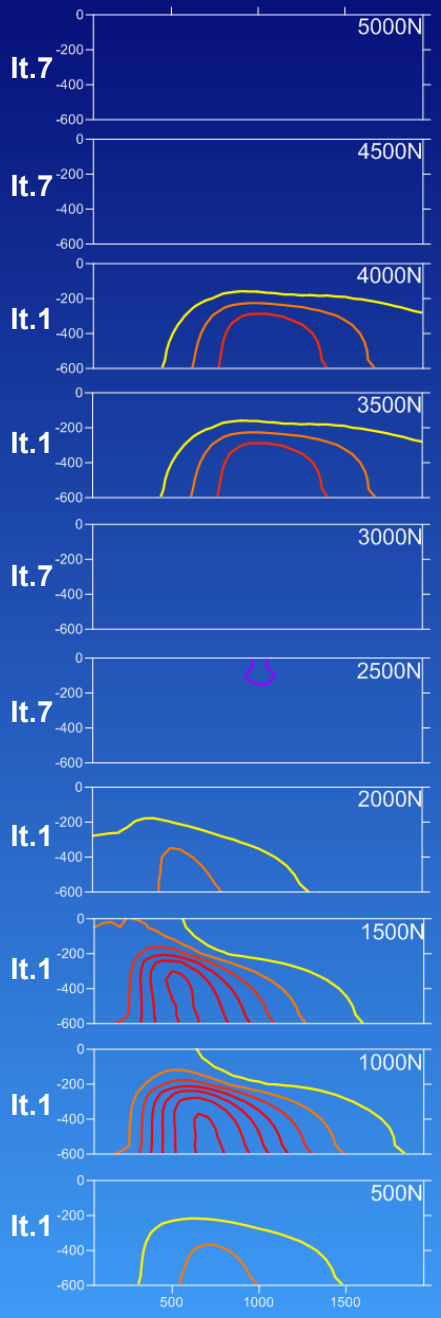
2D inversion sections



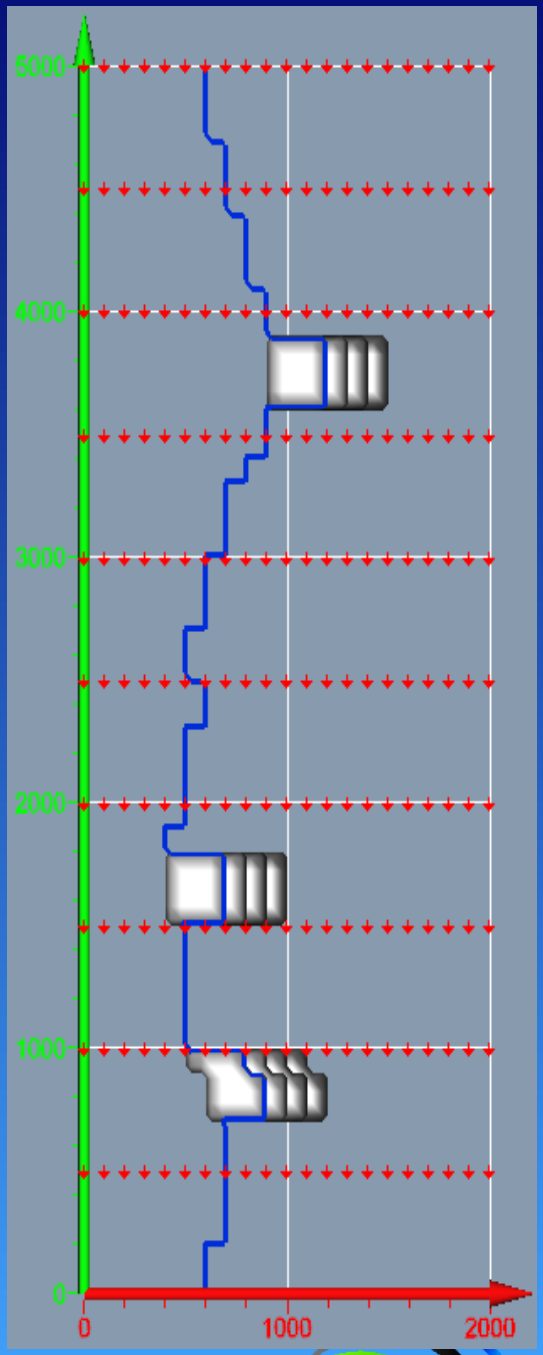
400m Chargeability



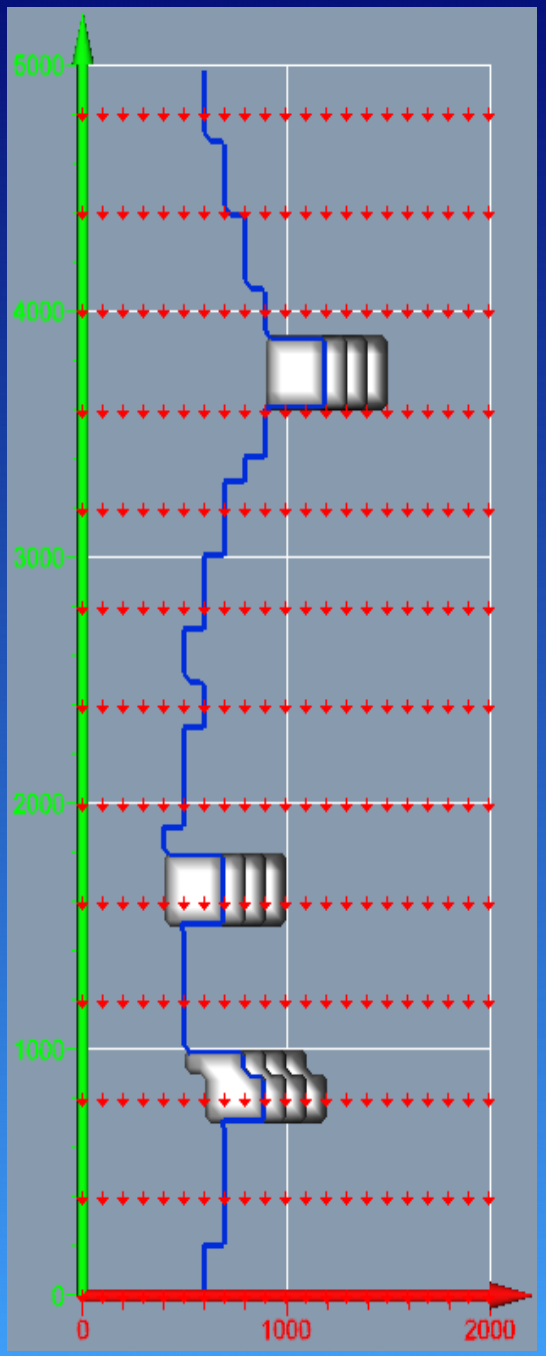
500m Chargeability



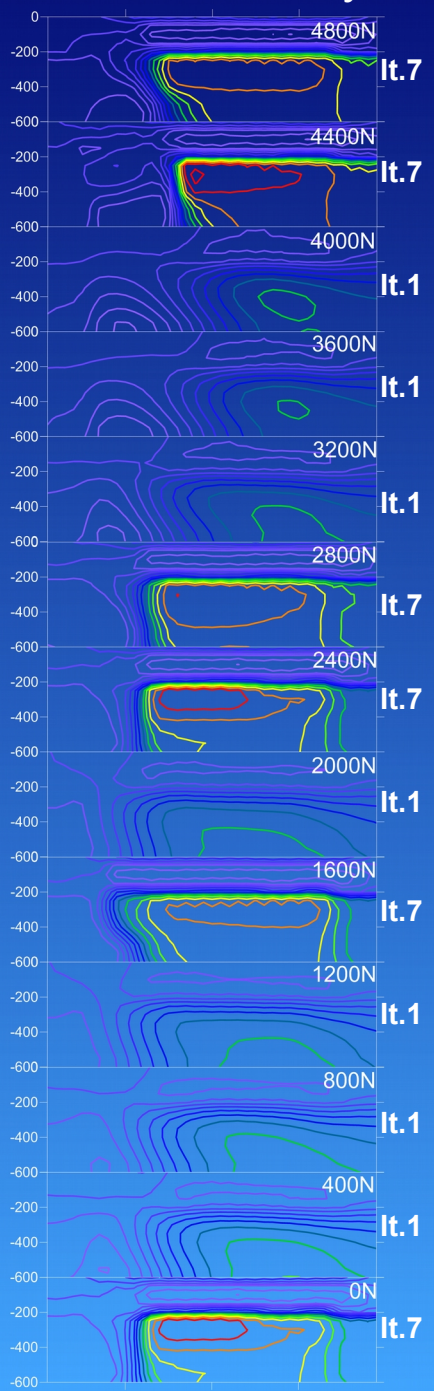
It = Iteration



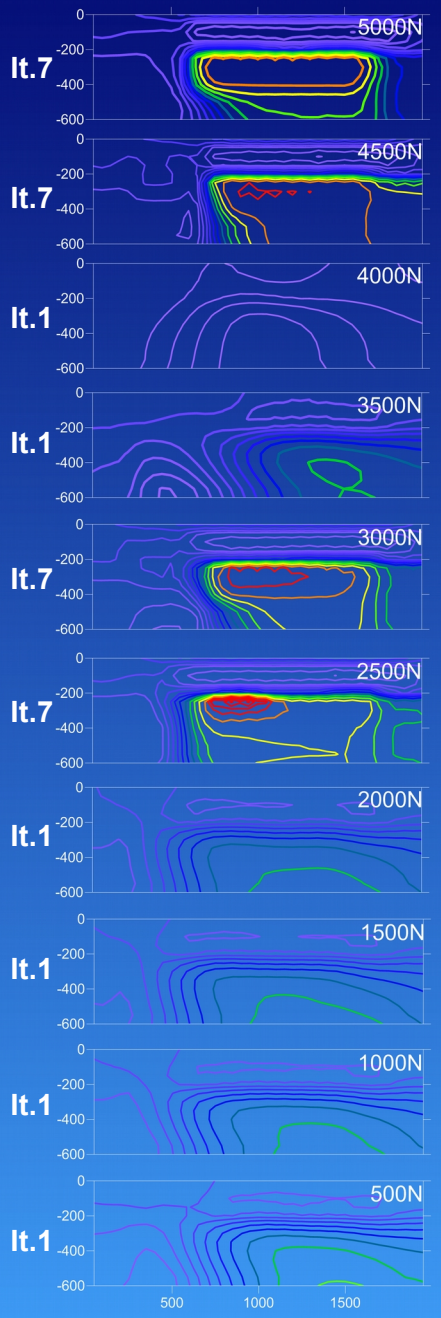
2D inversion sections



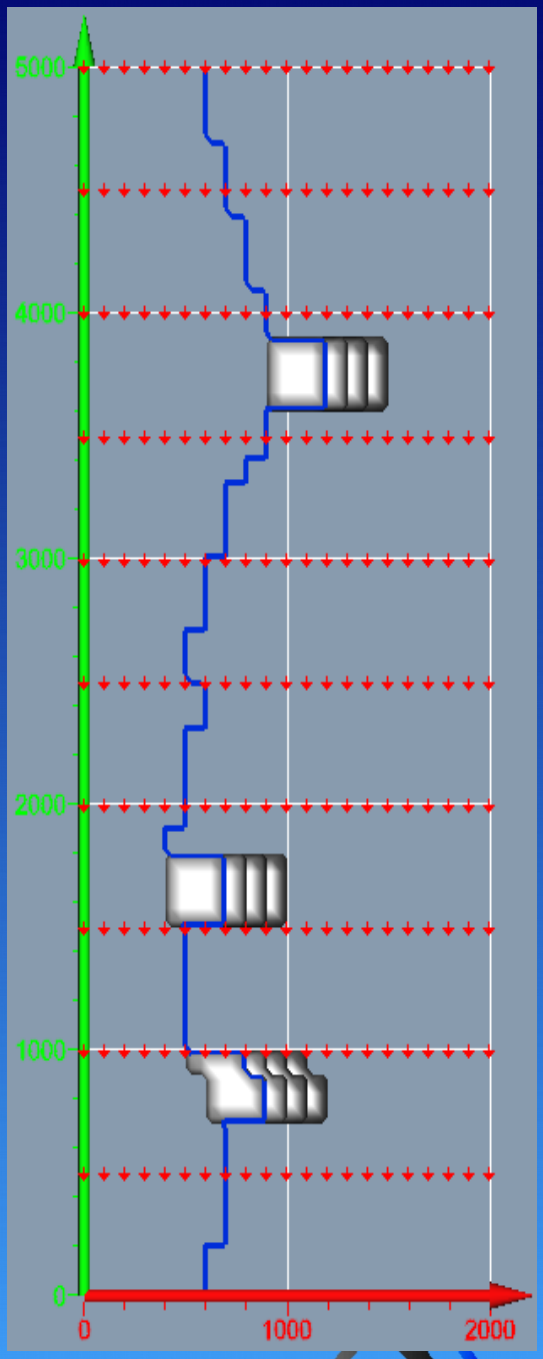
400m Resistivity



500m Resistivity



It = Iteration

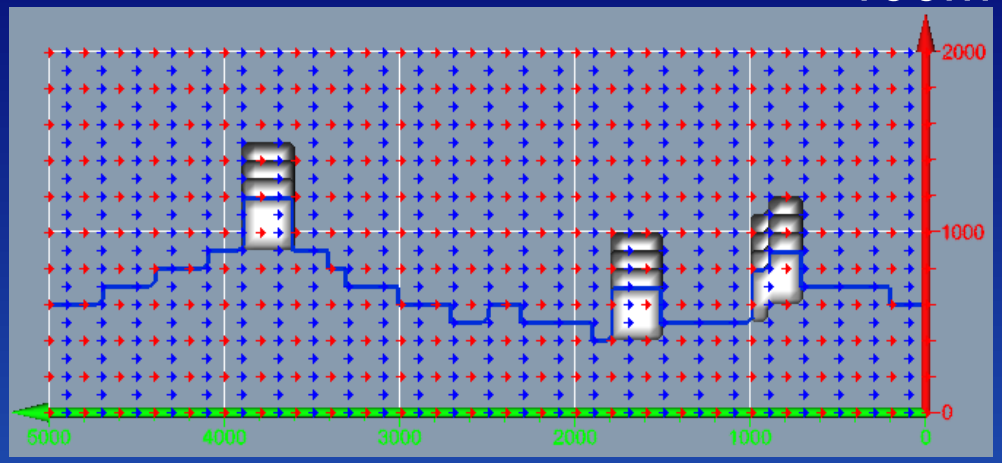


Observations – 80º dip 2D Dipole-Dipole

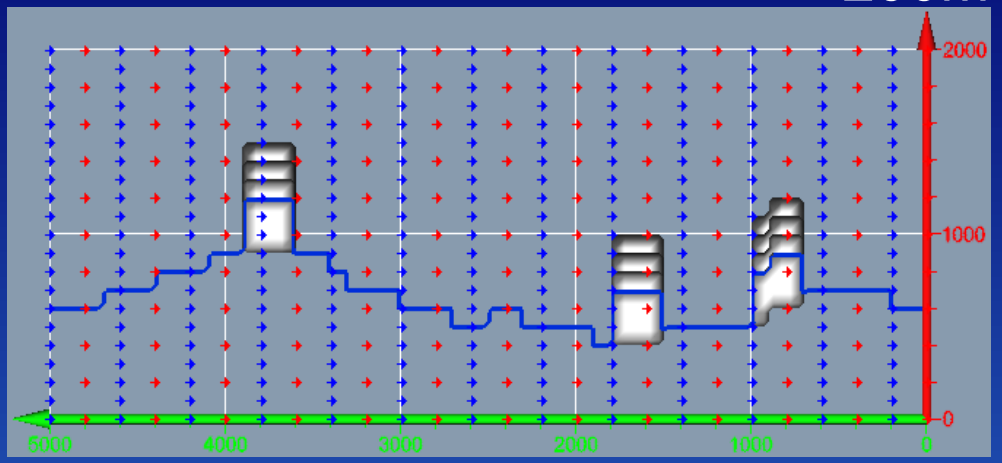
- For the 500m line spacing, none of the lines actually lie over a target and the maximum inverted response is offset from the bodies. Drilling based on a line spacing larger than the target size would likely lead to disappointing results.
- There is poor resolution of dip at coarse line spacings.

2.5D QODD with variable line spacing

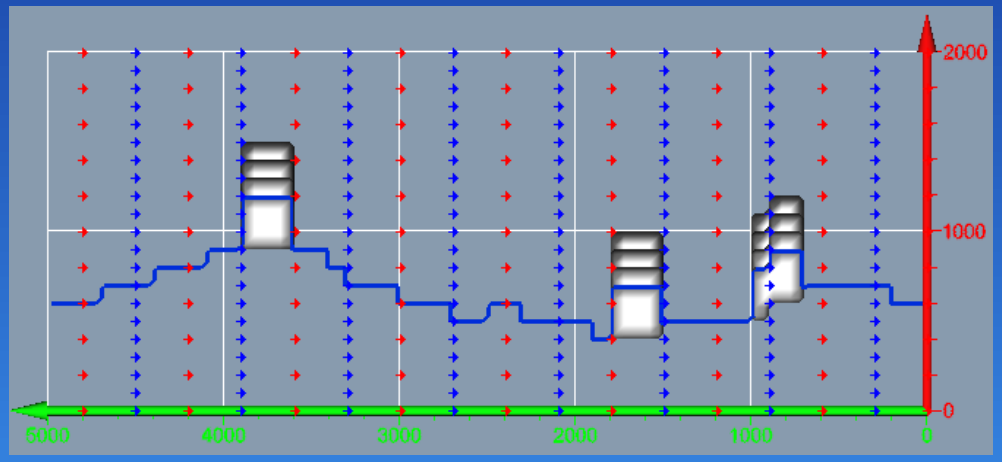
100m



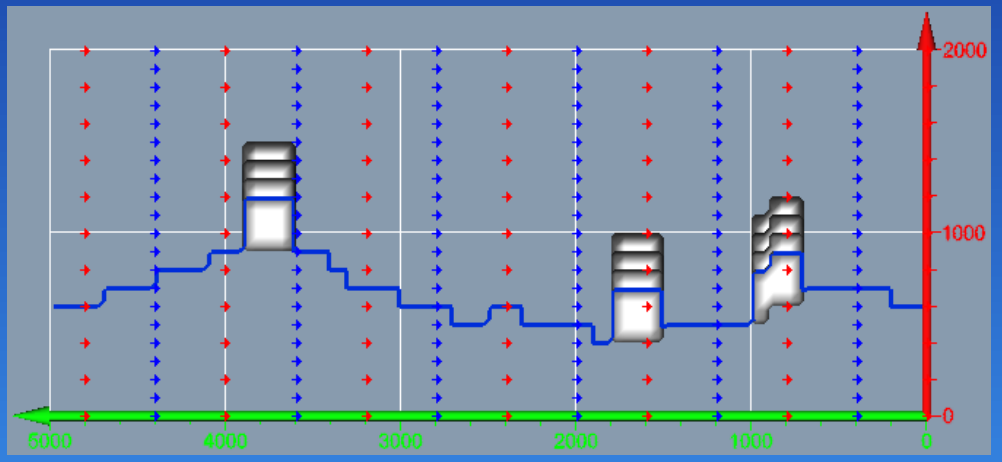
200m



300m



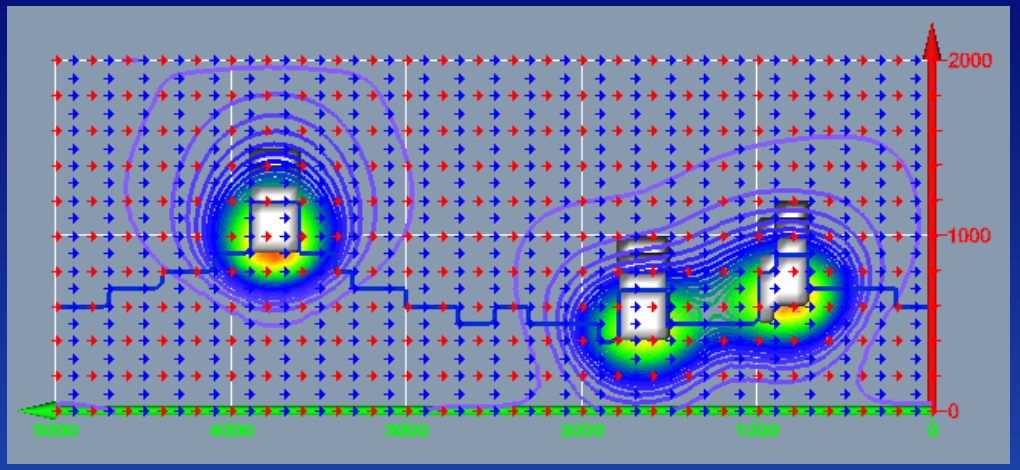
400m

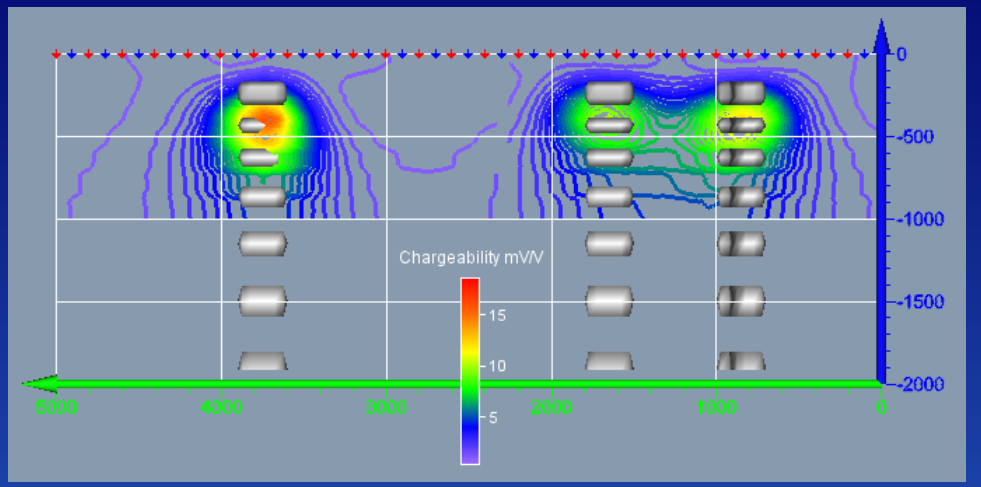


- 200m transmitter electrode spacing.
- 100m receiver electrode spacing.
- 100m, 200m, 300m and 400m line spacing.
- 4 lines of 21 receivers active each reading.

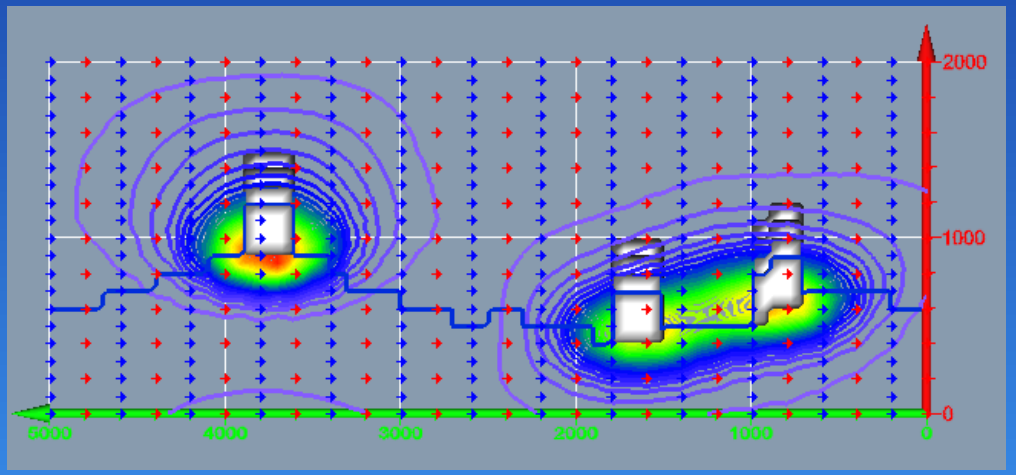
2.5D QODD

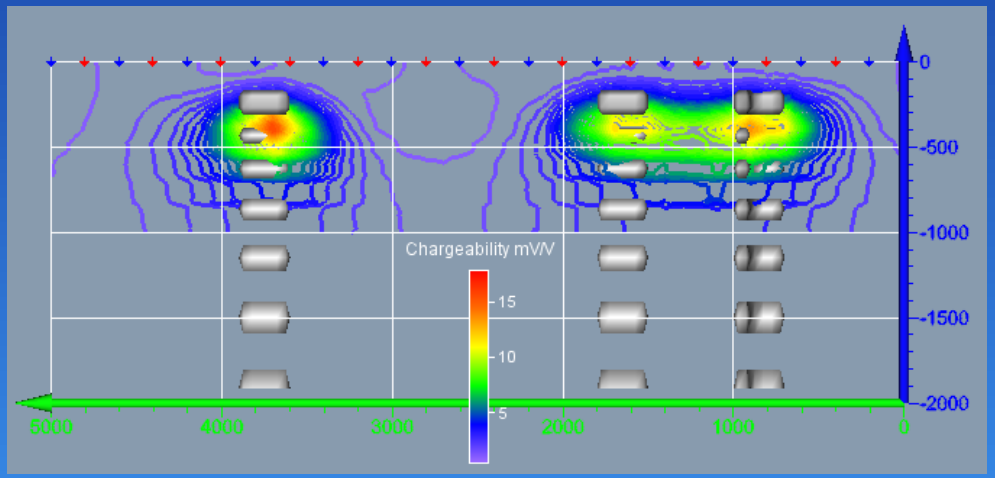
100m Chargeability





200m Chargeability



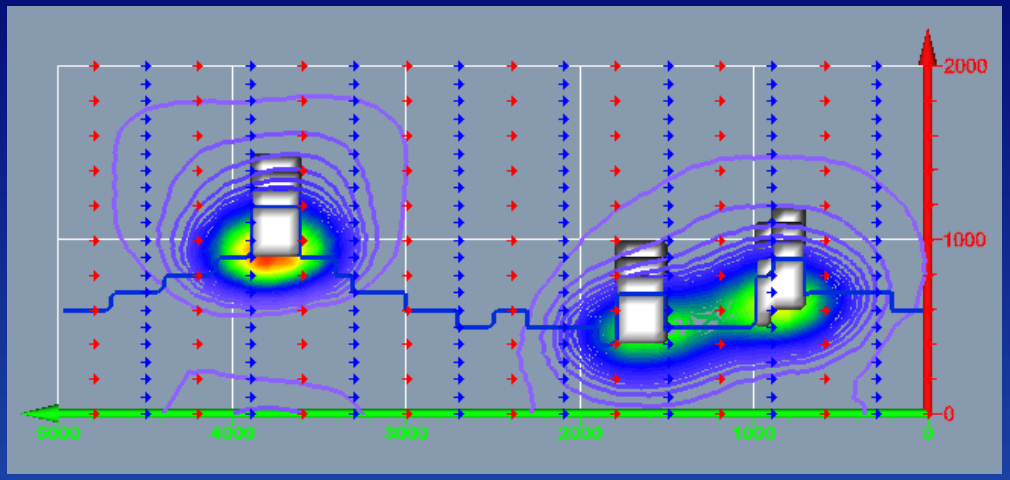


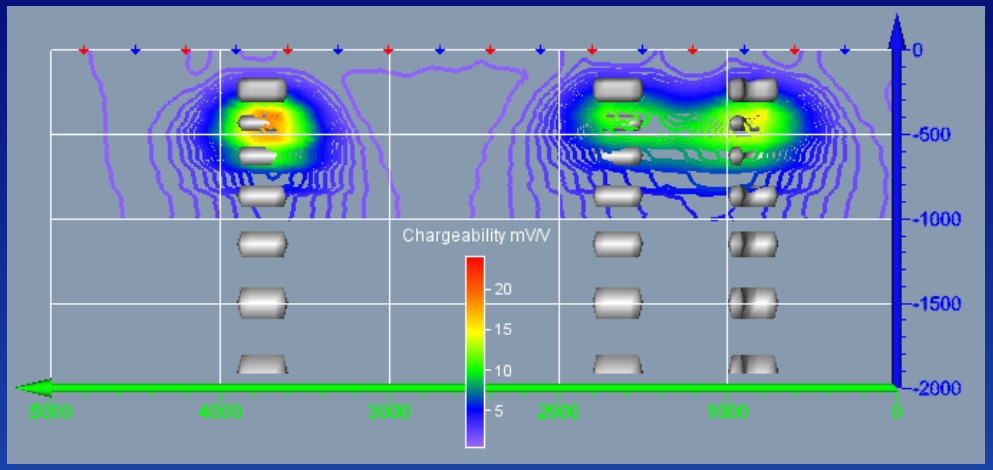
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

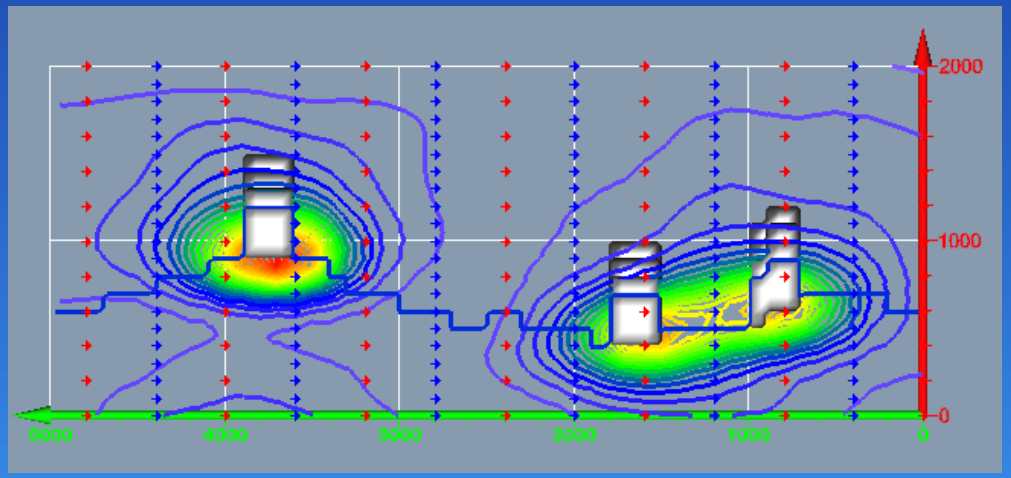
2.5D QODD

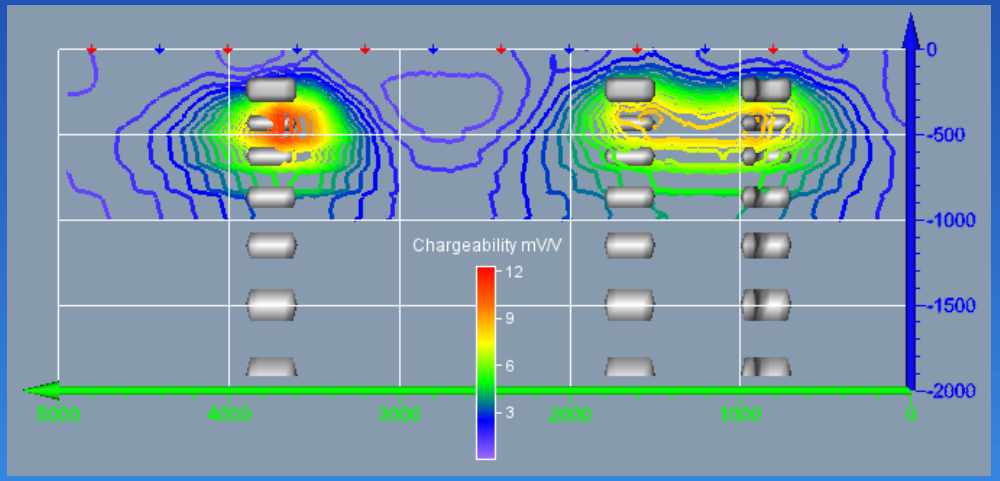
300m Chargeability





400m Chargeability



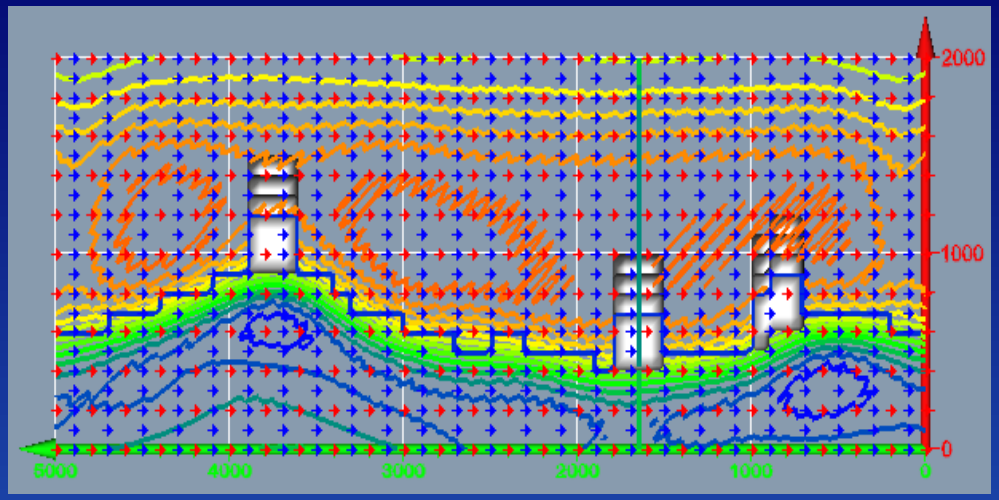


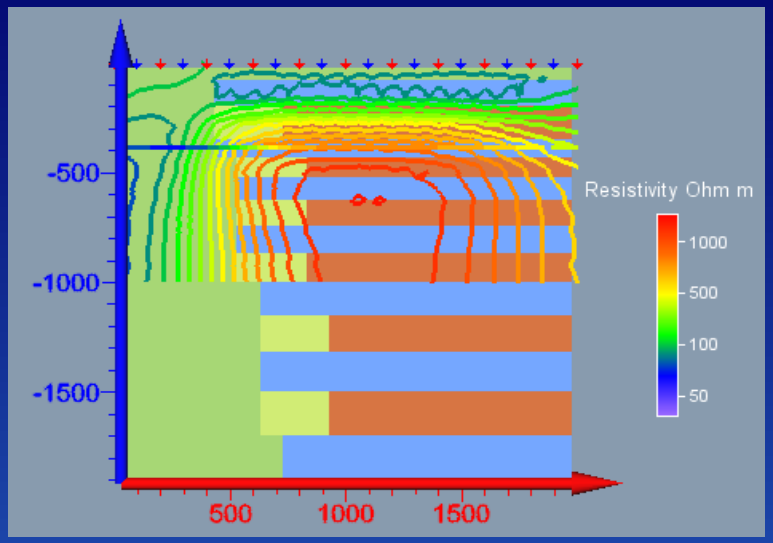
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

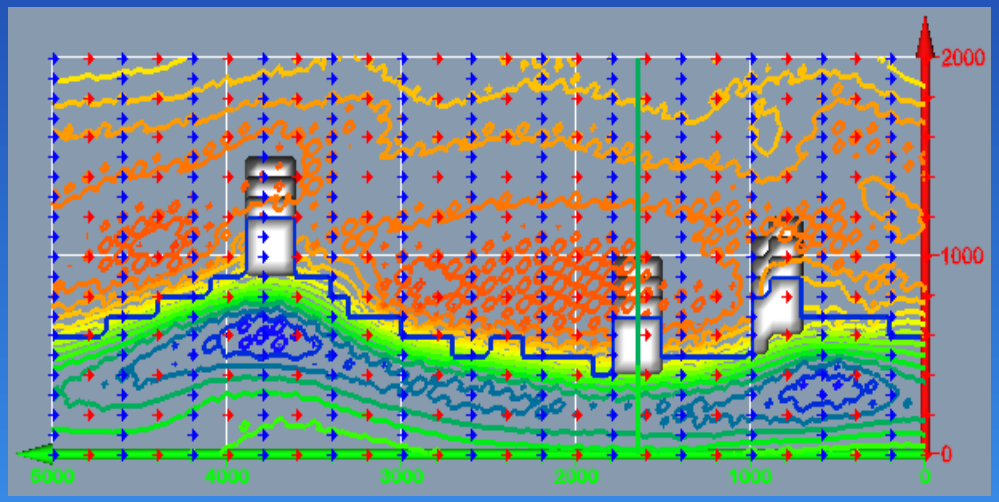
2.5D QODD

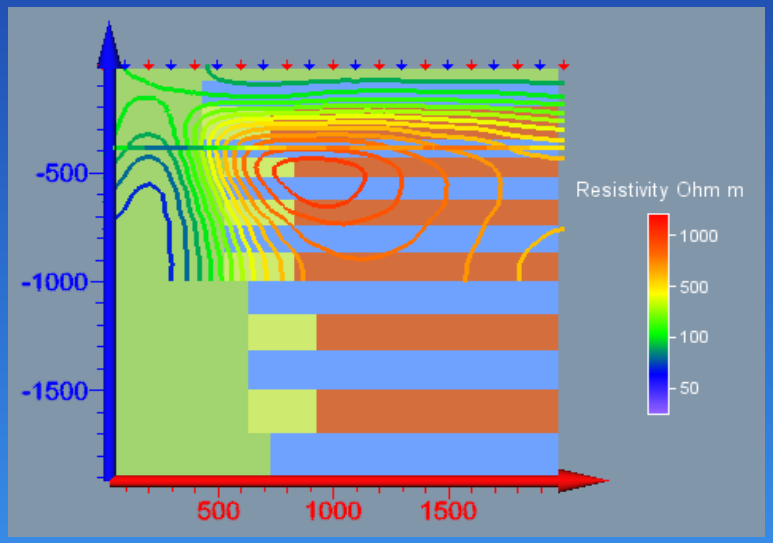
100m Resistivity





200m Resistivity



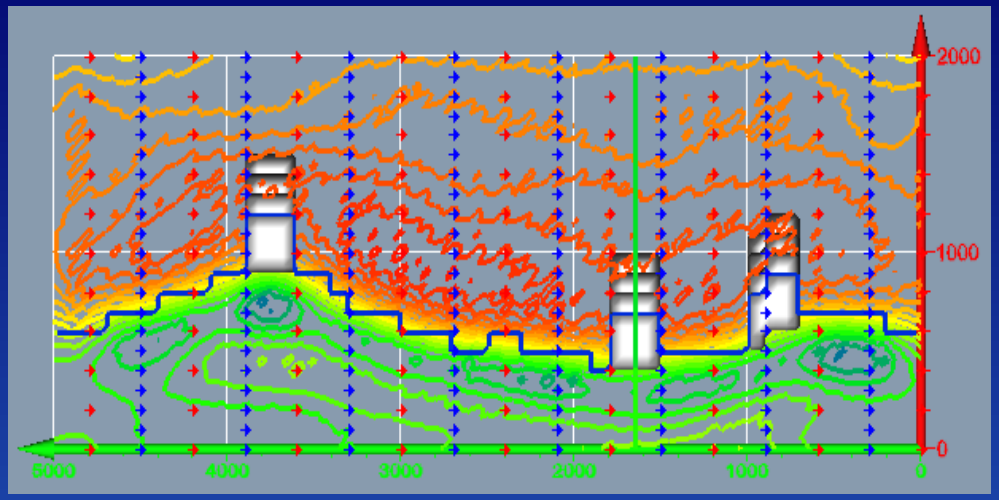


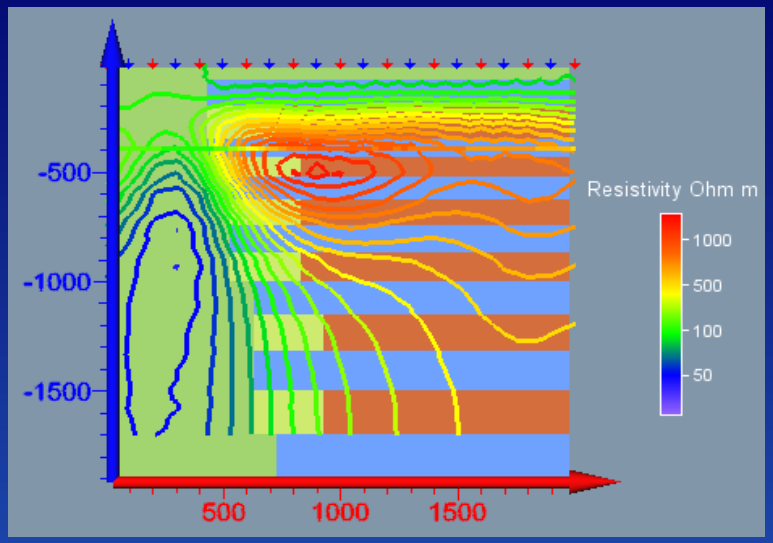
Plan view of contour slice at -400m

Cross section through the middle of the chargeable centre body

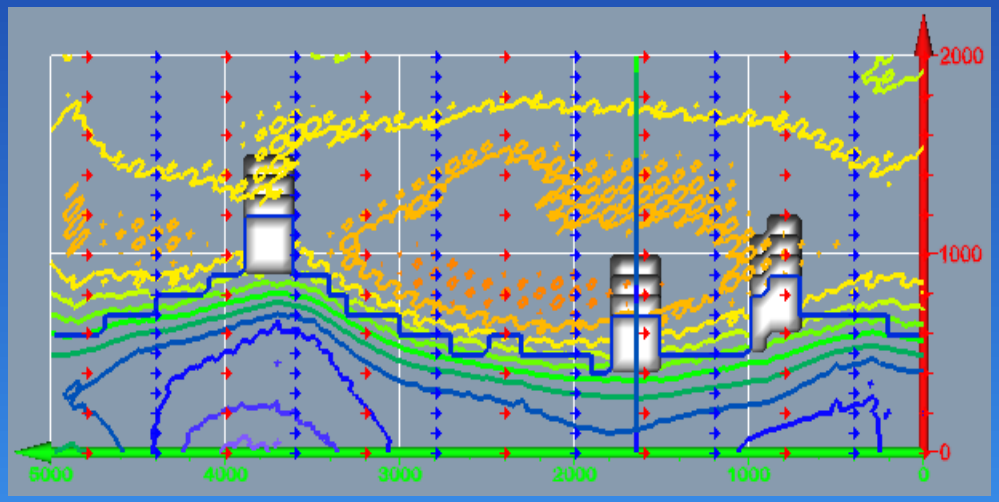
2.5D QODD

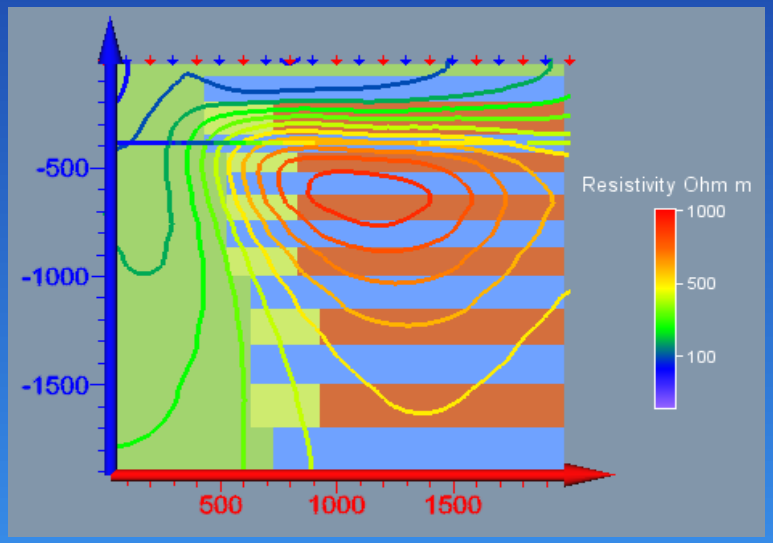
300m Resistivity





400m Resistivity





Plan view of contour slice at -400m

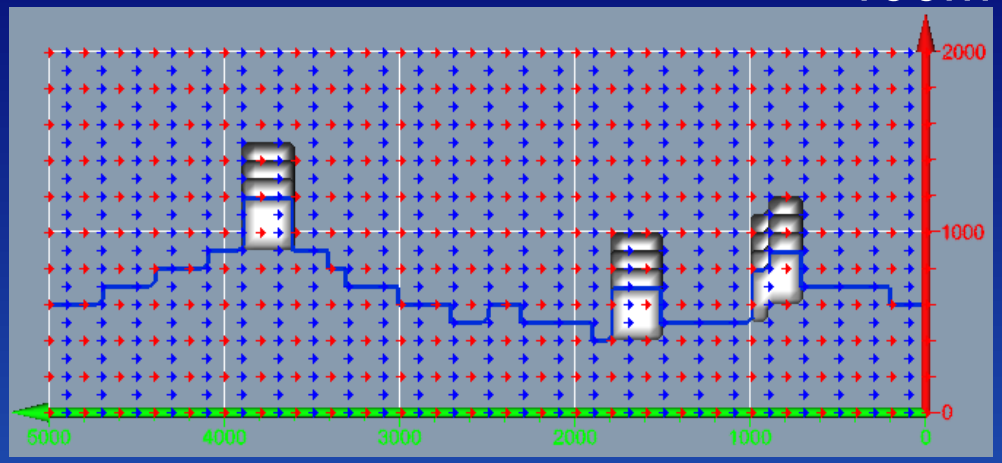
Cros section through the middle of the chargeable centre body

Observations – 80º dip 2.5D QODD

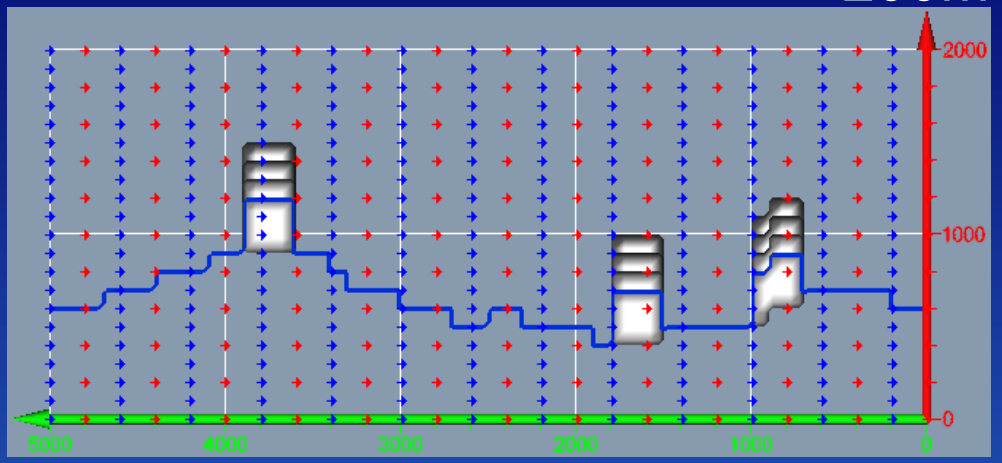
- Good dip resolution is apparent in all line spacings and 100m line spacing resolves the two closely spaced bodies very well.

2.5D Multipole QODD with variable line spacing

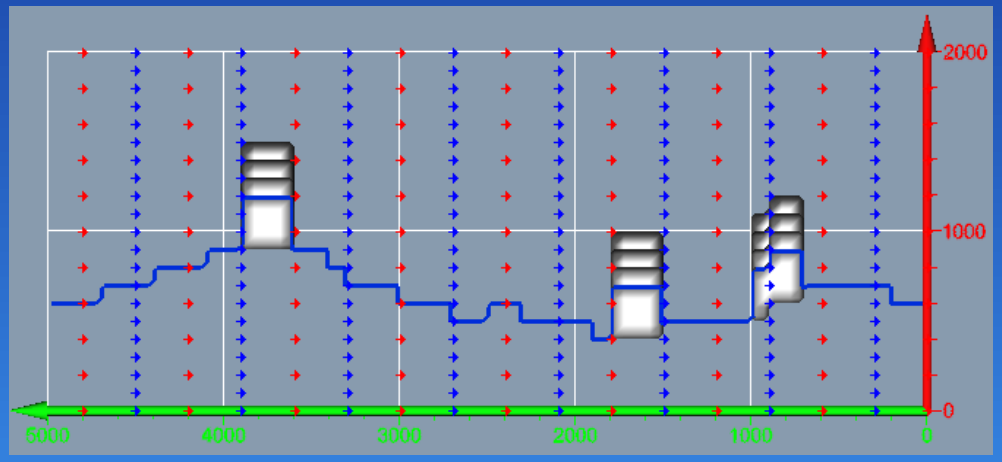
100m



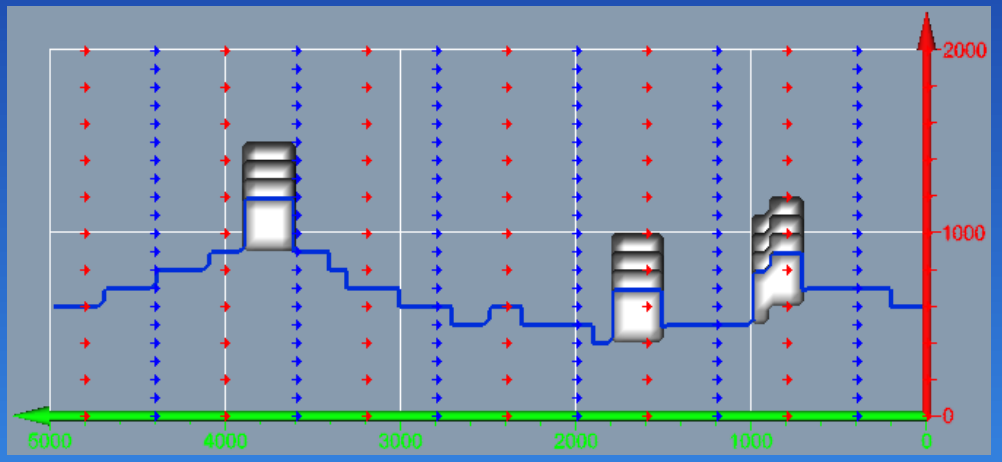
200m



300m



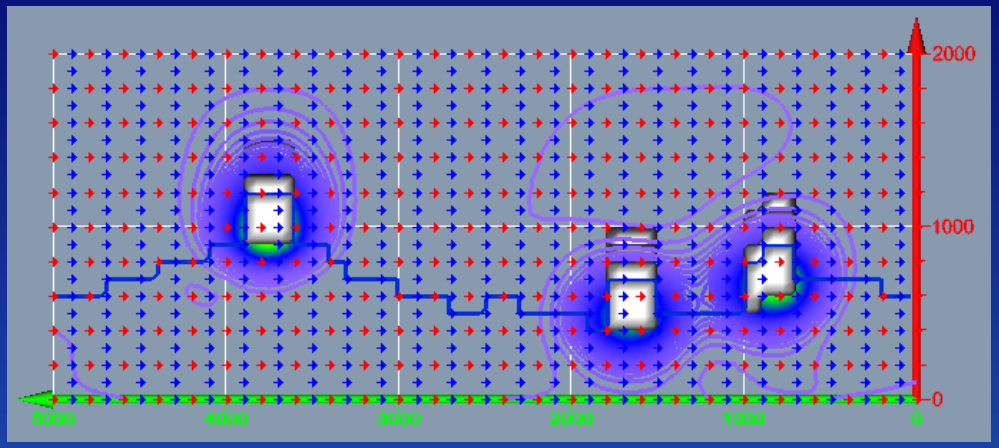
400m

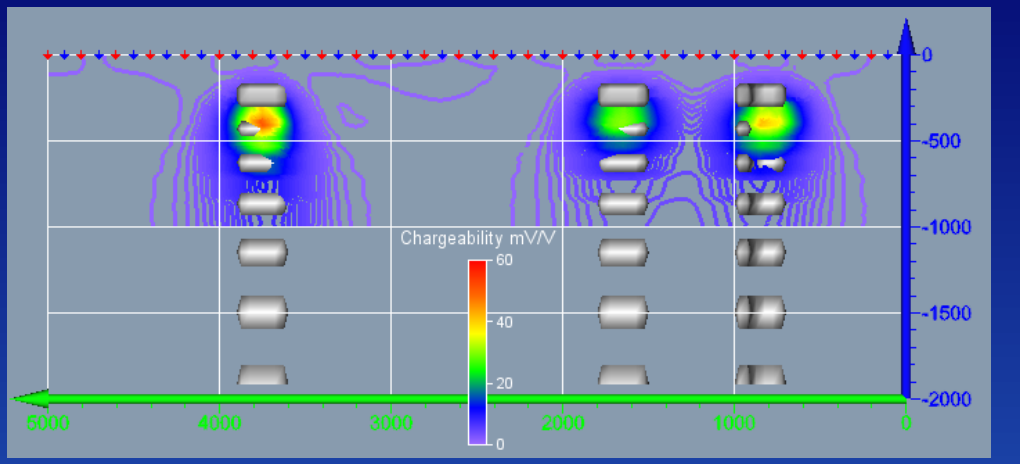


- 200m transmitter electrode spacing.
- 100m receiver electrode spacing with dipole sizes of 100m, 200m, 300m and 400m.
- 100m, 200m, 300m and 400m line spacing.
- 4 lines of 21 dipoles active each reading.

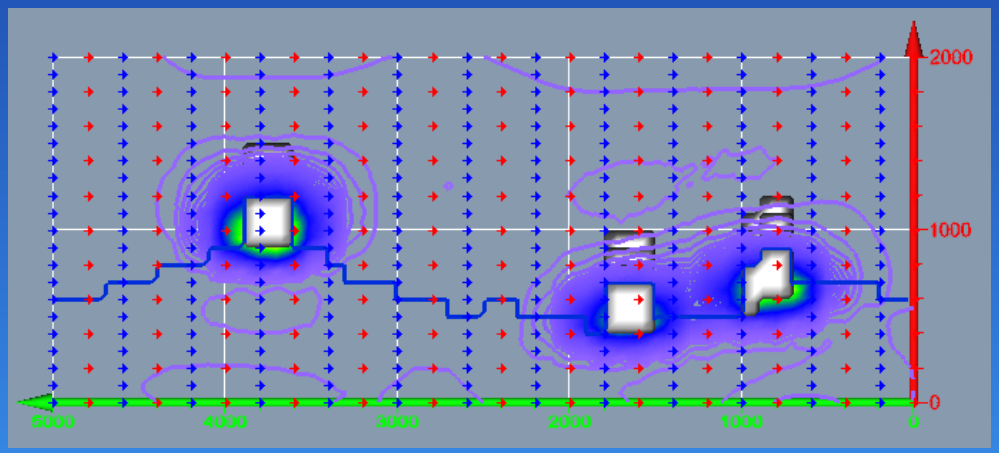
Multipole QODD

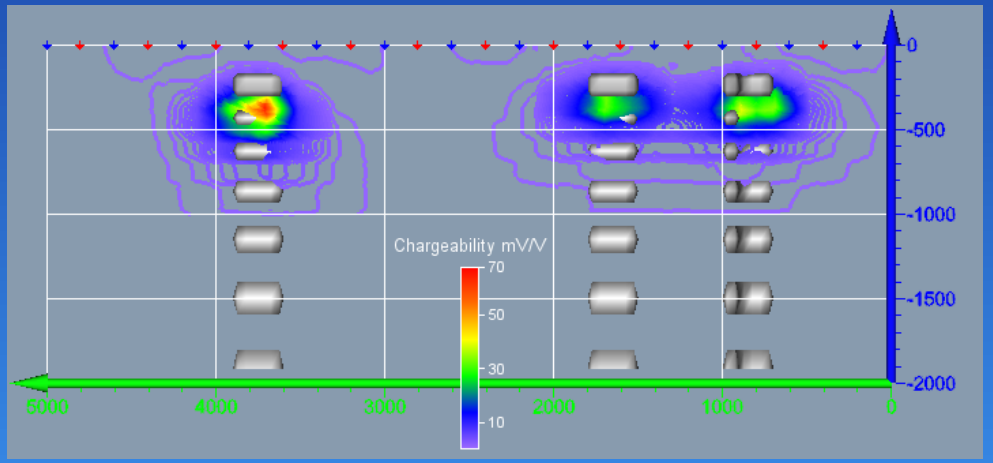
100m Chargeability





200m Chargeability



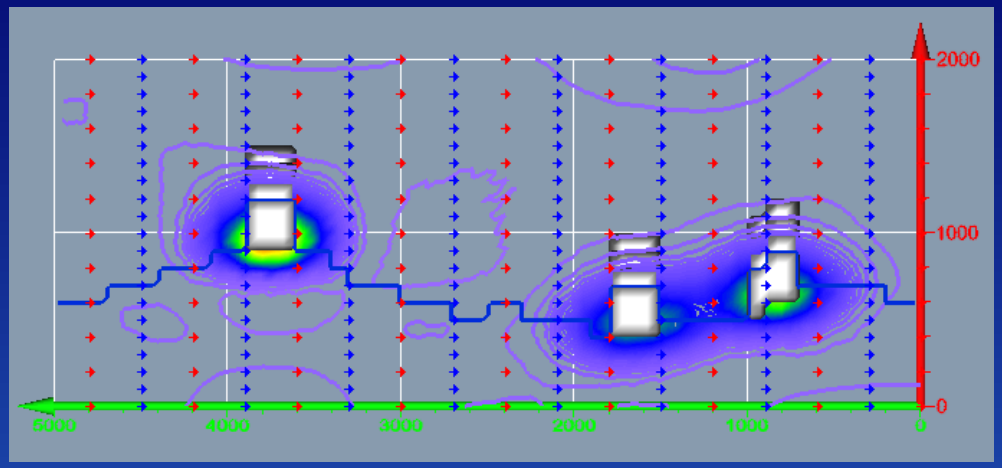


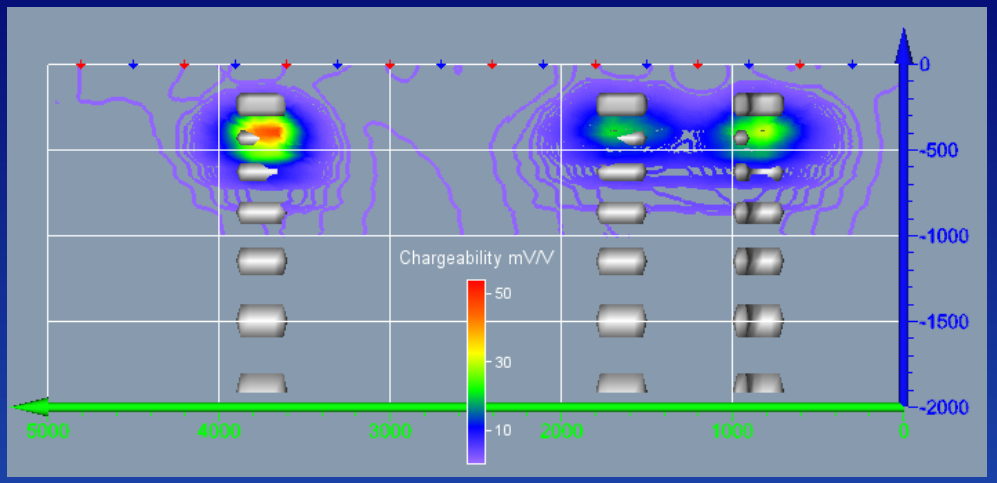
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

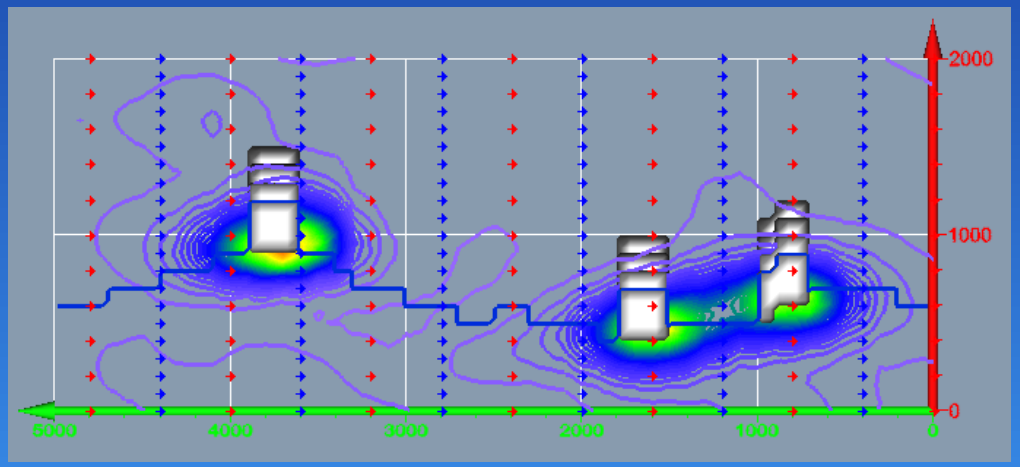
Multipole QODD

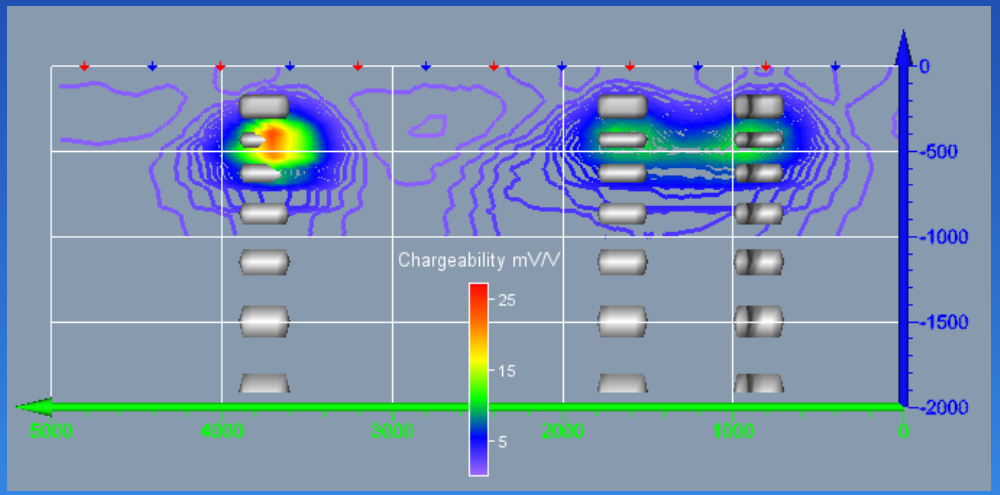
300m Chargeability





400m Chargeability



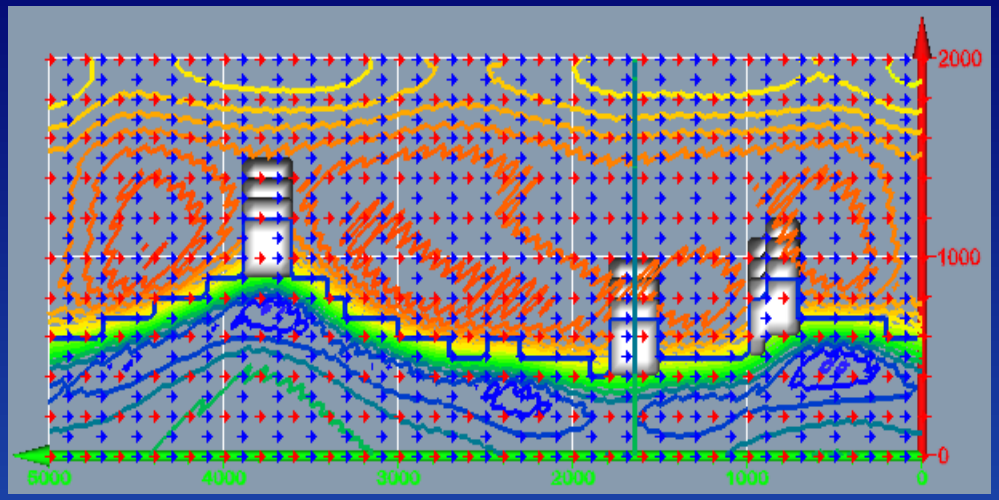


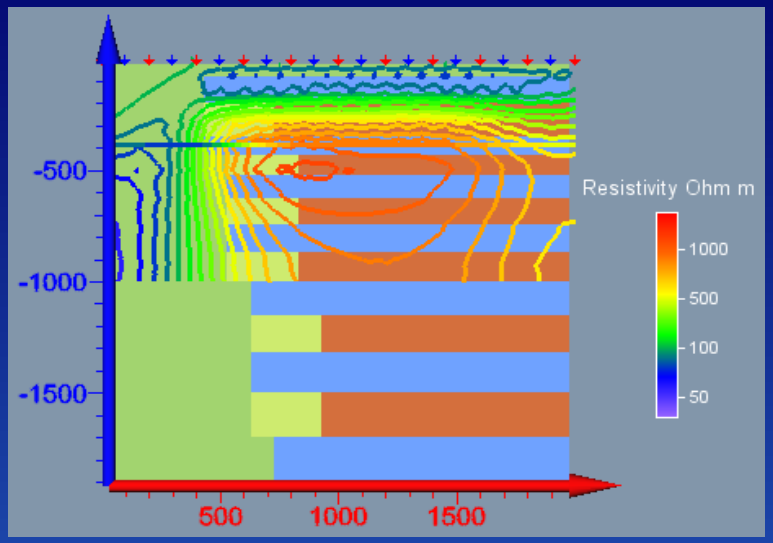
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

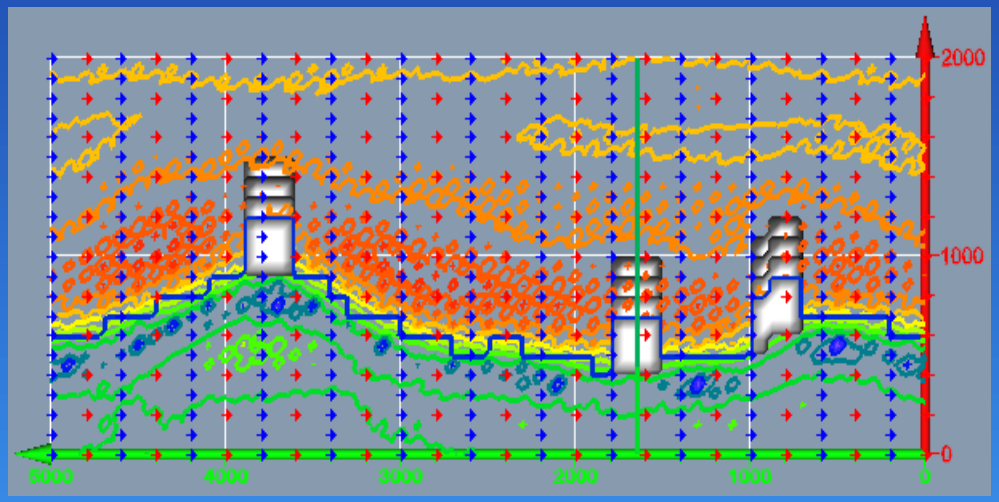
Multipole QODD

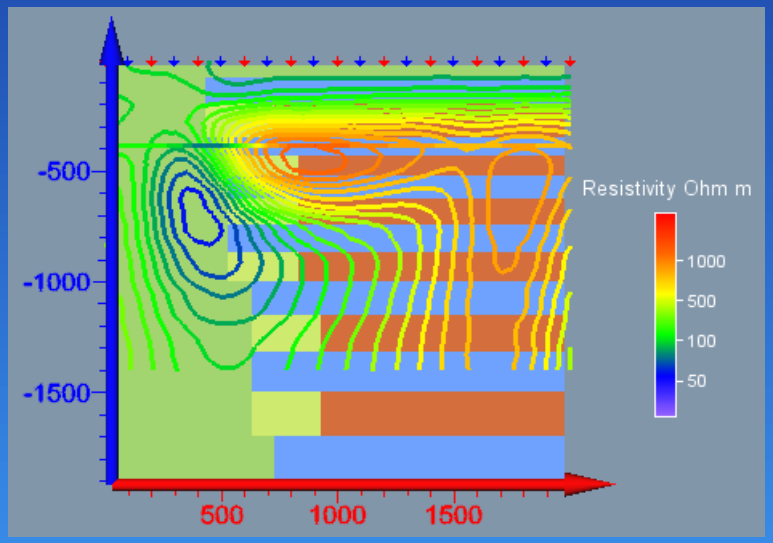
100m Resistivity





200m Resistivity



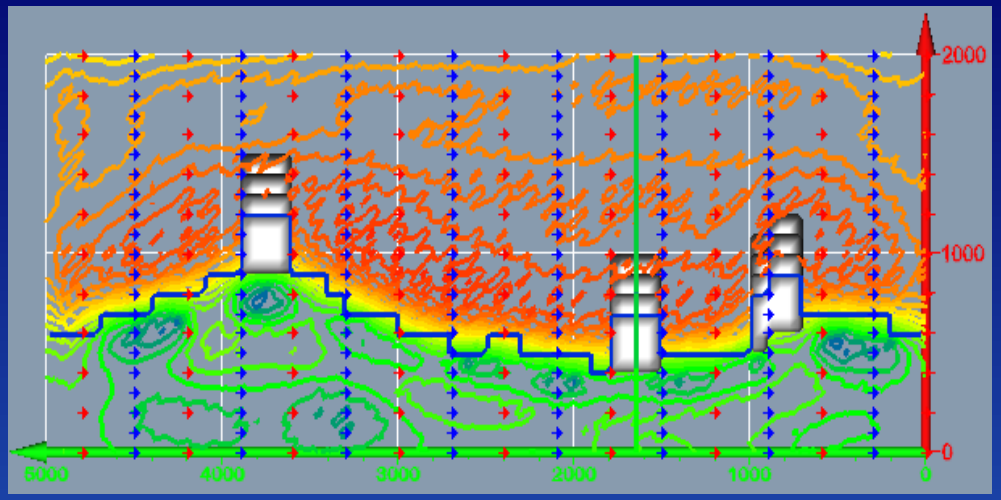


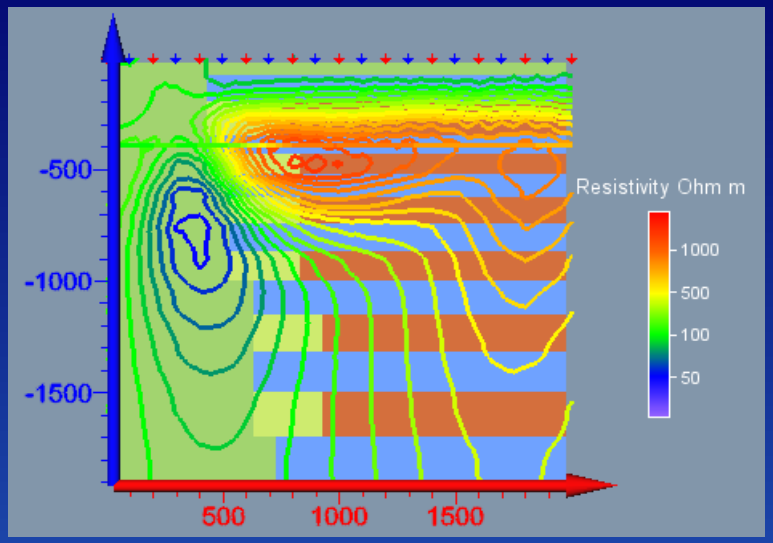
Plan view of contour slice at -400m

Cross section through the middle of the chargeable centre body

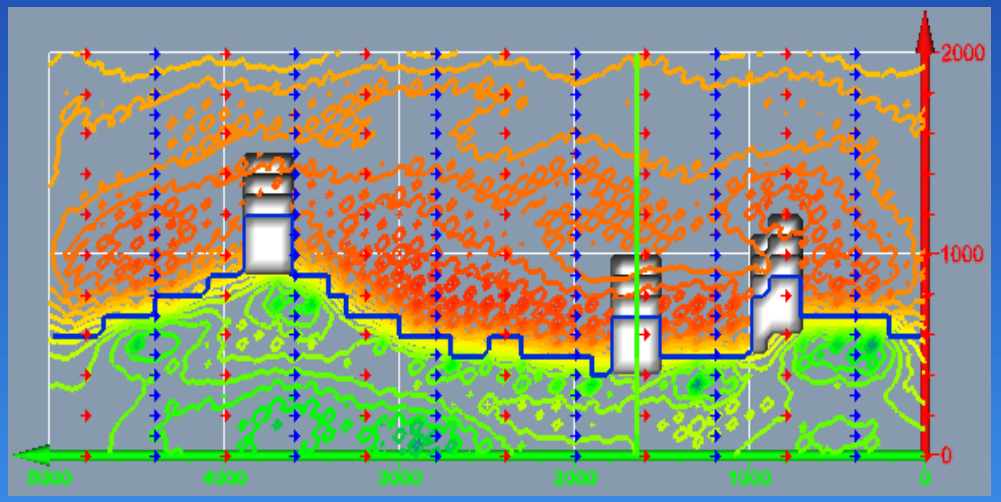
Multipole QODD

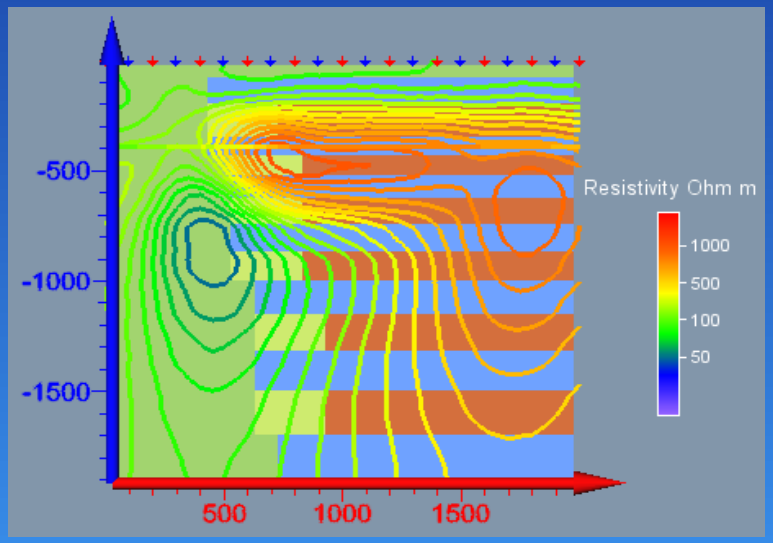
300m Resistivity





400m Resistivity





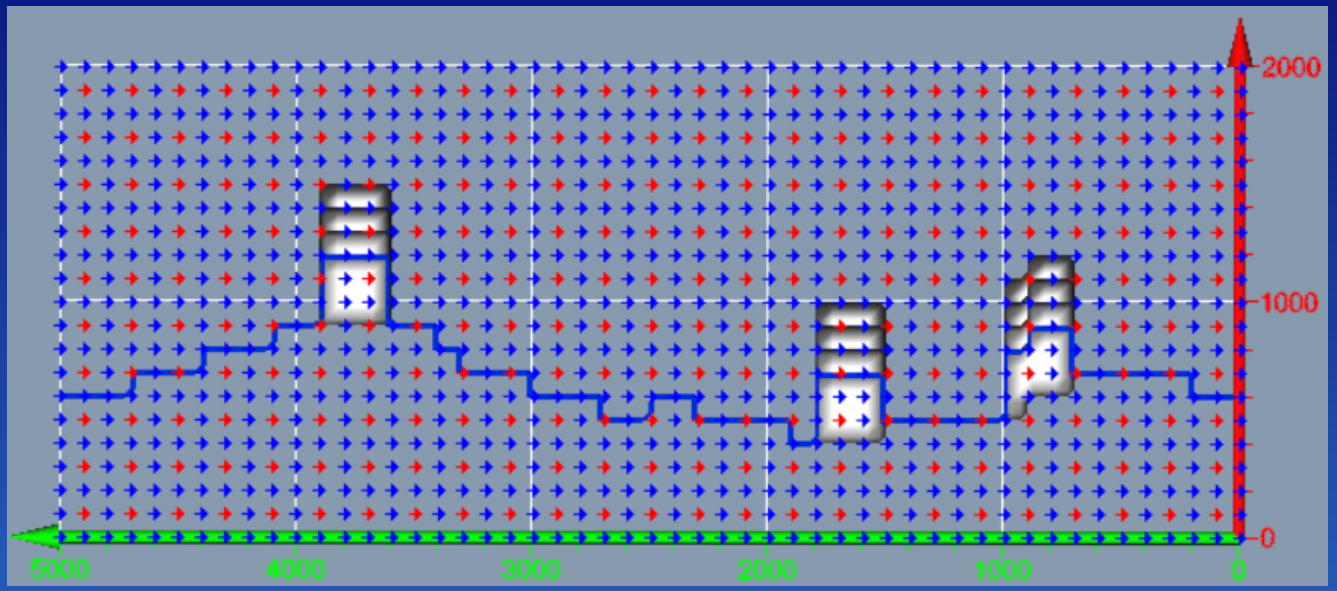
Plan view of contour slice at -400m

Cross section through the middle of the chargeable centre body

Observations – 80º dip 2.5D Multipole QODD

- When the line spacing is greater than the electrode spacing, the dip is overestimated.

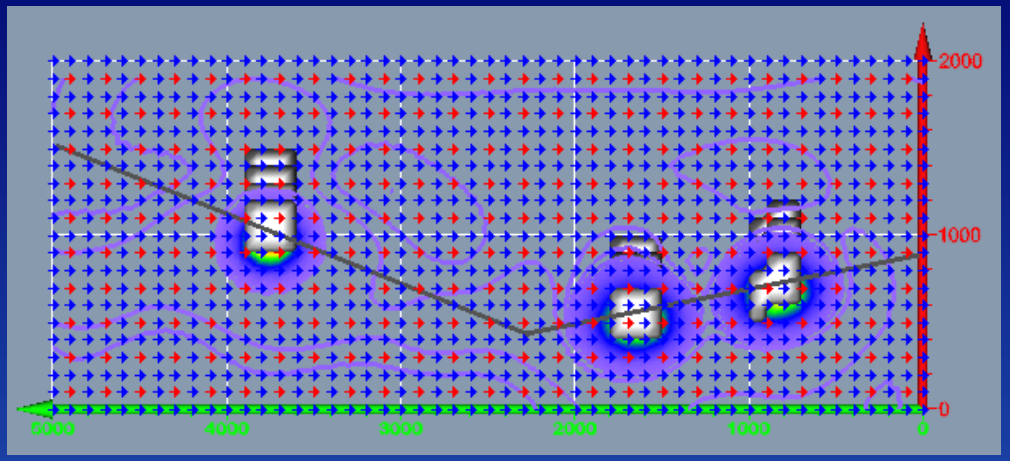
3D Pole-Dipole



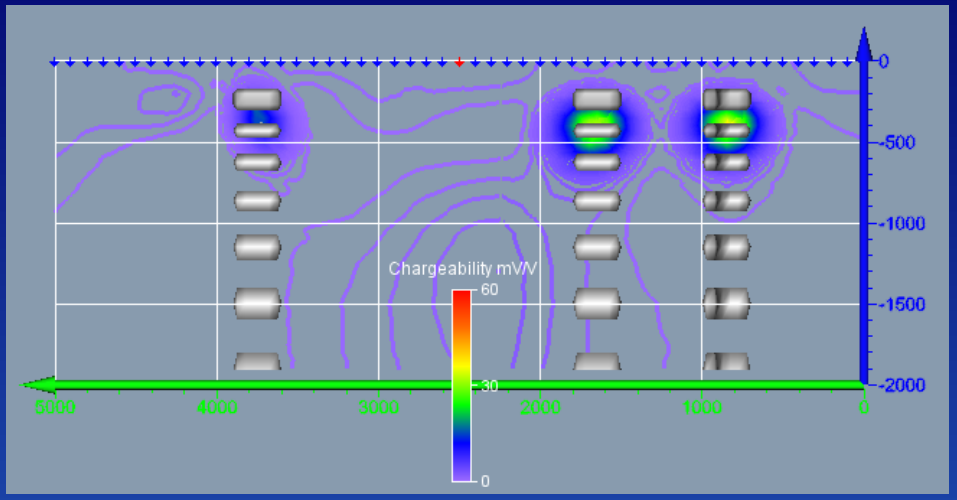
- 200m transmitter electrode spacing.
- 100m receiver electrode spacing.
- 100m line spacing.

3D Pole-Dipole

Chargeability

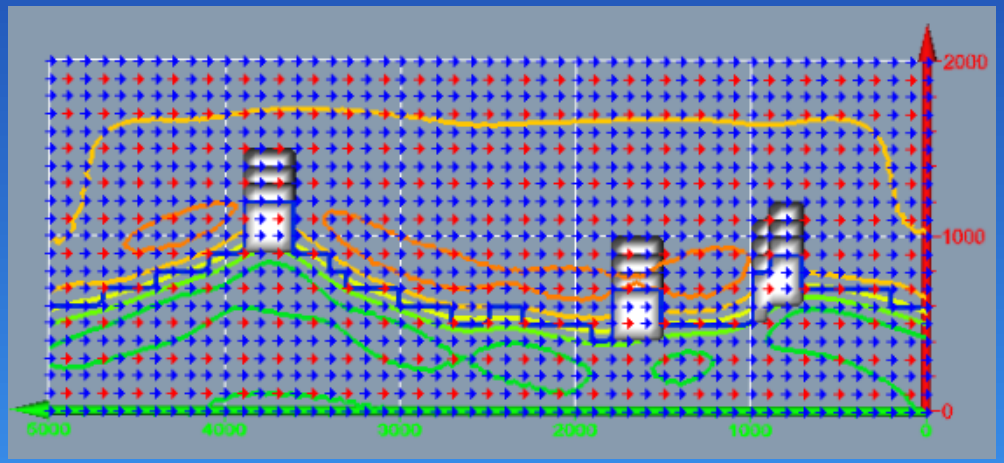


Plan view of contour slice
through maximum response

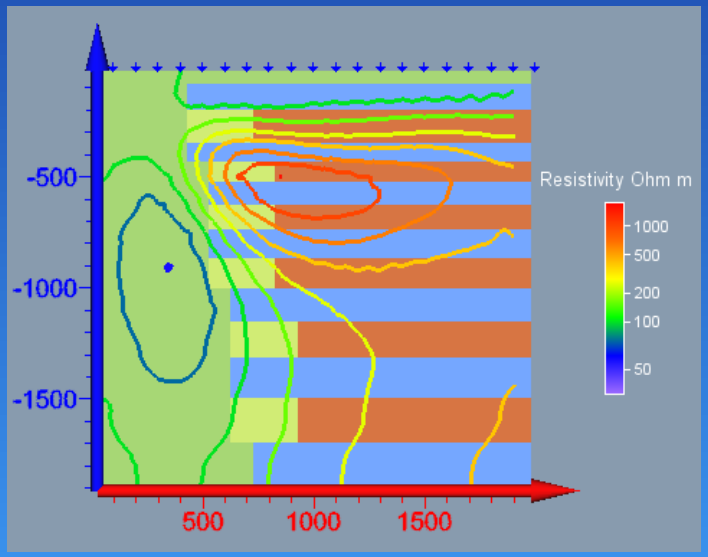


Bent and tilted long section view of
contours through body centres

Resistivity



Plan view of contour slice at -400m

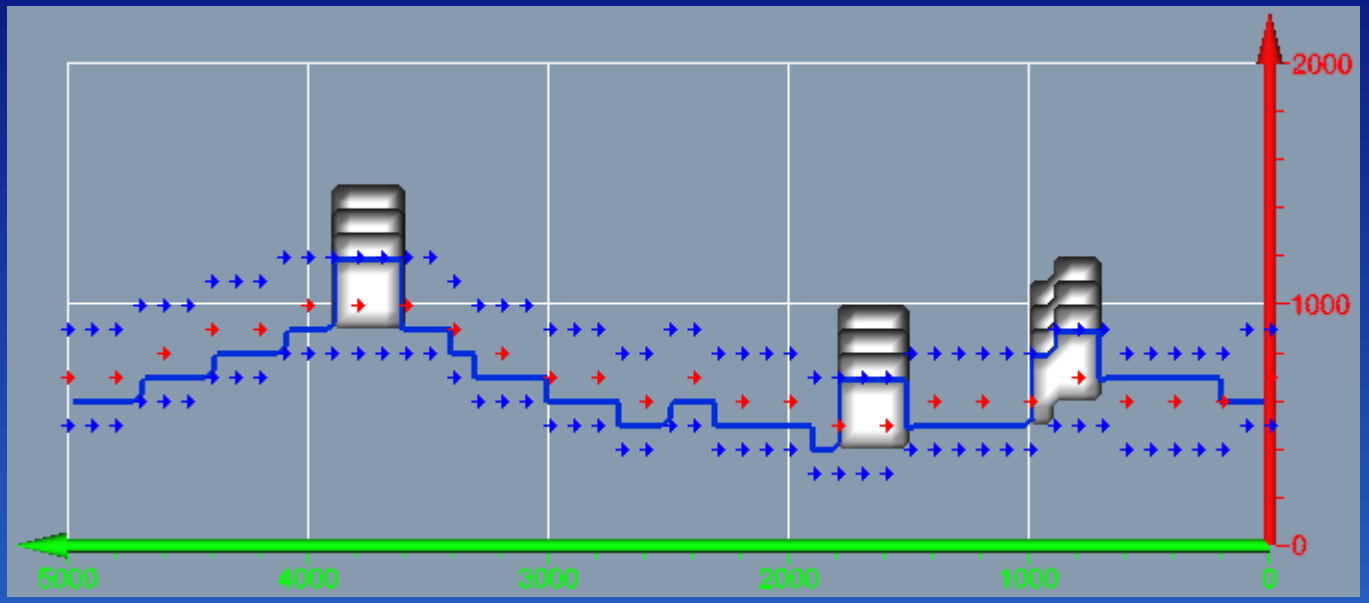


Cross section through the middle
of the chargeable centre body

Observations – 80º dip 3D Pole-Dipole

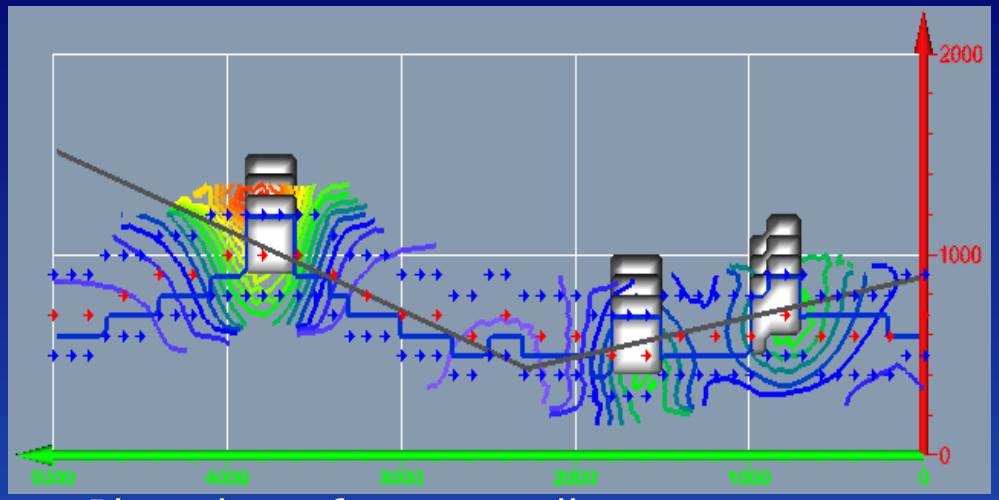
- This array achieves good chargeability mapping.

Strike parallel 2.5D Double Offset Dipole-Dipole

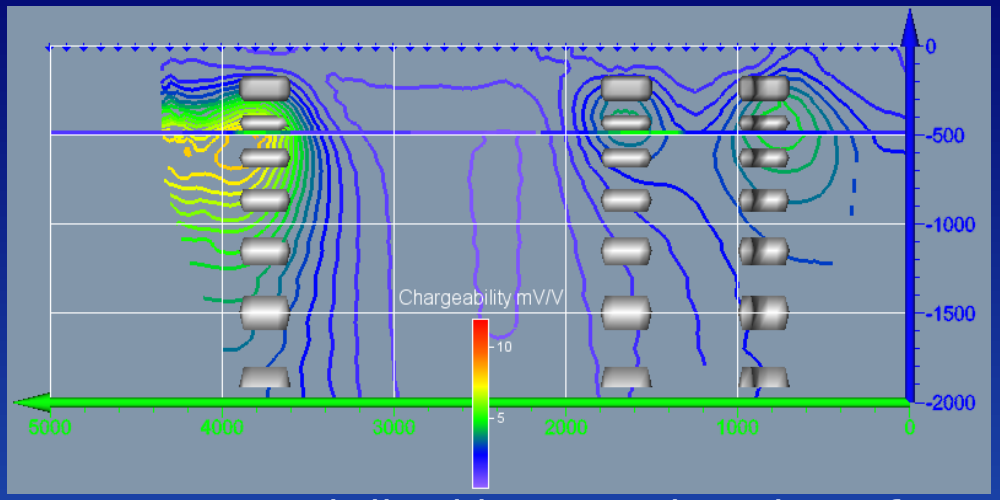


- 200m transmitter electrode spacing.
- 100m receiver electrode spacing.
- 200m line spacing.
- All electrodes active for each reading.
- Results masked in a window between ± 300m of the current electrode line.

Chargeability

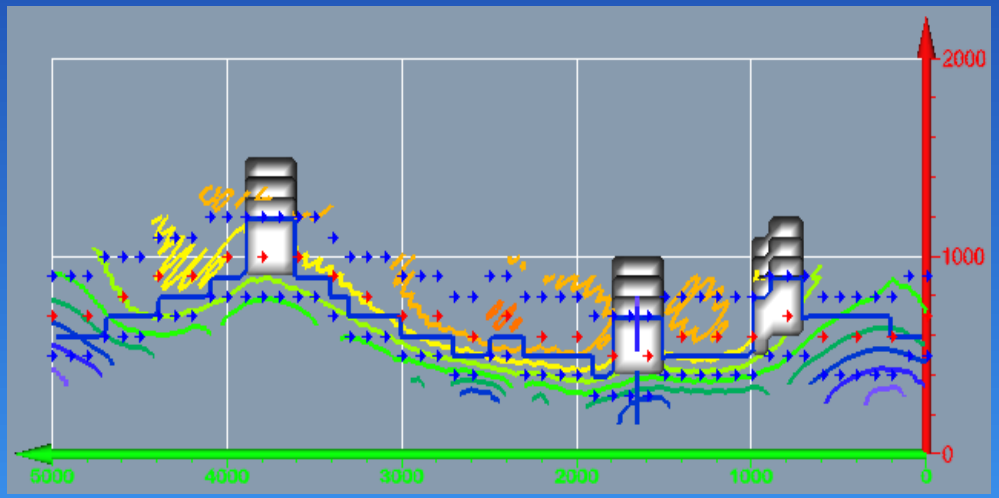


Plan view of contour slice
through maximum response

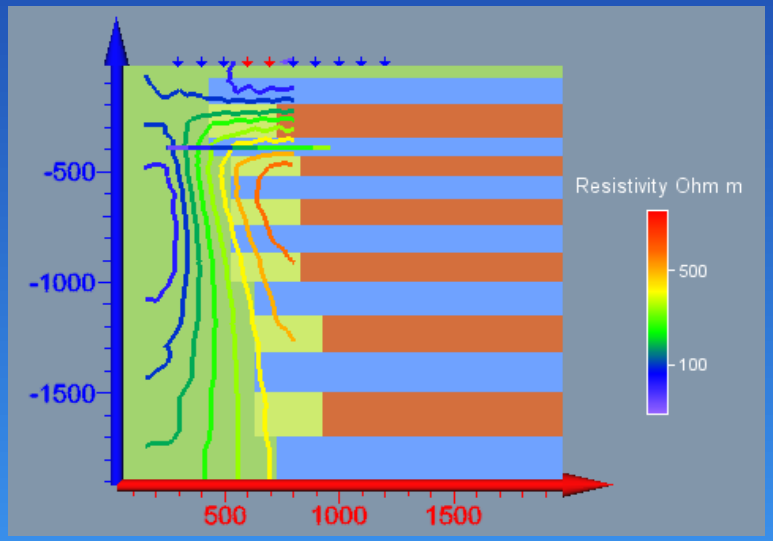


Bent and tilted long section view of
contours through body centres

Resistivity



Plan view of contour slice at -400m

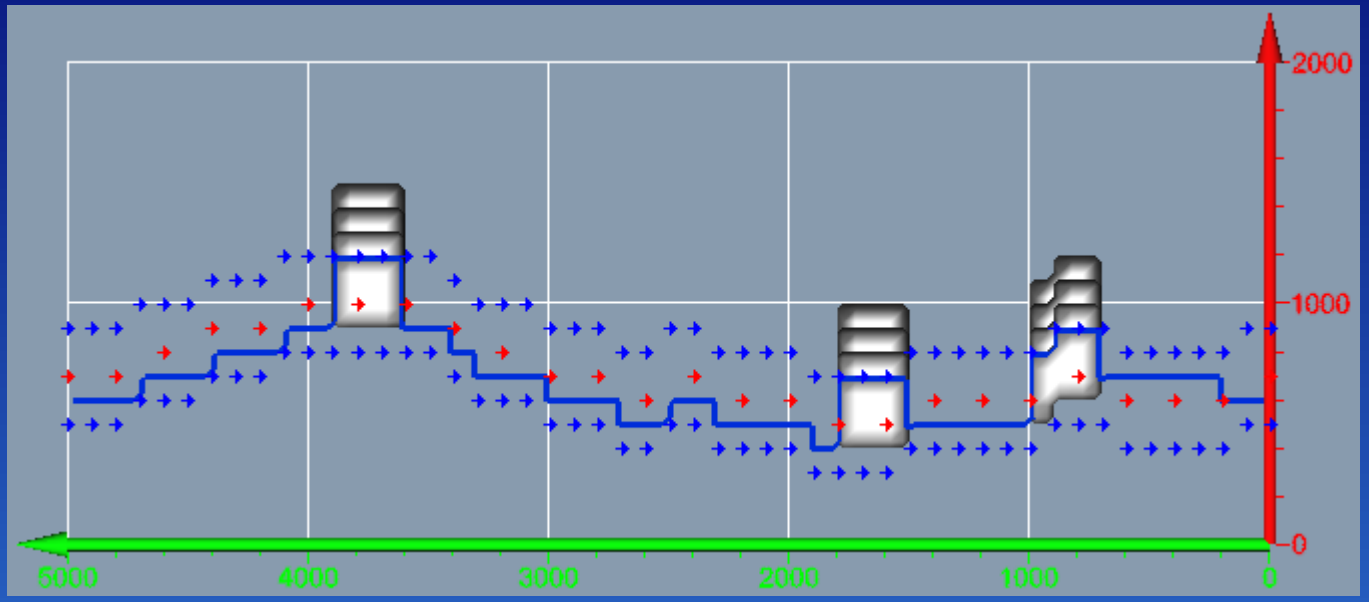


Cross section through the middle
of the chargeable centre body

Observations – 80º dip Strike parallel 2.5D

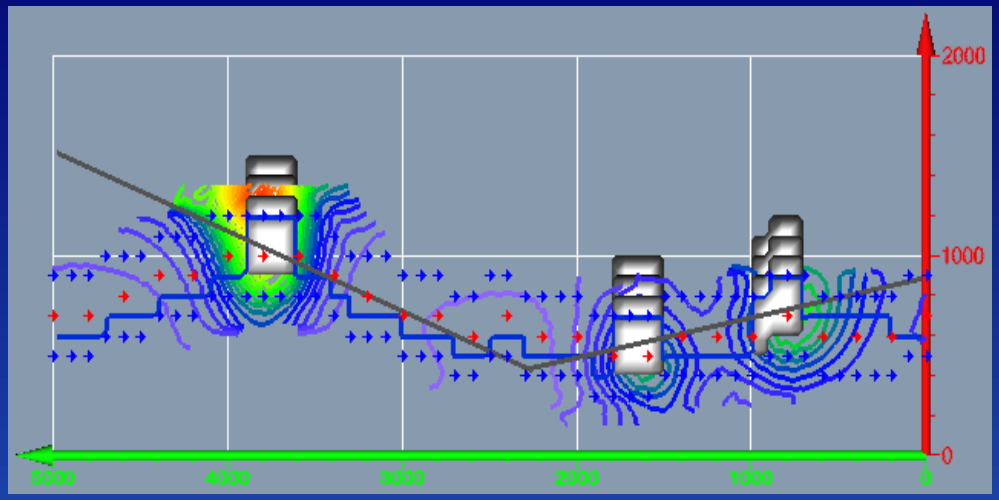
- This array achieves good dip and chargeability mapping.

Strike parallel 2.5D
Multipoles Double Offset Dipole-Dipole

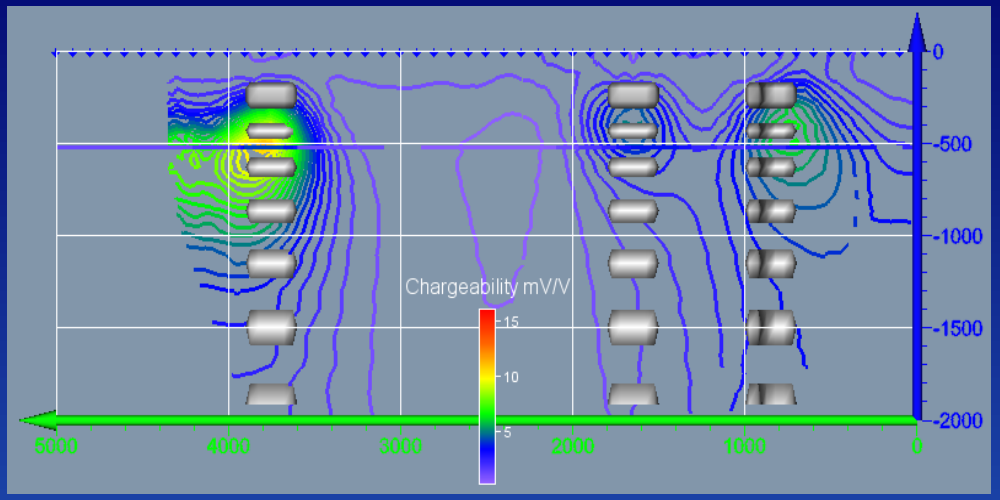


- 200m transmitter electrode spacing.
- 100m receiver electrode spacing with dipole sizes of 100m, 200m, 300m and 400m.
- 200m line spacing.
- All electrodes active for each reading.
- Results masked in a window between ± 300m of the current electrodes line.

Chargeability

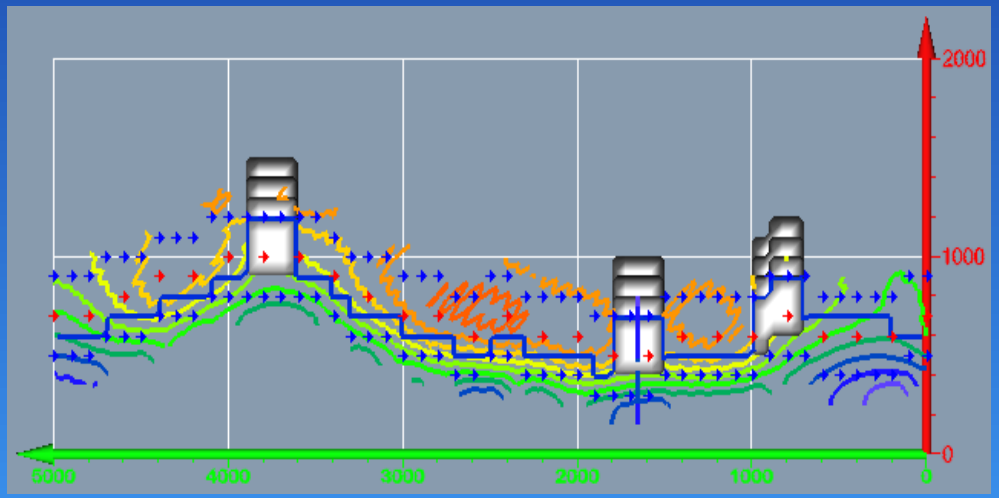


Plan view of contour slice
through maximum response

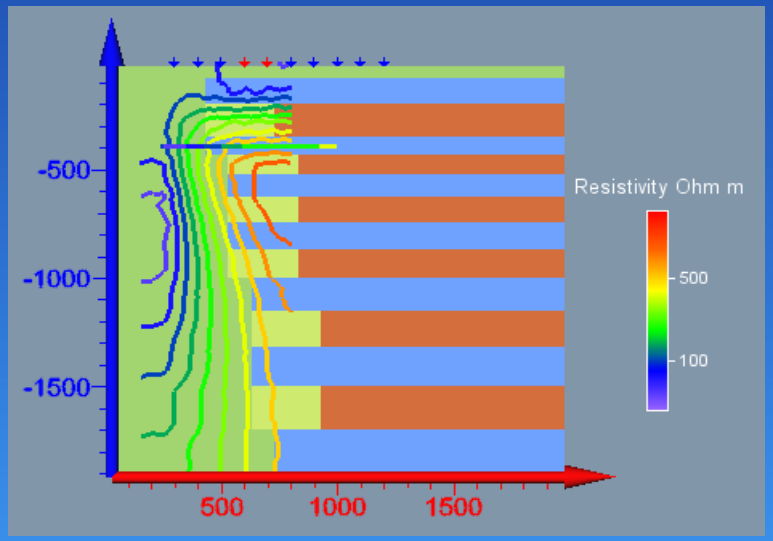


Bent and tilted long section view of
contours through body centres

Resistivity



Plan view of contour slice at -400m

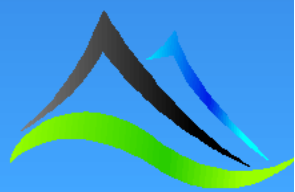


Cross section through the middle
of the chargeable centre body

Observations – 80º dip Strike parallel 2.5D multipole

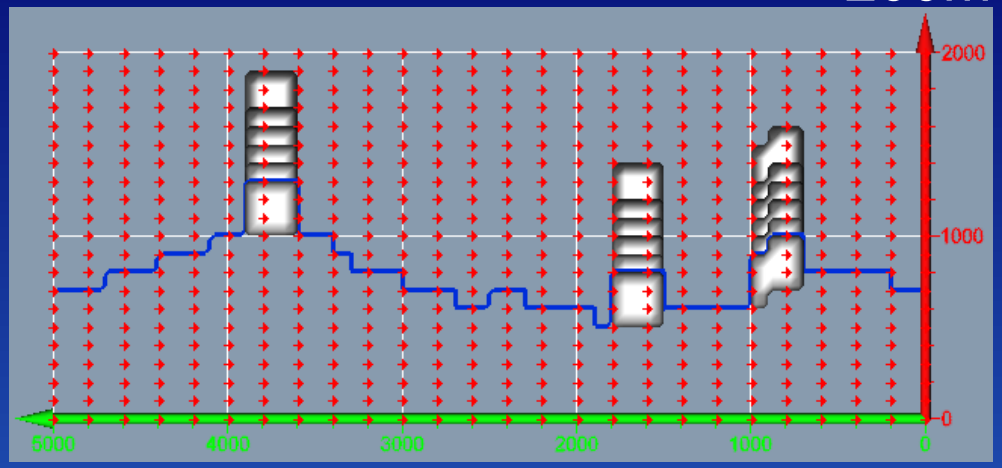
- This array achieves slightly better dip and chargeability mapping as compared to the non-multipole array.

Fault 70^{o} dip.

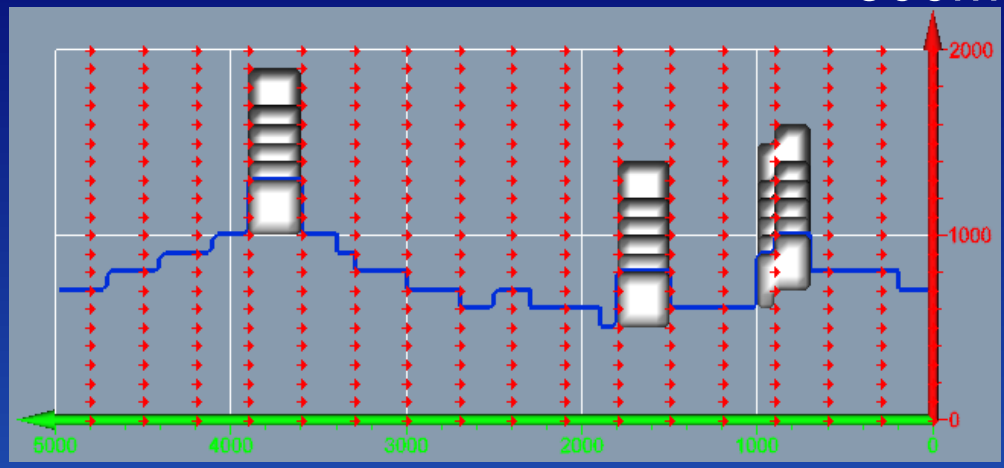


2D Dipole-Dipole with variable line spacing

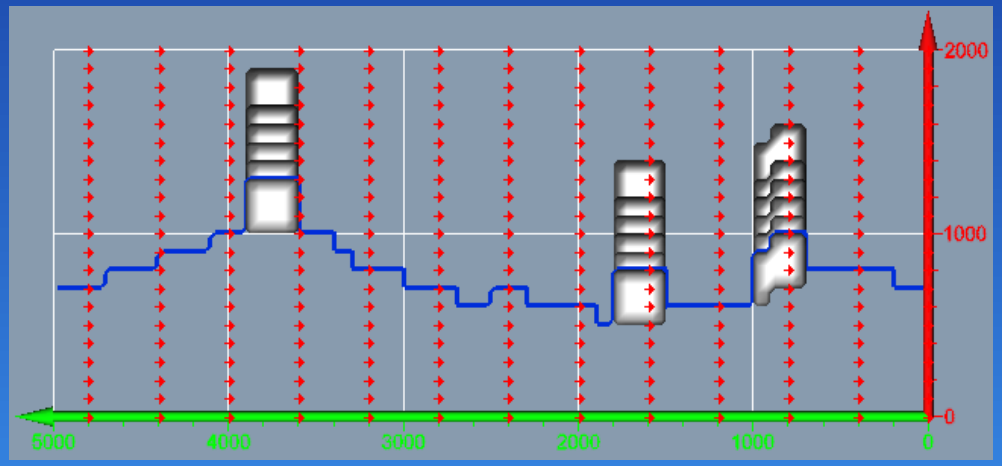
200m



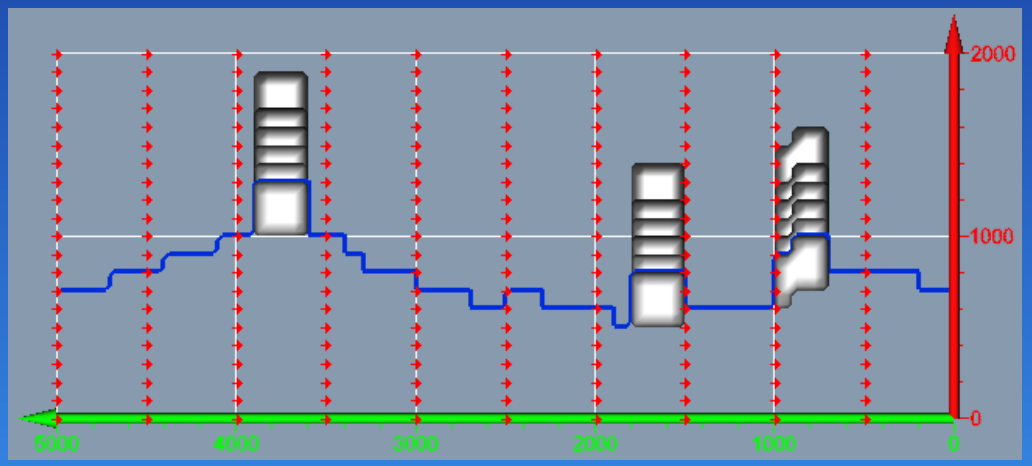
300m



400m



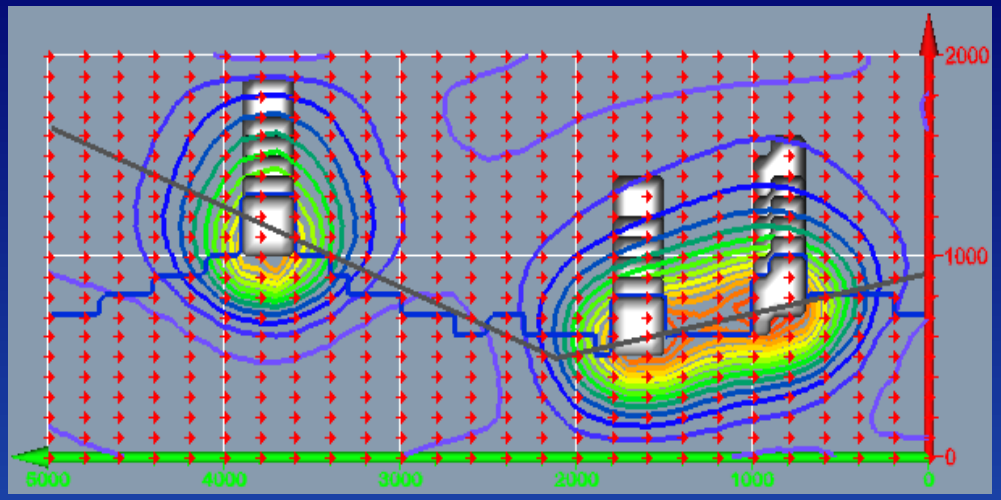
500m

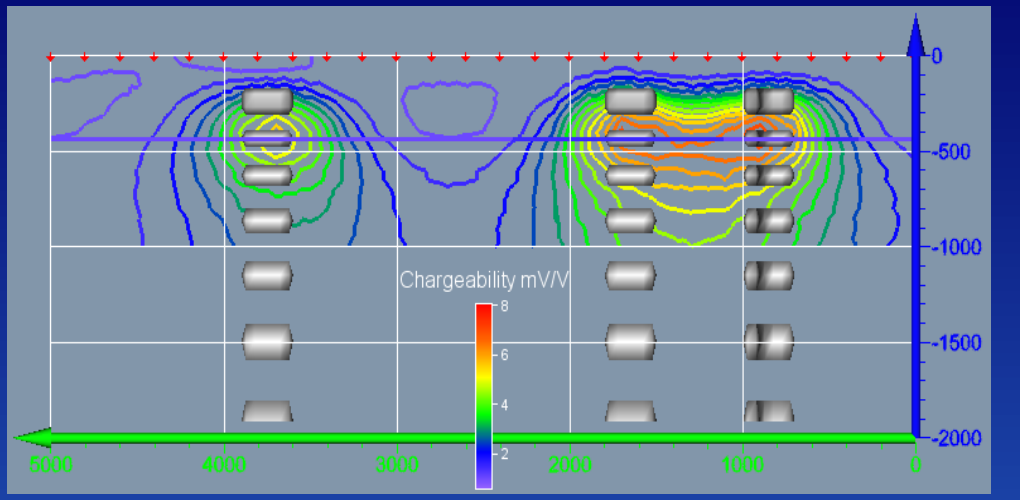


- 100m electrodes and 100m dipoles.
- 200m, 300m, 400m and 500m line spacing.
- Full line of 20 dipoles active each reading.

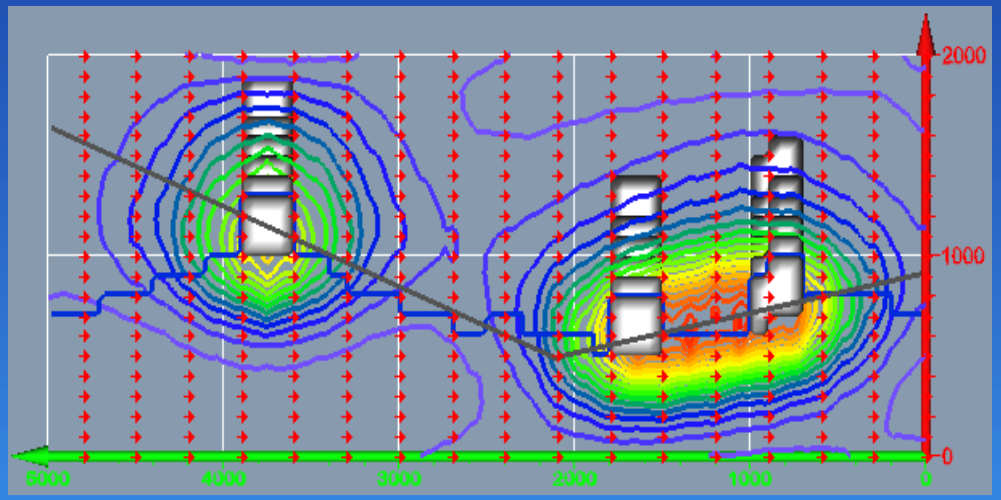
2DDD

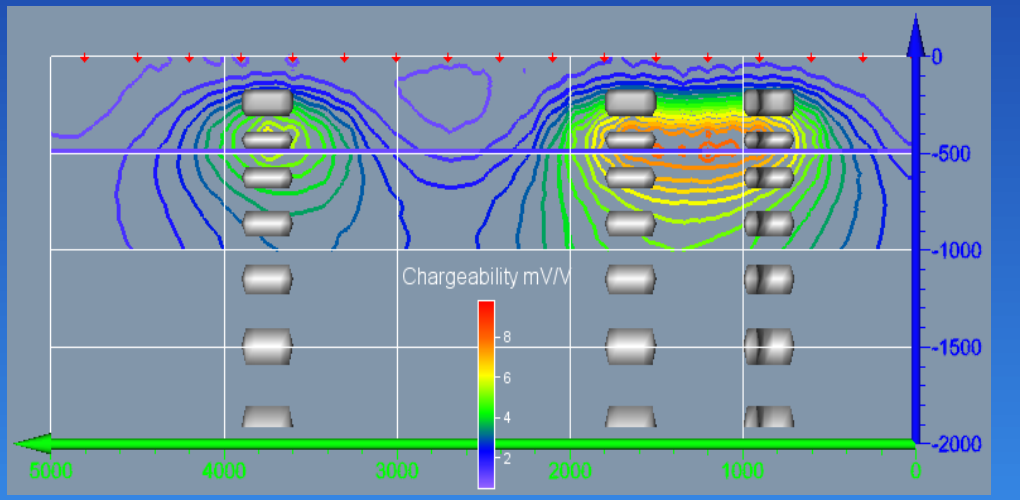
200m Chargeability





300m Chargeability



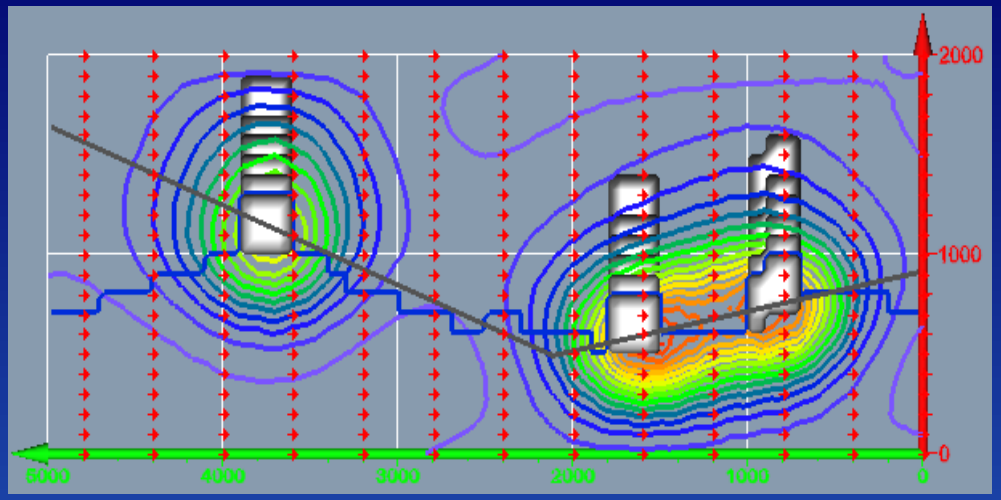


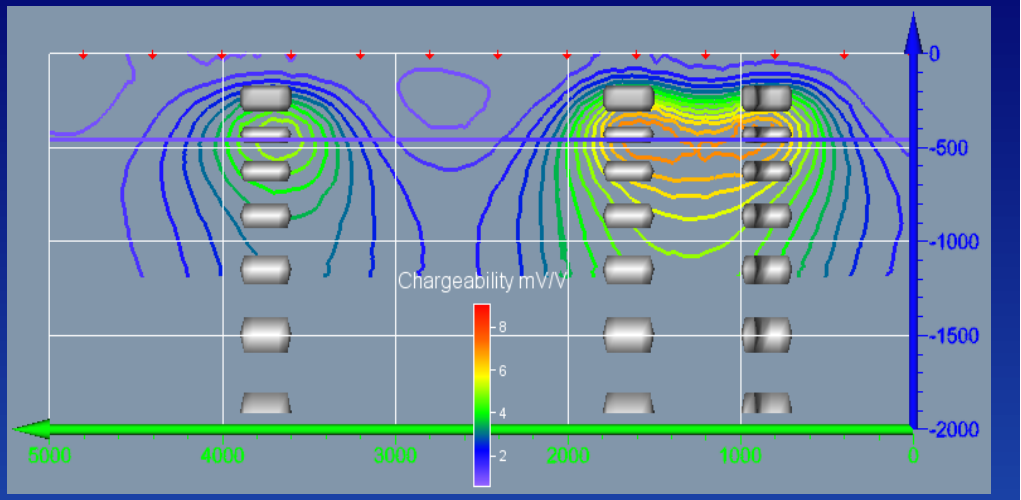
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

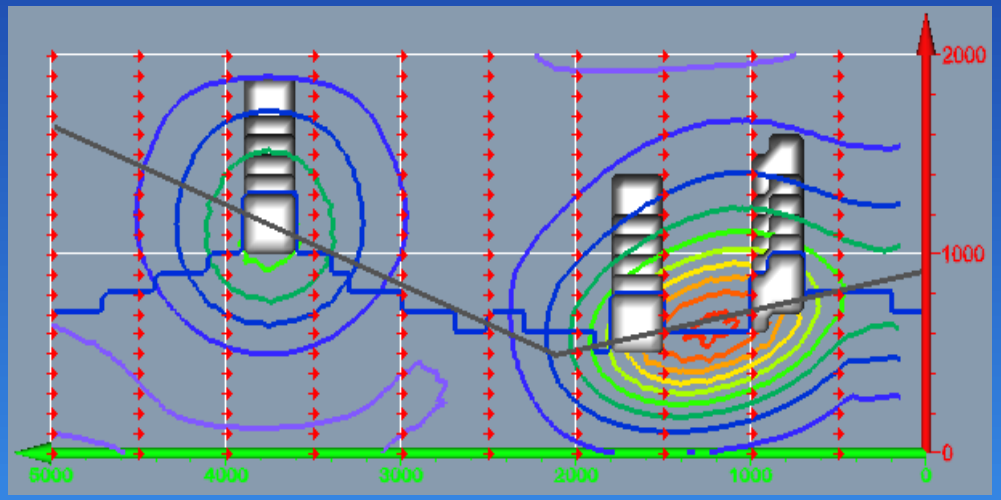
2DDD

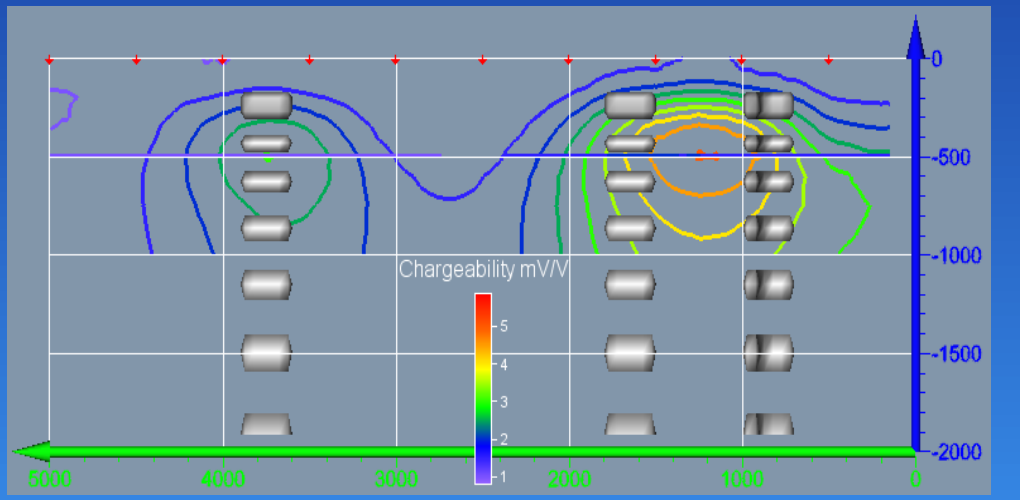
400m Chargeability





500m Chargeability



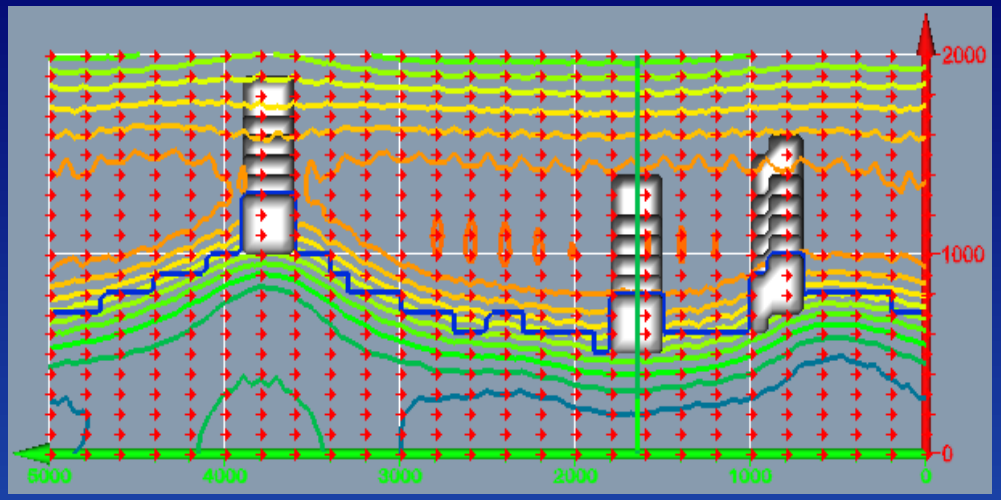


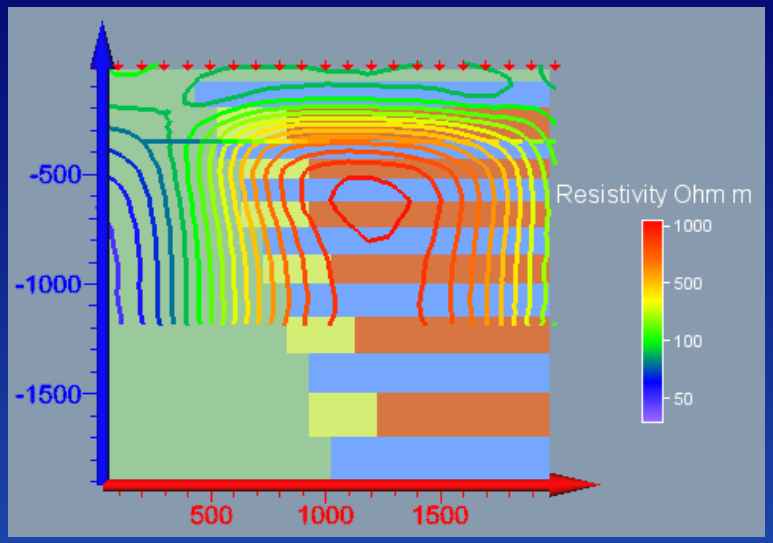
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

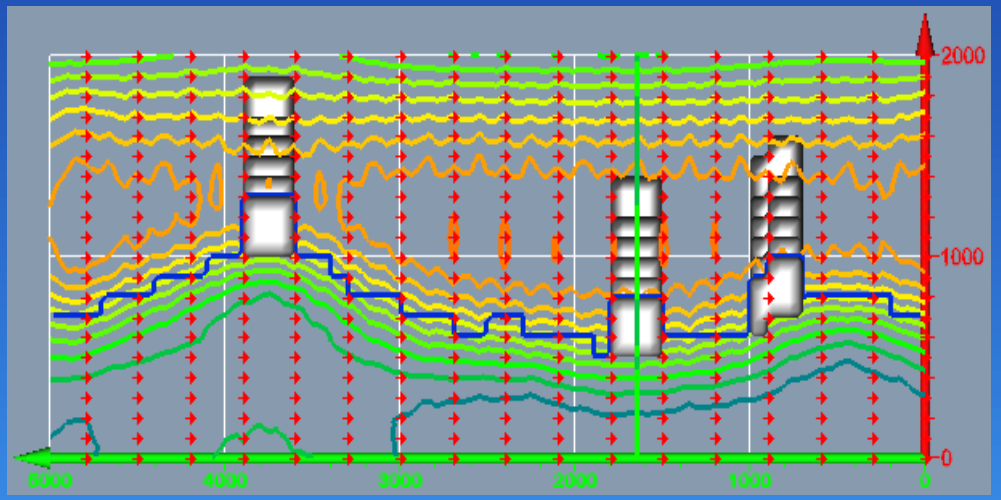
2DDD

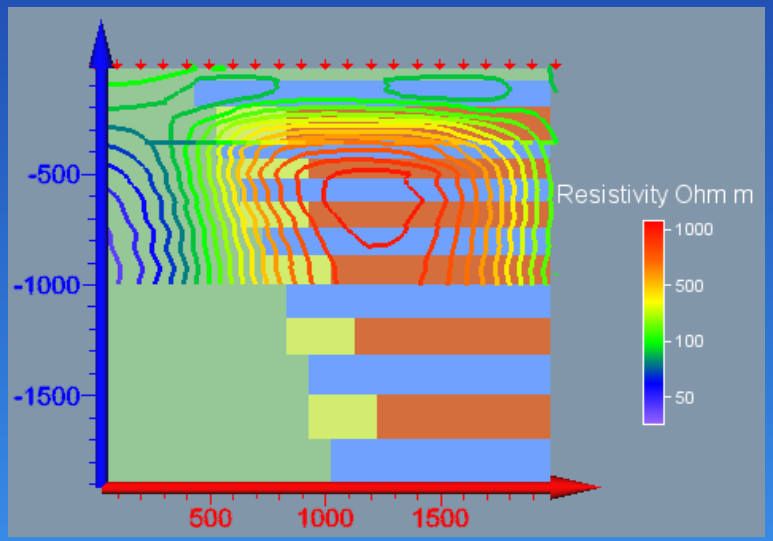
200m Resistivity





300m Resistivity



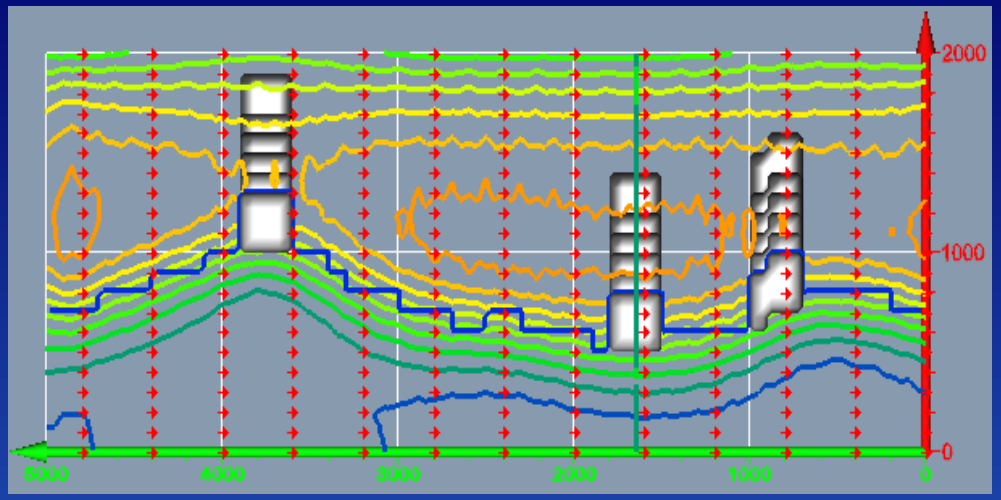


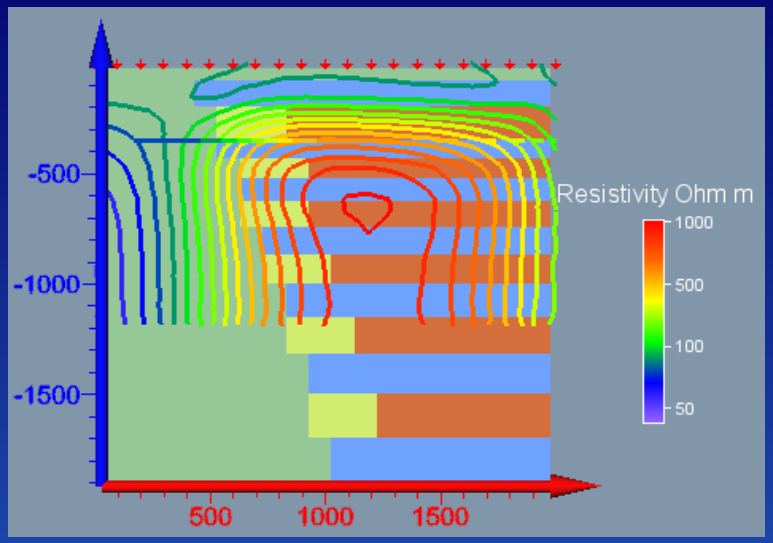
Plan view of contour slice through the middle of the chargeable centre body

Cross section through the middle of the chargeable centre body

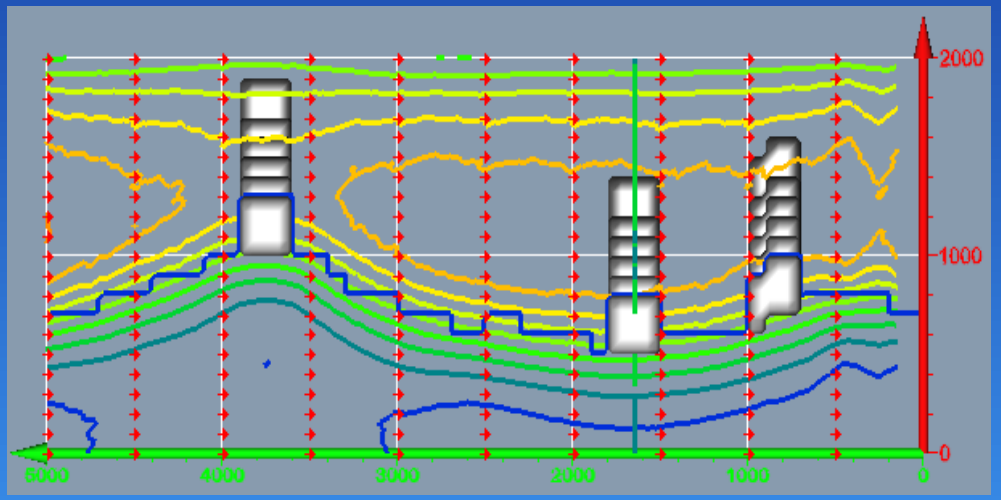
2DDD

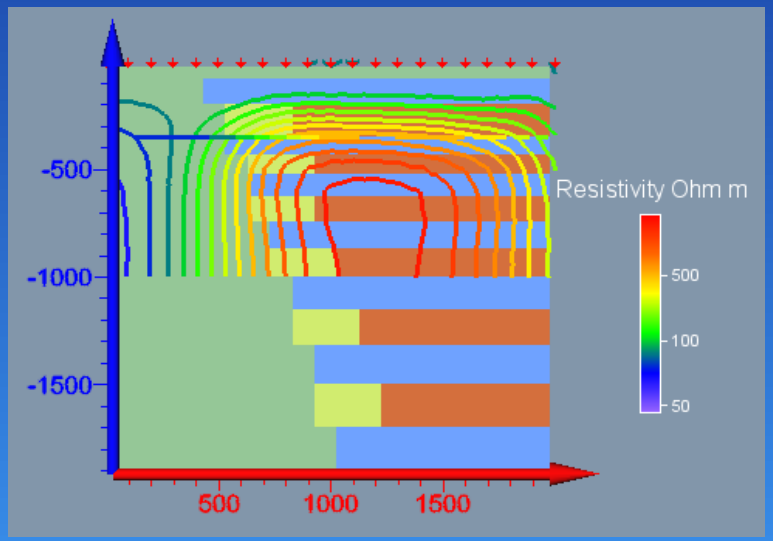
400m Resistivity





500m Resistivity

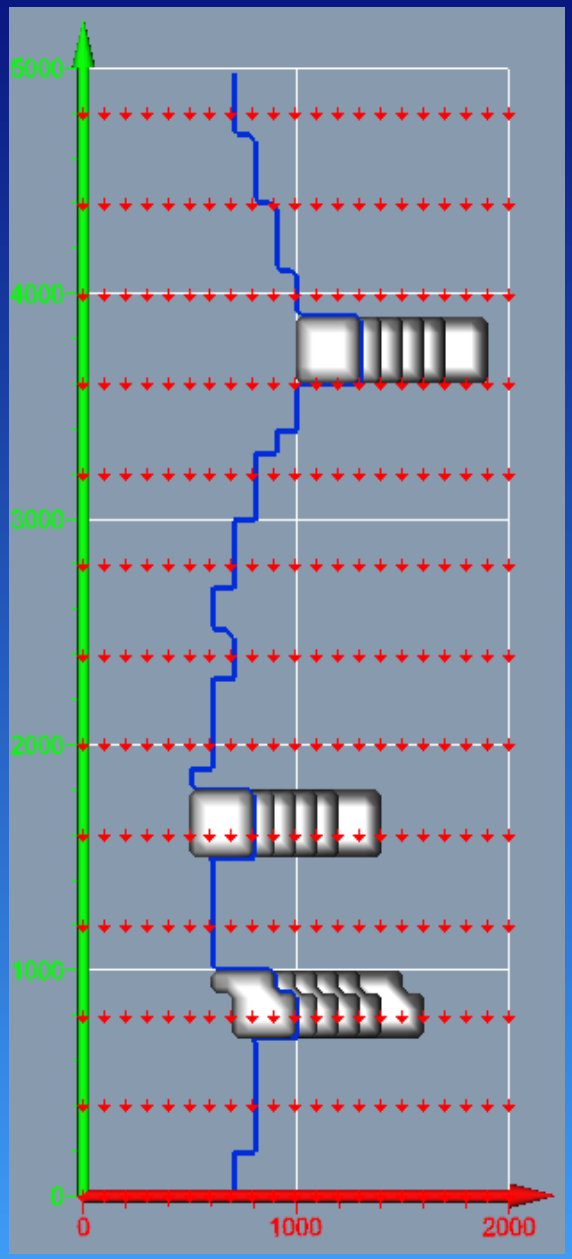




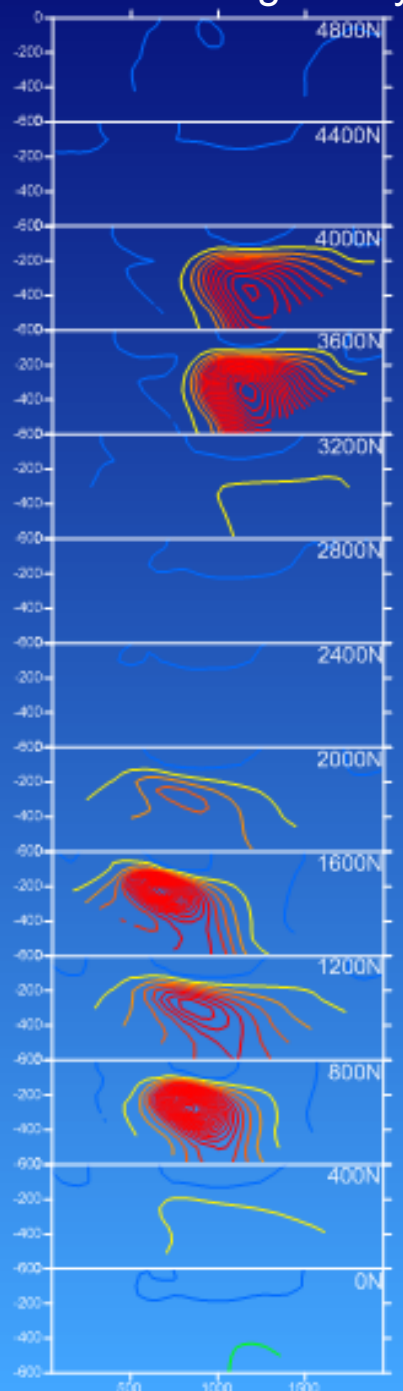
Plan view of contour slice through the middle of the chargeable centre body

Cross section through the middle of the chargeable centre body

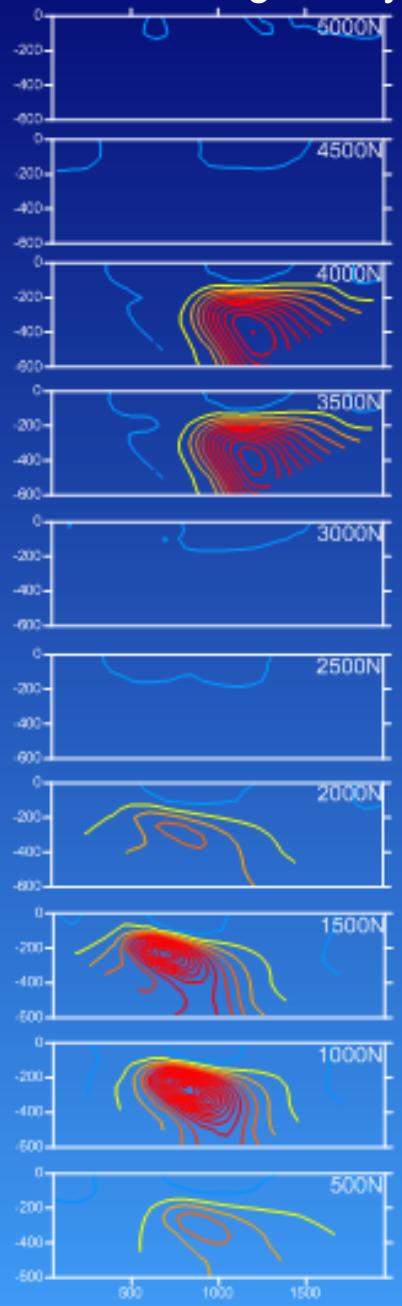
2D inversion sections

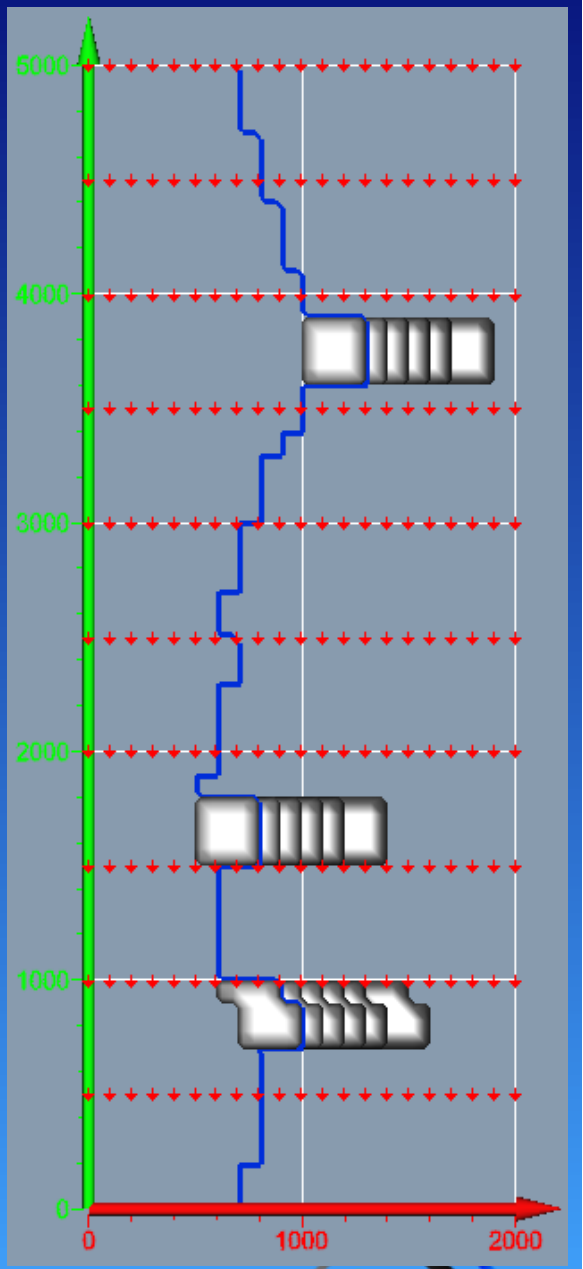


400m Chargeability

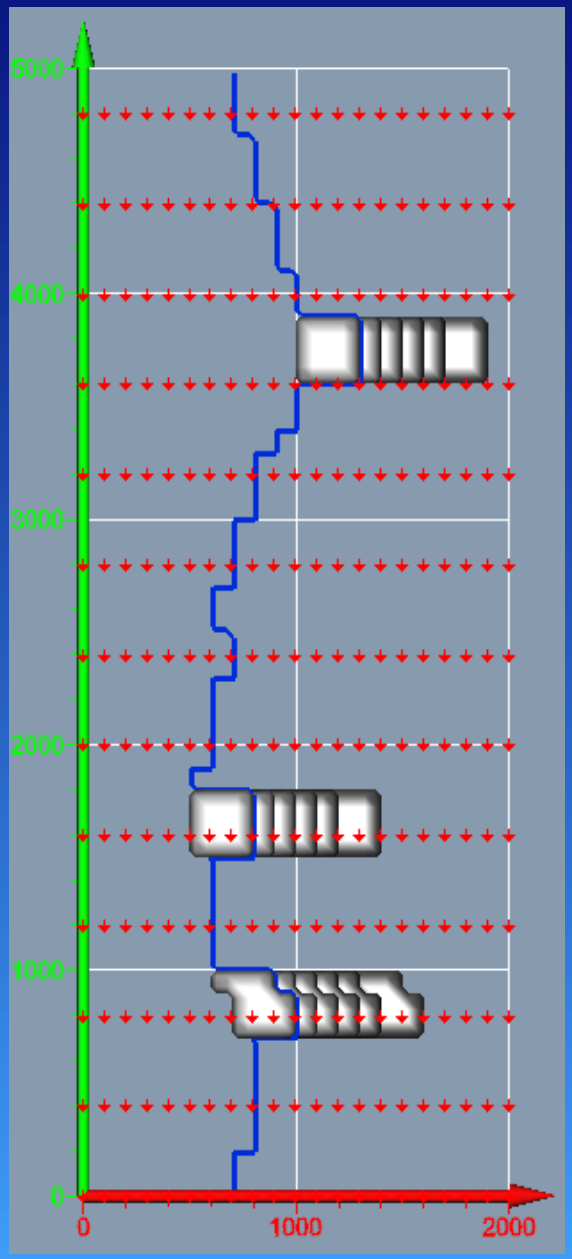


500m Chargeability

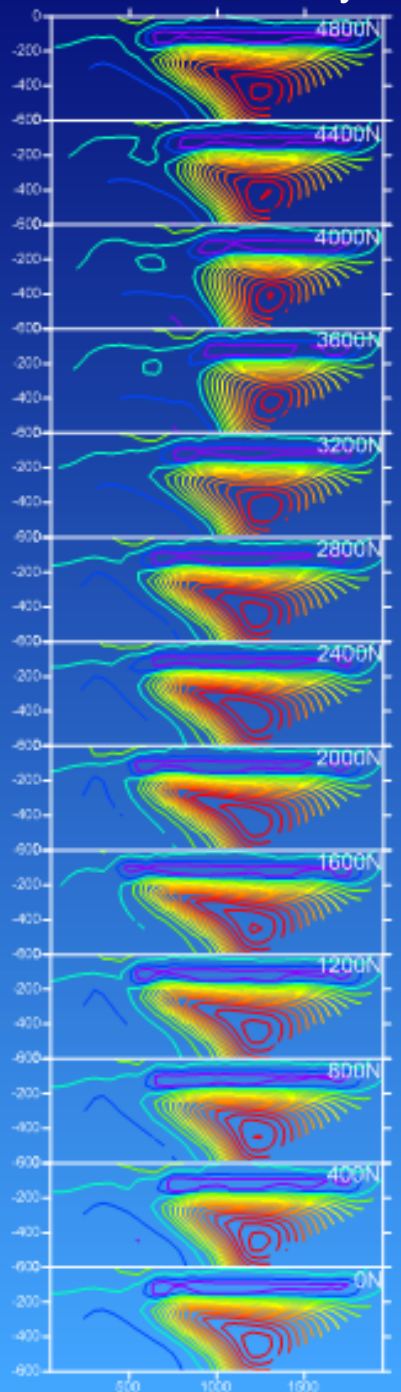




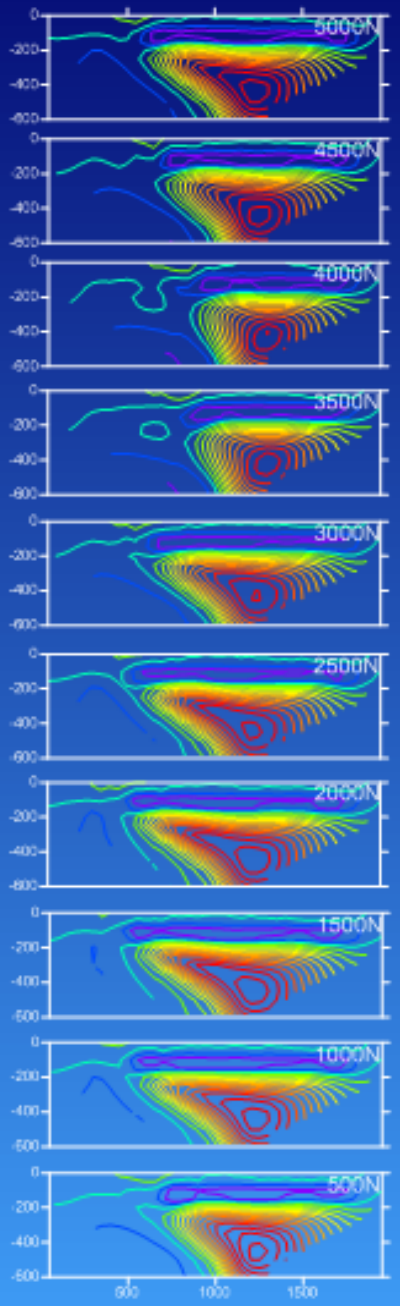
2D inversion sections

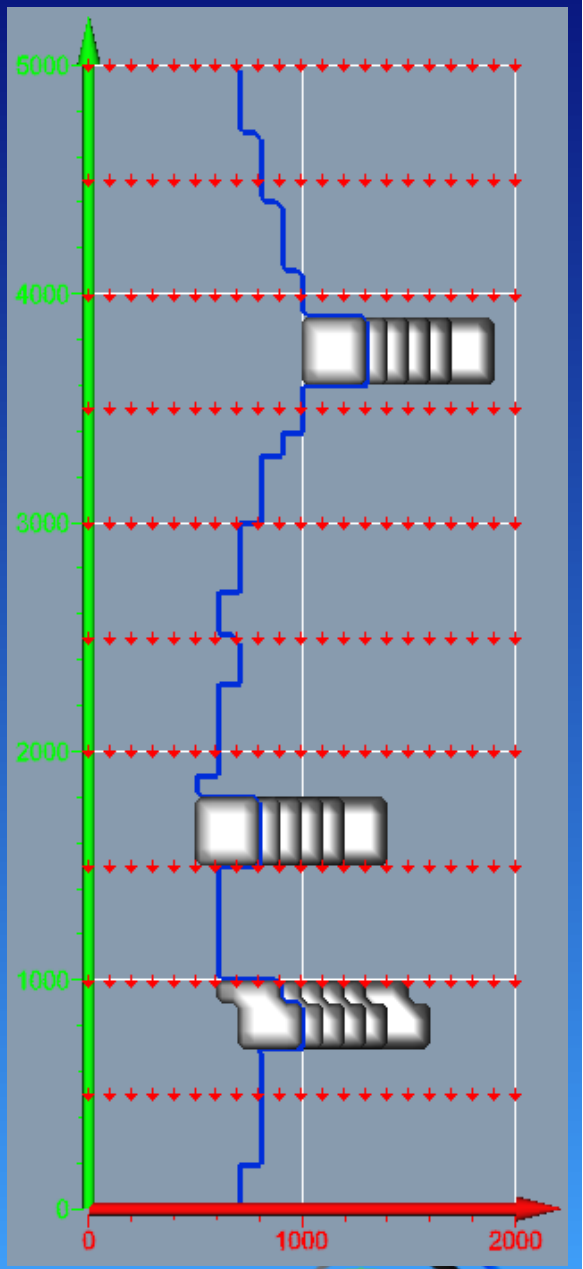


400m Resistivity



500m Resistivity



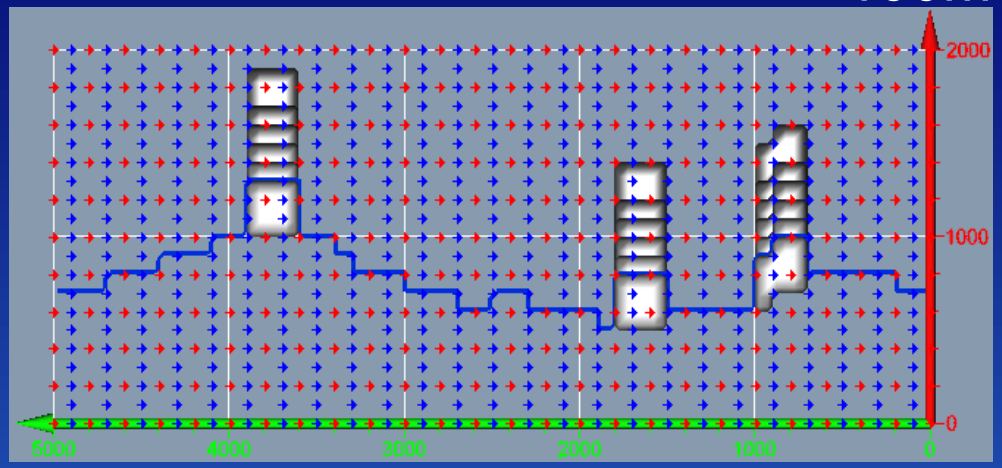


Observations – 70º dip 2D Dipole-Dipole

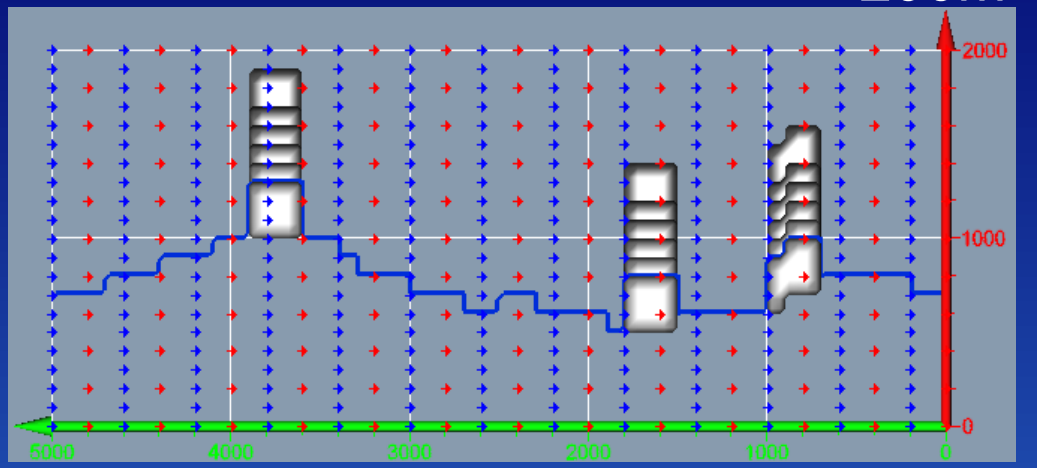
- The 2D inversion appears to do a better job of resolving the dip than the 3D inversion.
- 500m line spacing will lead to poor drill hole design as was the case for the 80º dip example.

2.5D QODD with variable line spacing

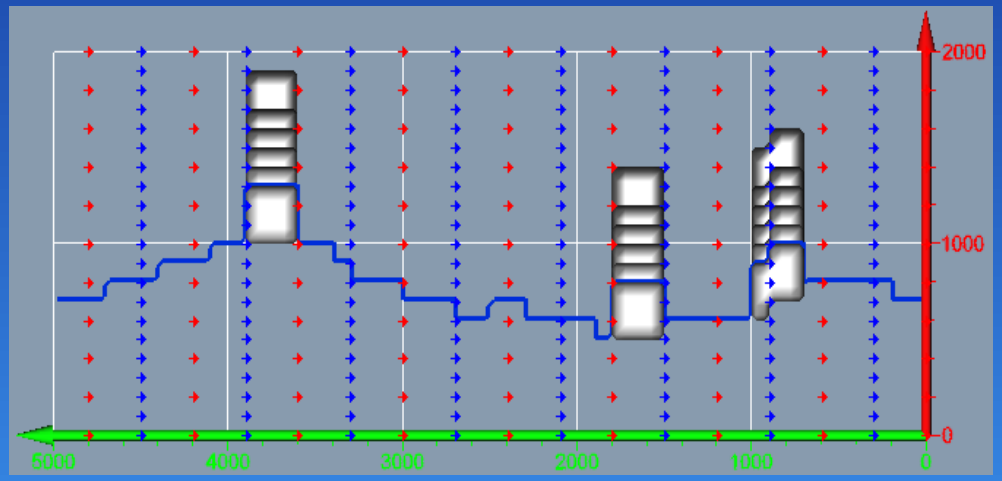
100m



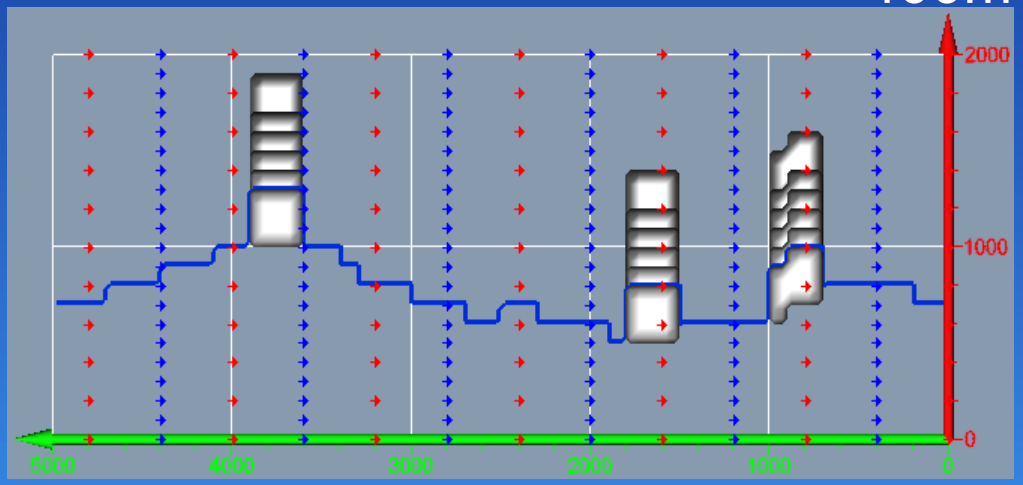
200m



300m



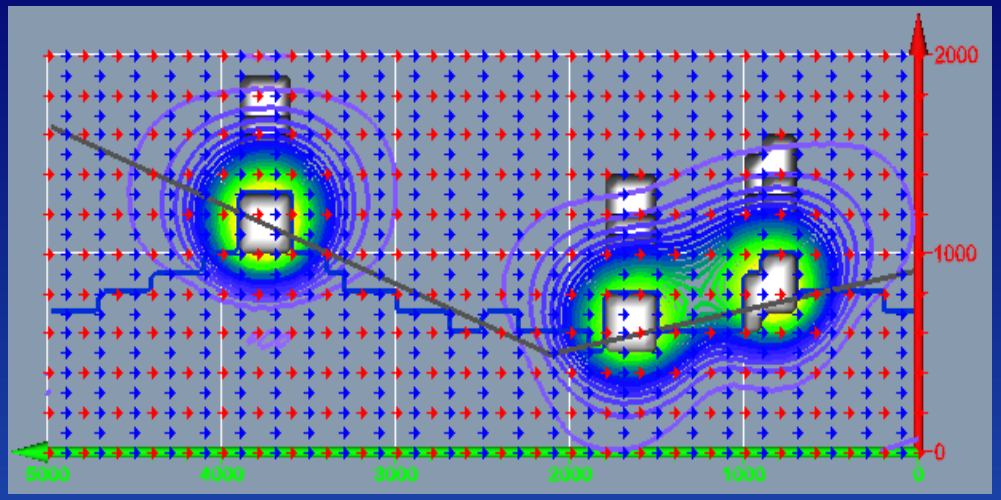
400m

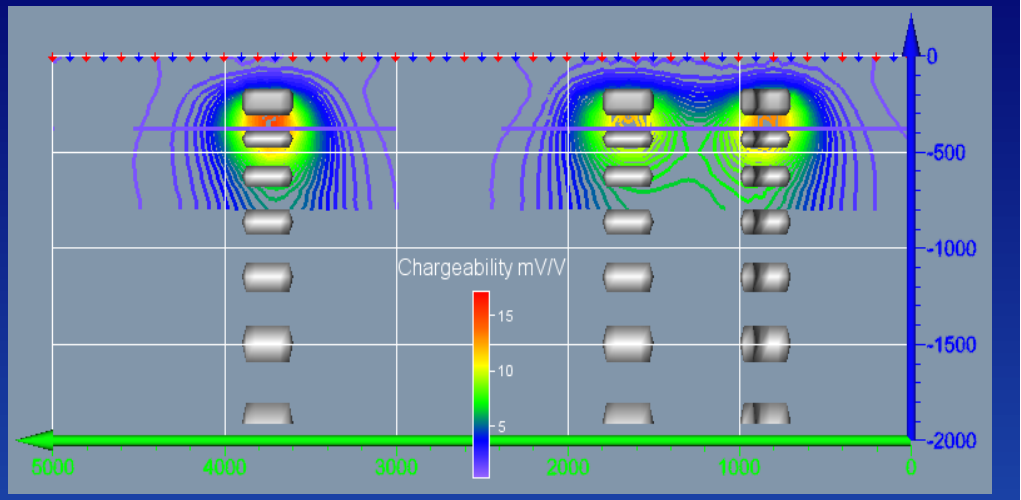


- 200m electrode spacing.
- 100m receiver electrode spacing with dipole sizes of 100m, 200m, 300m and 400m.
- 100m, 200m, 300m and 400m line spacing.
- 4 lines of 20 dipoles active each reading

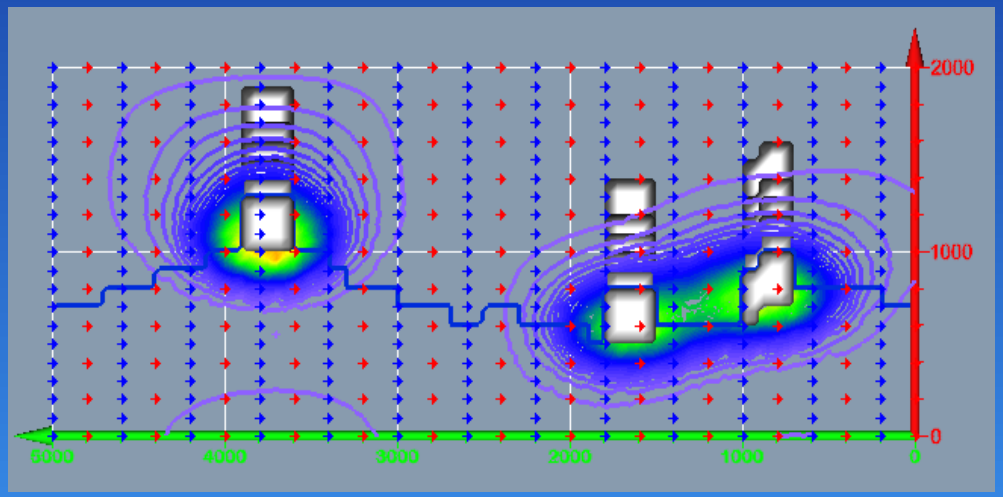
2.5D QODD

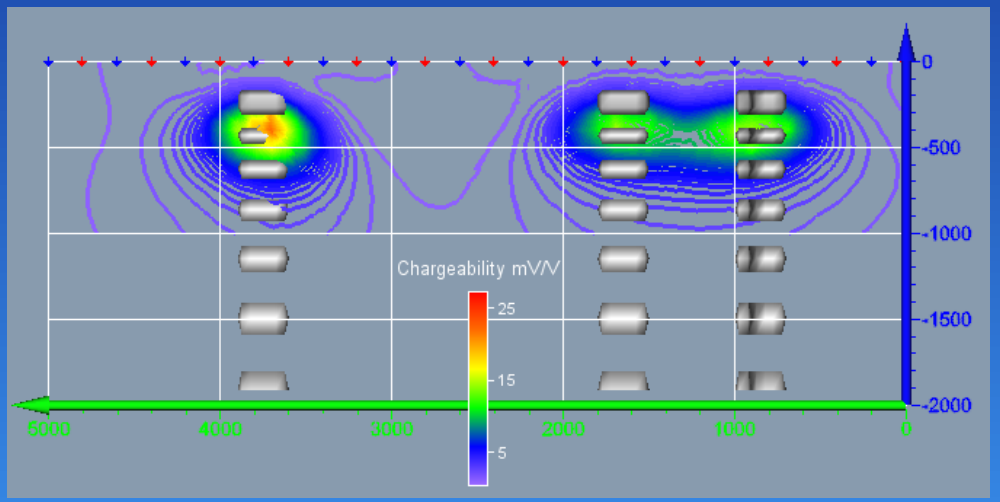
100m Chargeability





200m Chargeability



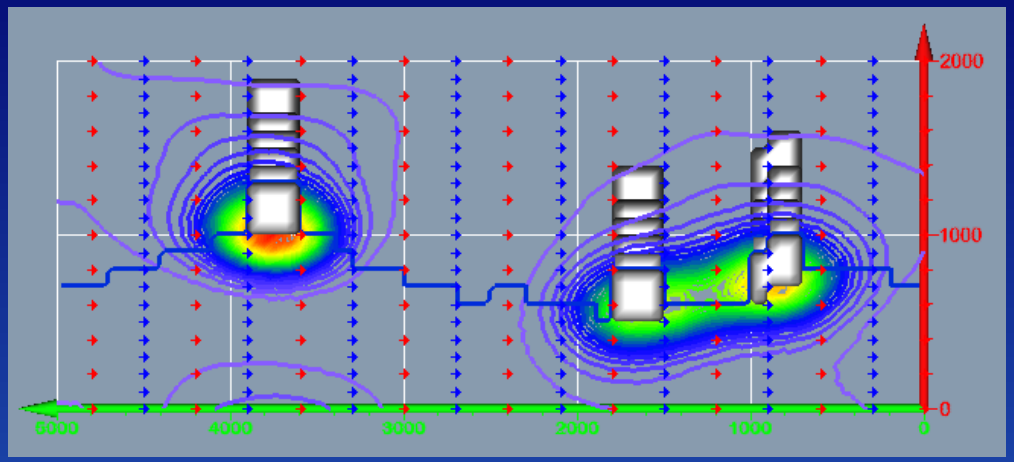


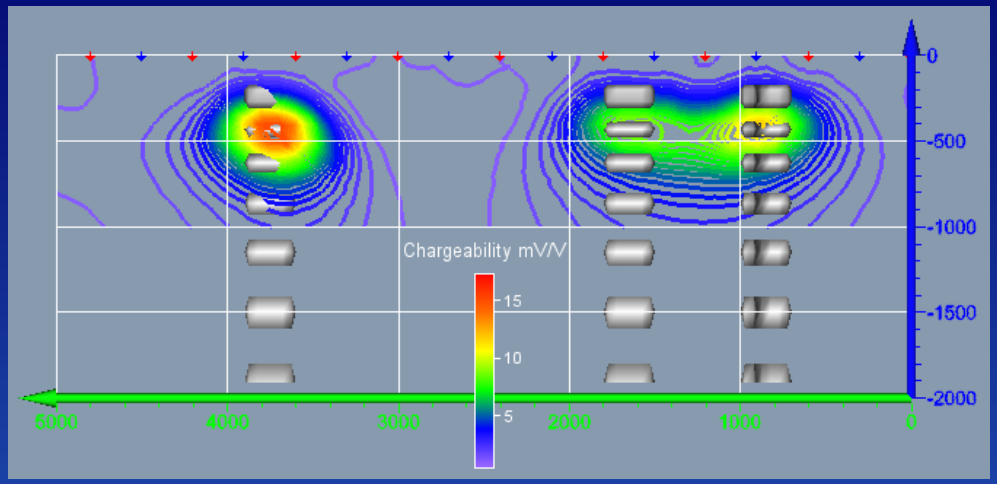
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

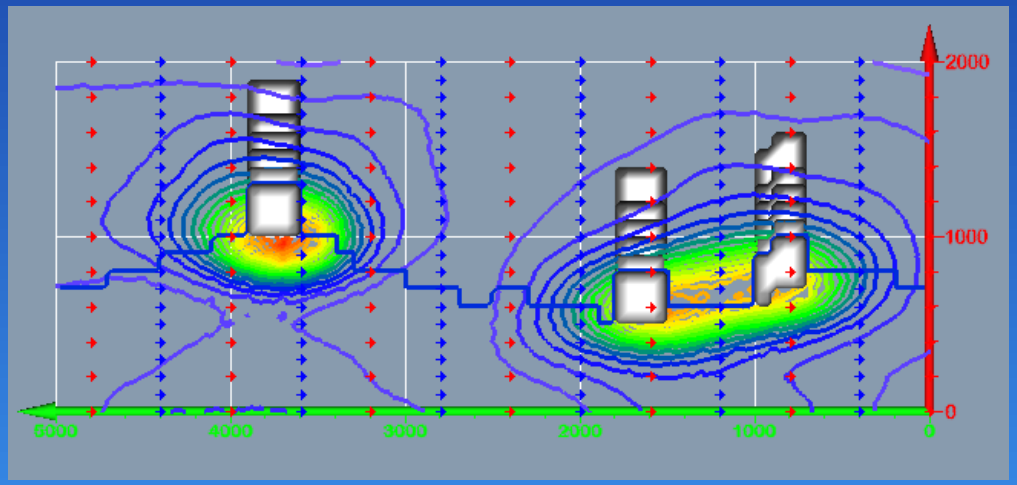
2.5D QODD

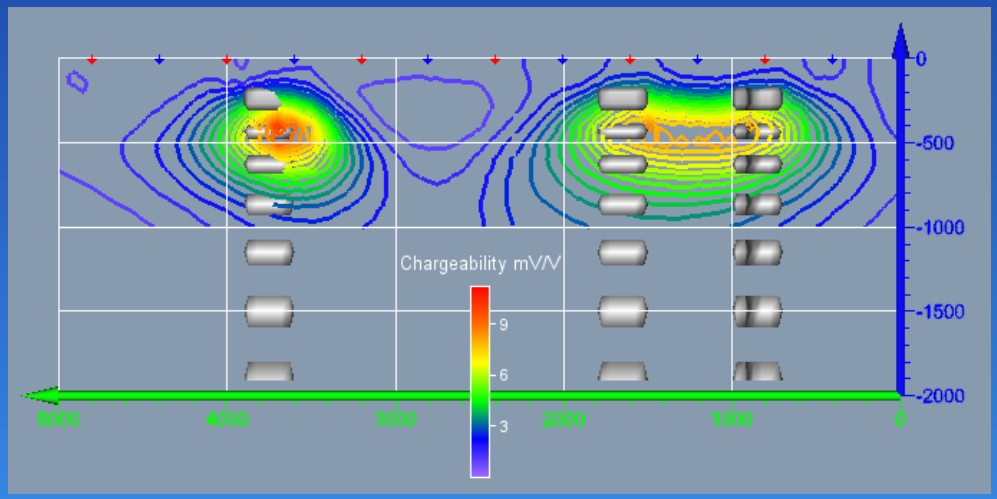
300m Chargeability





400m Chargeability



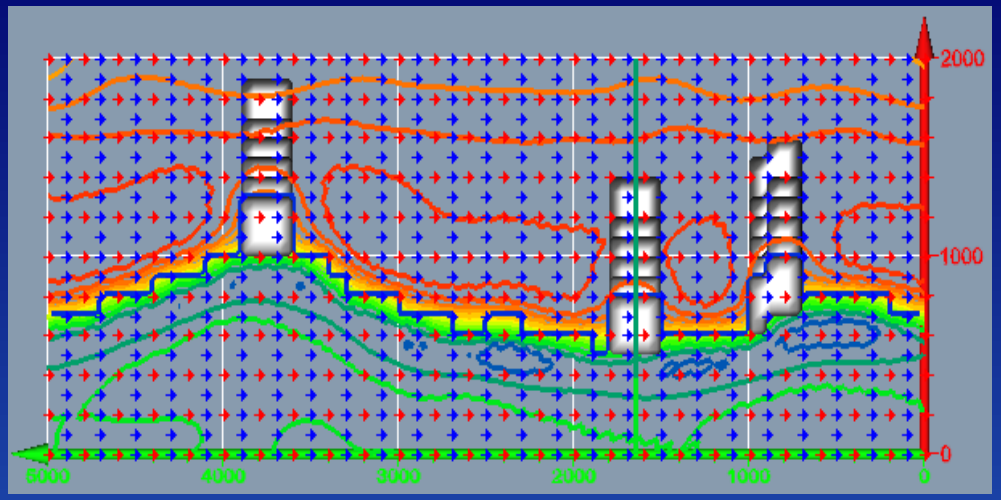


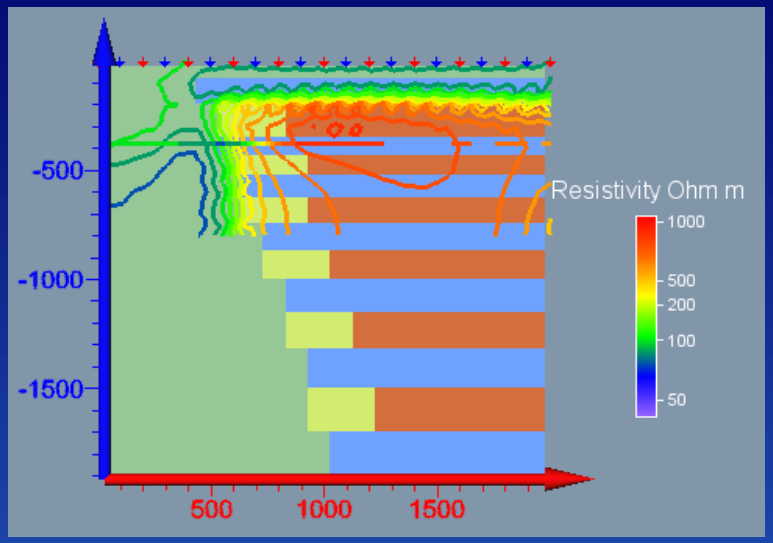
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

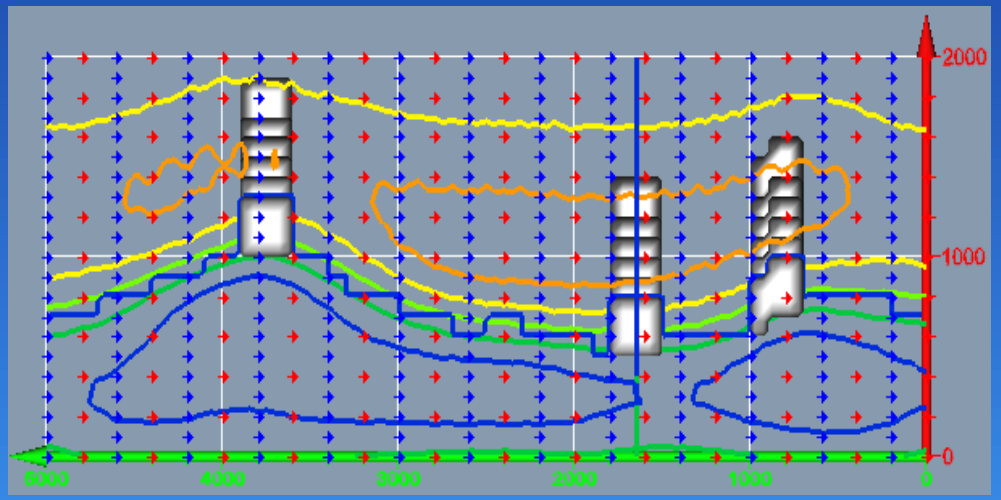
2.5D QODD

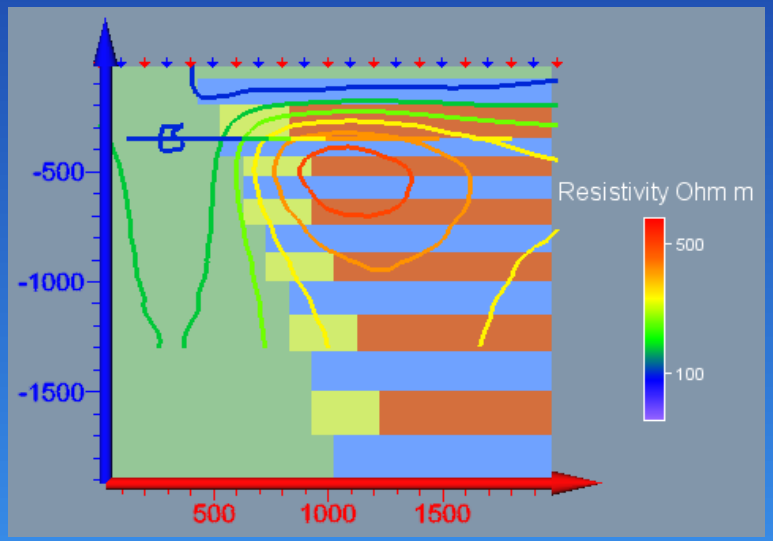
100m Resistivity





200m Resistivity



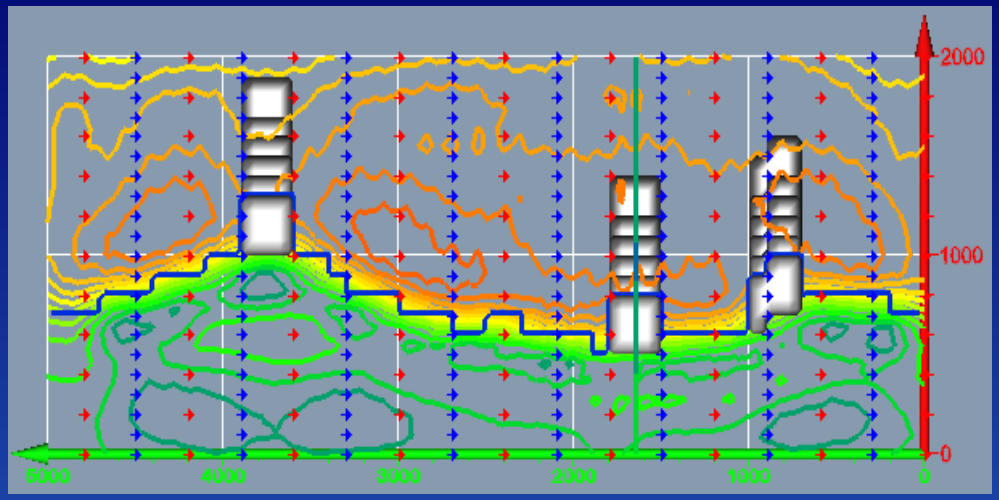


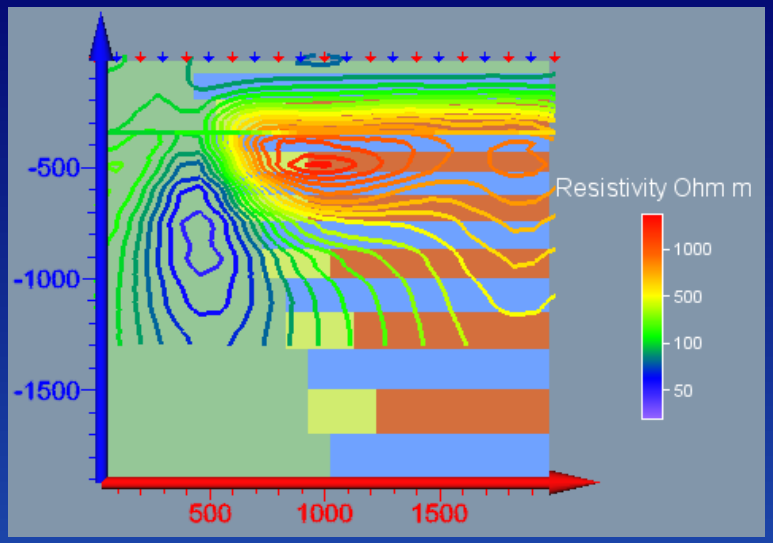
Plan view of contour slice through the middle of the chargeable centre body

Cross section through the middle of the chargeable centre body

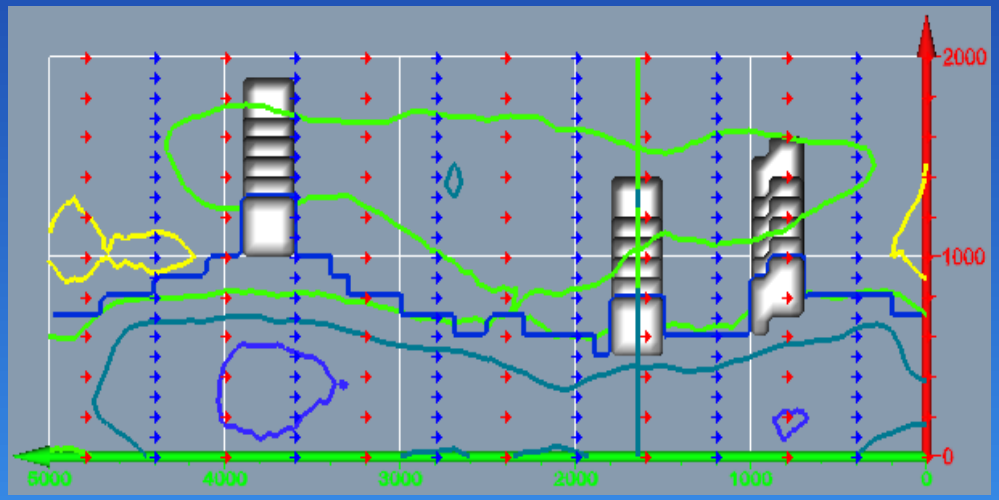
2.5D QODD

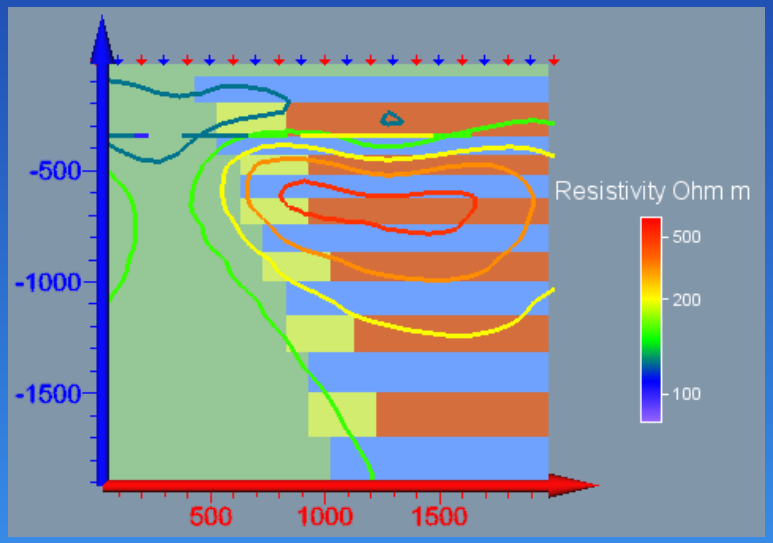
300m Resistivity





400m Resistivity





Plan view of contour slice through the middle of the chargeable centre body

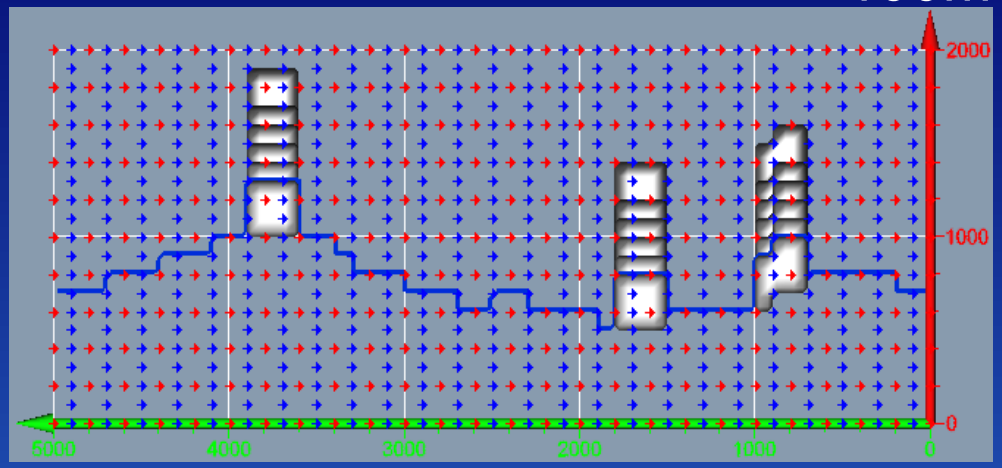
Cross section through the middle of the chargeable centre body

Observations – 70º dip 2.5D QODD

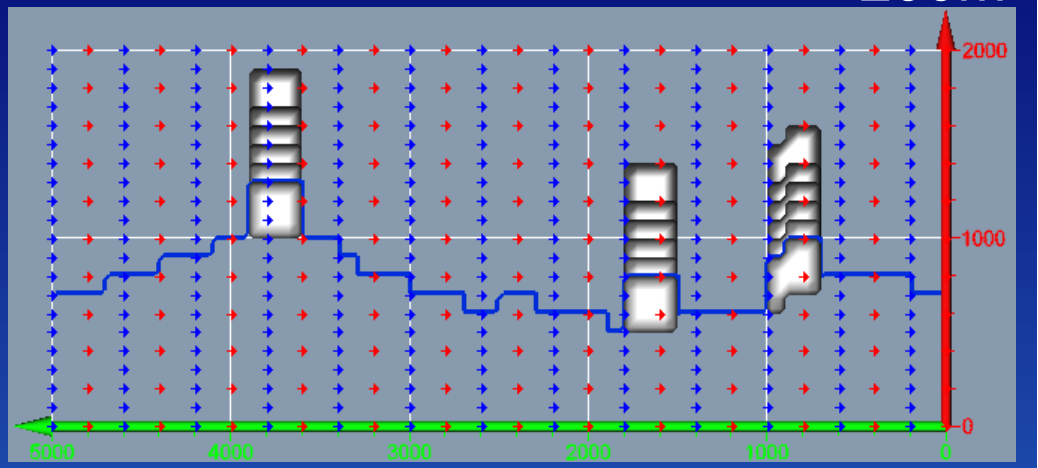
- Good dip resolution is apparent in all line spacings and the 100m line spacing resolves the two closely spaced chargeable bodies very well.

2.5D Multipole QODD with variable line spacing

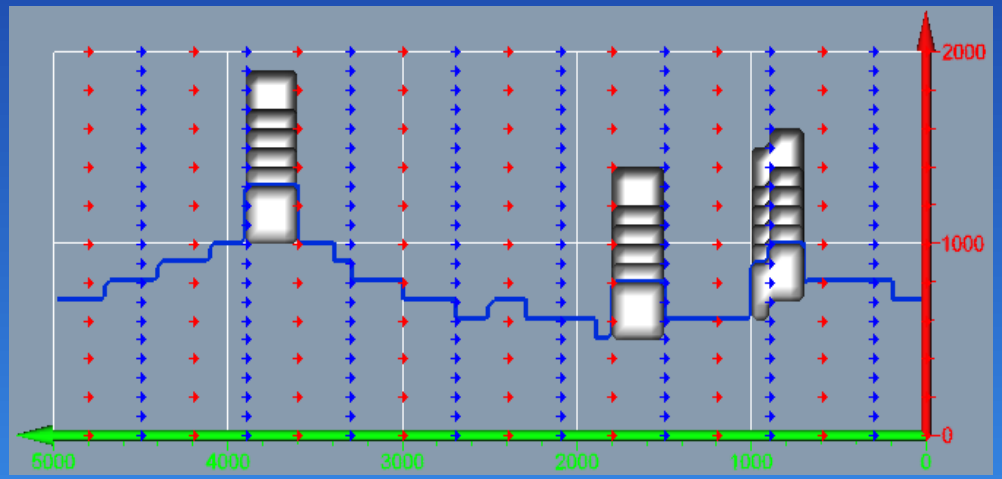
100m



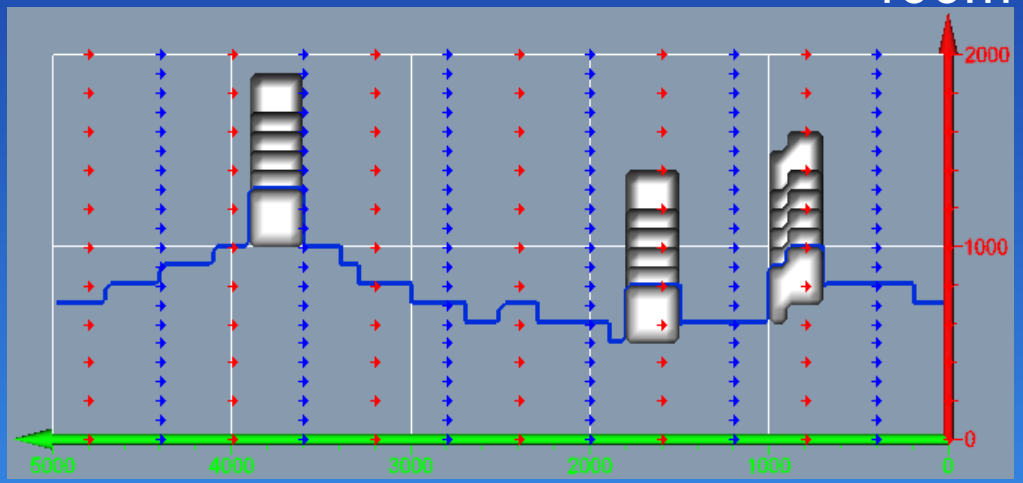
200m



300m



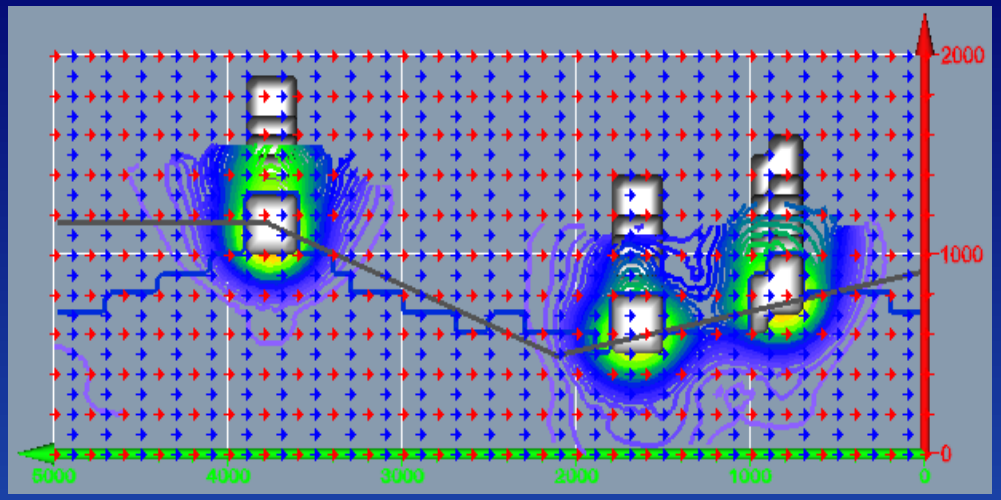
400m

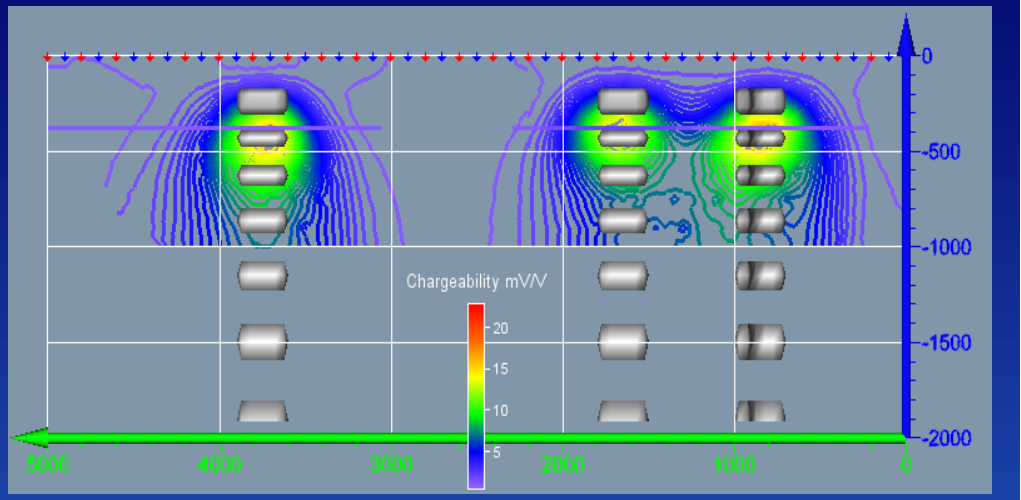


- 200m transmitter electrode spacing.
- 100m receiver electrode spacing.
- 100m, 200m, 300m and 400m line spacing.
- 4 lines of 20 dipoles active each reading.

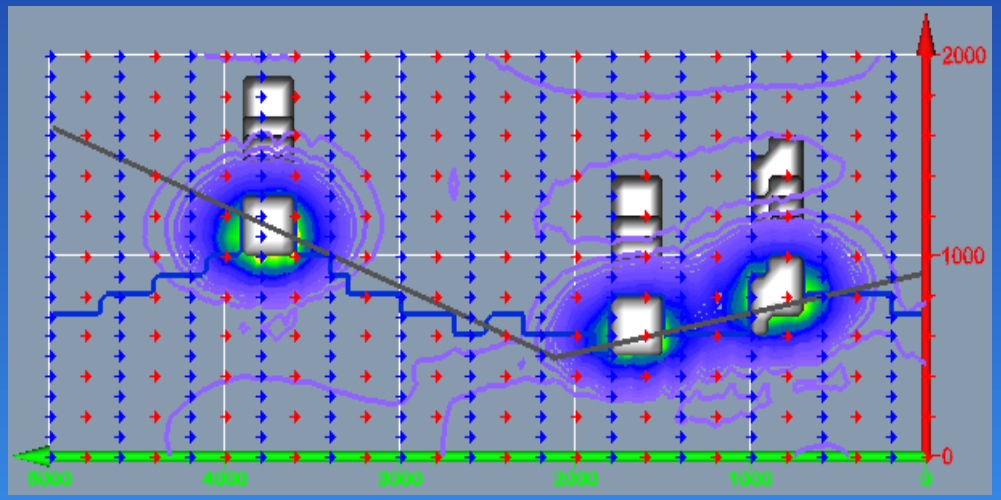
Multipole QODD

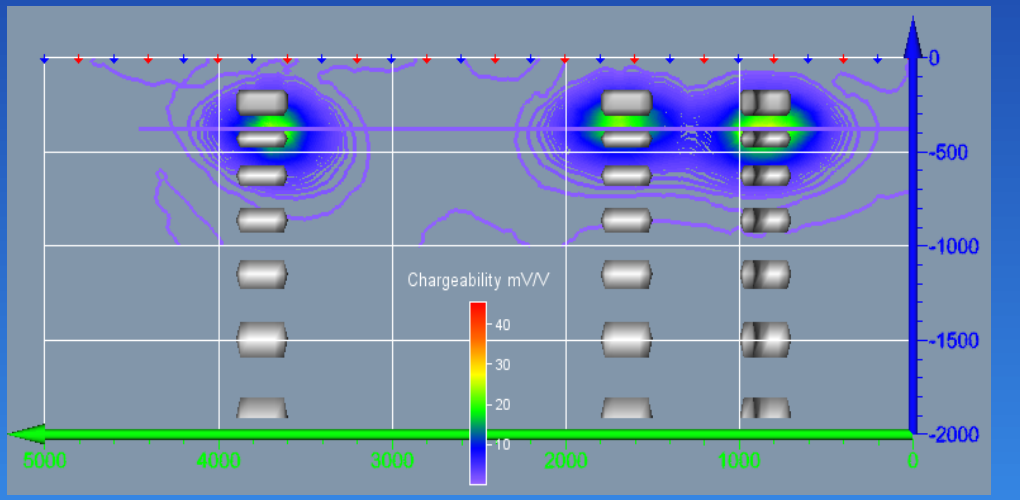
100m Chargeability





200m Chargeability



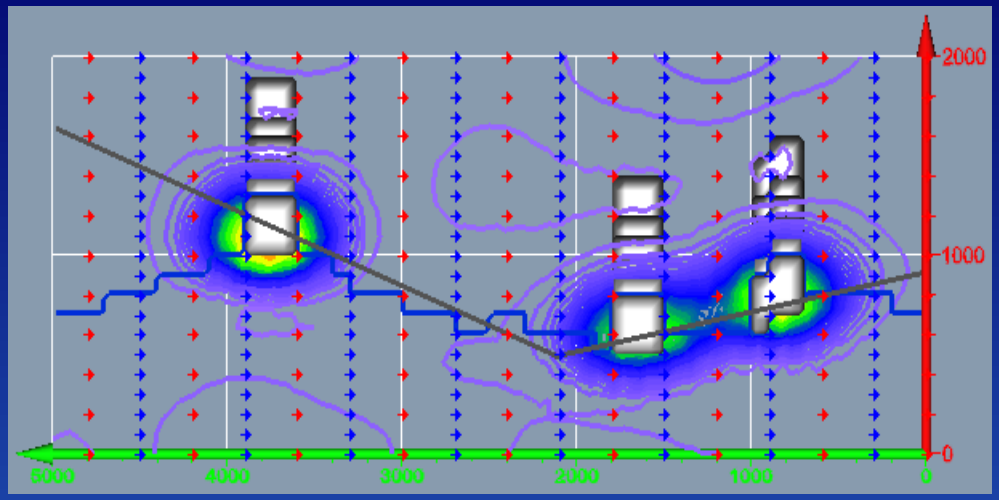


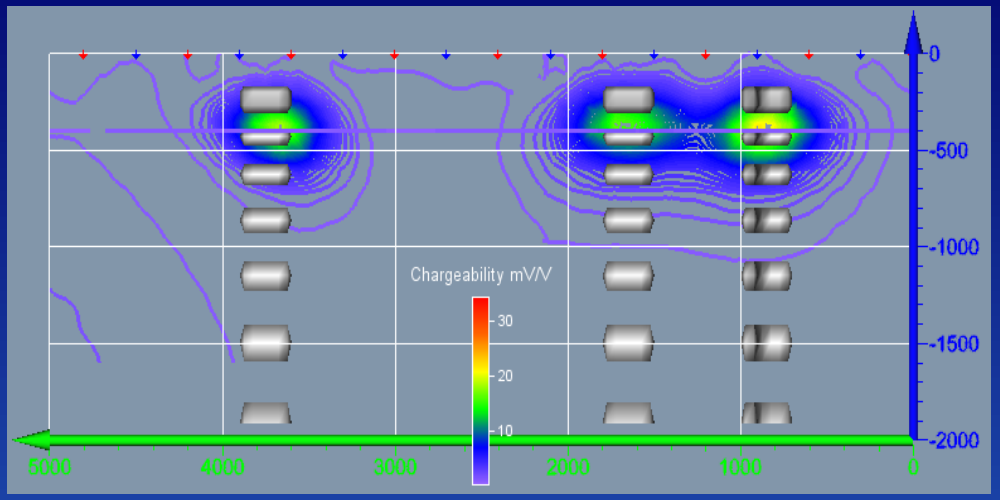
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

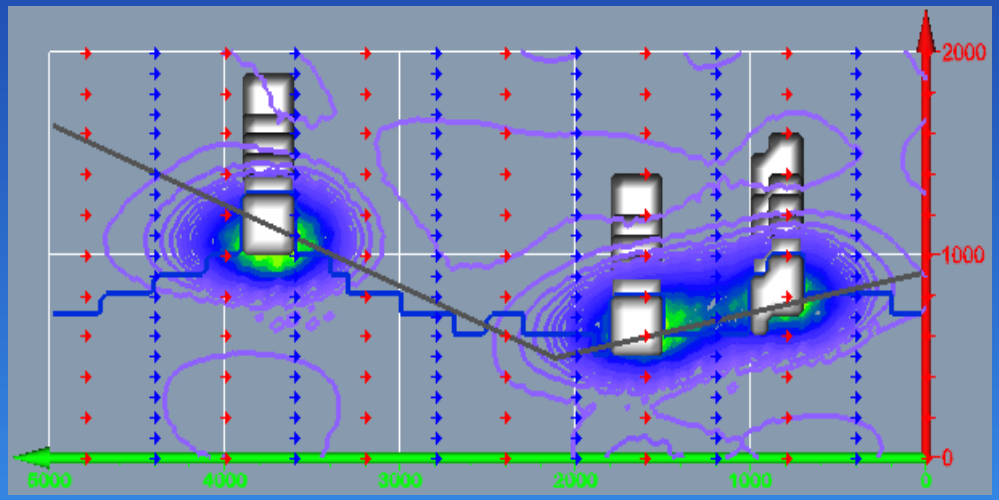
Multipole QODD

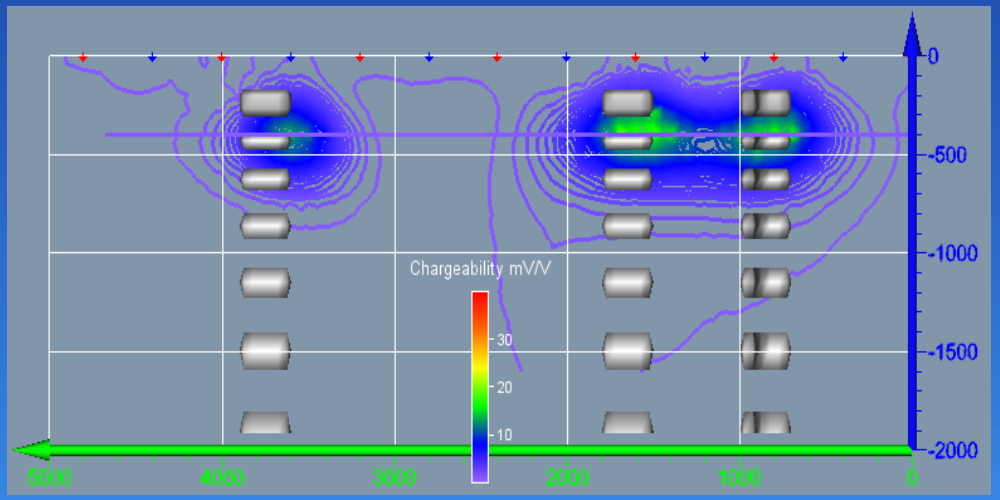
300m Chargeability





400m Chargeability



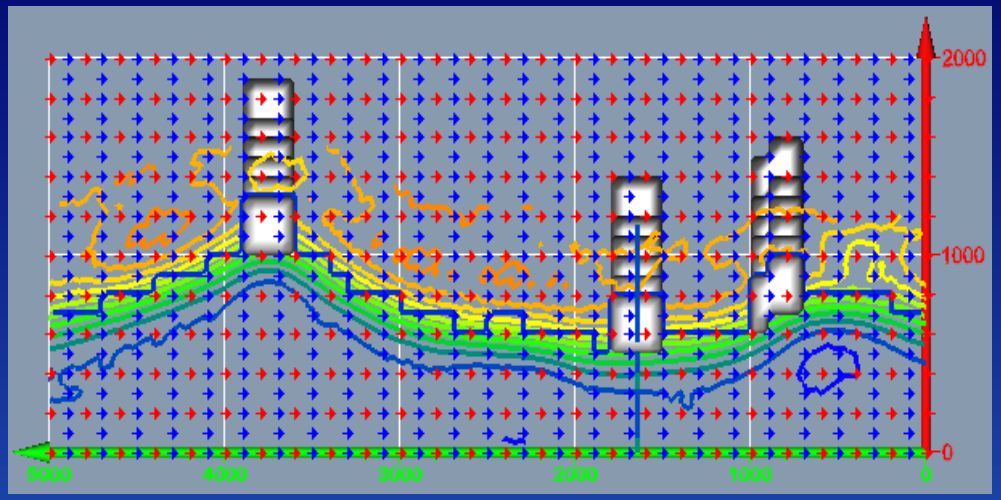


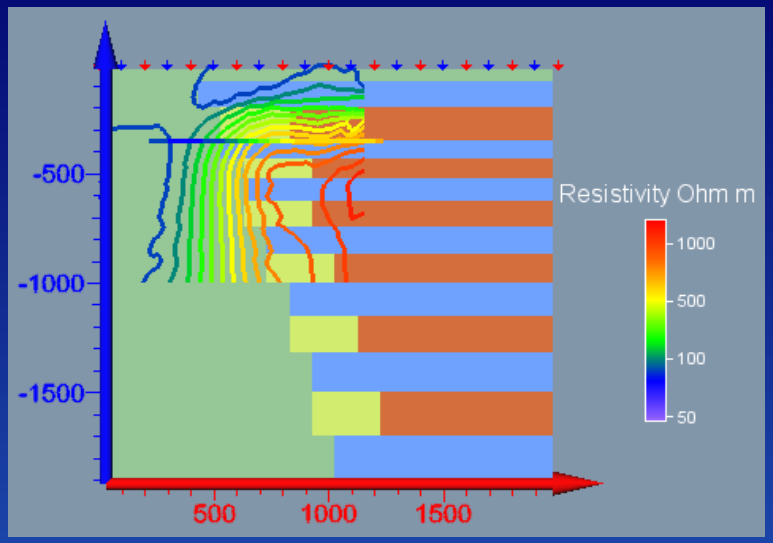
Plan view of contour slice through maximum response

Bent and tilted long section view of contours through body centres

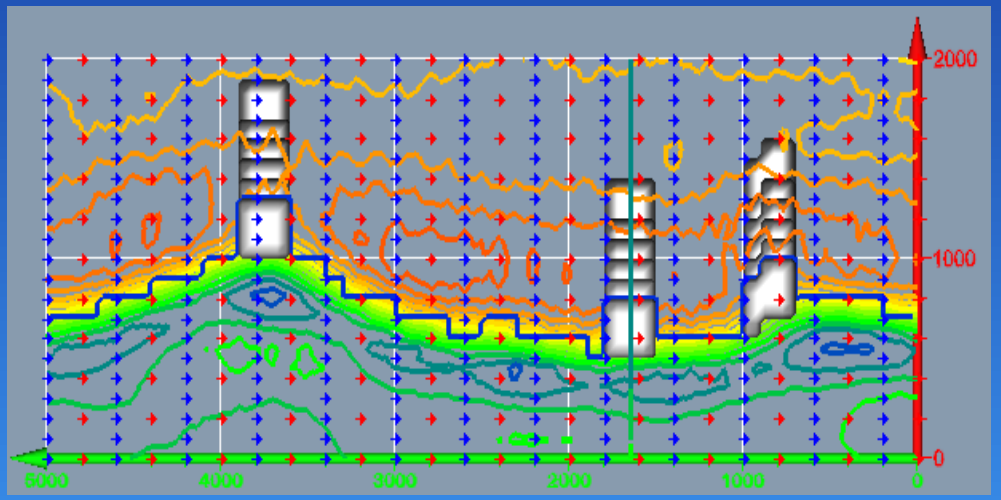
Multipole QODD

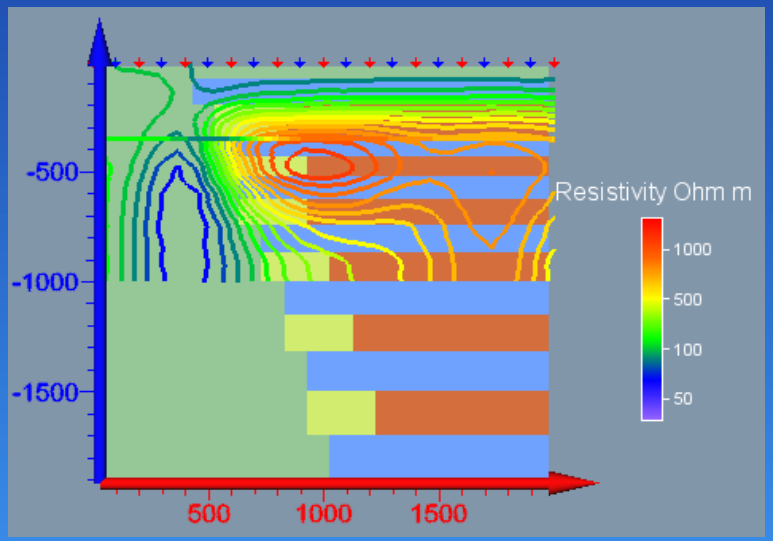
100m Resistivity





200m Resistivity



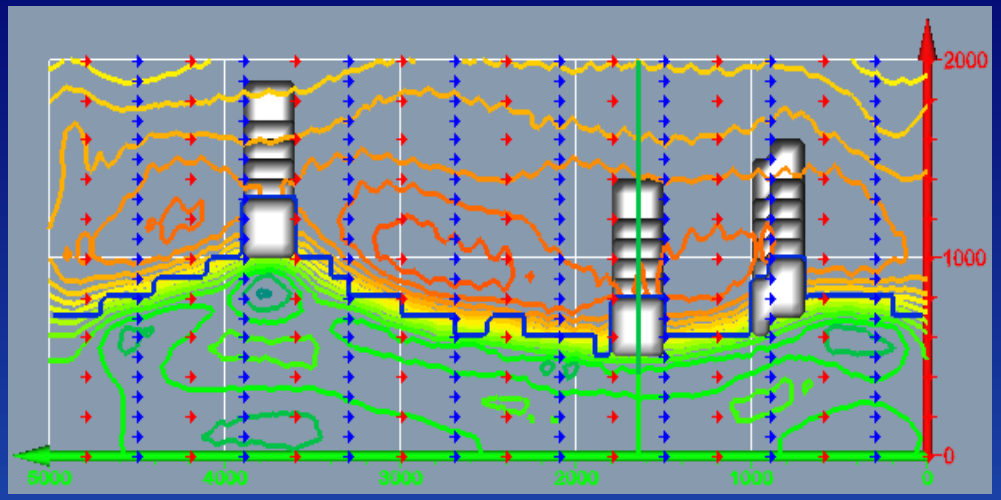


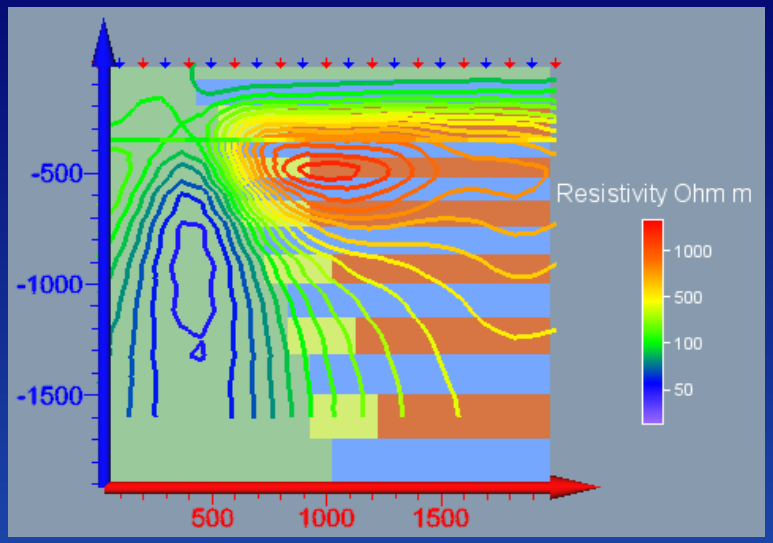
Plan view of contour slice through the middle of the chargeable centre body

Cross section through the middle of the chargeable centre body

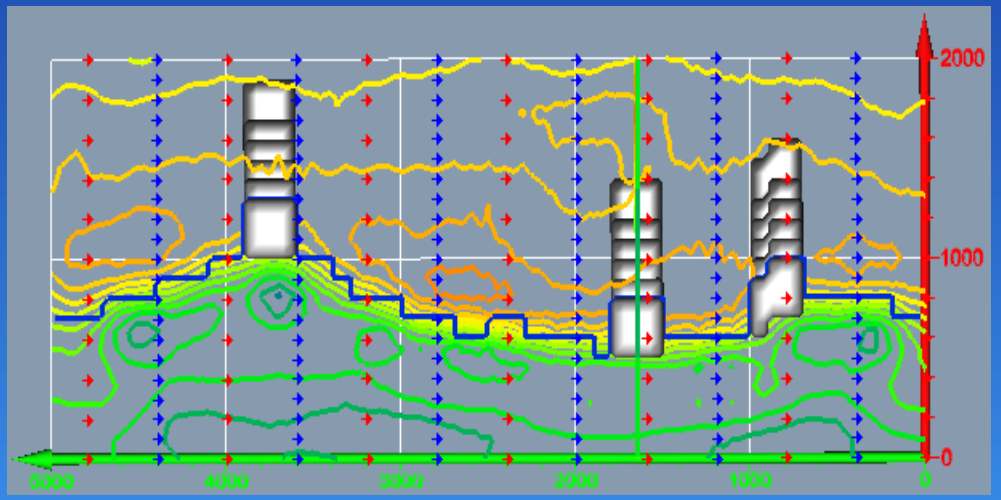
Multipole QODD

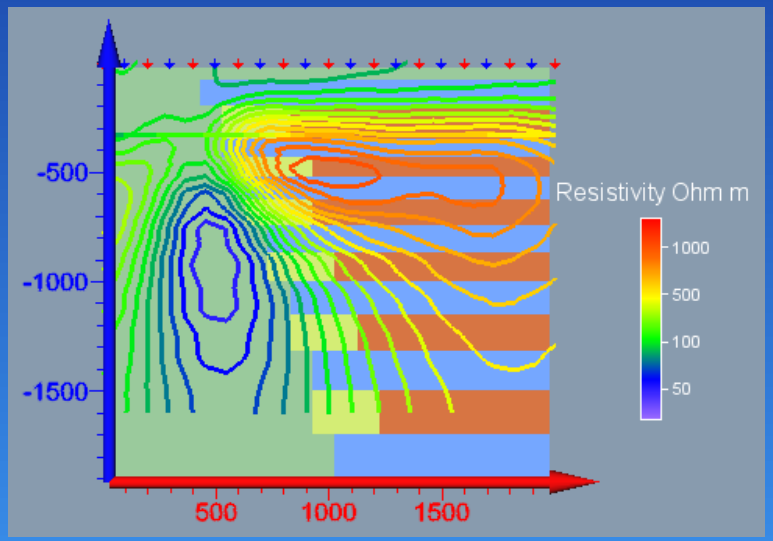
300m Resistivity





400m Resistivity





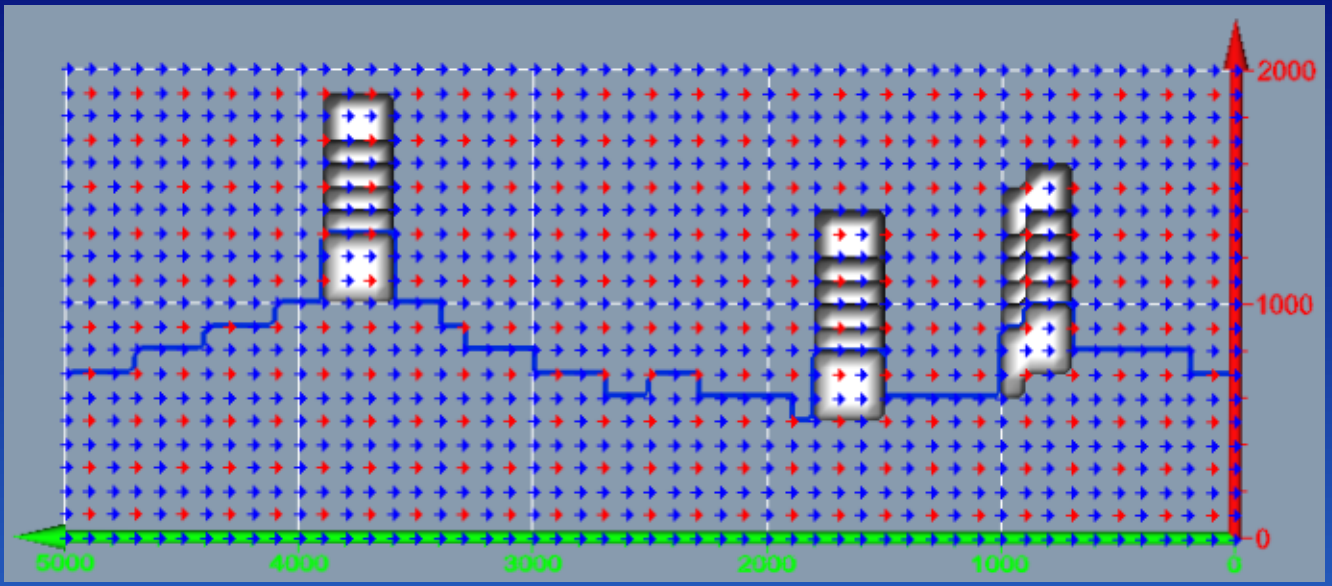
Plan view of contour slice through the middle of the chargeable centre body

Cross section through the middle of the chargeable centre body

Observations – 70º dip 2.5D Multipole QODD

- This array provides good dip resolution and all line spacings resolve the two closely spaced chargeable bodies.

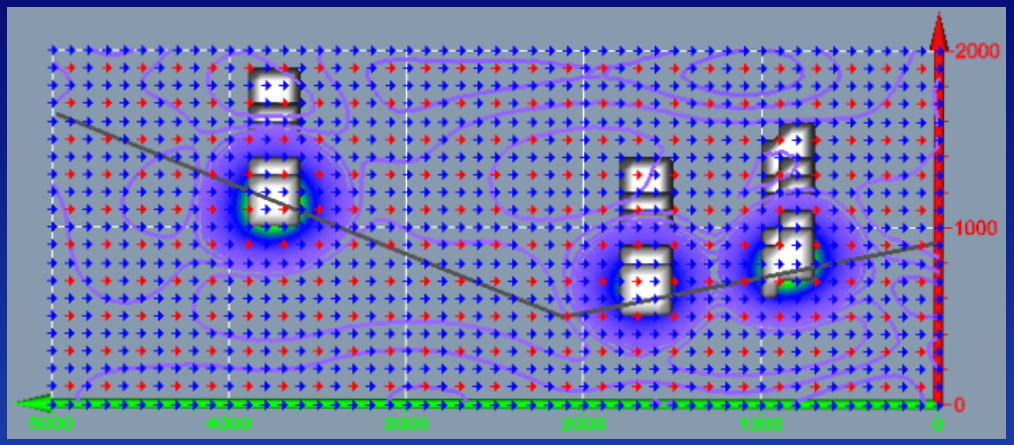
3D Pole-Dipole



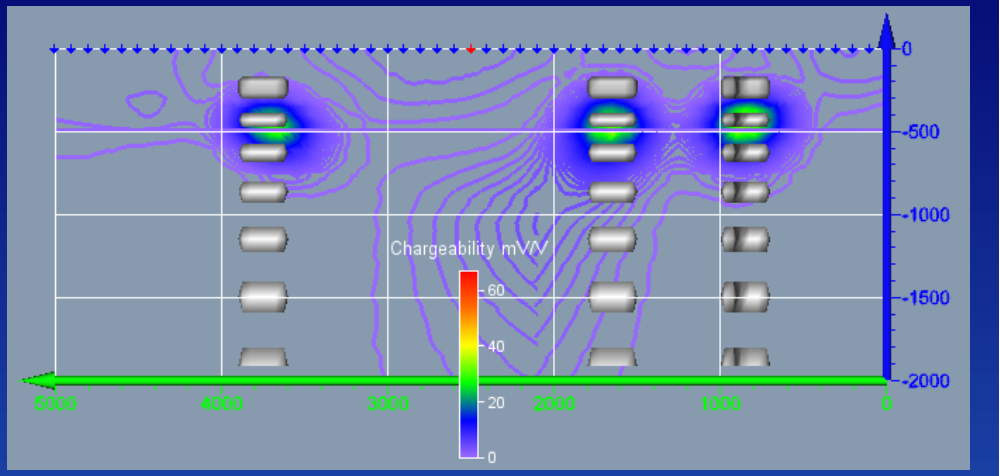
- 200m transmitter electrode spacing.
- 100m receiver electrode spacing.
- 100m line spacing.

3D Pole-Dipole

Chargeability

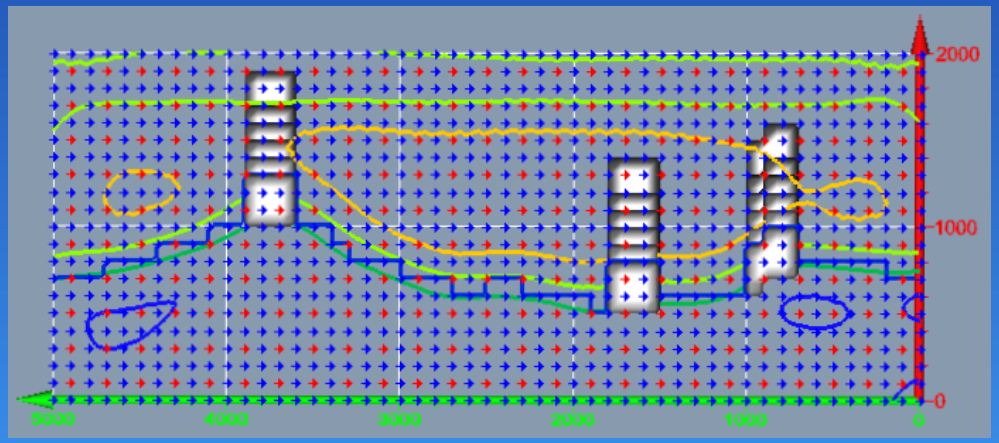


Plan view of contour slice through maximum response

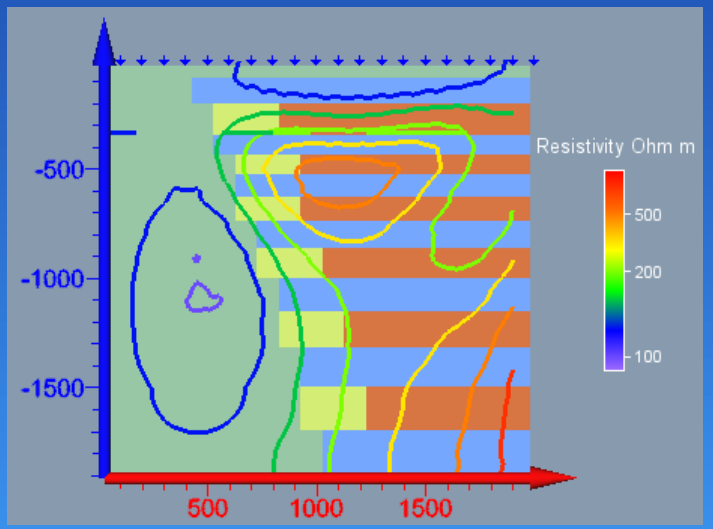


Bent and tilted long section view of contours through body centres

Resistivity



Plan view of contour slice through the middle of the chargeable centre body

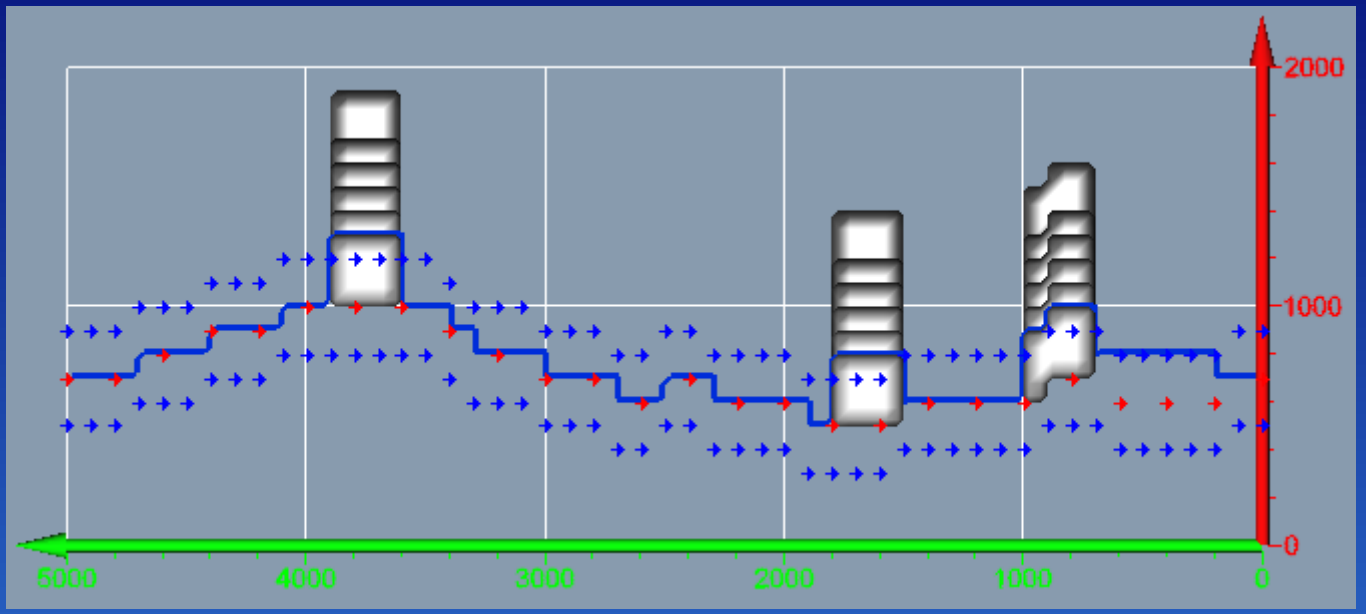


Cross section through the middle of the chargeable centre body

Observations – 70º dip 3D Pole-Dipole

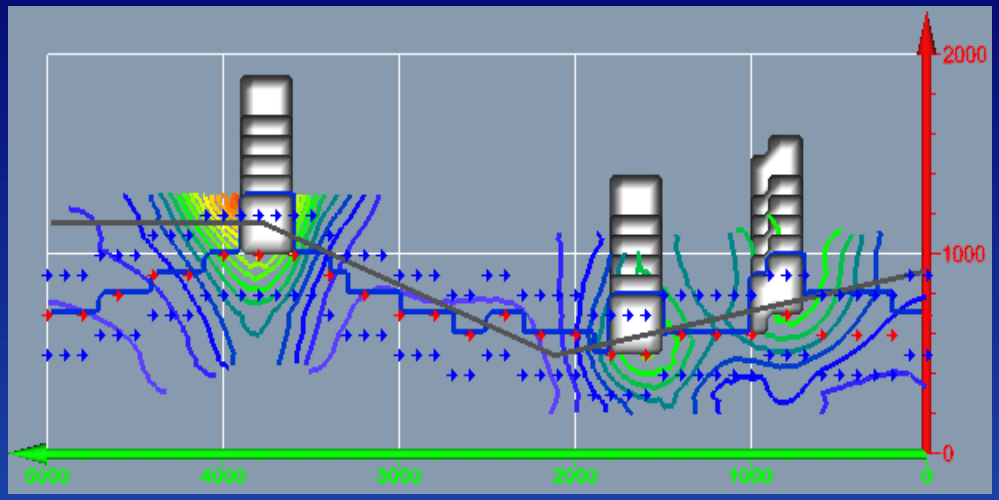
- This array achieves good chargeability mapping, and resolves the dip quite well.

Strike parallel 2.5D Double Offset Dipole-Dipole

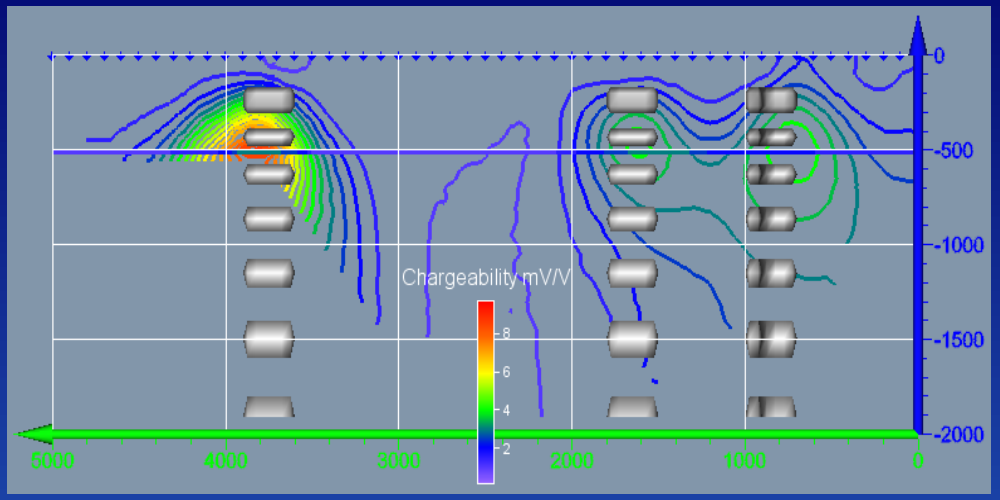


- 200m transmitter electrode spacing.
- 100m receiver electrode spacing.
- 200m line spacing.
- All electrodes active for each reading.
- Results masked in a window between ± 300m of the current electrodes line.

Chargeability

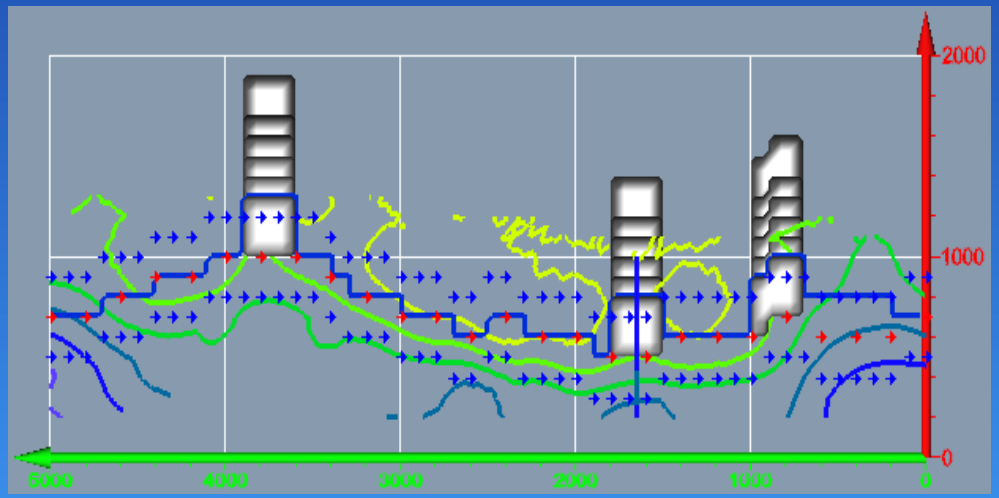


Plan view of contour slice through maximum response

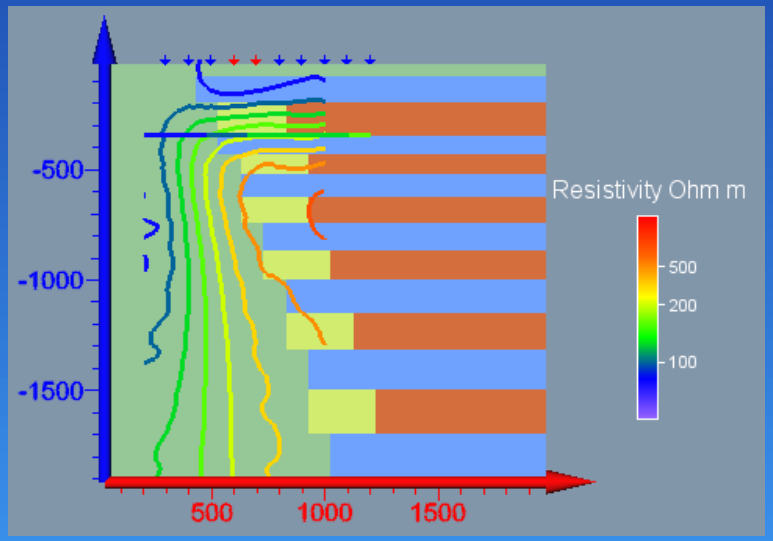


Bent and tilted long section view of contours through body centres

Resistivity



Plan view of contour slice through the middle of the chargeable centre body

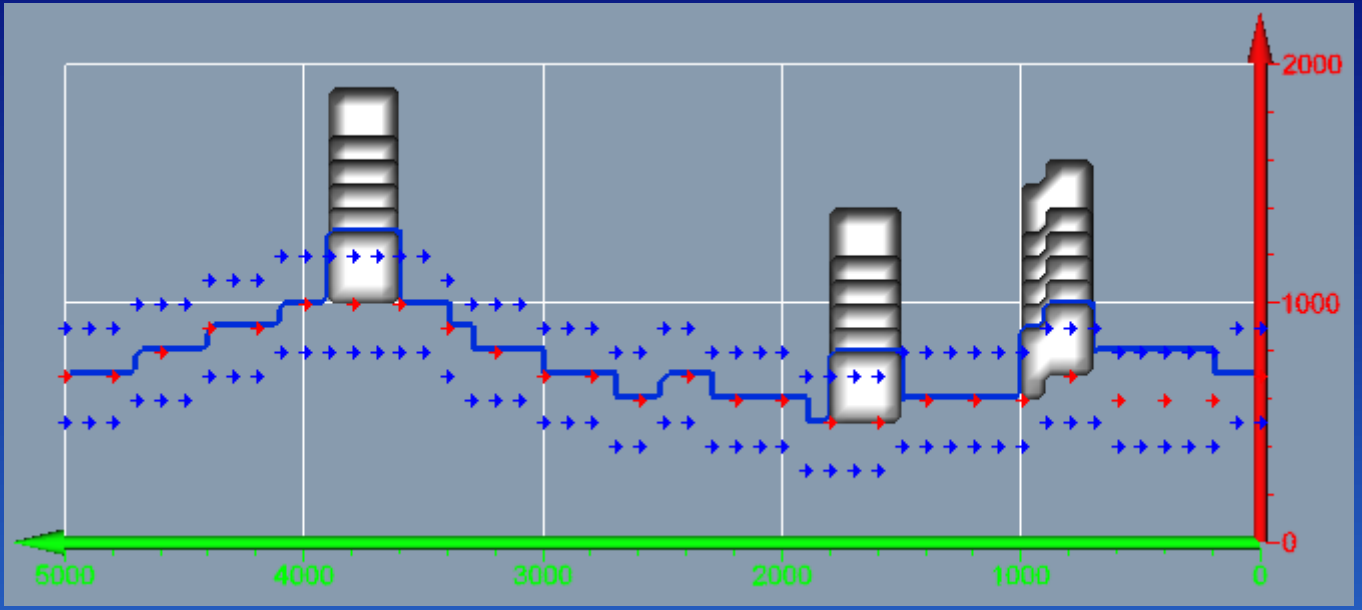


Cross section through the middle of the chargeable centre body

Observations – 70º dip Strike parallel 2.5D

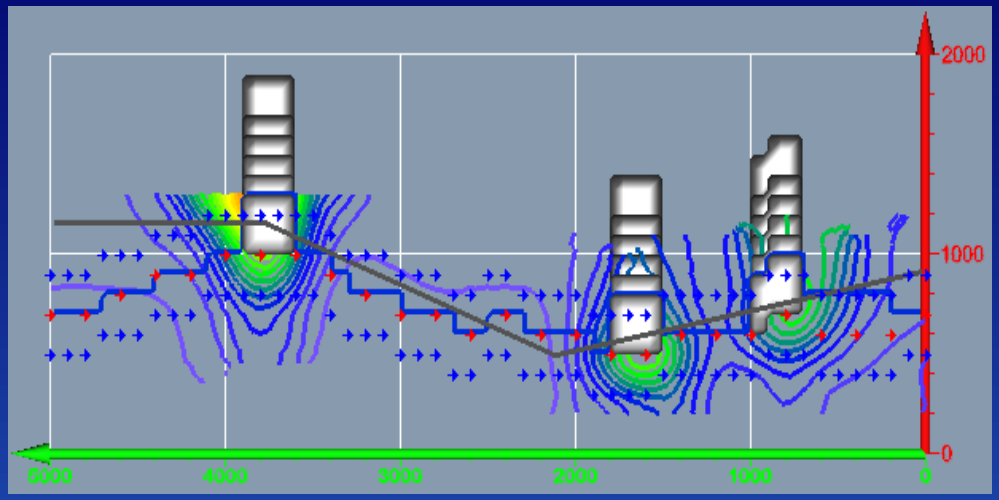
- The dip resolution looks relatively poor. The inverted values are higher than the model values and only one contour follows the dip.

Strike parallel 2.5D
Multipoles Double Offset Dipole-Dipole

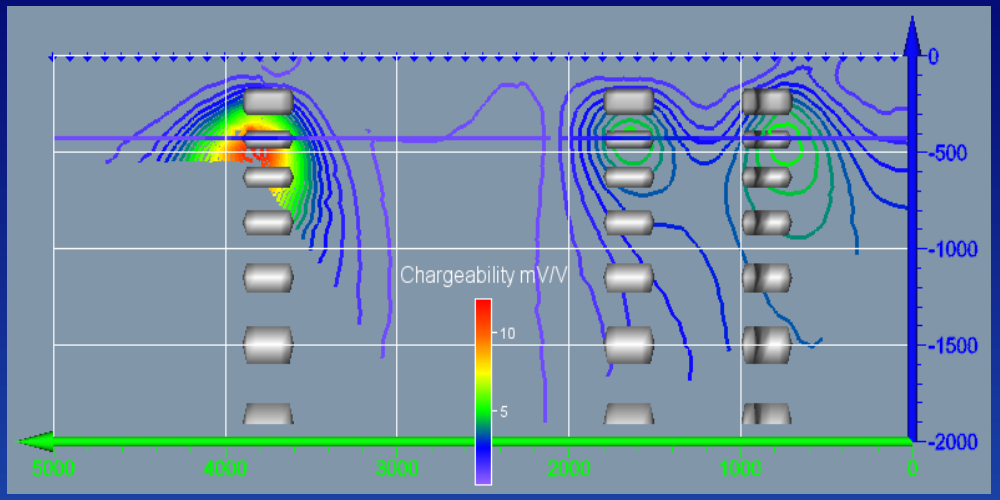


- 200m transmitter electrode spacing.
- 100m receiver electrode spacing with dipole sizes of 100m, 200m, 300m and 400m.
- 200m line spacing.
- All electrodes active for each reading.
- Results masked in a window between ± 300m of the current electrodes line.

Chargeability

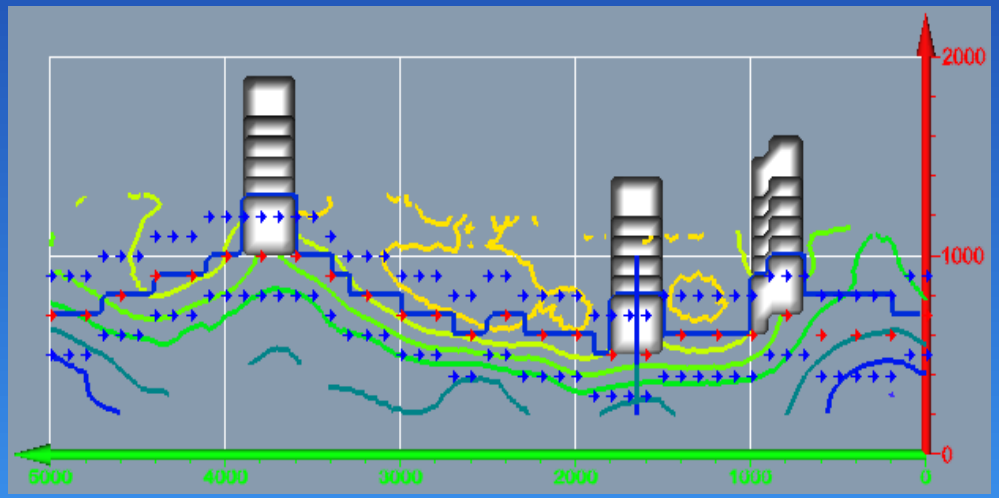


Plan view of contour slice through maximum response

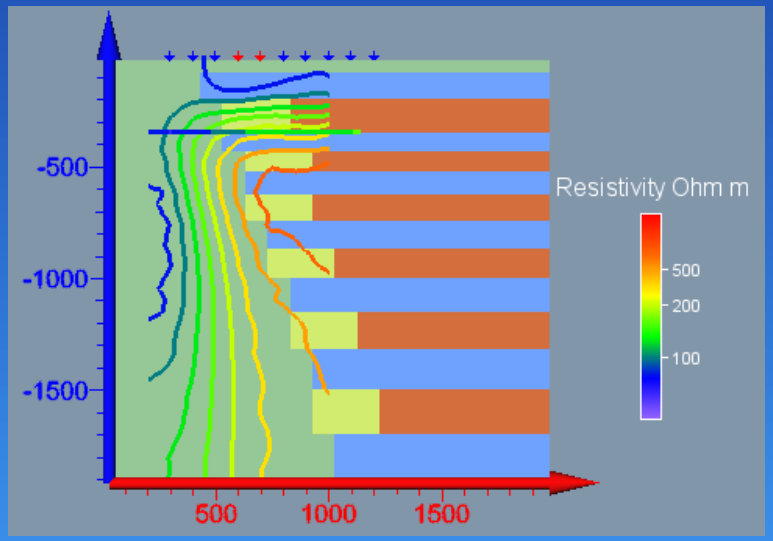


Bent and tilted long section view of contours through body centres

Resistivity



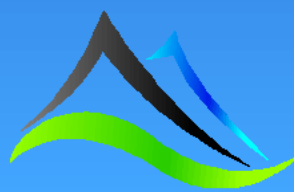
Plan view of contour slice through the middle of the chargeable centre body



Cross section through the middle of the chargeable centre body

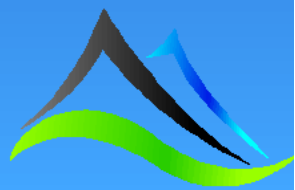
Observations – 70º dip Strike parallel 2.5D Multipole

- The dip resolution looks relatively poor. The inverted values are higher than the model values and only one contour follows the dip; but is slightly better than the non-multipole array.



Conclusions Pt 1 – The Effect of Dip

- All of the line spacings of the 2D dipole-dipole array were unable to resolve the two closely spaced zones and made them appear as one large zone. A tighter spatial resolution can be seen in the 80º plans and sections. The resistivity inversion for both dip angles are very similar.
- The 2.5D multipole QODD was able to resolve the closely spaced zones for all line spacings. The 80º example shows higher spatial resolution and dynamic range for both plans and sections.
- The 3D pole-dipole array was able to resolve all three zones very clearly for both dip angles.
- Both the strike parallel and strike parallel multipole arrays were able to resolve the closely spaced zones for both dip angles, with the multipole array having a slightly tighter resolution and higher dynamic range.
- All of the arrays calculate the centre of the anomalies to be deeper than the upper lenses of the stacks. Most of them place the anomalies between 200m and 400m too deep. The 2.5D multipole QODD gets the closest by placing the anomalies less than 100m too deep.



Conclusions Pt 2 – The Effect of Dip

- The strike parallel 2.5D multipole double offset dipole-dipole is the most cost effective array due to the lower number of electrodes required. As a comparison, the 200m 2.5D QODD array uses 405 electrodes, whereas the strike parallel array used just 125 electrodes.
- For a dipping stack of targets the maximum chargeability anomaly appears to be under the uppermost target. Drilling this from the wrong direction may lead to a barren hole.
- Using multipoles will increase the processing cost slightly but this cost is justified by the increased resolution that is achieved.