Merits of multi-spacing Gradient Induced Polarization (GIP) and its applications

Tenyears Gumede

Knowledge Factory P/L

Preamble

- History of resistivity arrays
  - 1-D surveys
  - 2-D surveys
  - 3-D Surveys
- Conventions of presenting the survey results

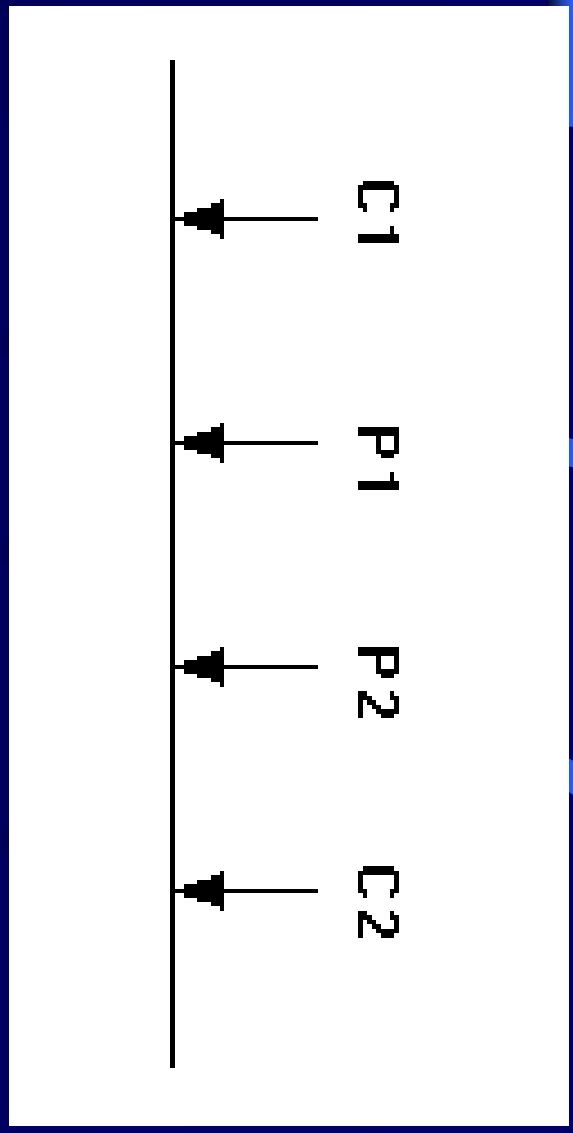
✓ Discuss the MGIP – Implications of results and some examples

✓ DOI

✓ Modelling

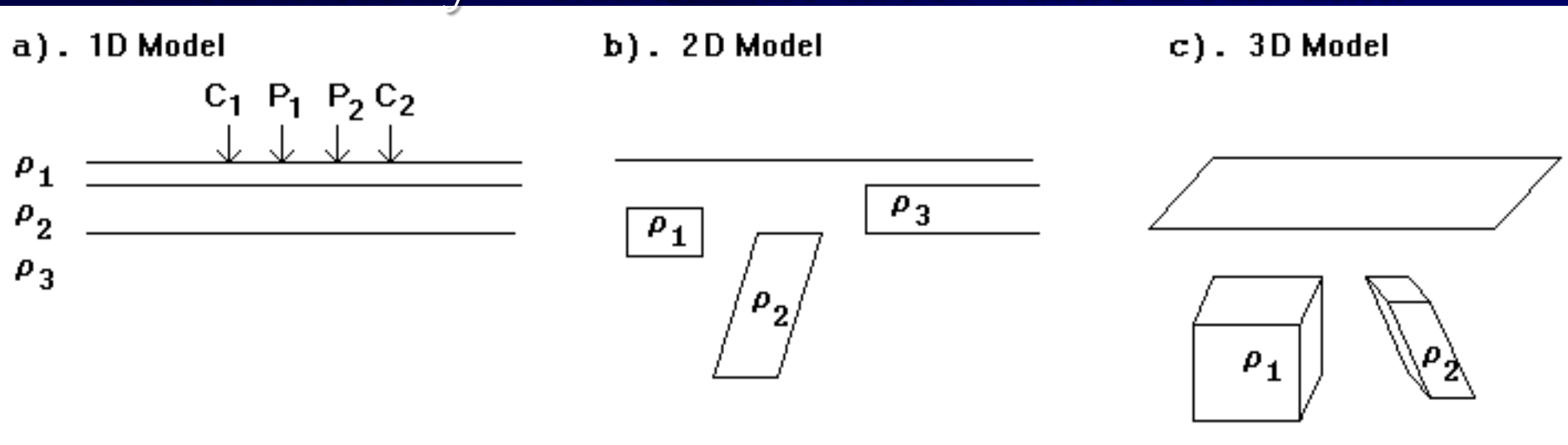
Preamble

- ✓Its origins are as far back as 1920s – Schlumberger Brothers
- ✓Data plotted on a log-log graph paper
- ✓Assumed subsurface consists of horizontal layers → resistivity changes only with depth and constant in the horizontal direction
- ✓Still common for siting water borehole in Zimbabwe - $150



Cont

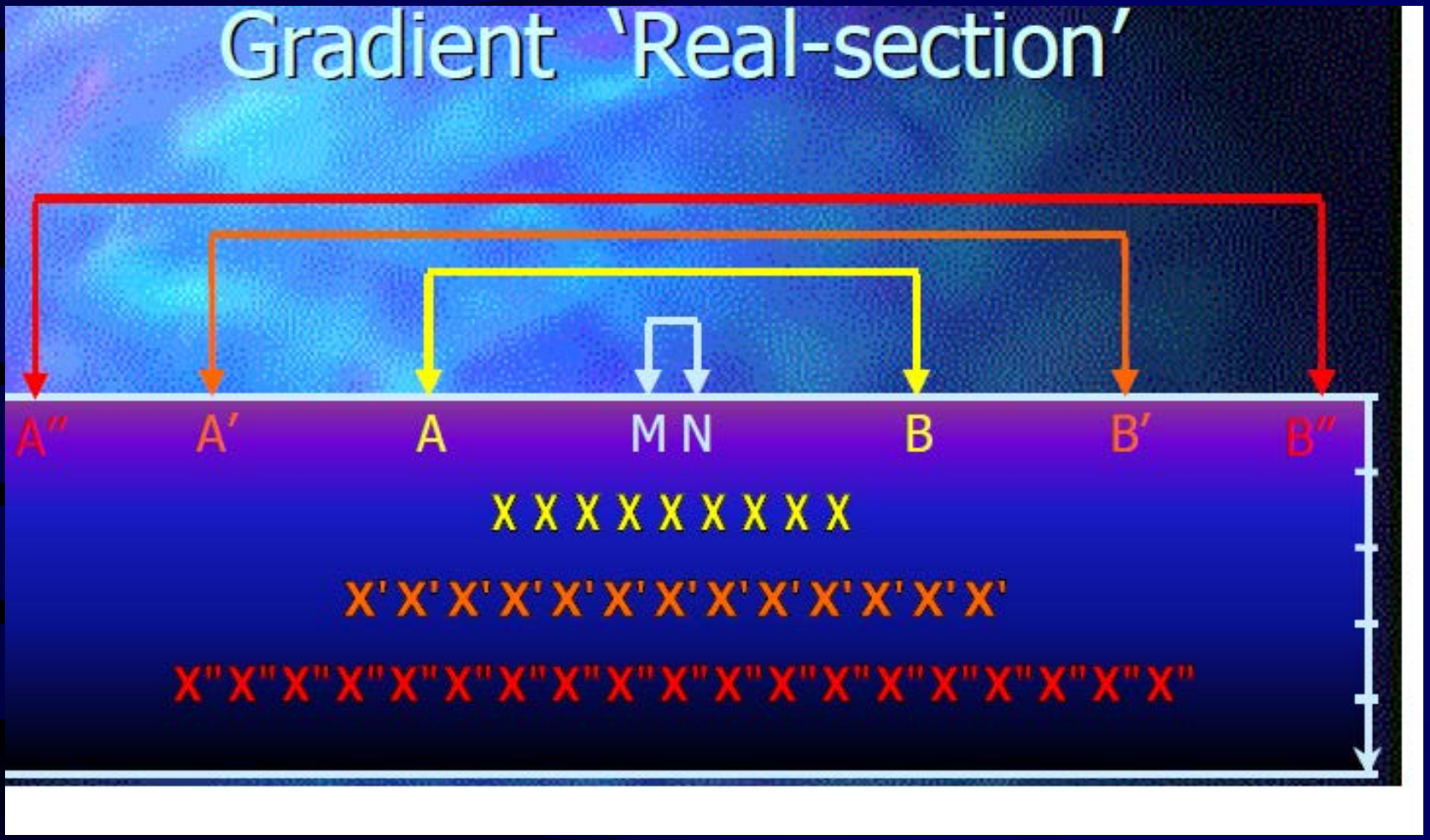
- ✓ 2-D and 3-D survey are now practical due to multi-electrode surveying equipment – Costs up to $1000/day or more depending on DOI
- ✓ Conventions were adopted to present the data
- ✓ Therefore IP and Resistivity images need not be taken literally – extract the most value from data



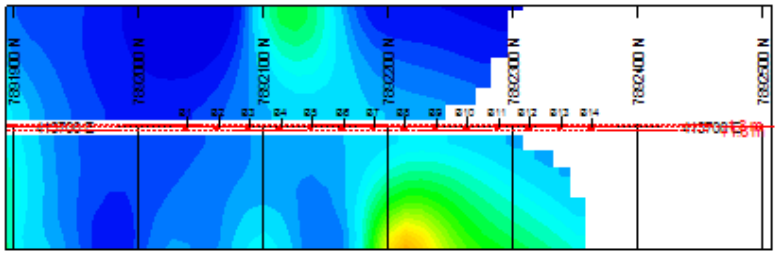
- ✓ Cost of 2-D surveys probably comparable with a seismic survey
- ✓ Most Cases, 2-D imaging surveys can give results complementary to other geophysical methods
- ✓ E.G Seismic methods will map undulating interfaces well, but suffer mapping discrete bodies like boulders, cavities and pollution plumes
- ✓ GPR give more detailed pictures but have limited depth penetration in areas with conductive unconsolidated sediments e.g clayey soils

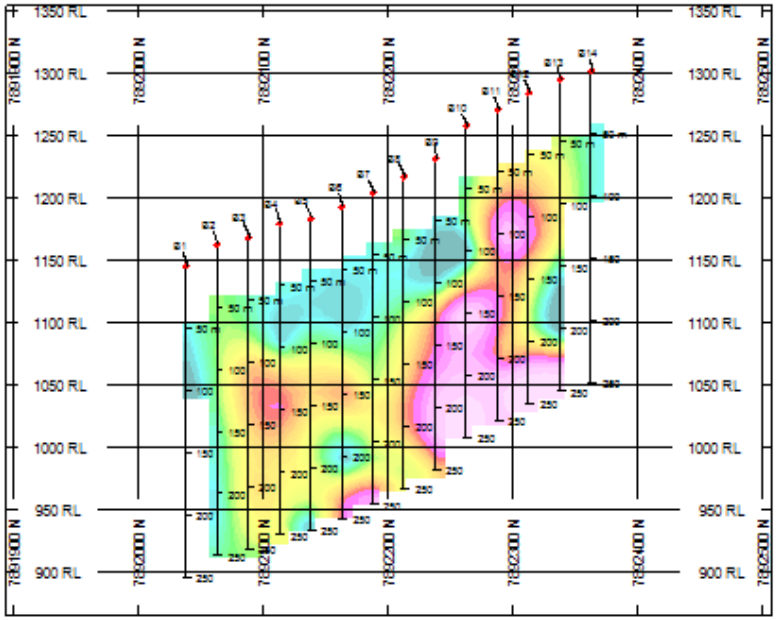
Plotting Conventions

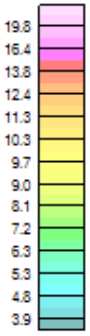
- Schlumberger – centre of spread (MN or C1C2
- DPDP – intersection of 2, 45˚ lines from centre of MN and C1C2

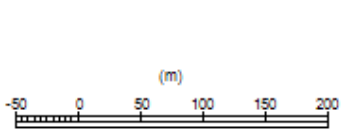


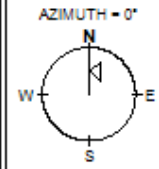
- ✓ MN is the separation of potential pots
- ✓ AB is the current electrode separation
- ✓ X is the conventional ploting point











413700E SECTION

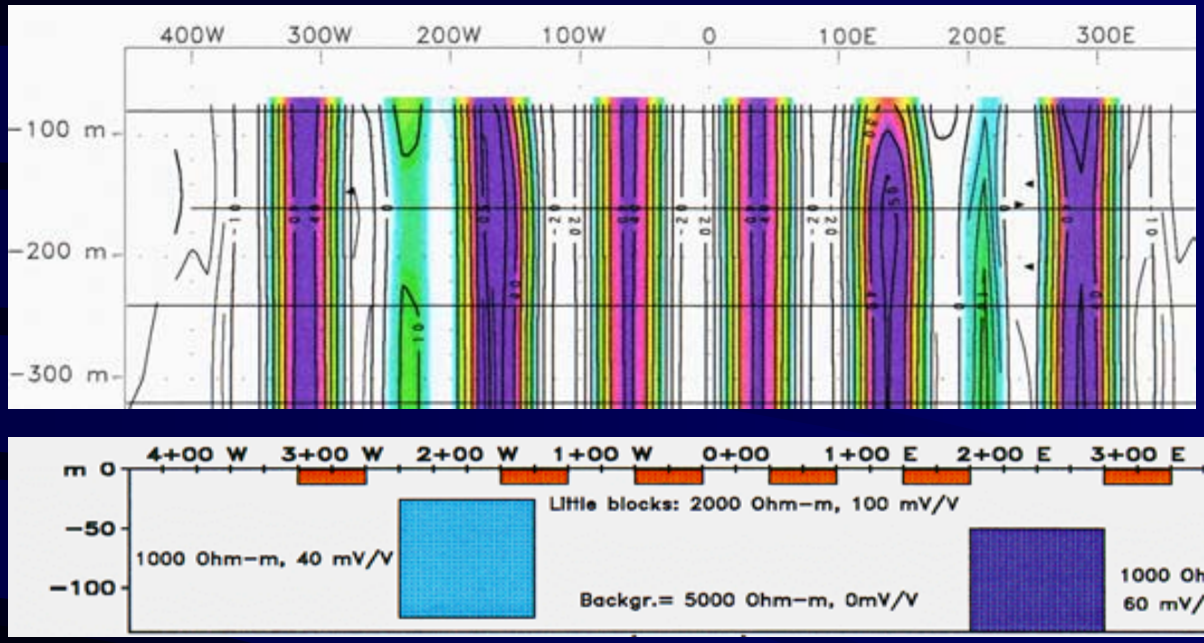
- The data is presented as a plotting convention
- Data is therefore a pseudo-section rather than a true sections since
  - No qualitative interpretation is performed to build a real section

  Real section suffer limitations as the pseudosections obtained in other arrays

  -the highest contribution to measured signal is in the area nearest the active electrodes

  -therefore cannot get rid of surface effects

Forward Model

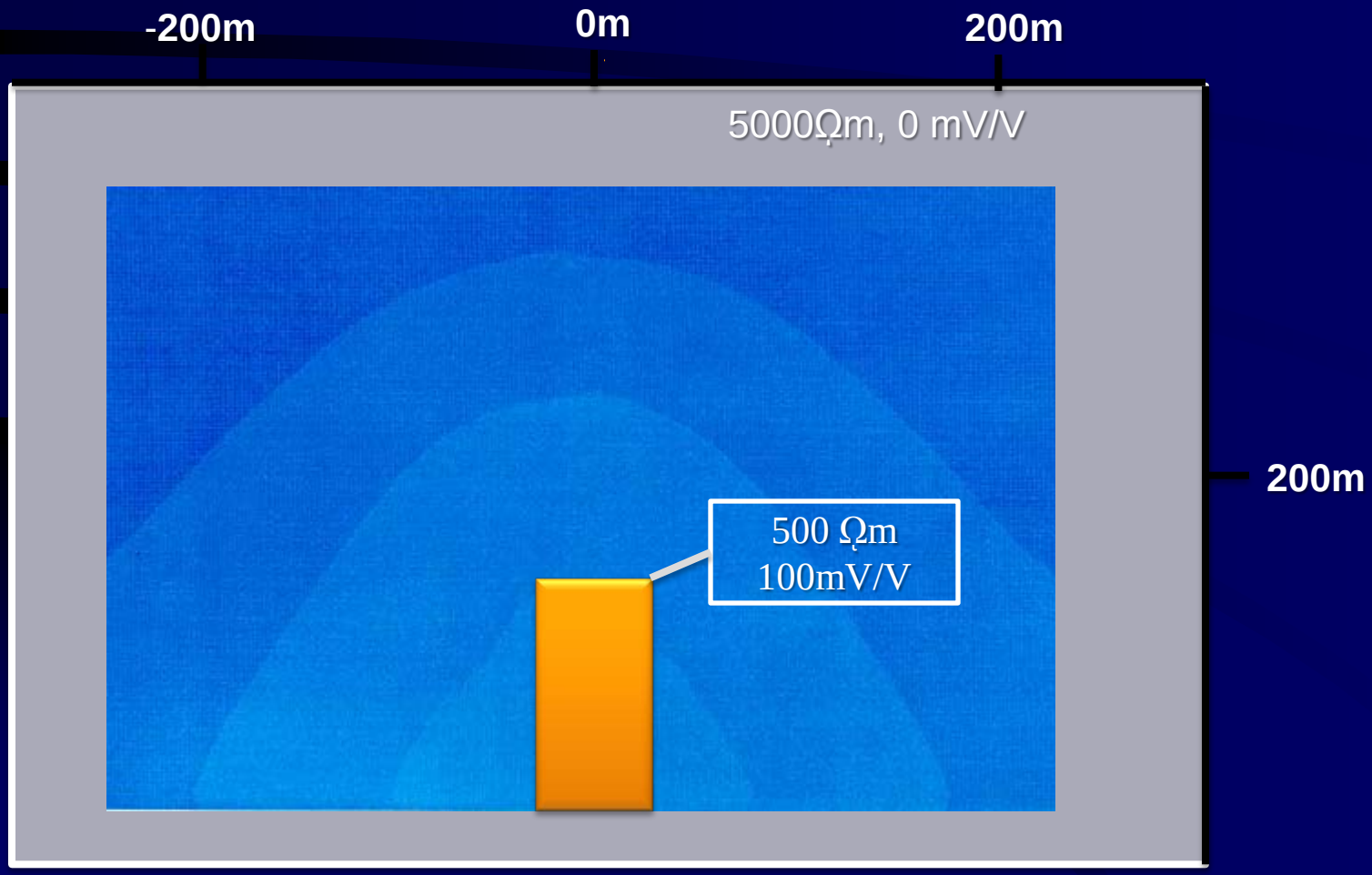


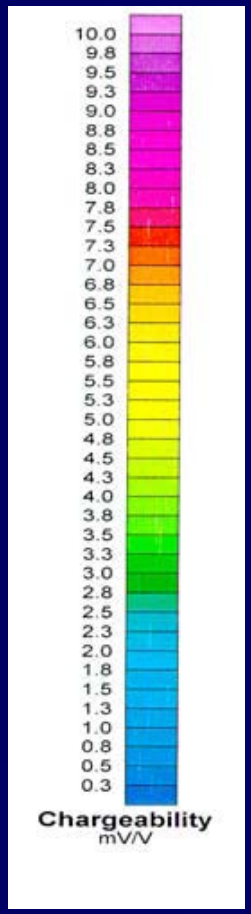
Note: A 1000Ω, 40mV/V Block at depth gives a similar signature as a little shallow block - surface

However, from the image, a single anomaly for each block is recognized, unlike pant leg anomaly

Depth of Investigation - DOI

- Related to size and physical property contrast between target and host rock





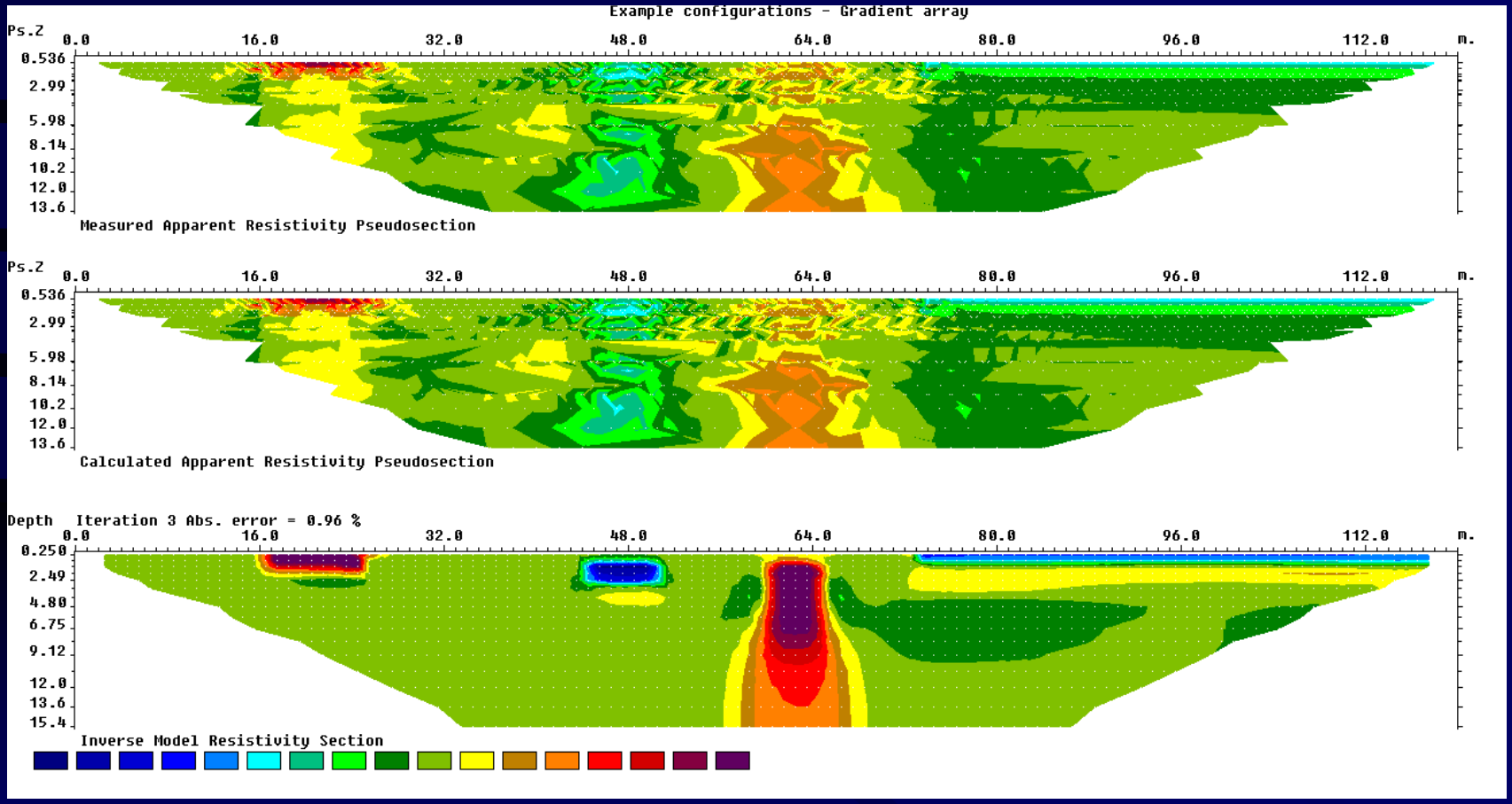
DOI

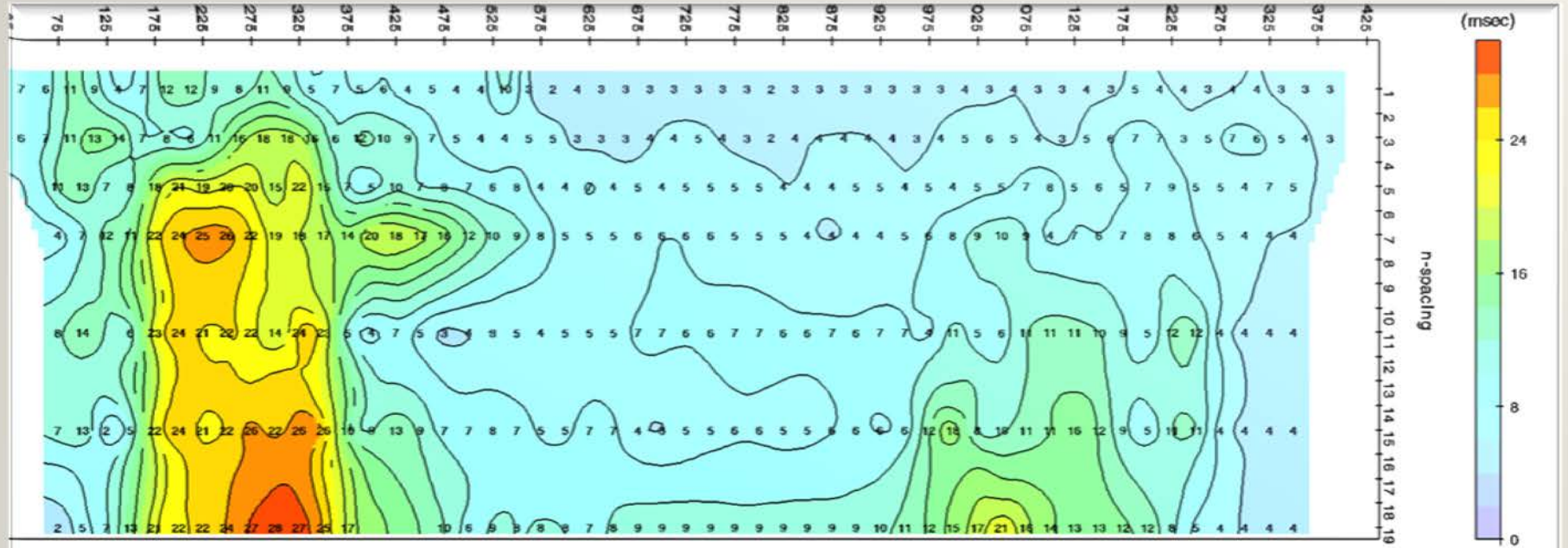
- Forward modelling of real-section data fails to detect a 50m
  - » Conductive
  - » Polarizable
  - » Dyke
  - » Buried 300m
  - » In resistive
  - » Non- polarizable
  - » Host Rock

DOI (Pierre Bérubé, 1998)

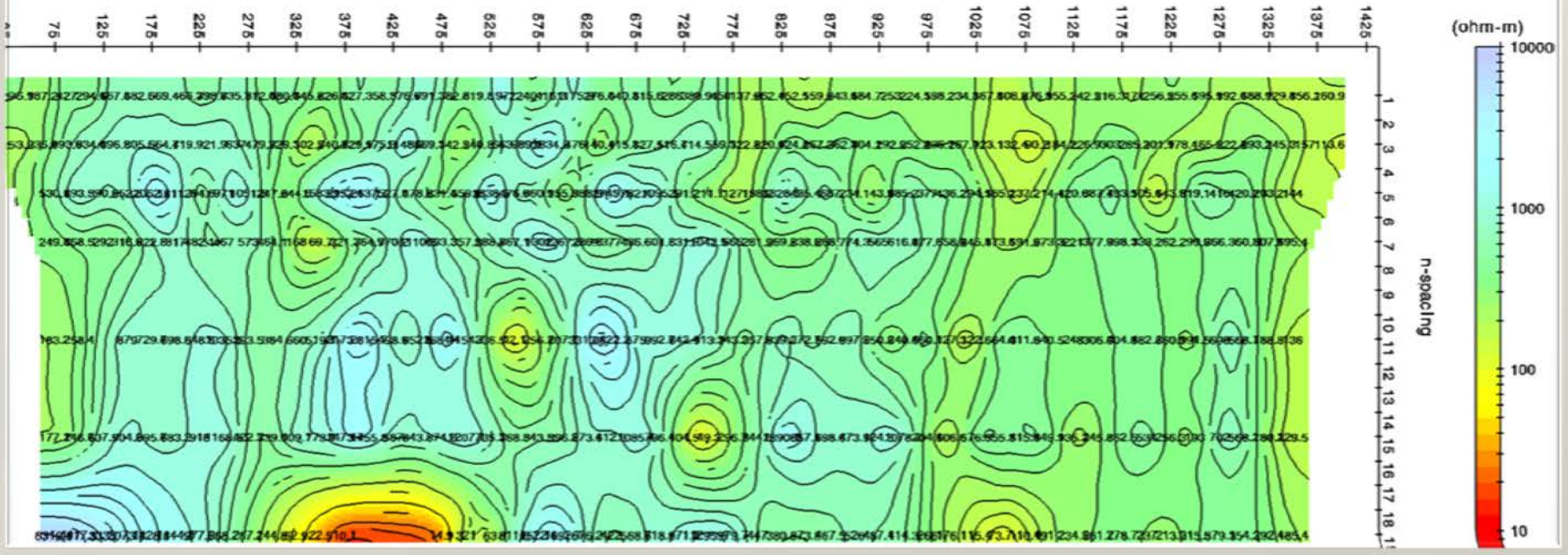
TYPE OF SOURCE	EXAMPLE	WORST CONDITION DOI	BEST CONTION DOI
<5m resistive and polarizable	Qtz Veins + 10% Sulphides	10m	30m
< 5m conductive and polarizable	Shear Zone + 6% sulphides	20m	60m
< 5m very conductive and polarizable	Graphite horizon	50m	100m
50m wide conductive and polarizable	Semi Massive Sulphides	100m	300m
500m wide polarizable	Porphyry Copper System	300m	600m

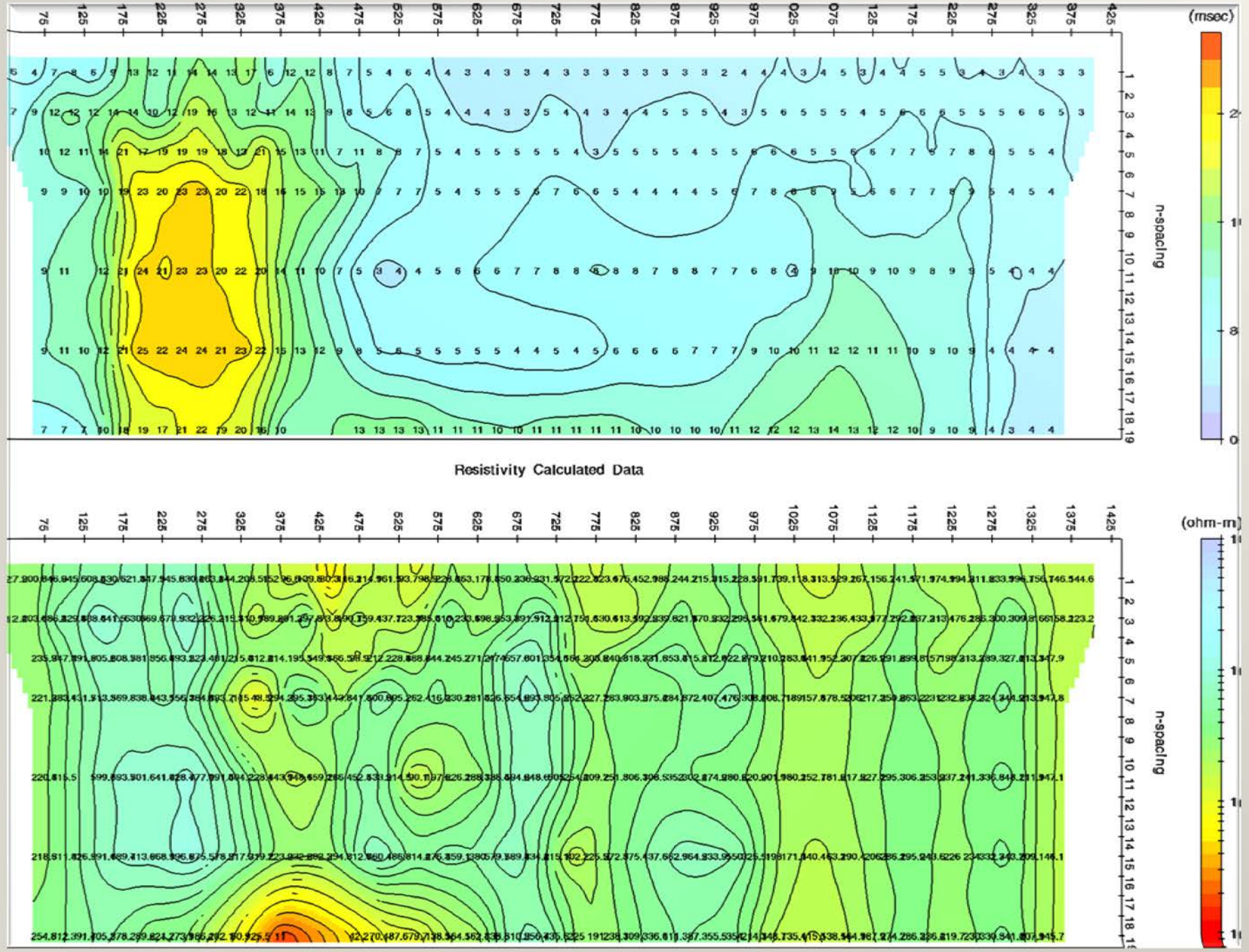
Thin Quartz Reef – 3D vs GPR





Resistivity Observed Data




(msec)
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Resistivity Calculated Data
(ohm-m)
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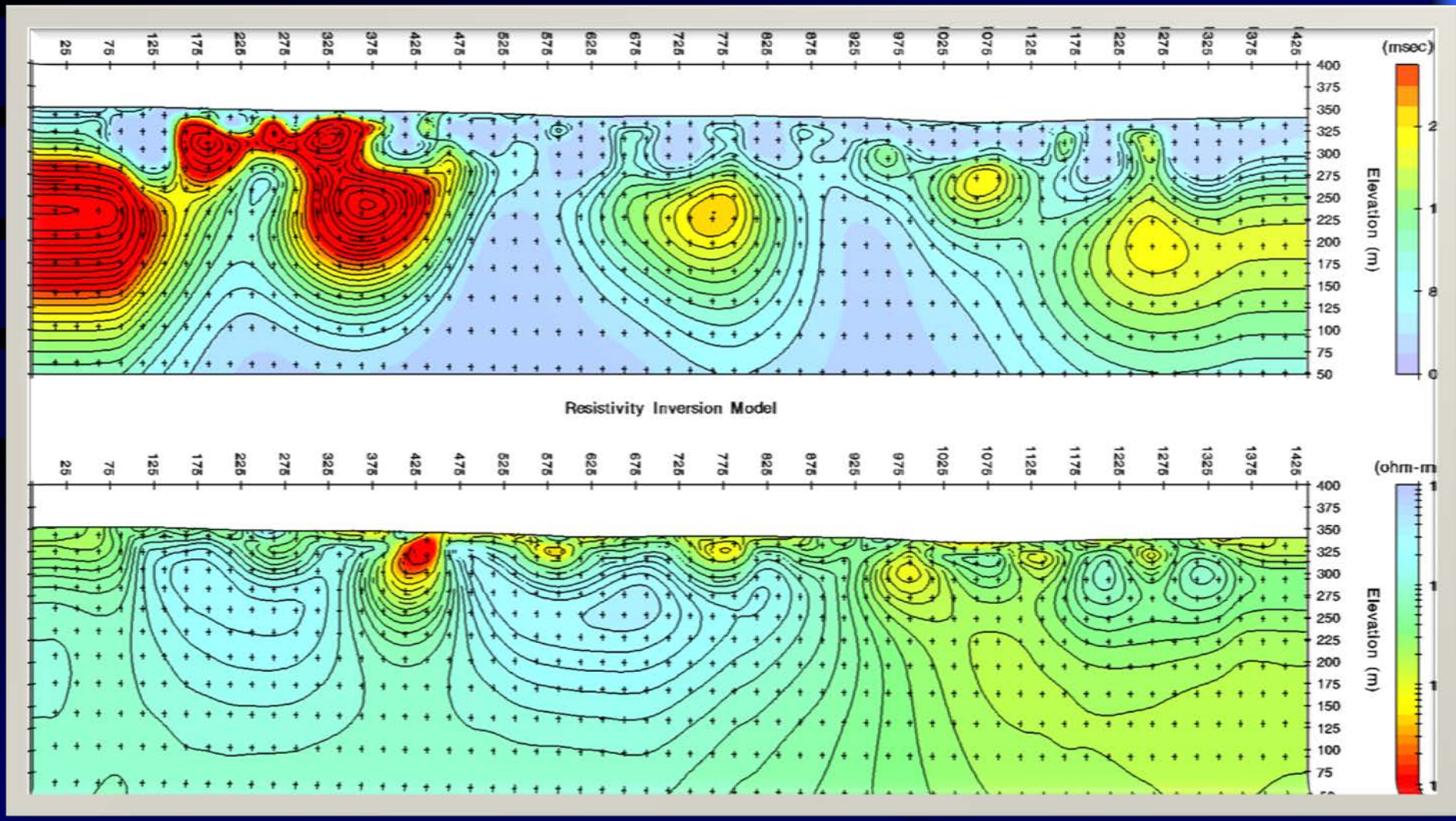
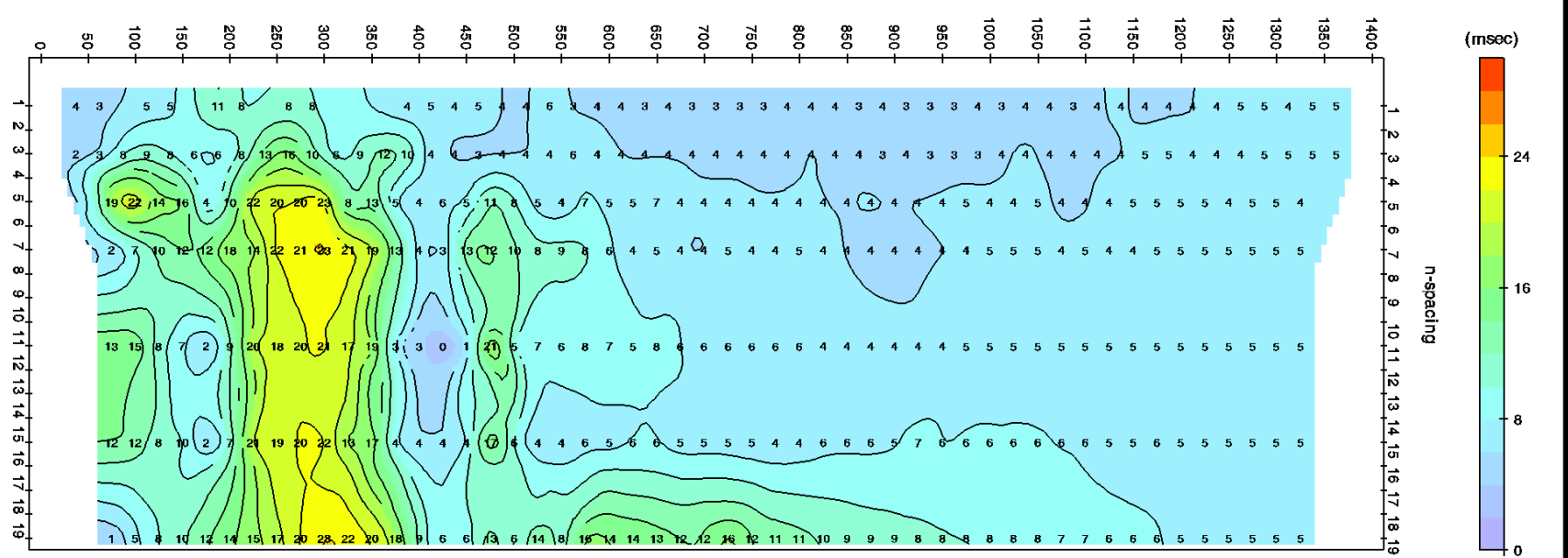
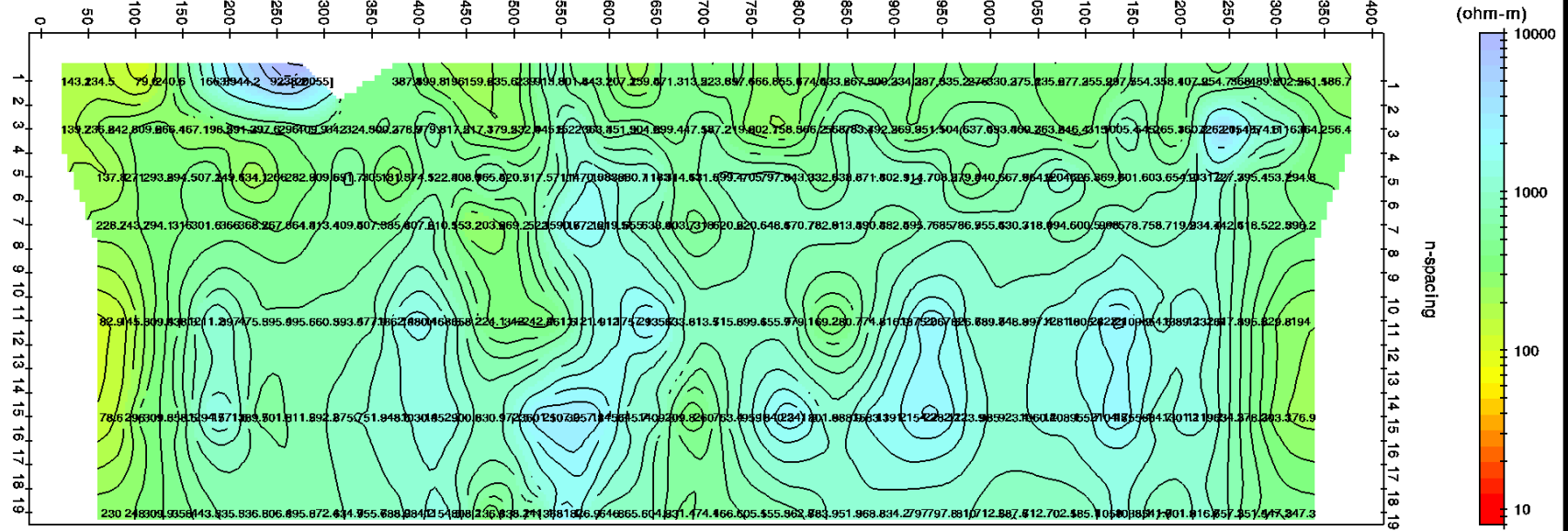
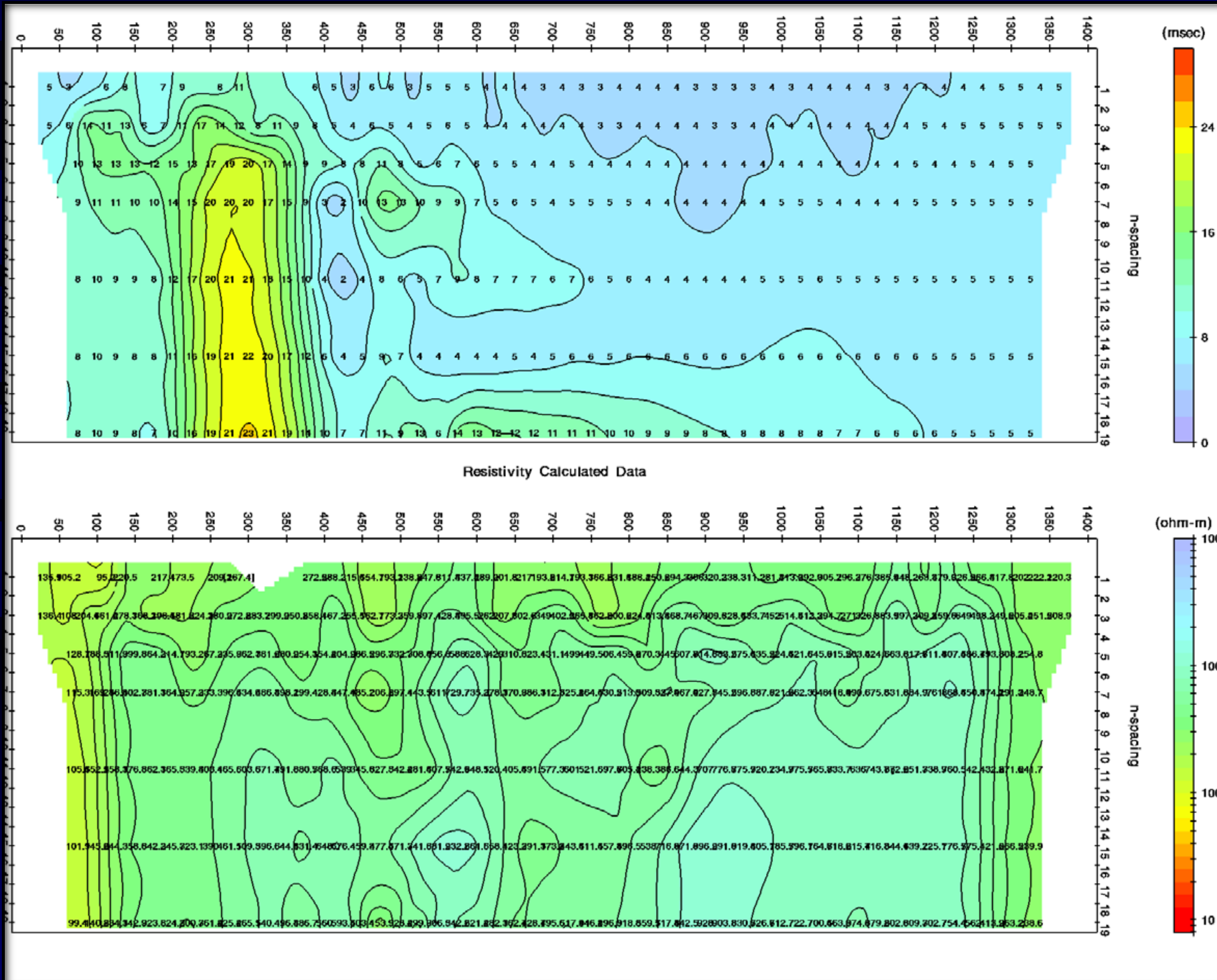
Flat Dipping Geological Features





Resistivity Observed Data

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Resistivity Calculated Data
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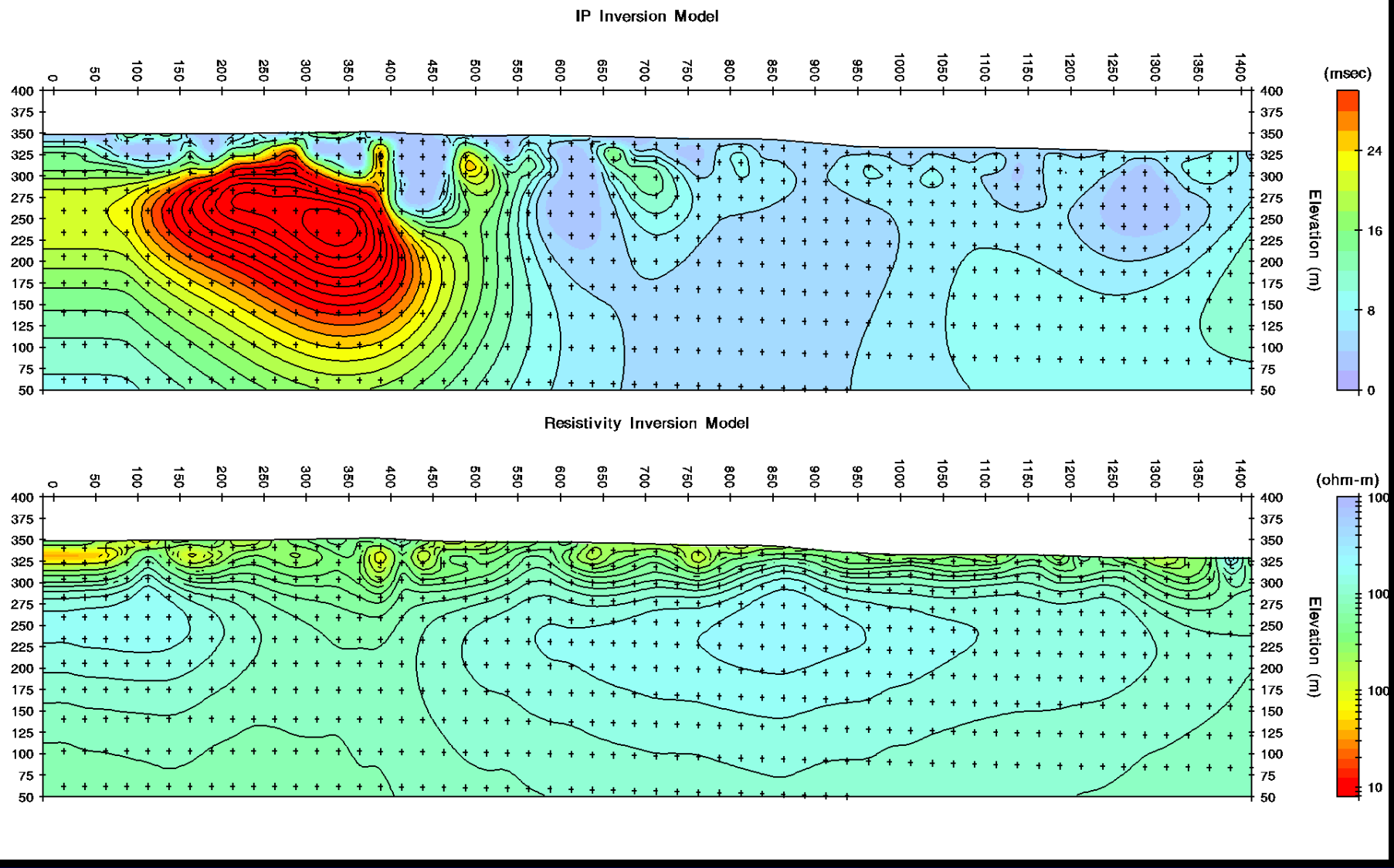
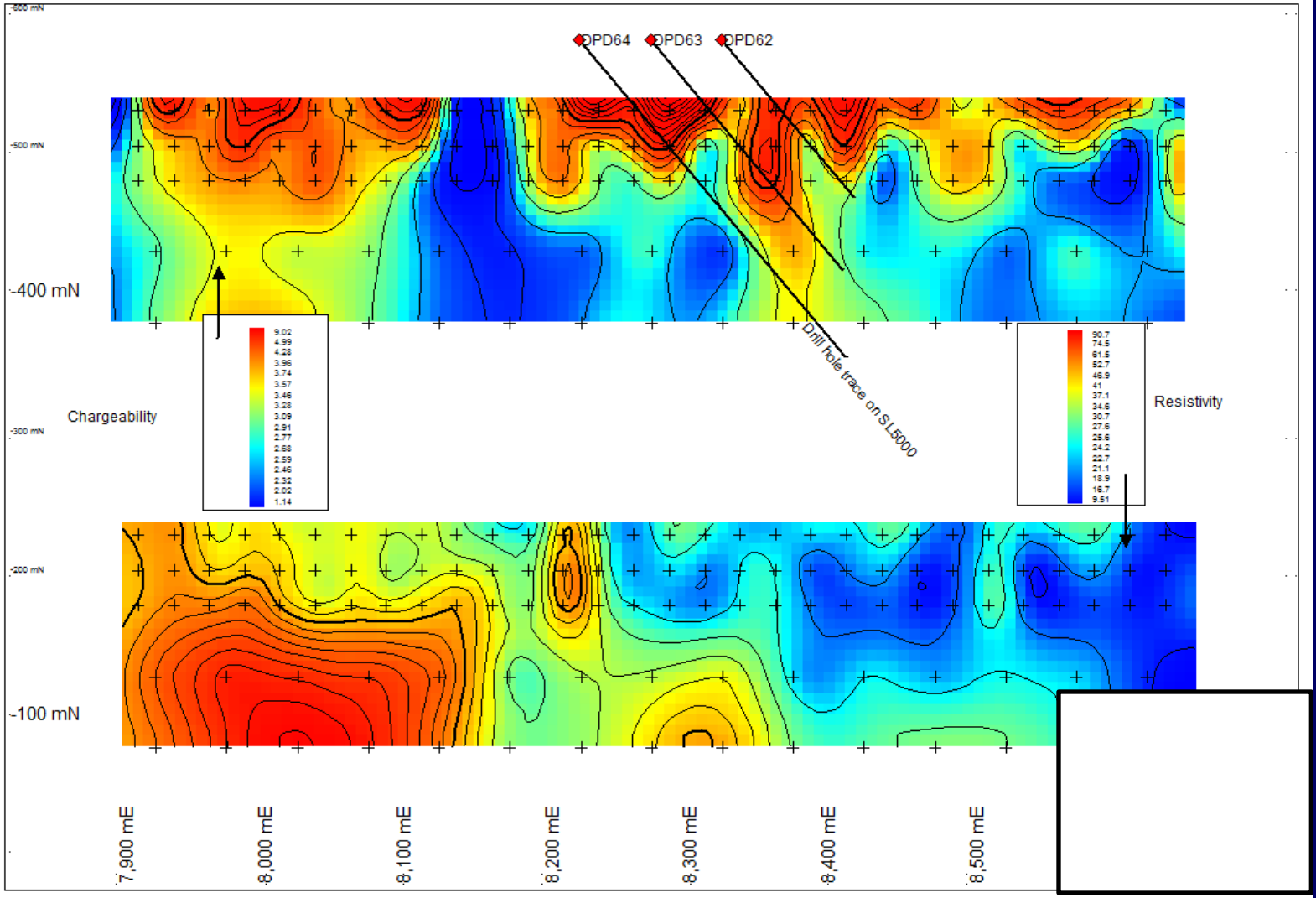
Flat Dipping Geological Features



Steeply Dipping Geological Features



- Real section cannot distinguish at depth signature from near surface effects – thorough check on anomalies that have a surface expression
- Advantage: does not suffer from pant leg effect – directly beneath potential dipole and pattern does not change whatever current electrode spread
- Has been effect in mapping flat dipping bodies of base metals and vertical gold reefs
- Can achieve greater DOI than DPDP and PD with lessor resources

Conclusion

- 2-D and 3-D surveys require modelling to attain true geological structure – otherwise a competent geophysicist will need to advise
- Need experienced and relevant geological constraints to provide reasonable to accurate model
- Proper survey planning to achieve required goals – not relevant to use a 50m dipole when the reef width is 50cm

- Thank You