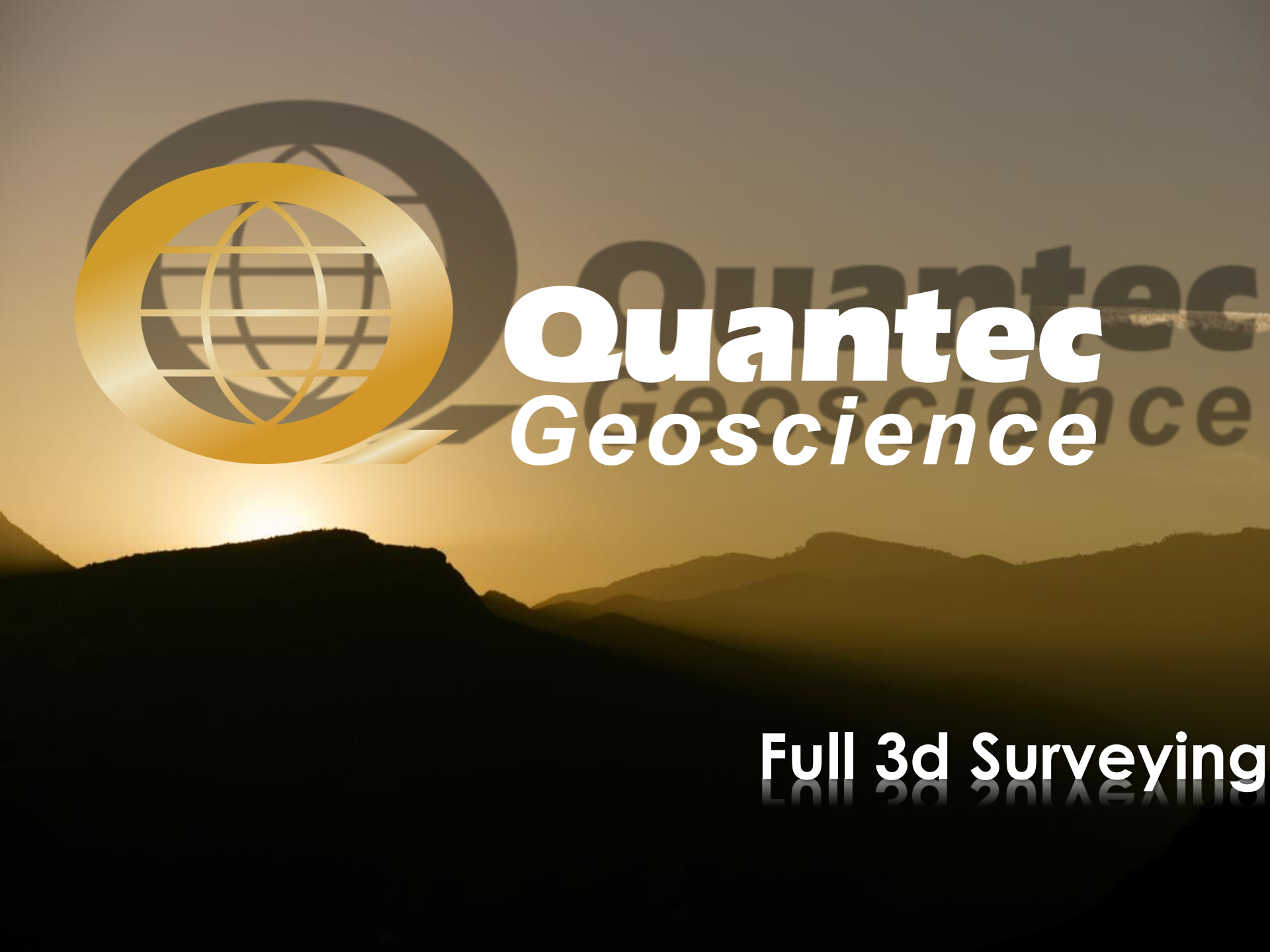

Quantec
Geoscience
Full 3d Surveying

Introduction

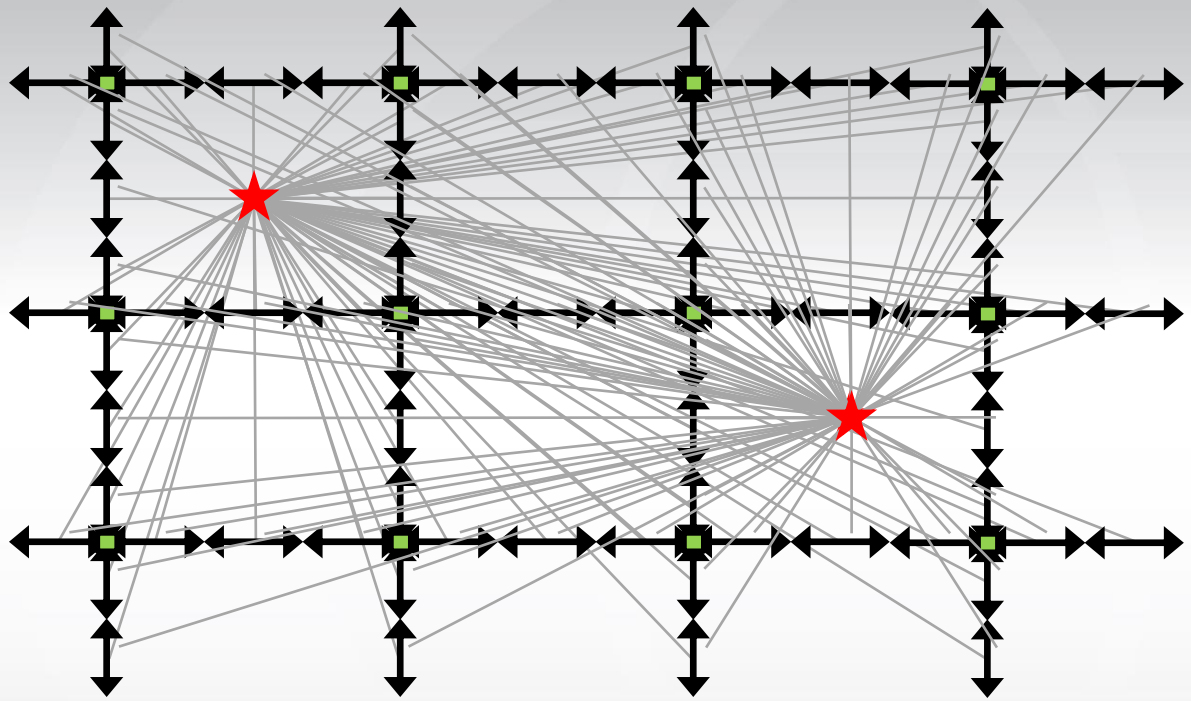
- How many channels?
- What configuration?
- What are the advantages?
- What are the problems?
  - (& the list of questions posed by Steve)
- Costs

Fundamental full 3d array

- How many channels?
  - 300 receiver channels for every transmit.
  - Covers ~ 2 x 2 km
- What configuration?
  - an equal number of dipoles in two orthogonal directions

ORION 3D

BLACKTHORN RESOURCES



Receiver Dipole

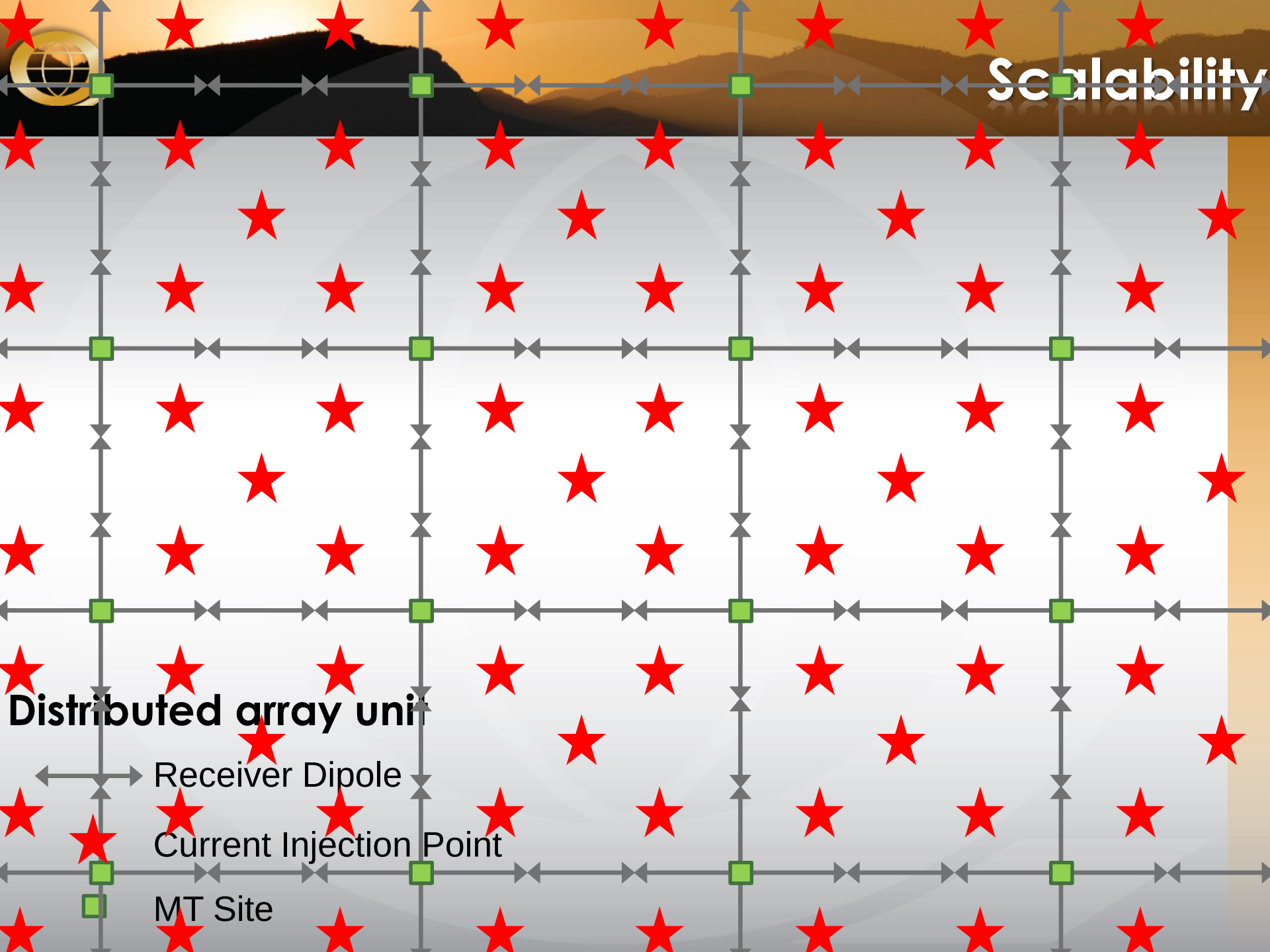
Data Recorder

Current Injection

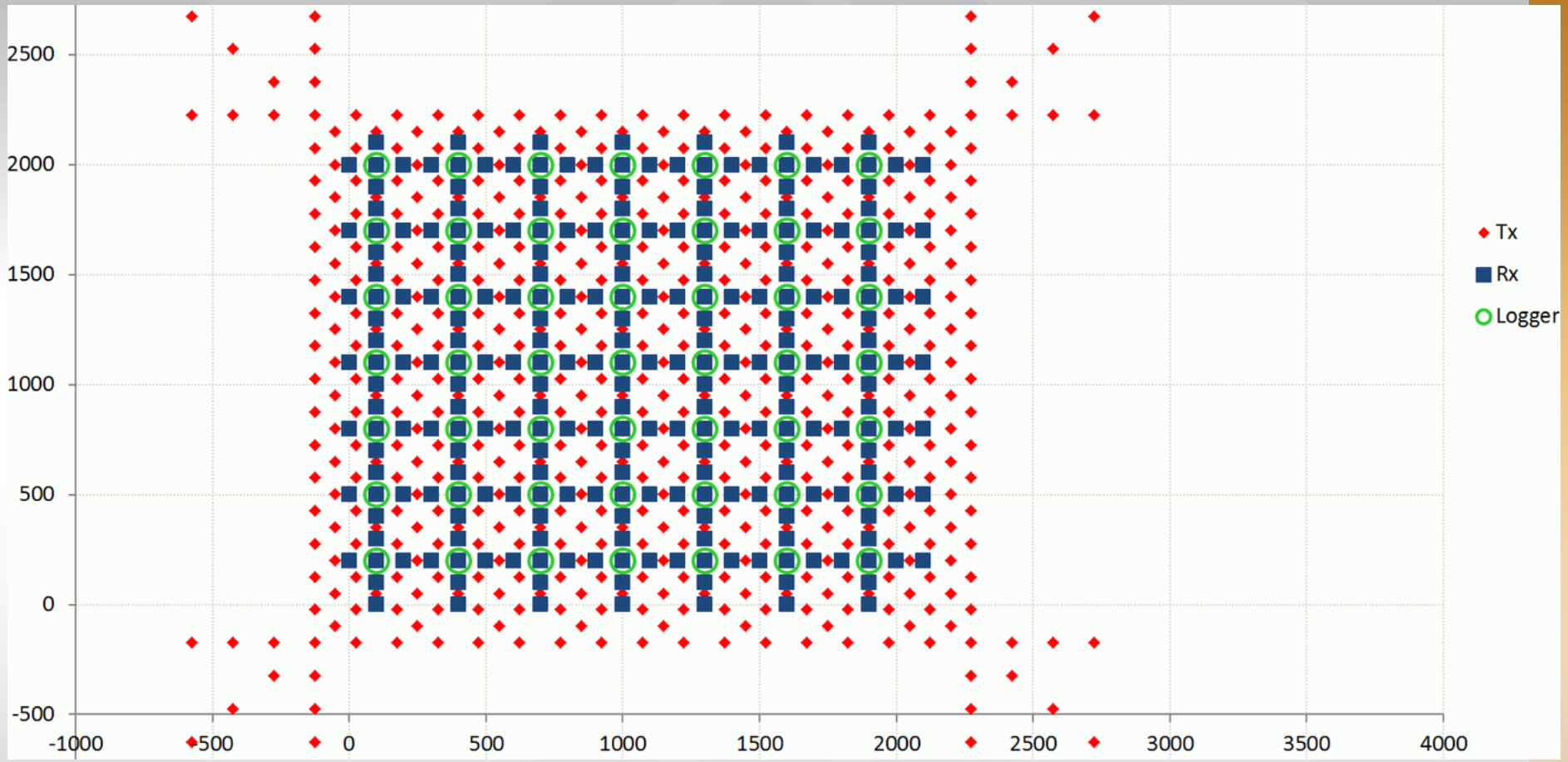
"Conceptual" Current Path

- True 3D DCIP measurement
- Simultaneous receiver sampling
- Omnidirectional data free from receiver geometry bias

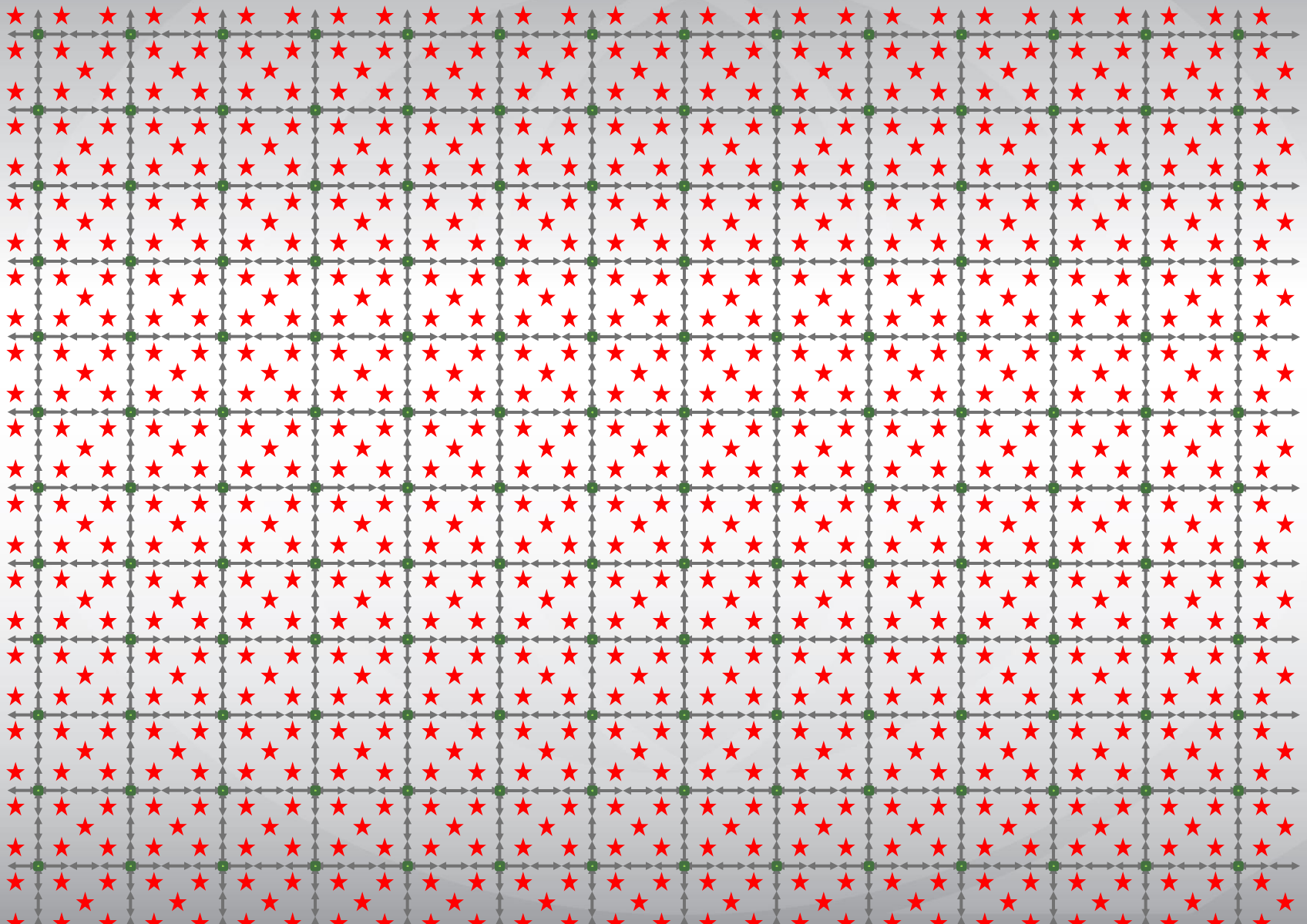
Scalability



Add Corner Transmits



Further Scalable as Patches



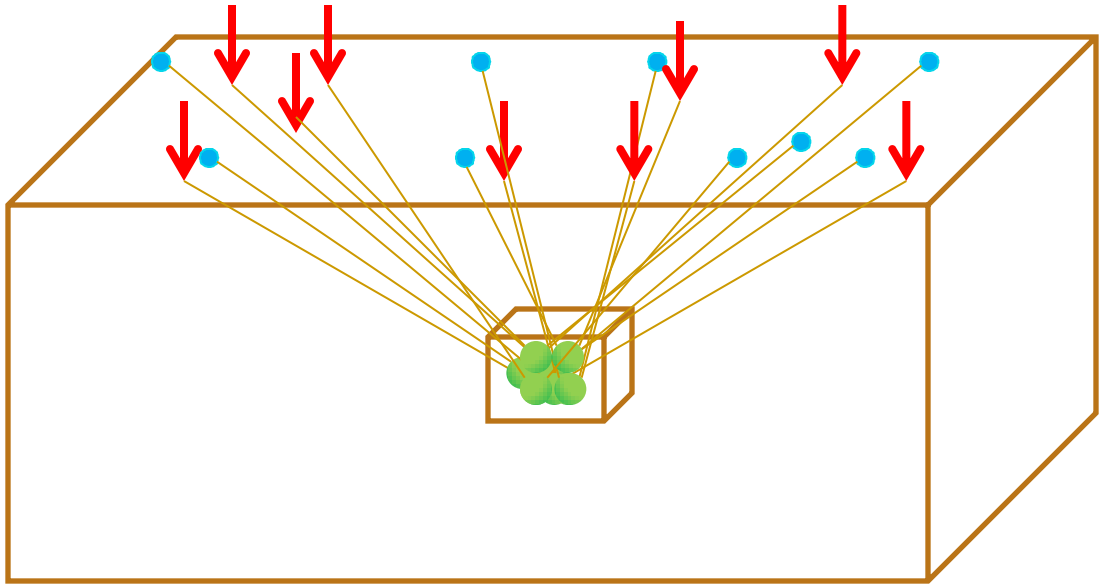
What are the advantages?

- Increased resolution
- No directional bias or distortion
- Map complexity in:
  - strikes,
  - folds,
  - structure,
  - and 3d ore
- Provides a robust base for 3d tomography and 3d target definition.
- Greenfield forays where strike is not known

Omnidirectional Coverage

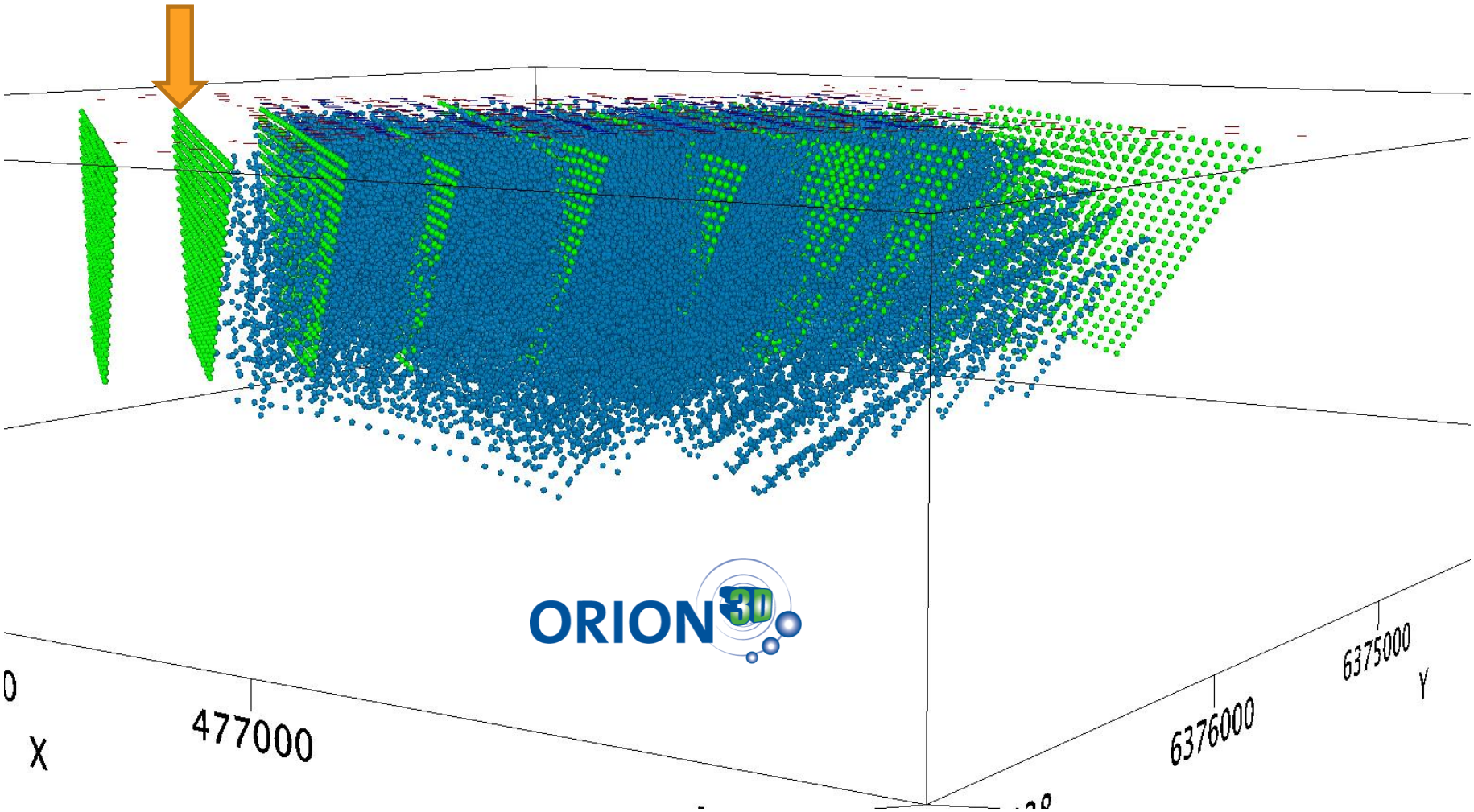
Within each “cell”, the multiple “plot points” all originate from different transmit-receiver pairs to give omnidirectional coverage (similar to tomography).

This adds to the information and helps constrain the inversion to a better solution.



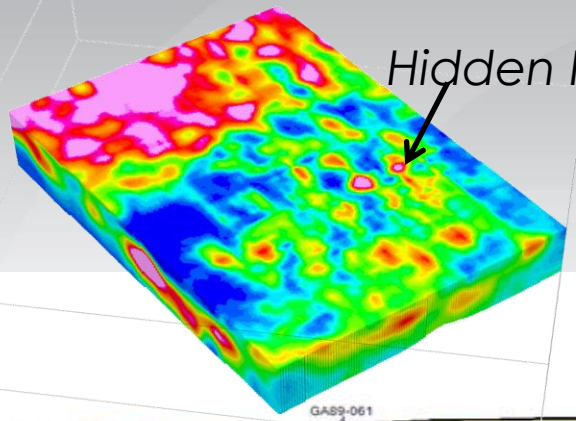
Titan 2D Vs Orion 3D Data Samples

Titan Lines

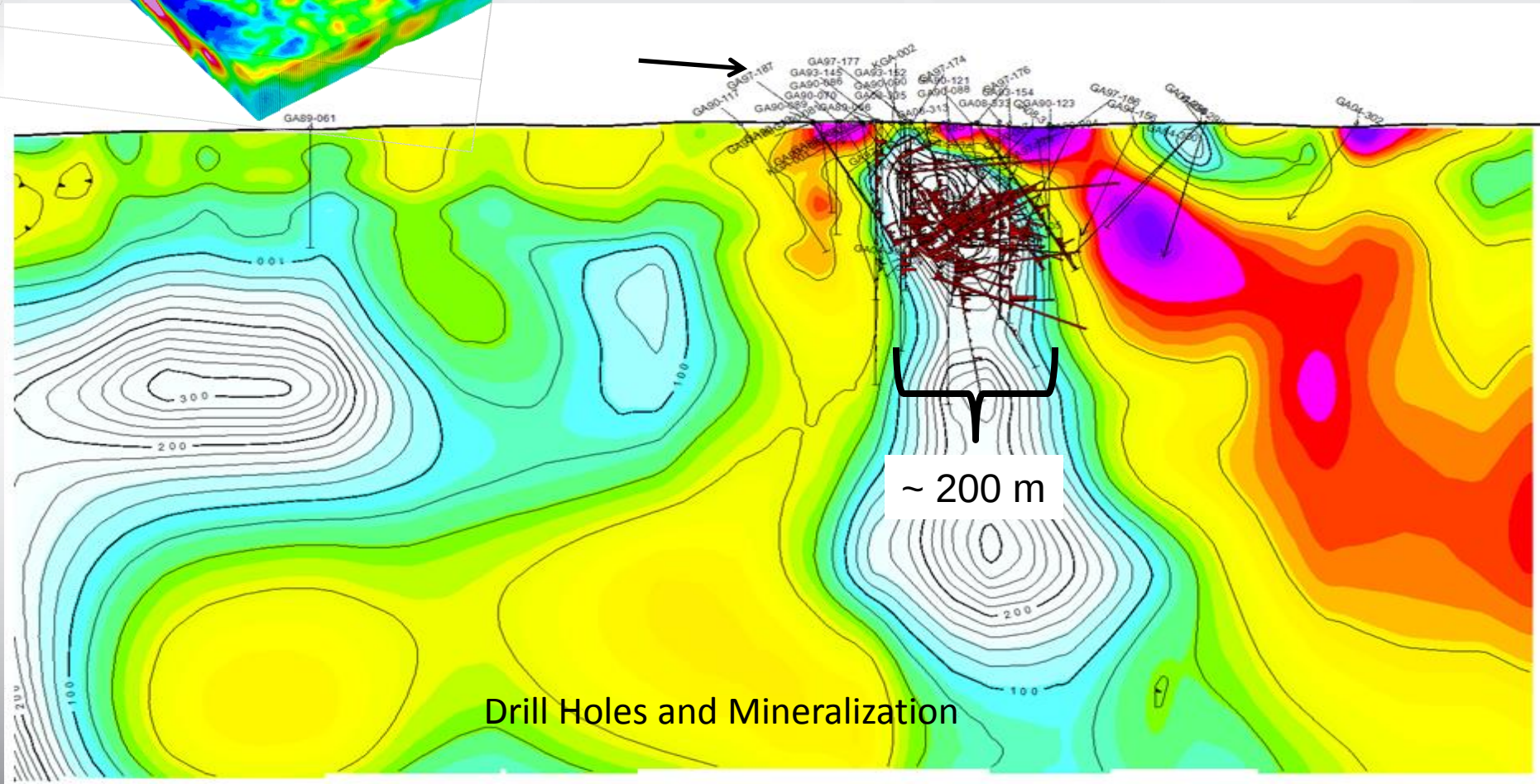


Omni Directional Sampling
Unparalleled Definition
~140,000 samples

Nevada Epithermal Gold

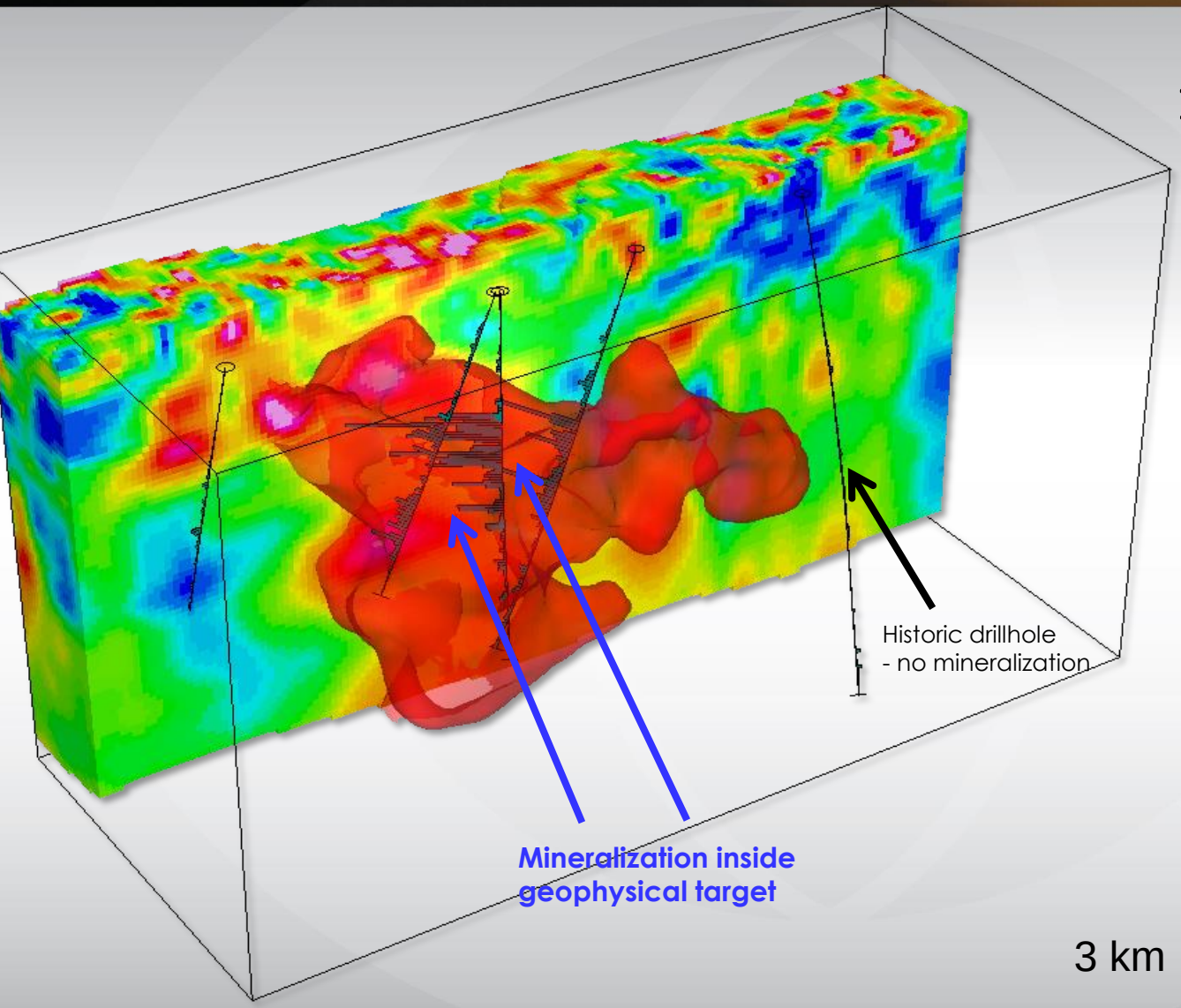


280,000 data points

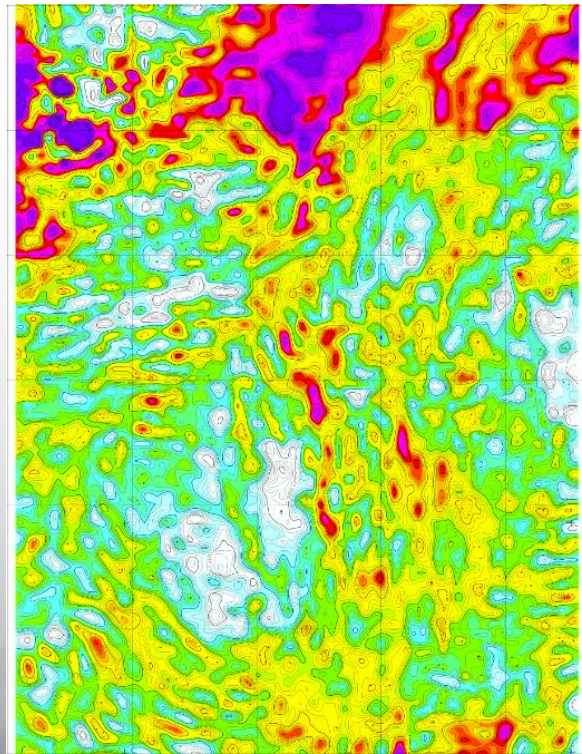


Zambia IOCG

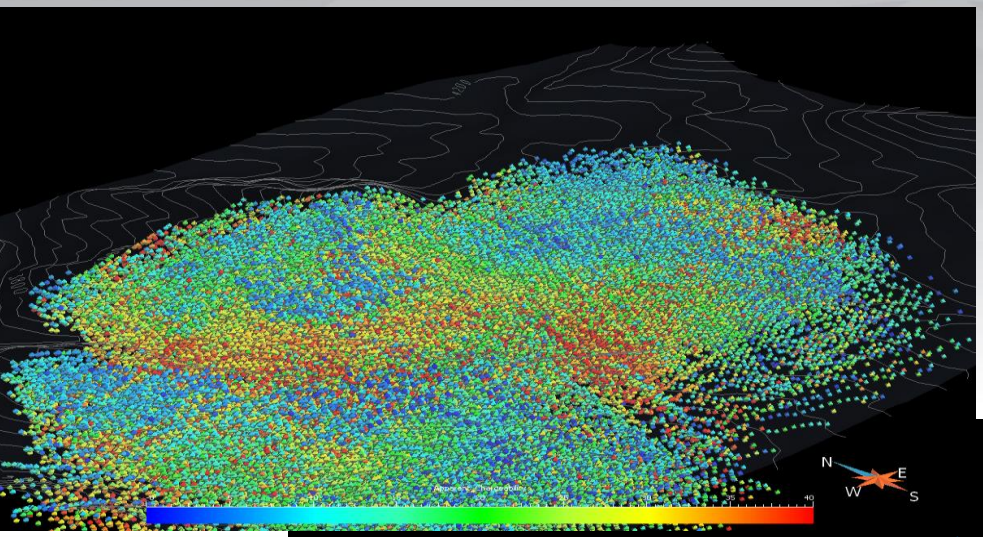
160,000 data points



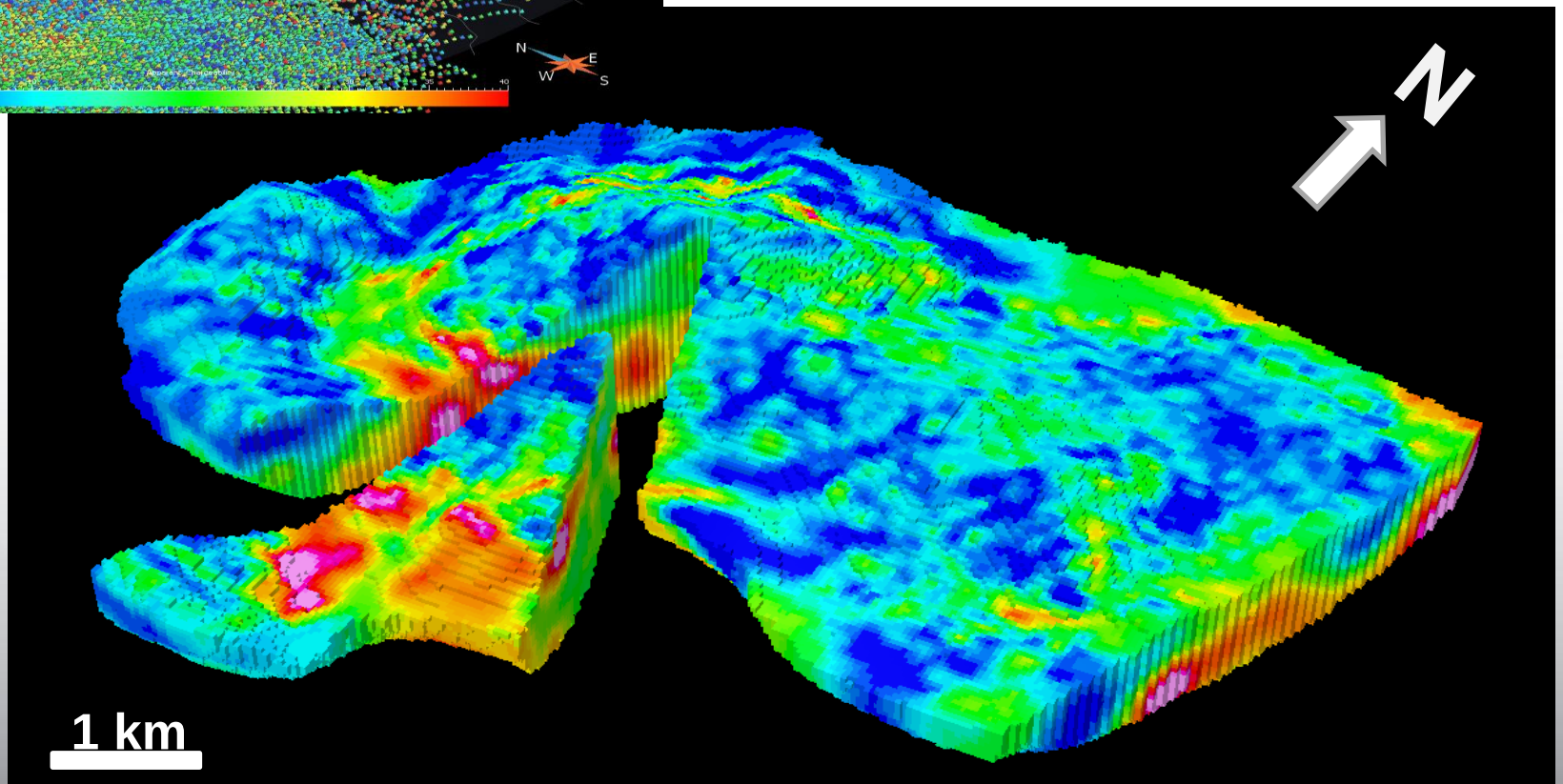
2 km



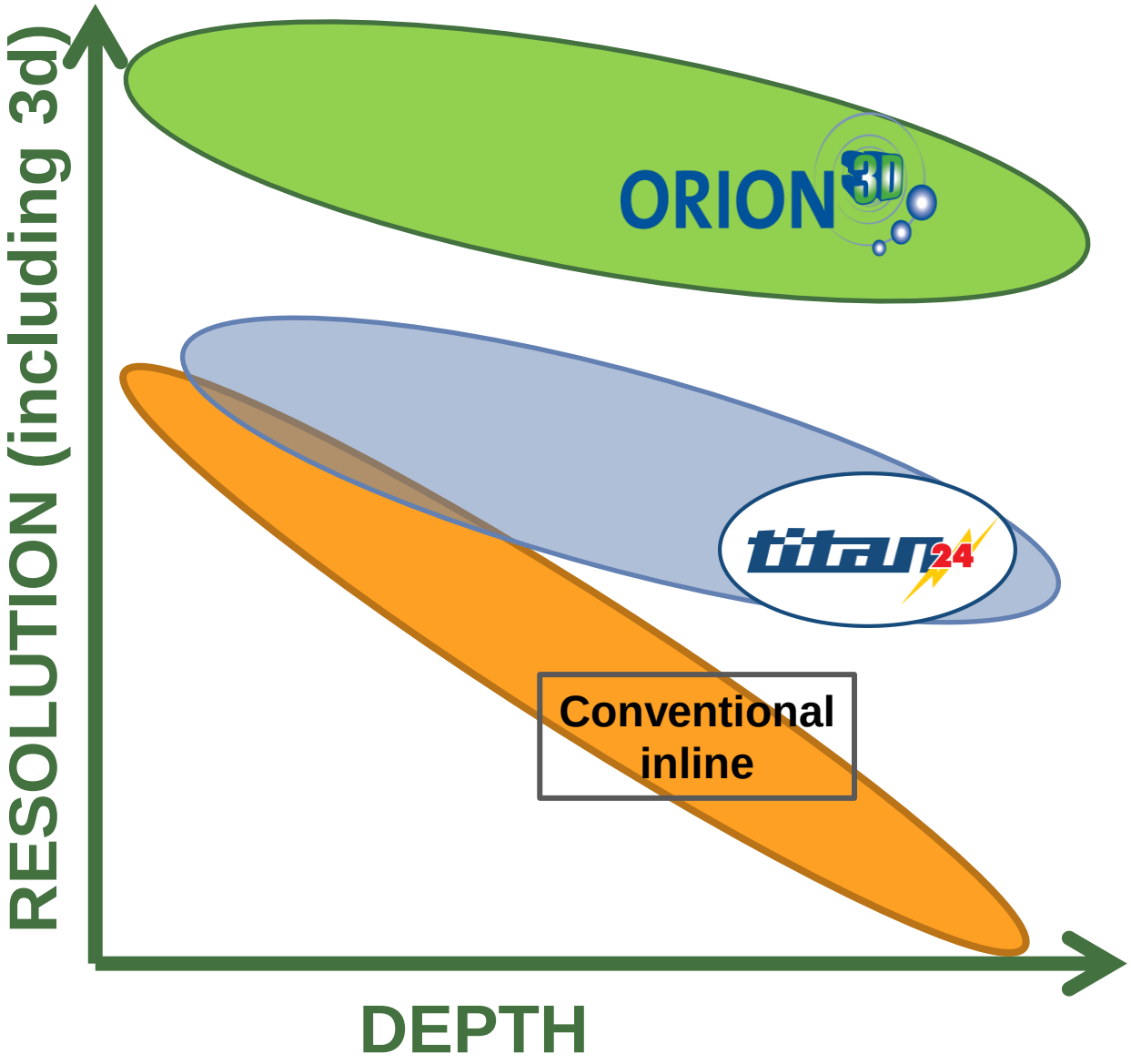
Chile porphyry



150,000 data points



Resolution and Depth



- Super-sampling provides unrivalled accuracy and precision in interpretation
- Distributed acquisition provides greater depth search and confidence
- Orion's 3D layout provides true 3-D results – unique in the industry

What are the problems (or requisits)?

- Fixed, distributed array
  - Certain dipoles will have long offsets
  - Certain dipoles will lie on equipotentials.
- QC and evaluation tools are critical –
  - Field operators notes
  - 3d QC tools
    - Review time-series and map up-time (if necessary)
    - Extract pseudo-sections at any azimuth
    - Display plan maps for every transmit
      - Review equipotentials
      - Check for extremes and exceptions
  - Detailed processing notes
  - Inversion preparation (conditioning log)

The Questions…

1. Signal strength at the receiver
   a) can large Rx to Tx separations be attained?

ANS: Use all the tricks (Like Titan and MIMDAS)

- *100 % duty cycle square wave*
- *Current monitor*
- *Distributed receivers (gain and common-mode voltage)*
- *Full-waveform at high sample rate*
  - *(1000 sps)*

The Questions…

2. Direction of current flow beneath the receiver locations.
   a) Is this always constant

ANS: No, every transmit couples uniquely (with the offset dipoles, - in-line dipoles have a more uniform characteristic)

   b) or are there a variety of transmitter current directions to assist the inversions in 3D.

ANS: Yes. And we recommend to use a pole for 'omnidirectional' current and max DOI. A pole is also less complicated for evaluating equipotential patterns – not critical but can help with QC

The Questions…

3. Logistics
   a) What are the implications for continuing the survey should one remote part of the setup be compromised due to external interference (animals or curious locals)
      i. does a small problem at a remote site result in the whole survey crew sitting on their backsides for a couple of hours while the problem is located?

ANS: Not usually. We designed to accommodate some losses (originally we conceptualized rolling along)

      ii. How easy is it to determine where a problem lies?

ANS: Usually very easy - evaluate the time-series.

      iii. Here generalised 3D surveys may be inappropriate.

ANS: we would disagree – Zambia, Ecuador, Ontario, Saskatchewan, Chile, Australia, Nevada

The Questions…

3. Logistics
   b) How much manpower is required to run the survey?

ANS: 15-20 men

   c) How difficult is it to setup?

ANS: It takes about 3 days

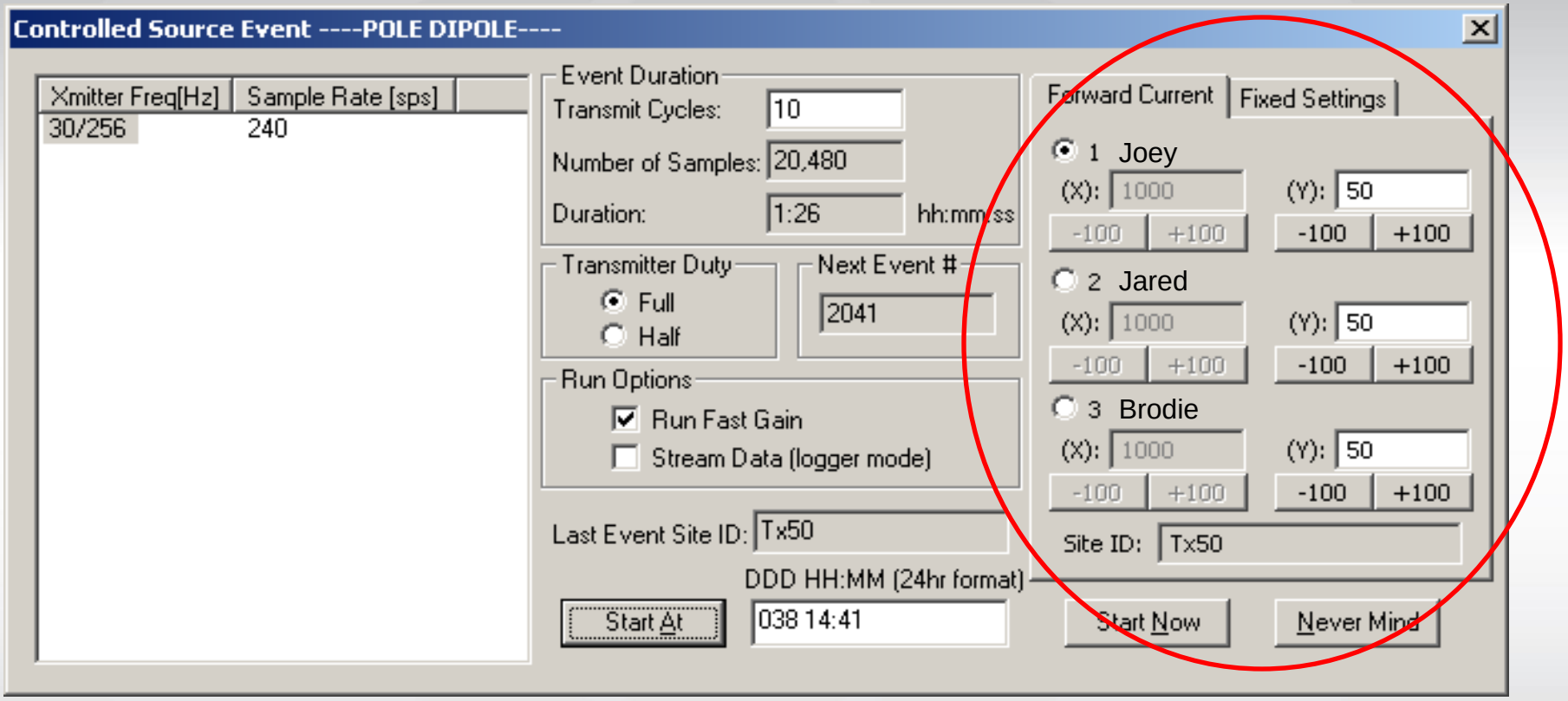
   d) How difficult is it to train local helpers to assist in the running of the survey?

ANS: The helpers carry gear and there is lots to do. It takes some training and understanding to run the loggers. We need 3-5 trained people on site.

   e) Is there a safety issue with high voltages on long wires. Pole transmitters are a problem here.

ANS: No more so than for any other pole survey. We control our runners very carefully with switch boxes, notes and rigorous radio protocol.

Transmit and Tx runner control



& Field operator notes with SOH (batteries state, contact impedance, gain setting)
& Listing of all transmits with voltage tap, current and comments.
List of equipment and culture.
Names and locations of runners

The Questions…

3. Logistics
   f) Is the use of dipole receivers preventing detection of deeper sources?

ANS: Modeling shows a modest improvement with larger dipoles at larger offsets. We are implementing built-dipoles to accommodate. This is an area of development.

   f) How easy is the setup in difficult terrain with no vehicle access? Cut lines in jungle or rocky steep ground.

ANS: Gear is man-portable. We have run Orion in steep terrain (Chile), jungle (Ecuador) and Canadian spruce forest

   f) Can the survey spread be quickly put in a state where it can be safely left overnight in areas with curious nocturnal, sharp teethed wildlife.

ANS: In terms of picking up at night, no

The Questions…

4. How susceptible is the geometry to EM coupling?

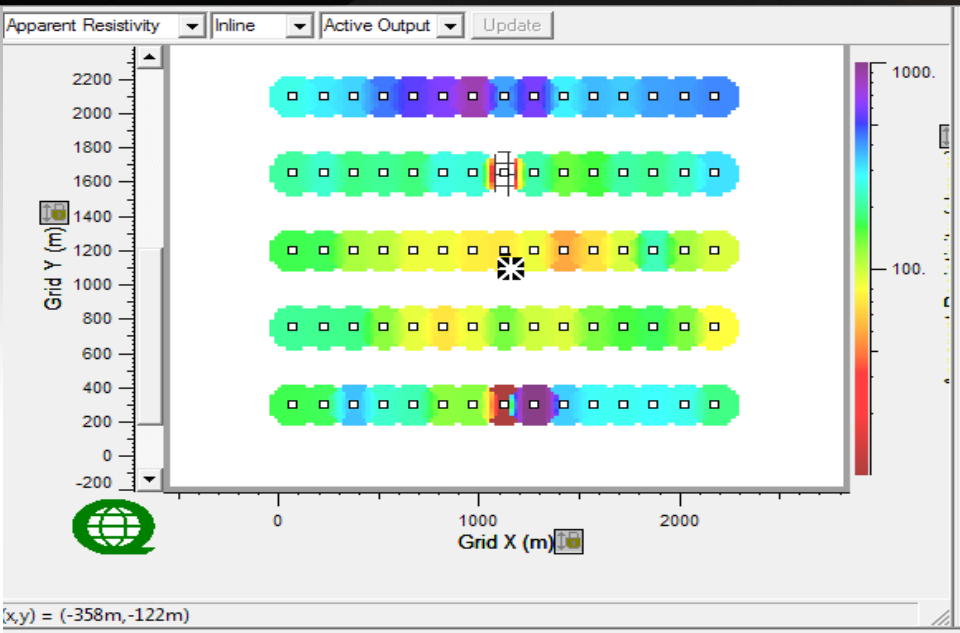
ANS: EM coupling moves later in time with distance from the transmit. We use a distant infinite and late-time signal extraction (.8 or 1.2 s start – same as Titan)

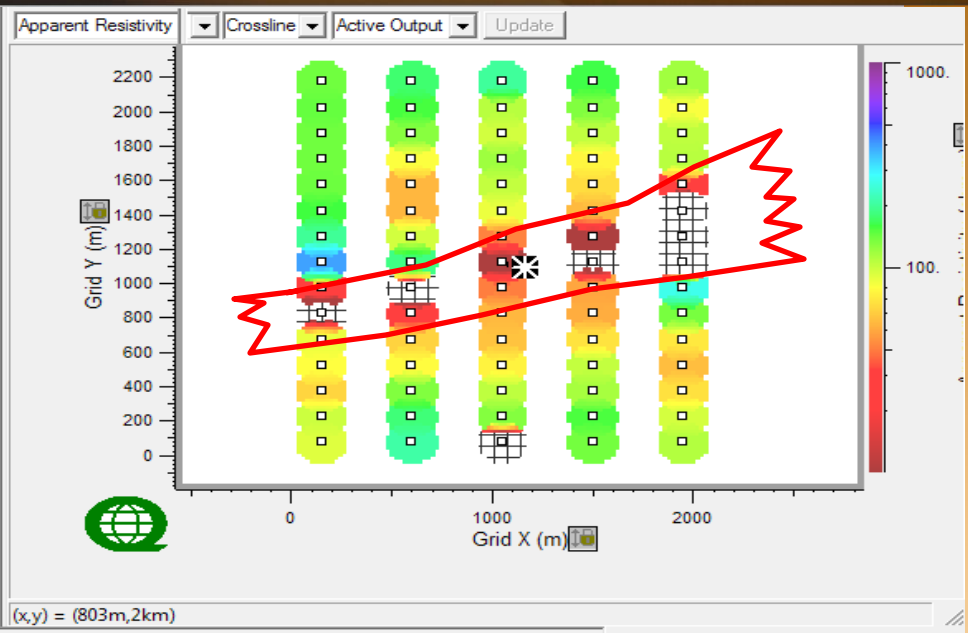
5. How likely is it that receiver dipoles lie near a transmitter equipotential and thus have errors associated with low primary voltage.

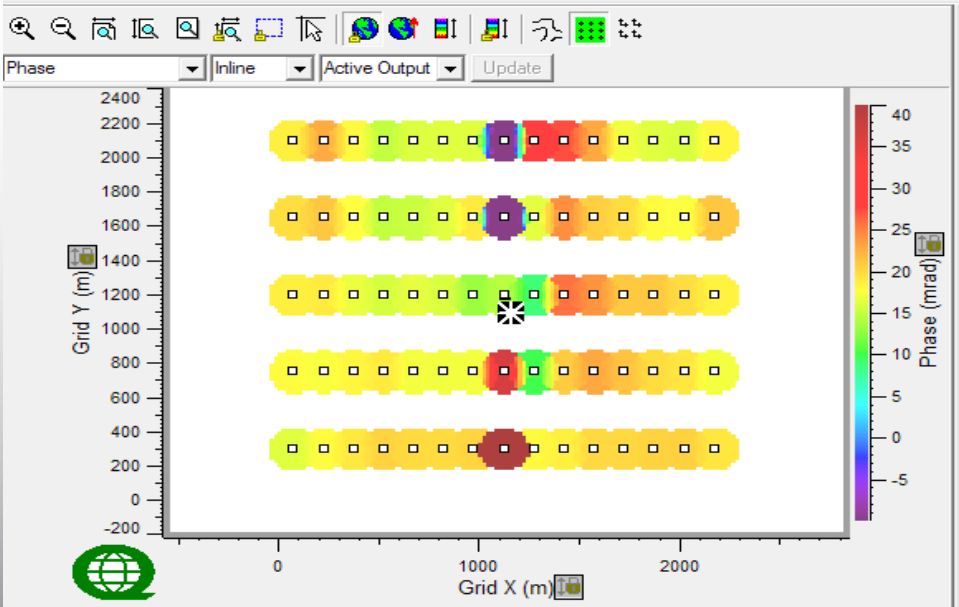
ANS: This will definitely happen. But who's to actually know where the equipotentials lie unless you measure them? The most interesting and economic earth is 3d.

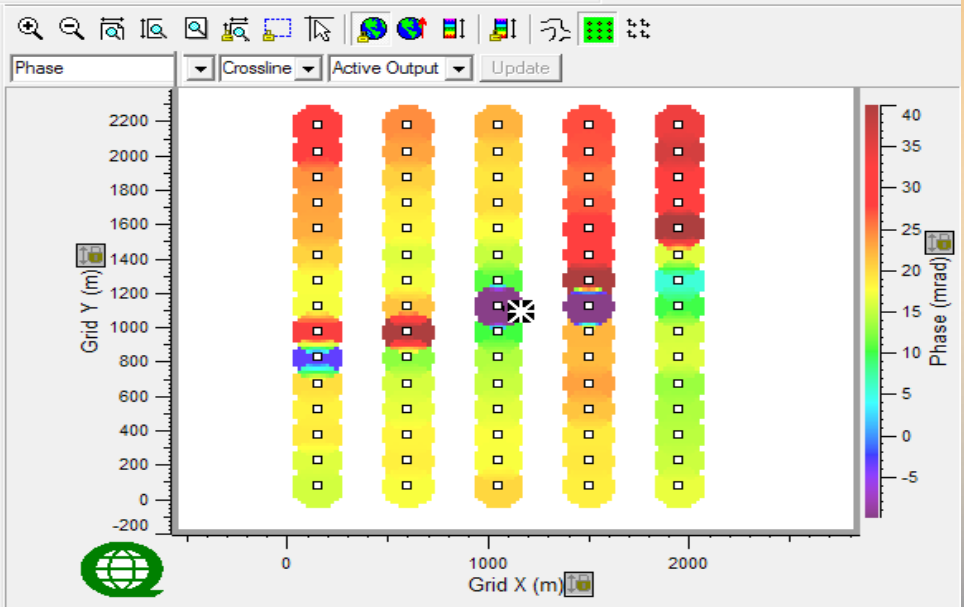
Equipotentials

Note the unpredicted pattern of crossline equipotentials







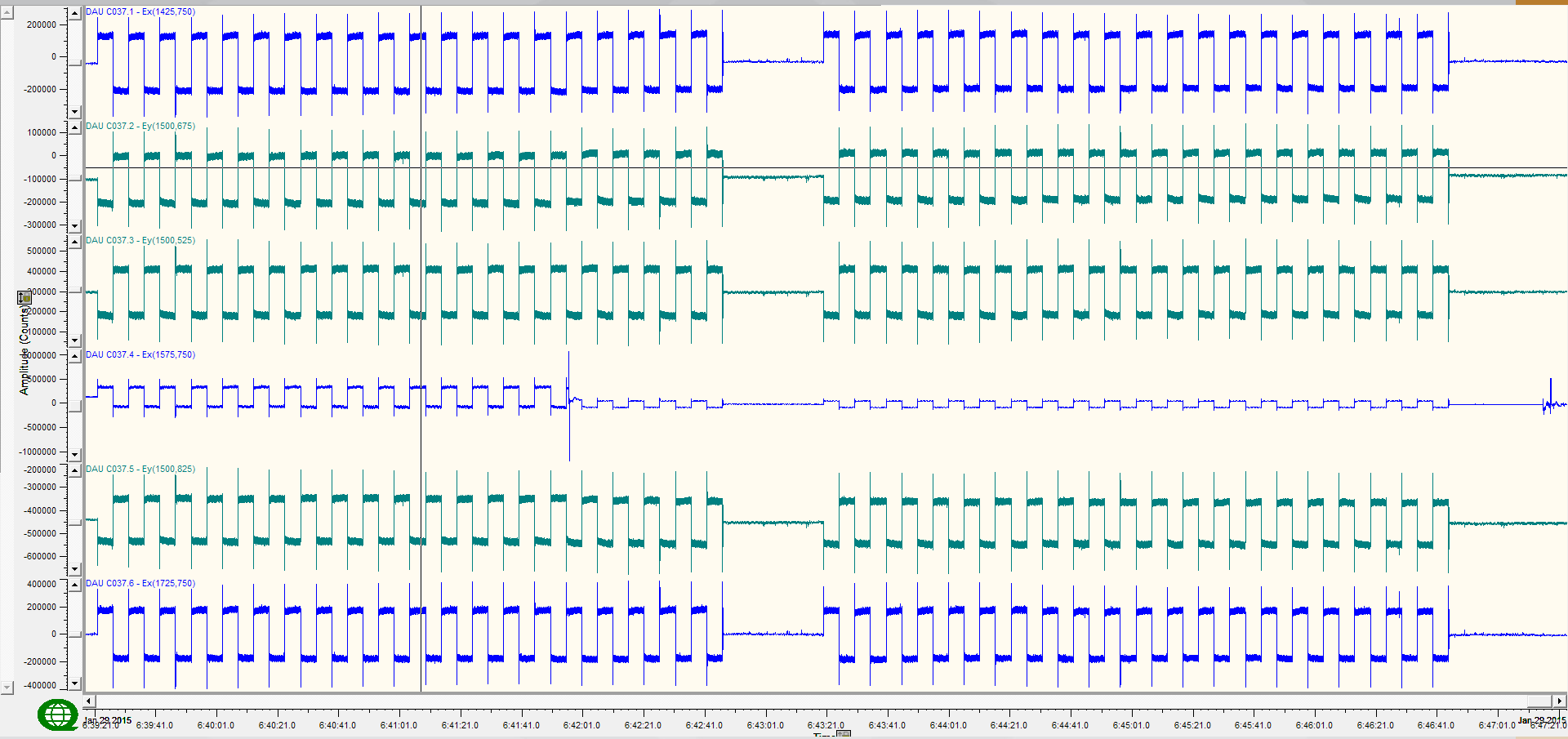


The Questions…

6. How susceptible is the receiver dipole to telluric noise and sferics?

ANS: We store full waveform so advances in signal processing can be applied well after the survey. Telluric Cancellation is available, and of course the processing is already very good (same as Titan).

Full Waveform acquistion



Showing time-series for two transmits and 6 channels of one logger. Problem with channel 4 purposely shown to highlight QC. Note no long period tellurics in these data. Small spherics are apparent in the inter-transmit period.

7. What is the cost per square kilometre?

- Our clients will tell you, “it’s worth it”.
  - It’s fast: the cost of a fully bidirectional 3d dataset can be reasonably compared to many 2d systems
  - To budget one patch:
    - 15-25 days with a 20 man crew;
    - and mobilize ~12,000 lbs of gear.

The result is an enduring data asset that will stand through many future tests and evaluations of the property (and mine!).

Quantec Geoscience

THANK YOU

ASEG, Steve Collins & sponsors