Magnetics Example

Inclination and Declination

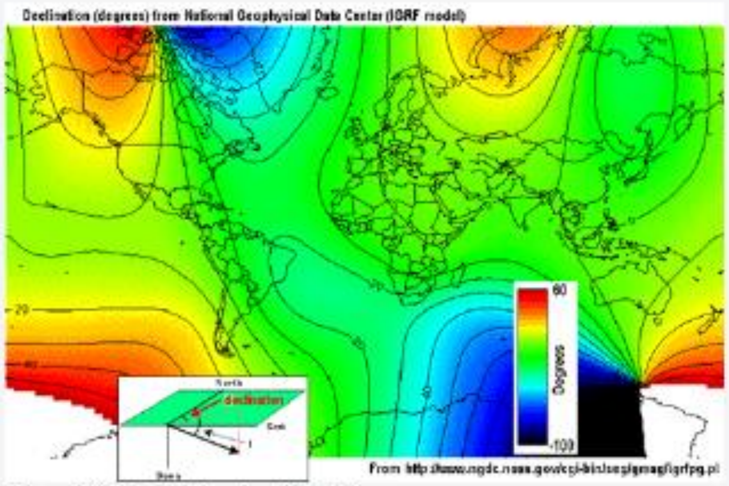


Fig. 26 Earth's declination.

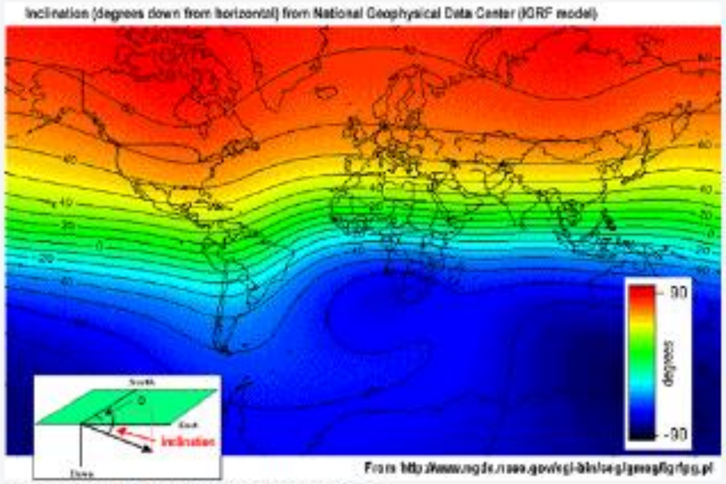
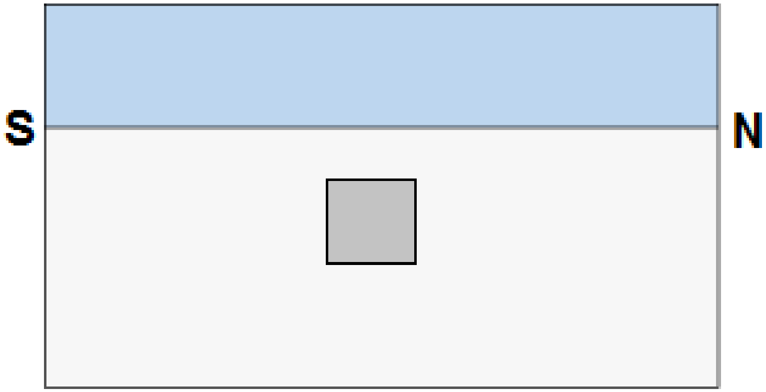


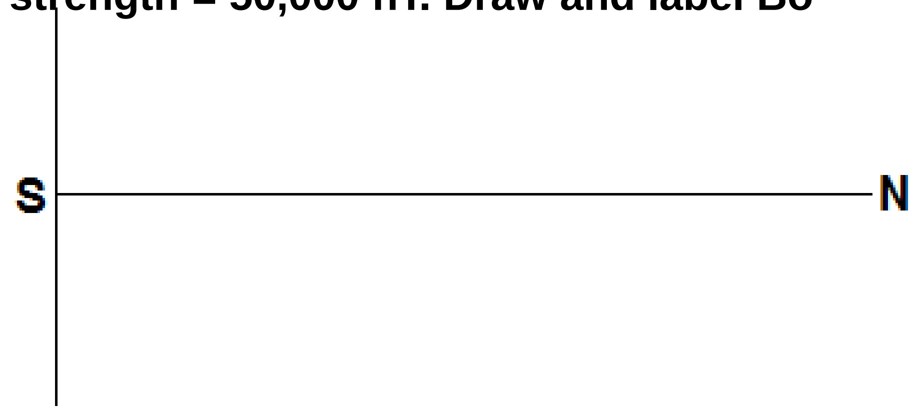
Fig. 27 Earth's inclination.

- If field direction is going **into** the ground, is inclination +ve or –ve?
- What is the range of declinations the Earth can have?
- What direction is inclination = +60 and declination = -45?
- What direction is inclination = -30 and declination 180?

Magnetics as Dipoles or Charges

- **Inducing field has incl. = 60, decl. = 0 and strength = 50,000 nT. Draw and label Bo**





- **If the magnetic susceptibility is 0.05 SI, compute the magnetization in the:**

  Easting:

  Northing:

  Upward:

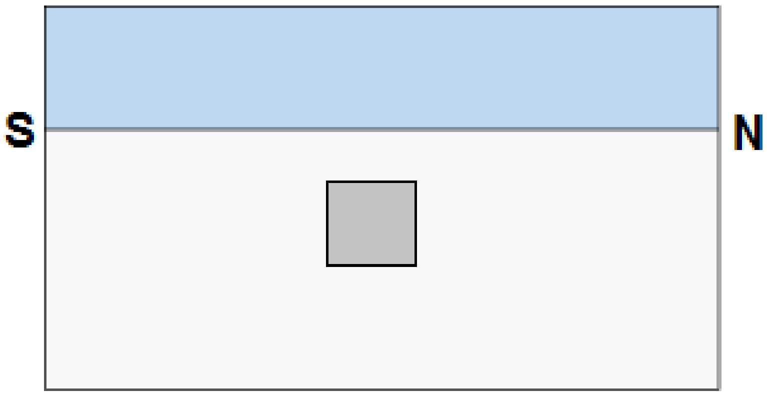
- **Block has remanence of 1.4 A/m at an incl = 45 and decl. = 180. Compute the total magnetization in the:**

  Easting:

  Northing:

  Upward:

Magnetics as Dipoles or Charges



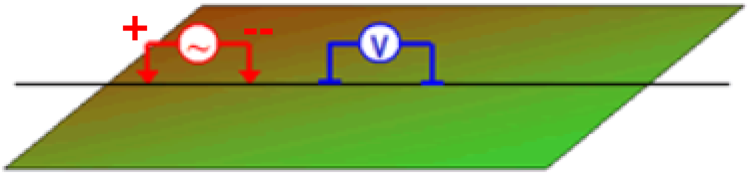
- **If the block has a side length of 2 m, what is the total magnetic charge on the top of the block?**

- **Draw the anomaly**

DC Resistivity Example

Physics Review

You are doing a dipole-dipole survey



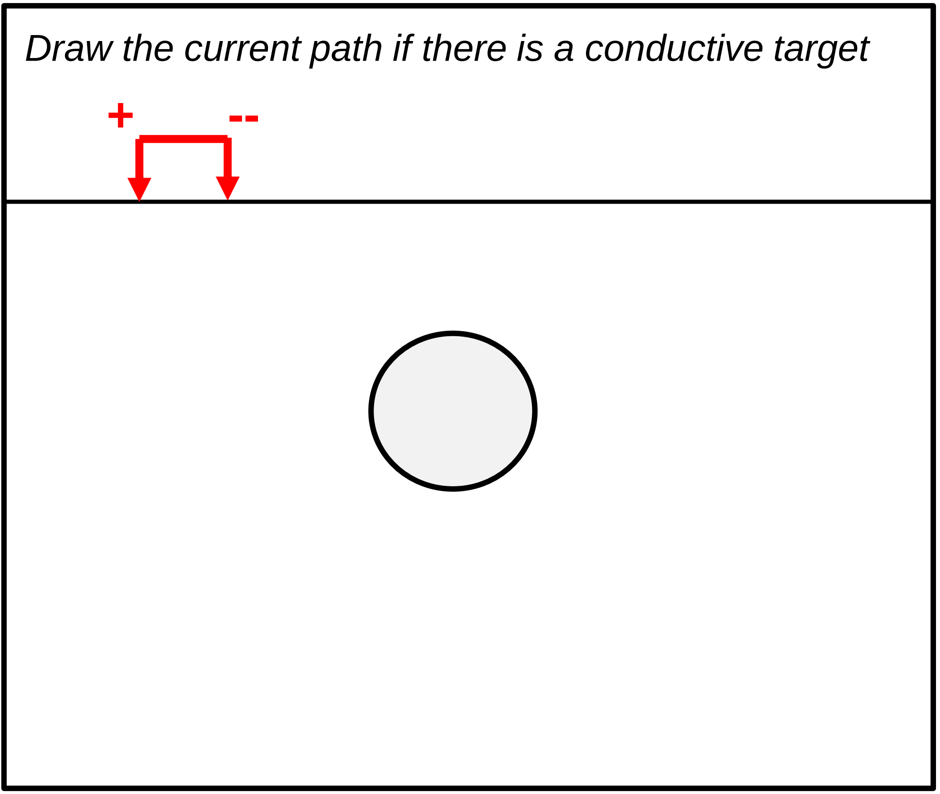
Voltage due to current electrode: $V = \dfrac{\rho I}{2\pi r}$

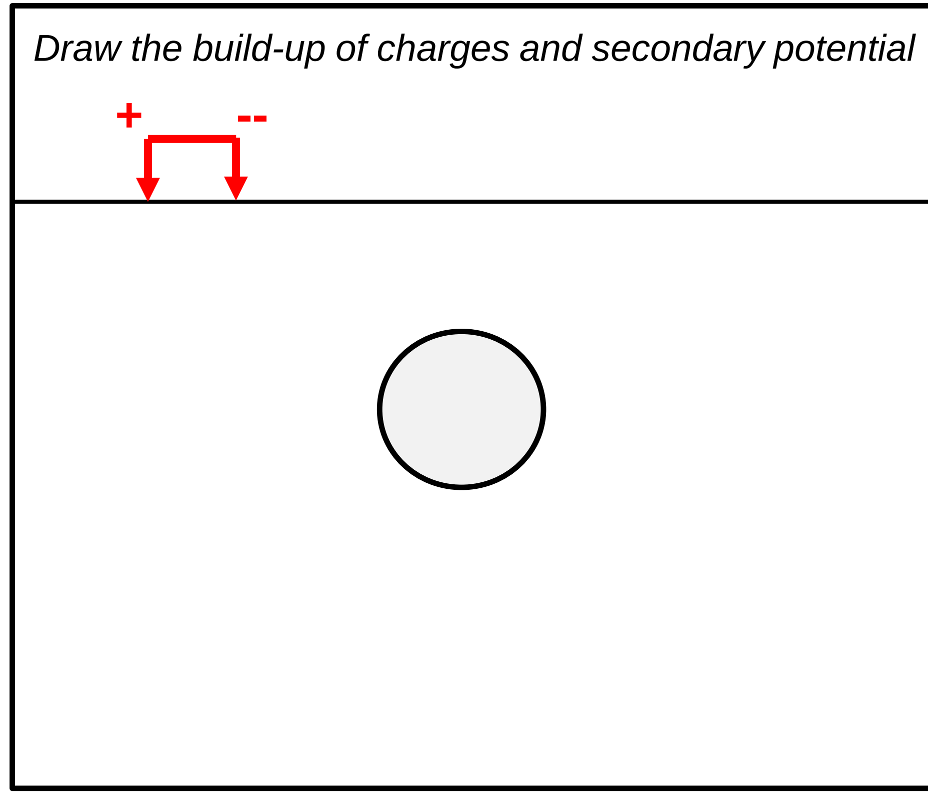
Electric potential and electric field: $\mathbf{E} = -\nabla \mathbf{V}$

Draw potential on Earth's surface due to a dipole current electrode

Draw the equi-potentials and current path in ground

Physics Review





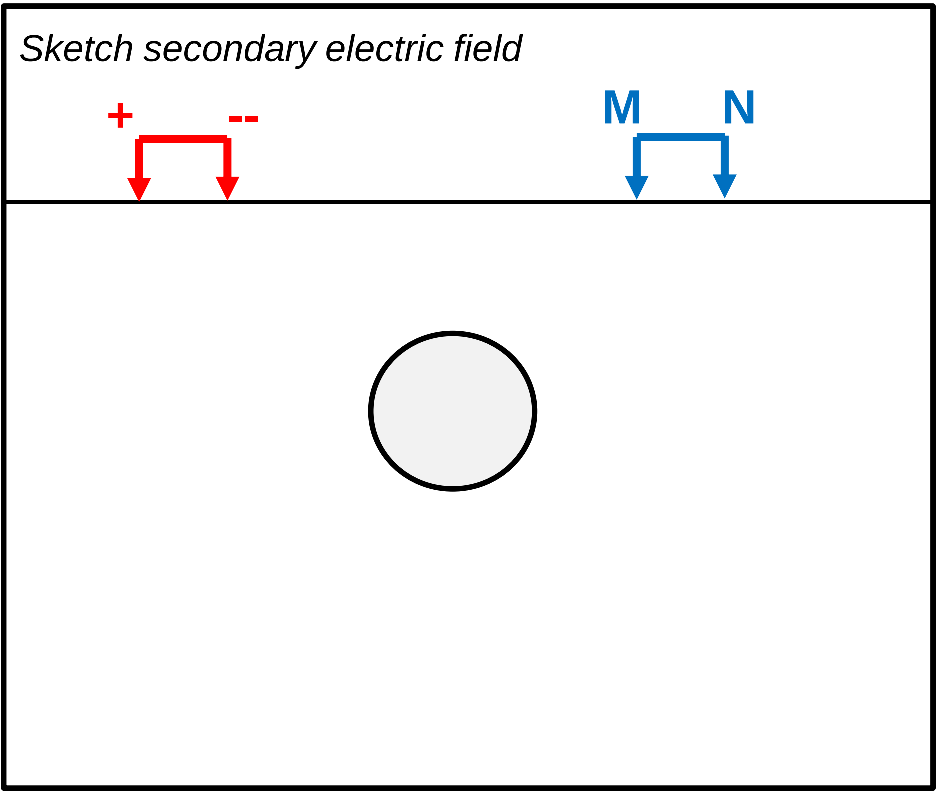
Boundary condition for normal currents

$$\left(\frac{1}{\sigma_2}-\frac{1}{\sigma_1}\right)\mathbf{J_n}=(\rho_2-\rho_1)\mathbf{J_n}=\frac{\tau}{\varepsilon_0}$$

Electric potential due to charges

$$\mathbf{V}(\mathbf{r})=\frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{N}\frac{Q_i}{\mathbf{r_i}}$$

Physics Review



Sketch primary and secondary potentials near receiver

Voltage measurement

$$\Delta V = V_N - V_M$$

Apparent resistivity

$$\rho_a = \frac{\Delta V}{IG}$$

- *Is Vs adding to or opposing Vo?*
- *How does this impact apparent resistivity?*

Physics Review

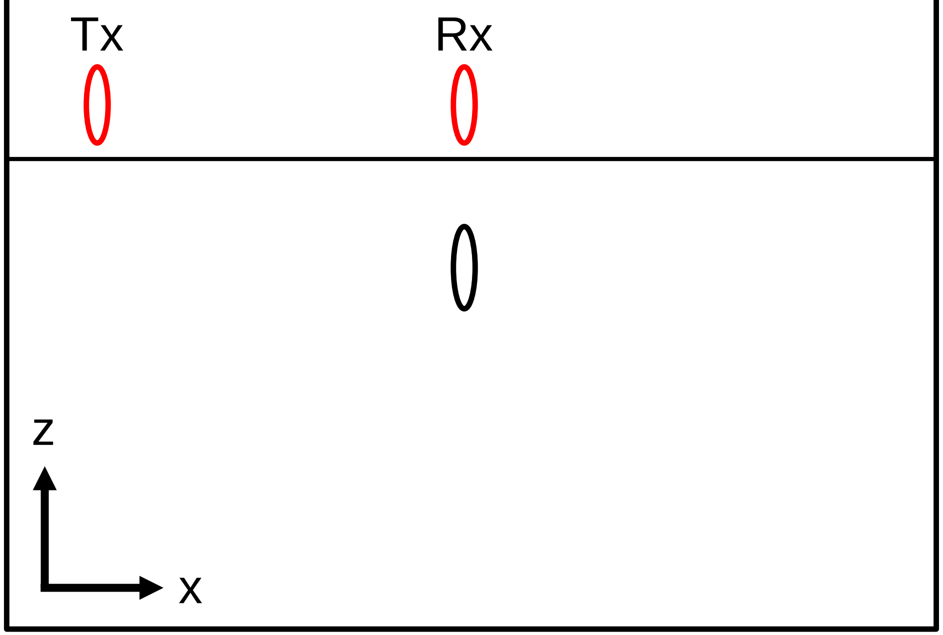
Sketch sounding data over this conductor

Sketch profiling data over this conductor

Electromagnetics

Vertical Coaxial Example

Sketch the primary and secondary fields. Define the transmitter to have a dipole moment in the x-direction



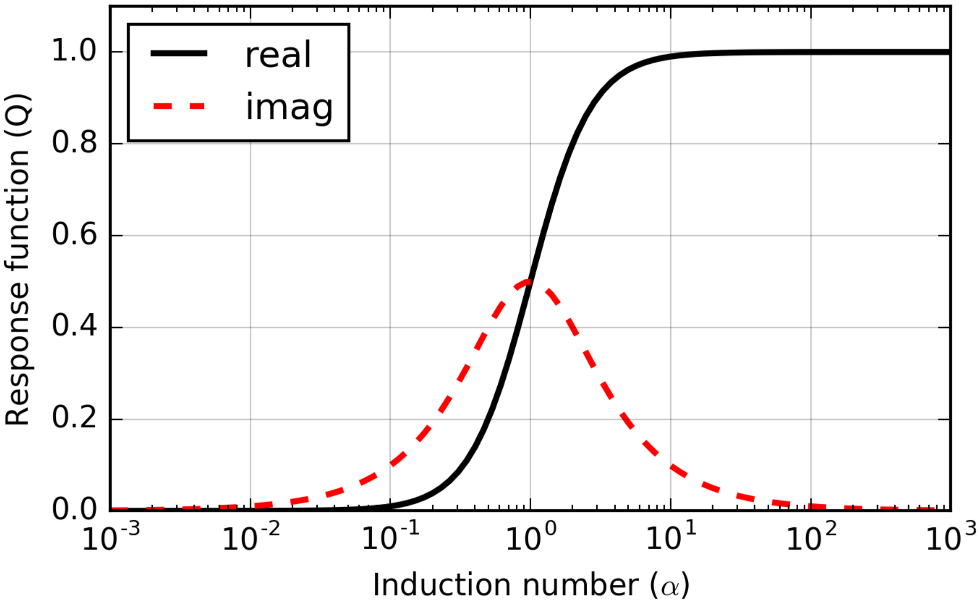
We have a vertical coaxial survey geometry over a target

The target is modeled as an LR circuit

If the radius of the transmitter loop is 50 cm, the amplitude of the current is 2 A and the coil has 5 turns, what is its dipole moment?

Is the transmitter and receiver well-coupled or null-coupled?

Vertical Coaxial Example



*The transmitter carries an oscillating current. The frequency and the properties of the target loop are such that the **inductance is 0.5***

What is the phase lag between the primary and induced current?

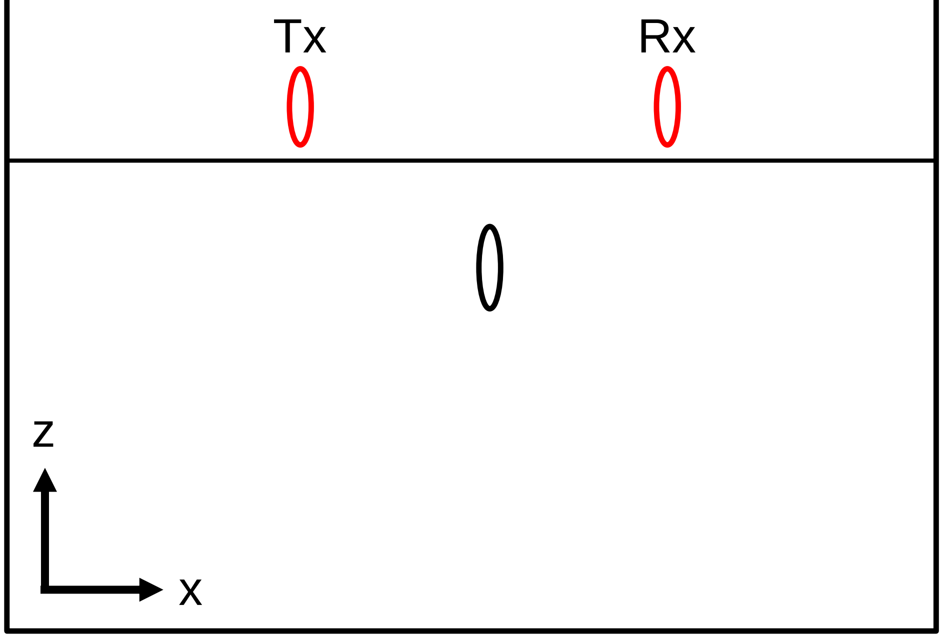
Will the response have a large in-phase or quadrature component?

$$\alpha = \frac{\omega L}{R}$$

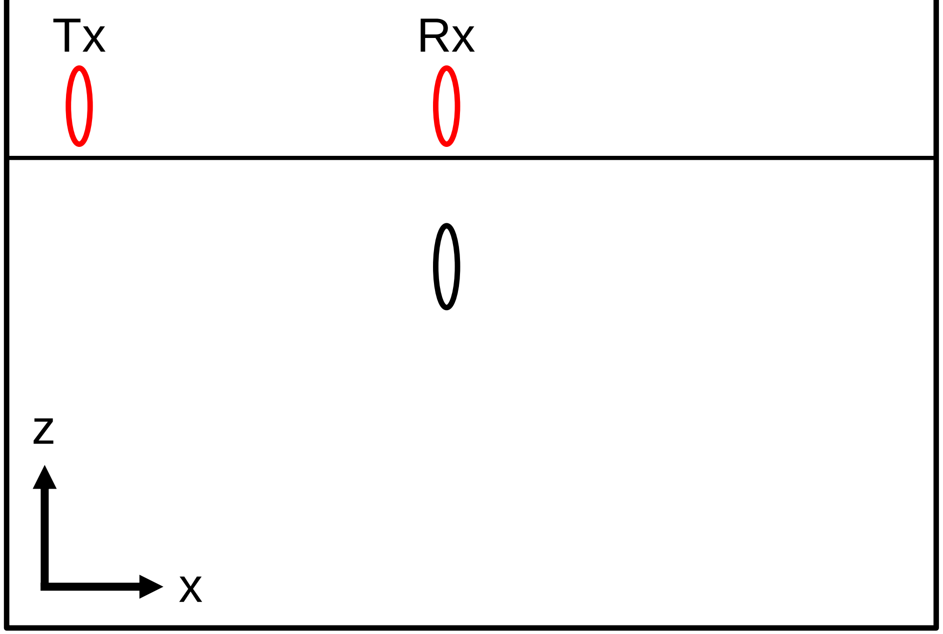
$$\psi = \frac{\pi}{2} + \tan^{-1}\left(\frac{\omega L}{R}\right)$$

Vertical Coaxial Example

Sketch the primary and secondary fields. Define the transmitter to have a dipole moment in the x-direction



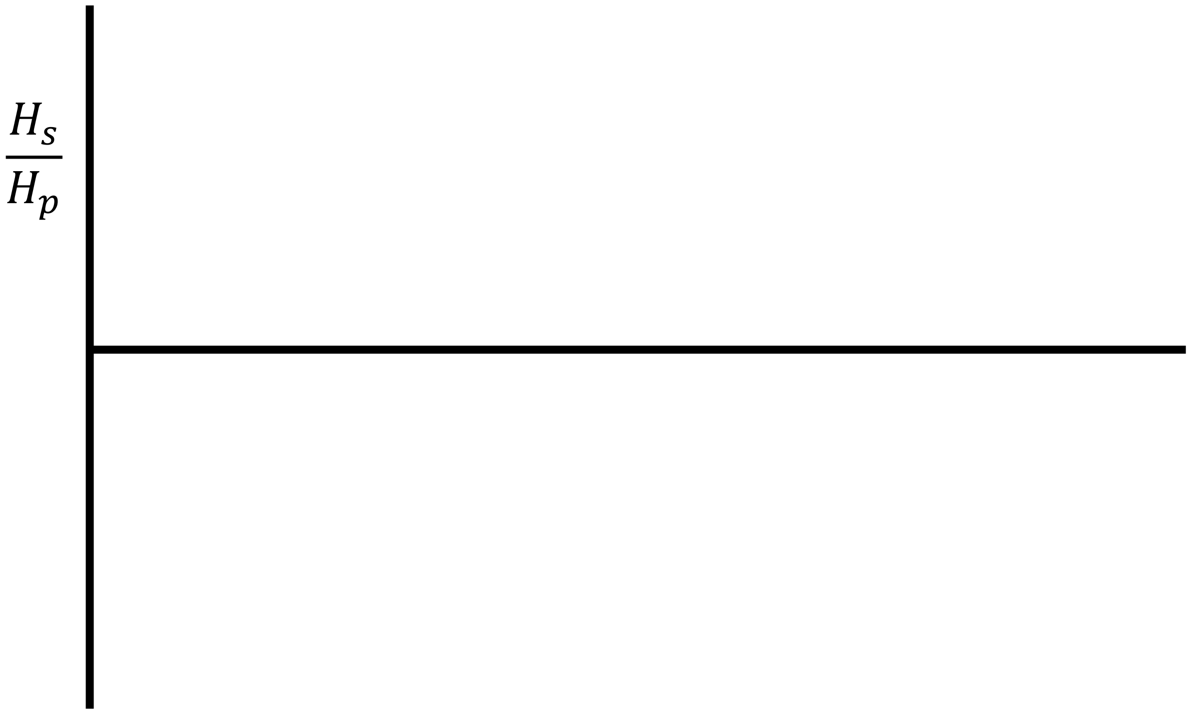
Sketch the primary and secondary fields. Define the transmitter to have a dipole moment in the x-direction



If the radius of the transmitter loop is 50 cm, the amplitude of the current is 2 A and the coil has 5 turns, what is its dipole moment?

Vertical Coaxial Example

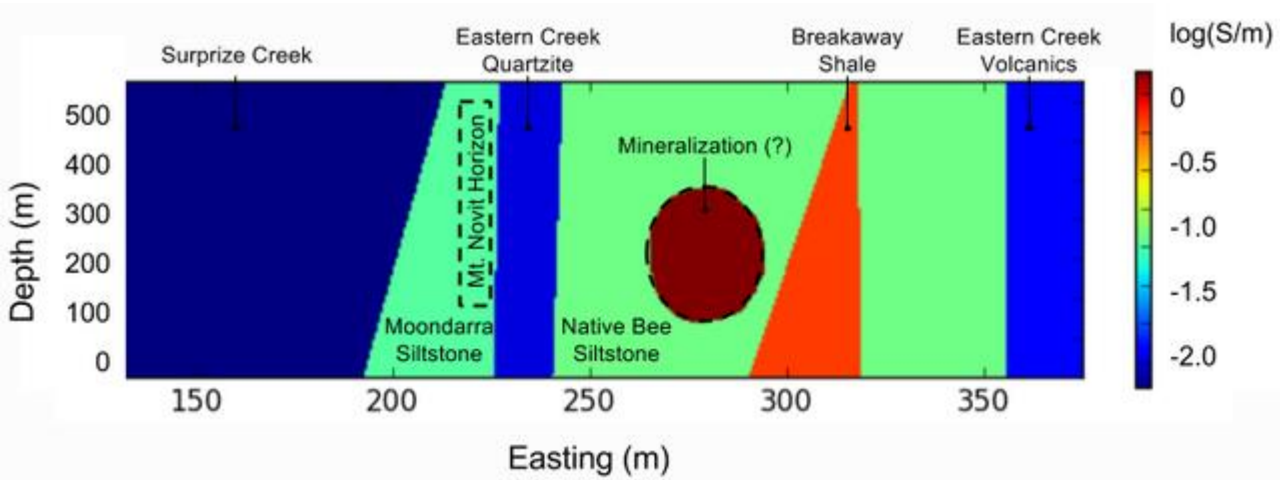
Sketch the anomaly. They halfway point between Tx and Rx is the data location



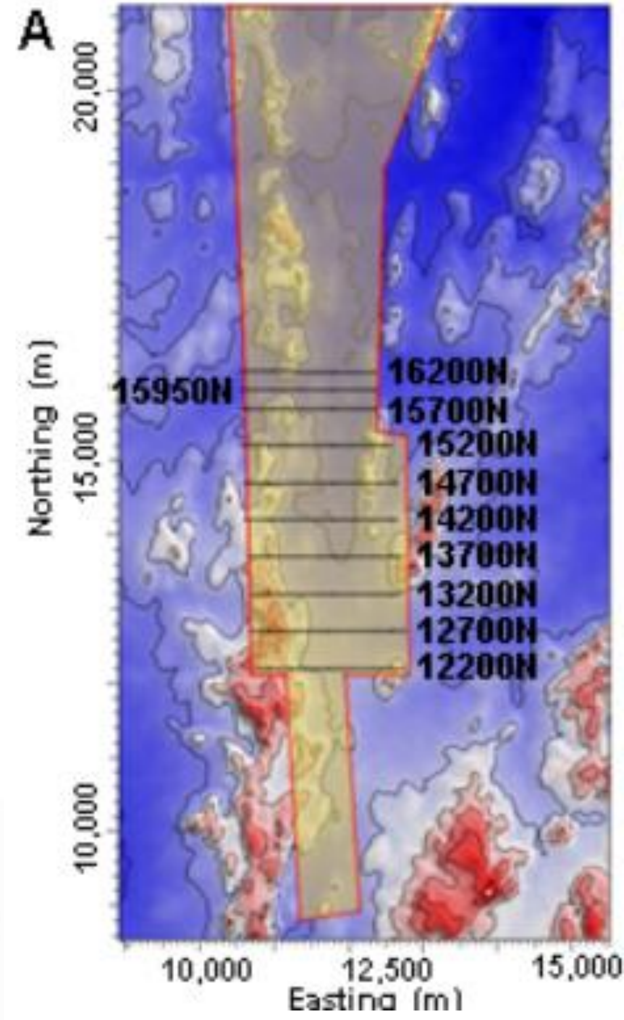
The Return of Mt. Isa

Mt. Isa (Setup)

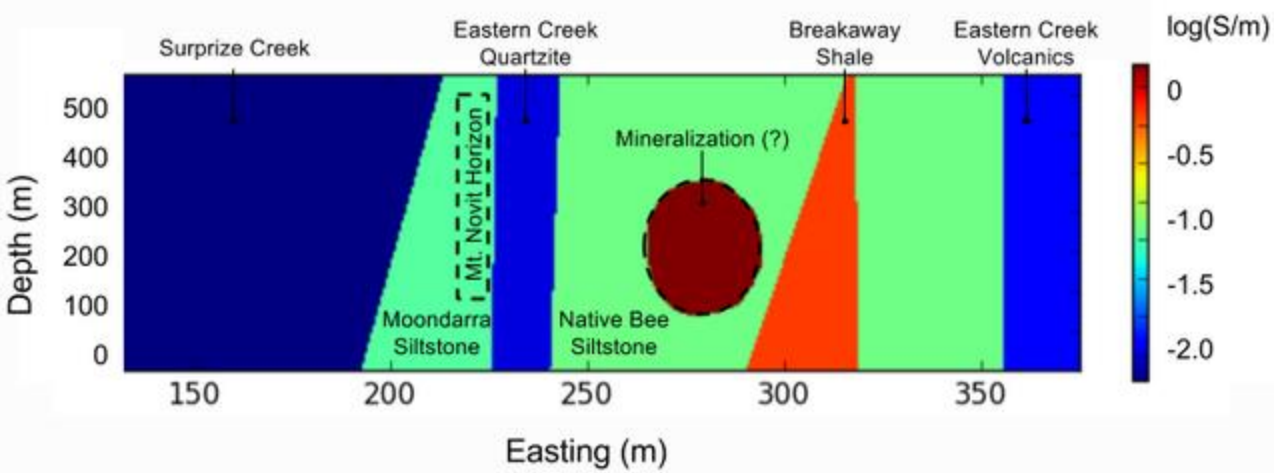
- **Objective:** Local sulphide mineralization within Native Bee Siltstone
- **Other info:** A geological cross-section



Simplified (log) conductivity distribution expected at Mount Isa (N:12200m).



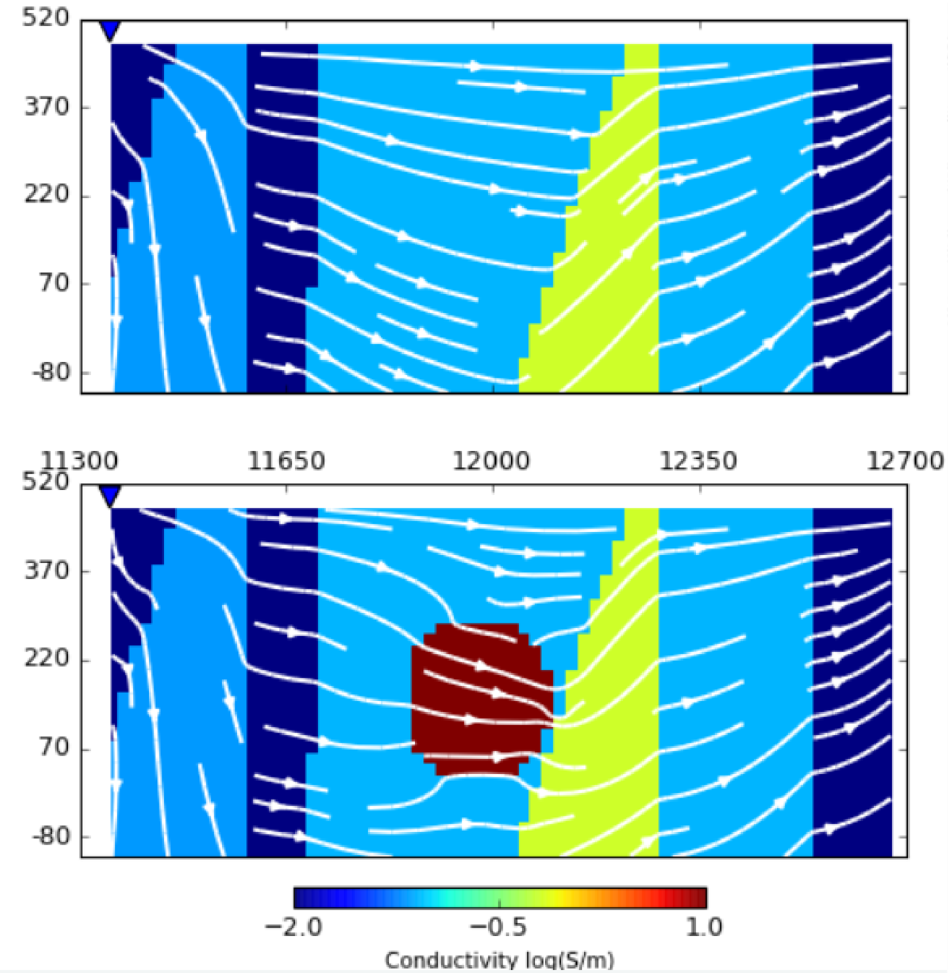
Mt. Isa (Properties)

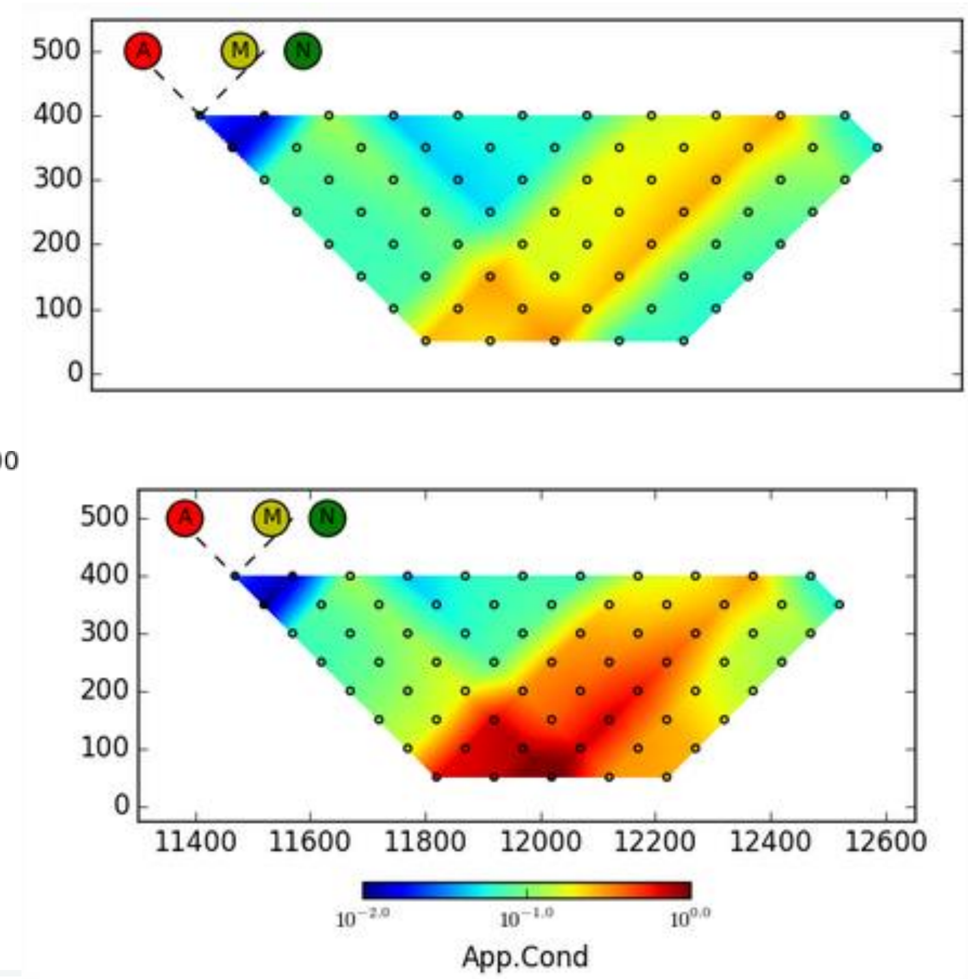


Simplified (log) conductivity distribution expected at Mount Isa (N:12200m).

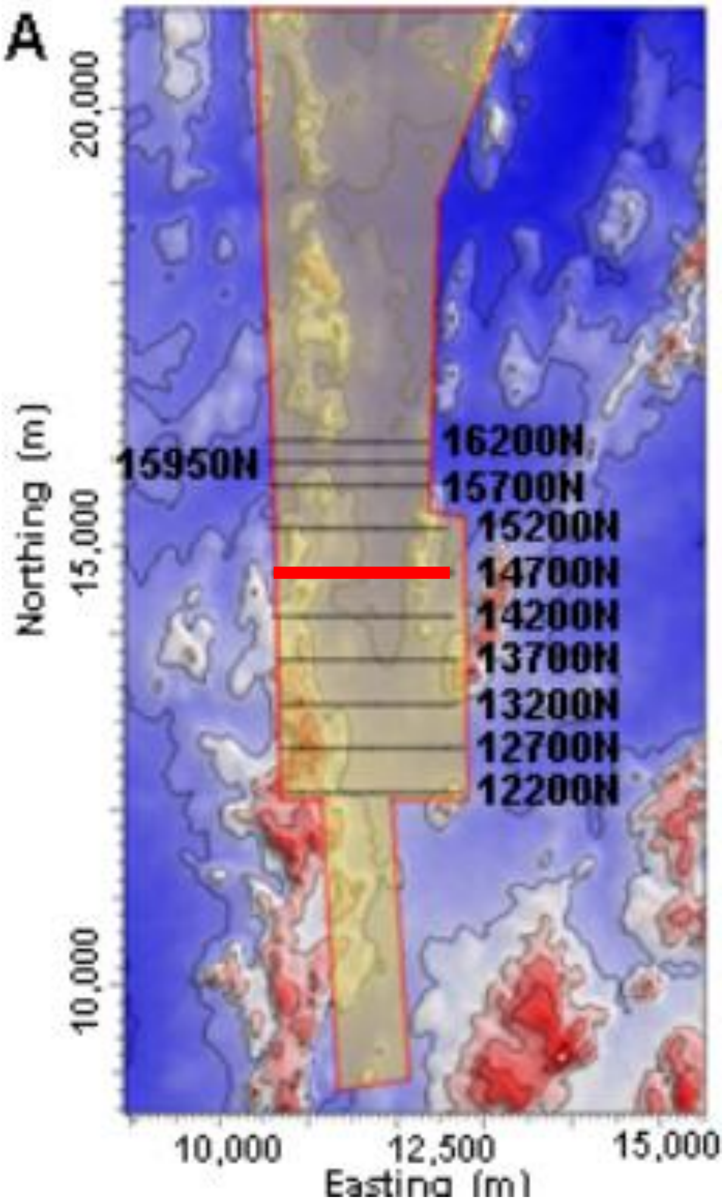
Rock Unit	Conductivity	Resistivity ($\Omega \cdot m$)	Chargeability
Native Bee Siltstone	Moderate	Moderate (~10)	Low
Moondarra Siltstone	Moderate	Moderate (~10)	Low
Breakaway Shale	Very High	Very Low (~0.1)	Low-None
Mt Novit Horizon	High	Low (~1)	High
Surprise Creek Formation	Low	High (~1000)	None
Eastern Creek Volcanics	Low	High (~1000)	None

Planning my survey (Synthetic Modeling)

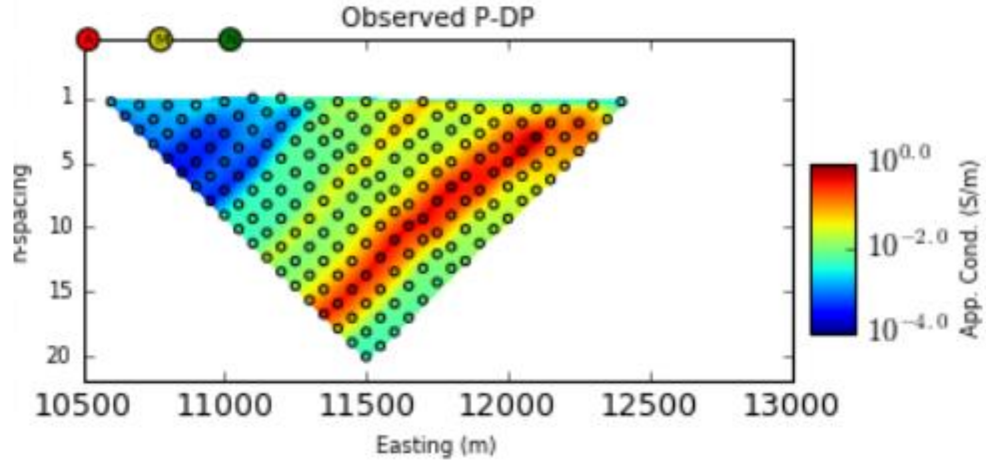




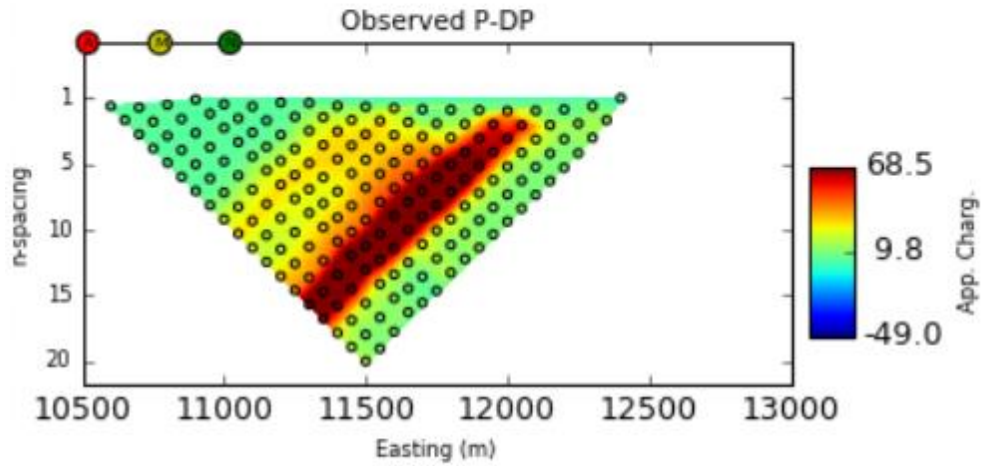
Mt. Isa (Survey and Data)



Conductivity pseudo-section



Chargeability pseudo-section

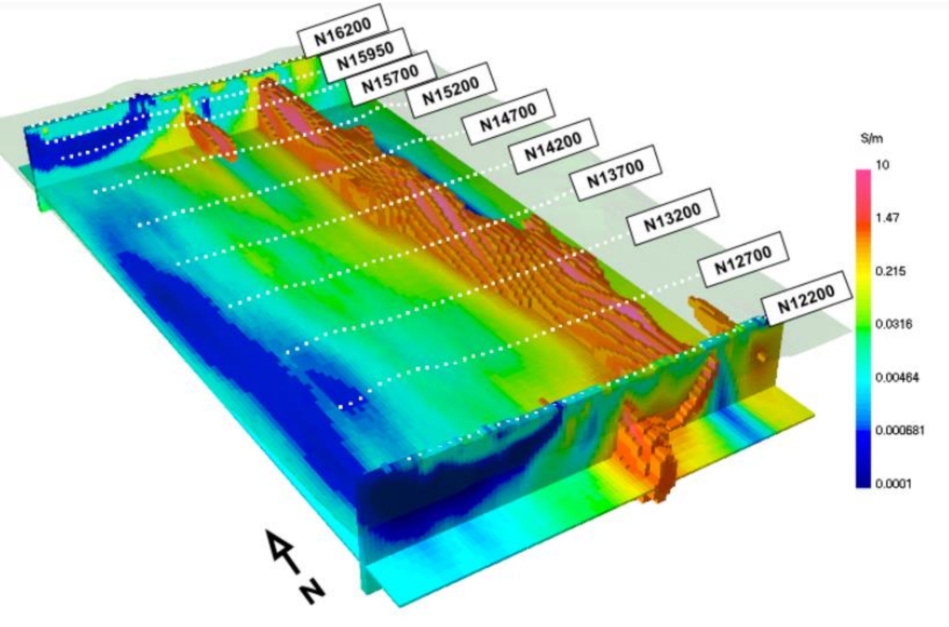


Q: What trends seen in data?

Mt. Isa (Processing)

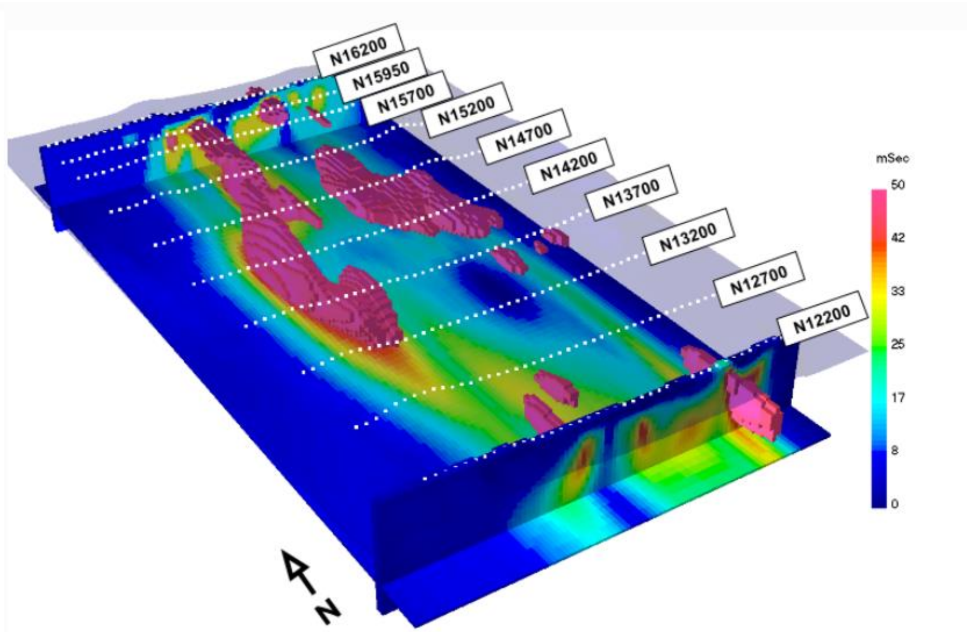
Apparent resistivity data (ρ_a)

Resistivity model (ρ)

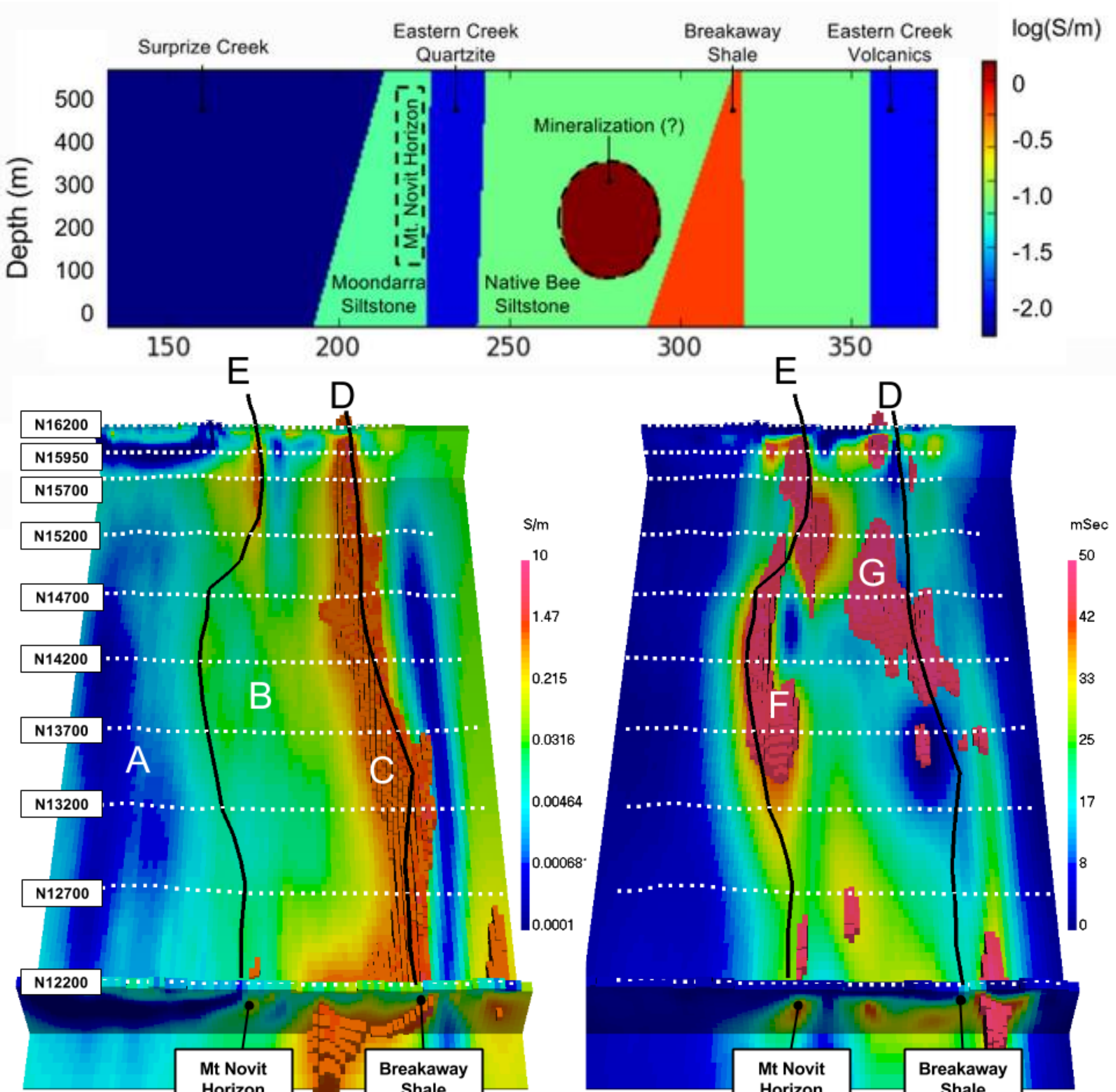


Integrated chargeability data (d_{IP})

Chargeability model (η)

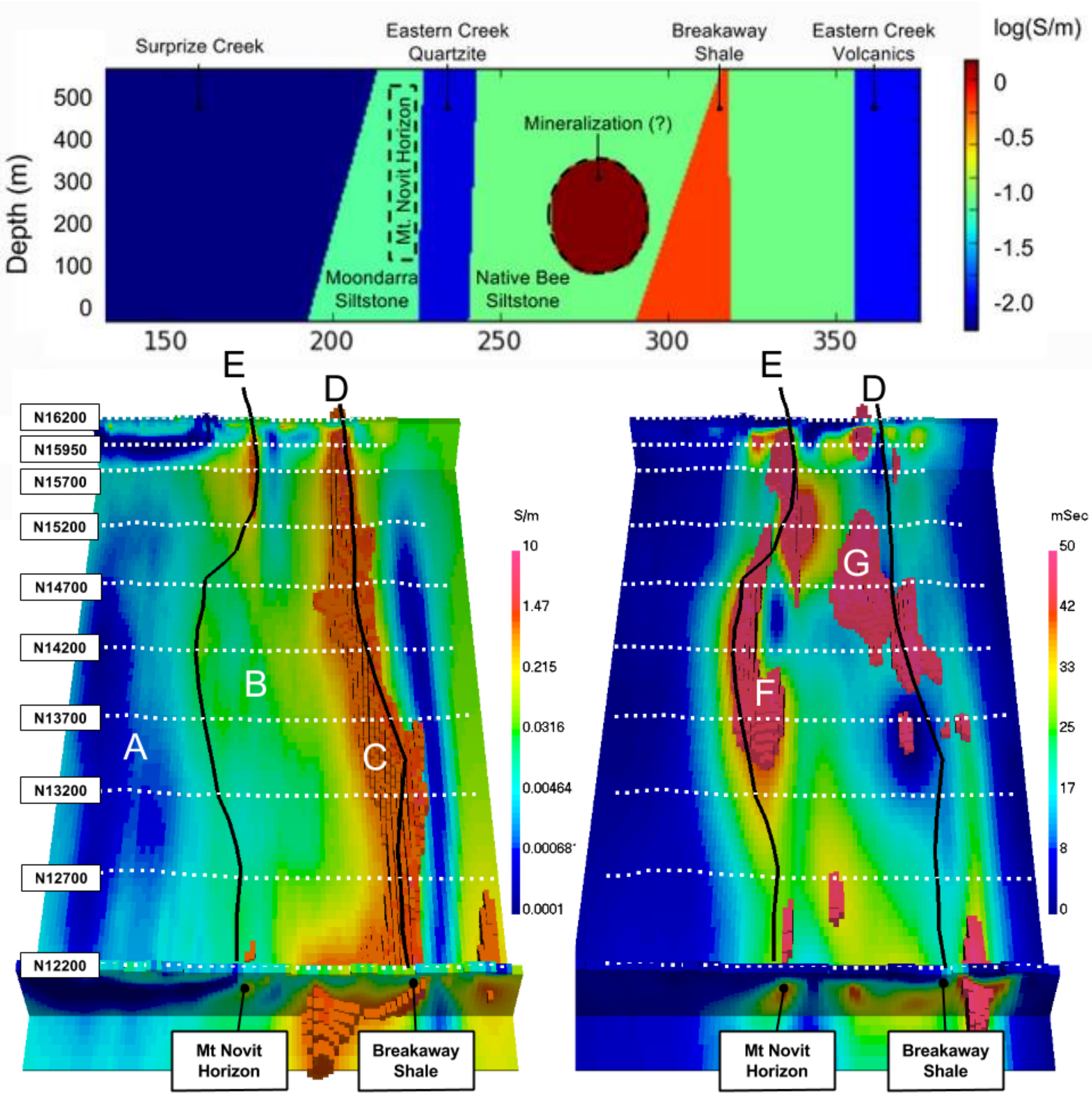


Mt. Isa (Interpretation)



A: Surprise creek
(low σ, low η)

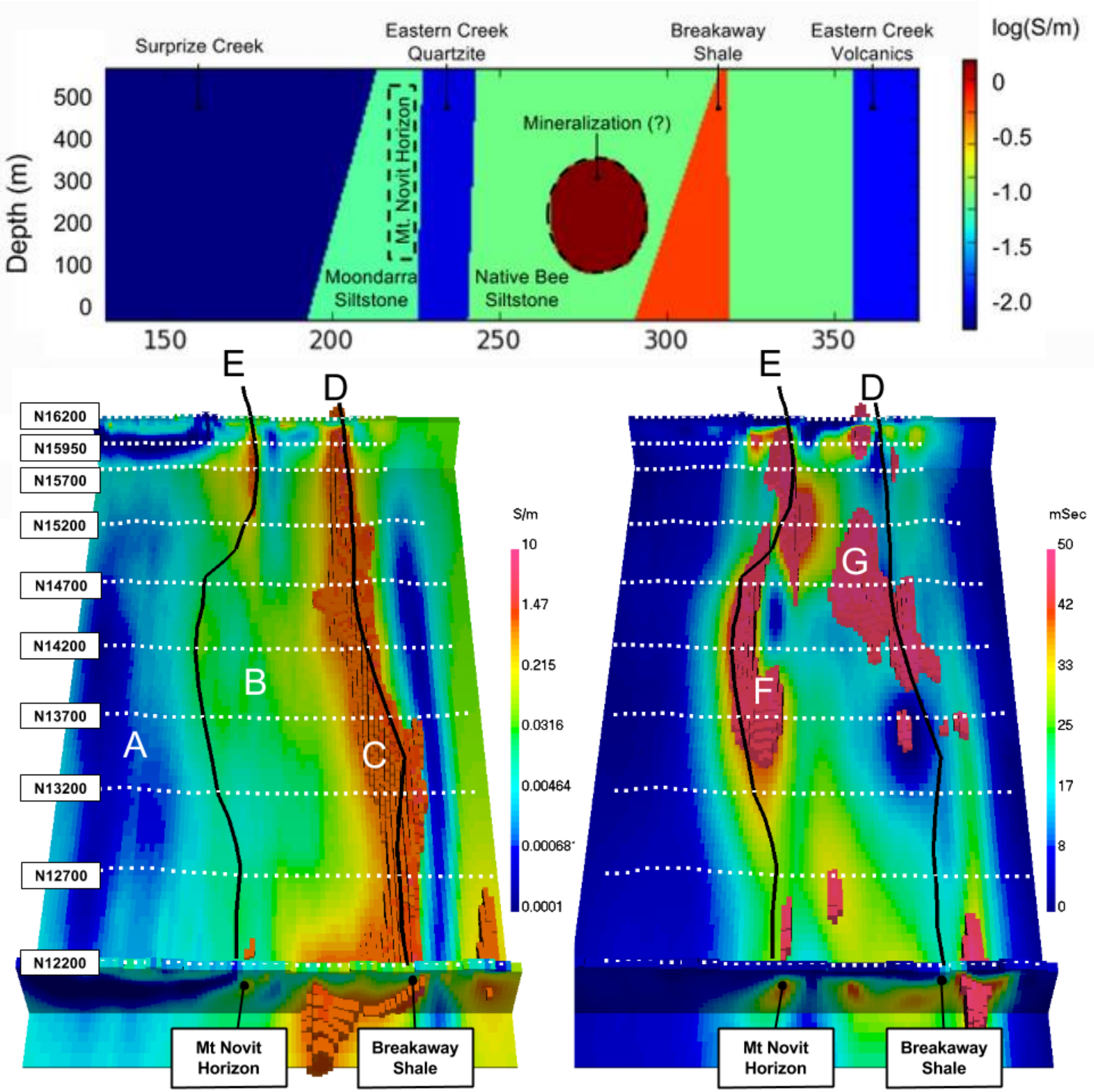
Mt. Isa (Interpretation)



A: Surprise creek (low σ, low η)

B: Moondarra and Native Bee siltstones (moderate σ, low η)

Mt. Isa (Interpretation)

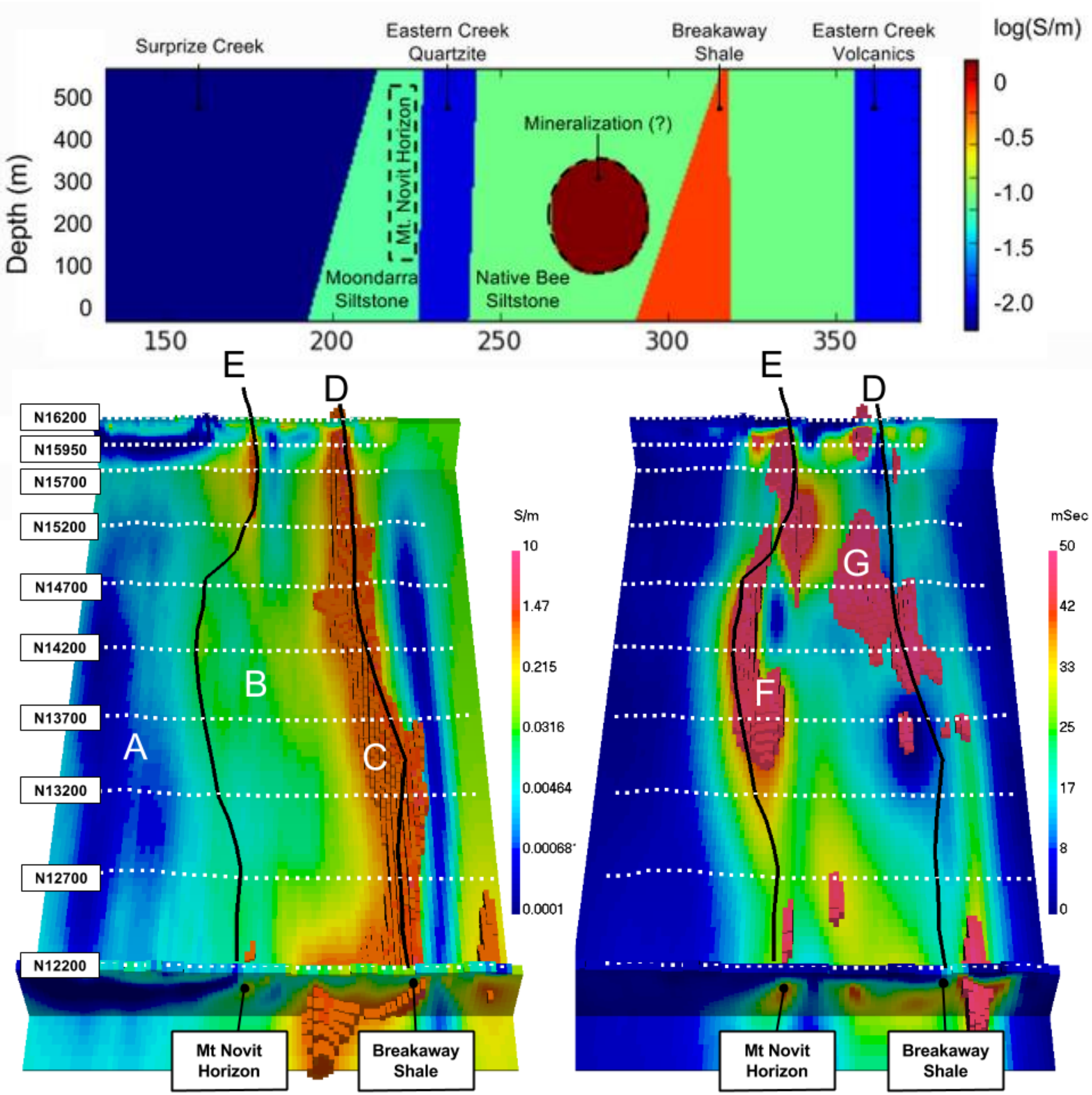


A: Surprise creek
(low σ, low η)

B: Moondarra and Native Bee siltstones
(moderate σ, low η)

C and D: Breakaway shales
(high σ, low η)

Mt. Isa (Interpretation)



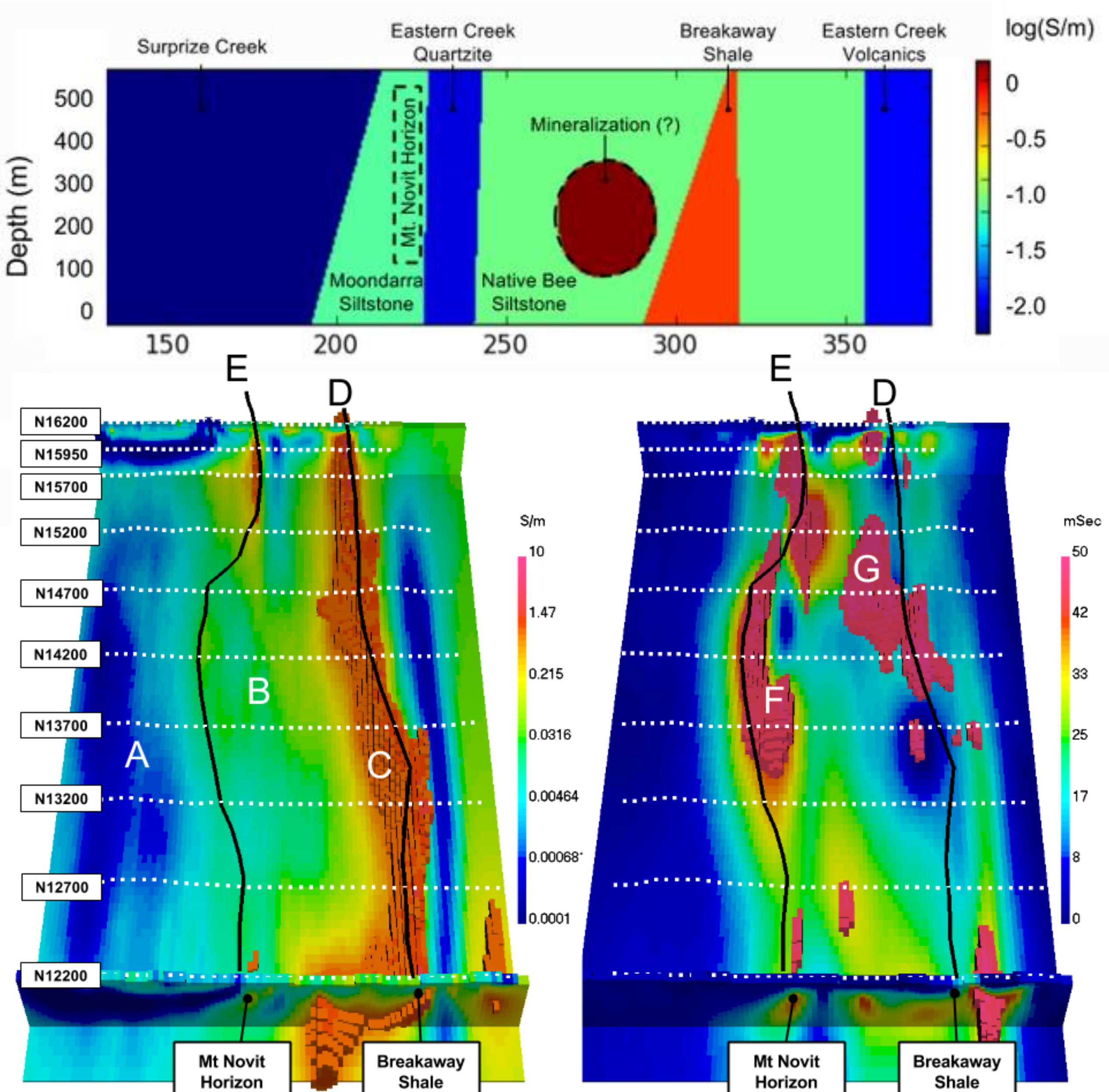
A: Surprise creek
(low σ, low η)

B: Moondarra and Native Bee siltstones
(moderate σ, low η)

C and D: Breakaway shales
(high σ, low η)

E and F: Mt. Novit horizon
(high σ, high η)

Mt. Isa (Interpretation)



A: Surprise creek
(low σ, low η)

B: Moondarra and Native Bee siltstones
(moderate σ, low η)

C and D: Breakaway shales
(high σ, low η)

E and F: Mt. Novit horizon
(high σ, high η)

G: Possible mineralization
(high σ, high η)