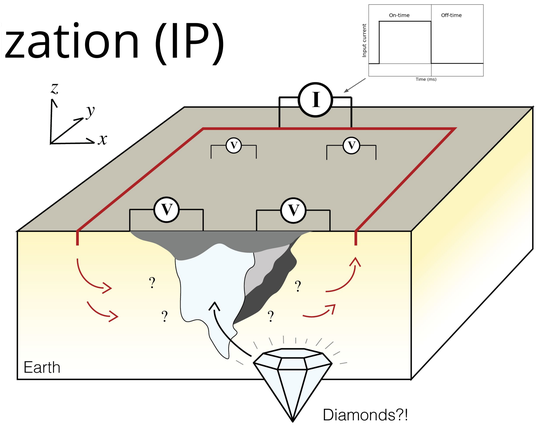
Where are the diamonds? - *using a giant battery*

Michael Mitchell, Seogi Kang and the SimPEG Team

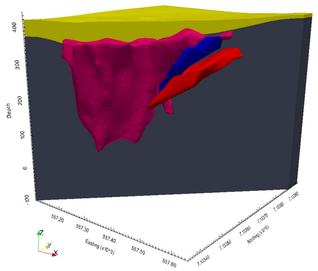
DC resistivity & Induced Polarization (IP)

- **Why?** Electrical properties (conductivity and chargeability) of rocks can be diagnostic for finding diamond-bearing kimberlites
- **How?** Inject currents, and measure resulting voltages during on- and off-times
- **Response.** Current flow depends on the electrical properties of the geologic units
- **Goal.** Use DC and IP data to characterize the kimberlite and find some diamonds

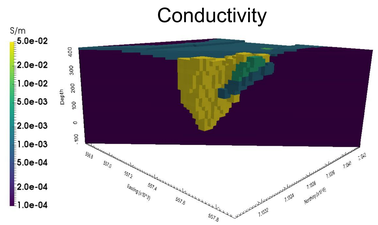


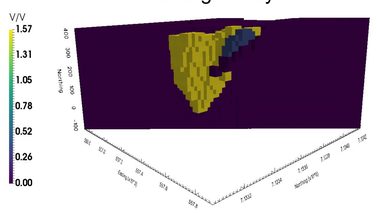
Model

- Diagnostic physical properties in DC, IP
  - Conductivity: ease with which current flows
  - Chargeability: a material's capacity to retain charges



	Conductivity	Chargeability
Host	V. Low	Low
Till	Mod	Low
PK	High	High
HK	Mod	Mod
VK	V. Low	Low





Physics

- Electrostatic Maxwell's equations

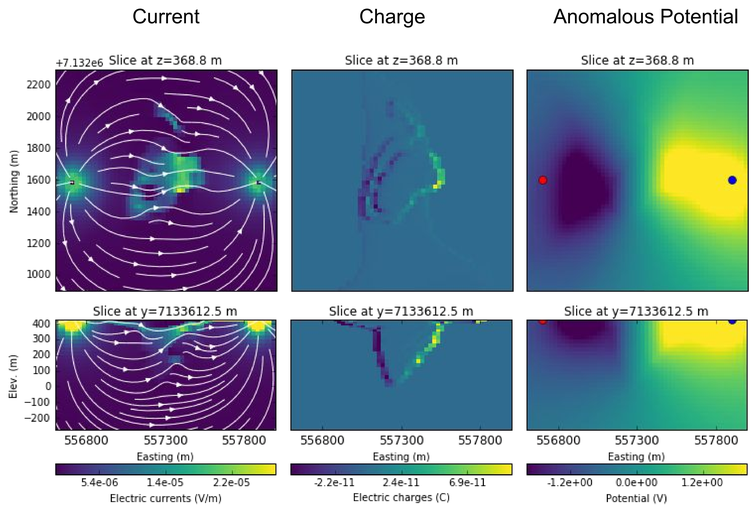
$$\vec{j} = \sigma\vec{e}$$
$$\vec{e} = -\nabla\phi$$
$$\nabla \cdot \vec{j} = -\vec{j}_s$$

$\vec{j}$: Current density (A/m ^{2})
$\vec{e}$: Electric field (V/m)
$\vec{j}_s$: current source (A/m ^{2})
σ: Conductivity (S/m)

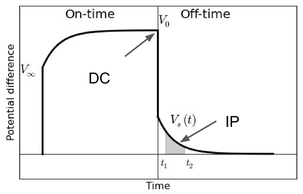
- Linearization of IP data

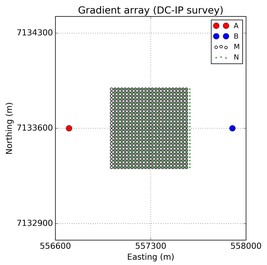
$$d^{IP} = F[\sigma(1-\eta)] - F[\sigma]$$
$$\simeq -\frac{\partial F[\sigma]}{\partial log(\sigma)}\eta$$

$F[\cdot]$: Static Maxwell's operator (taking $\sigma(x, y, z)$)
η: Chargeability (ms or mV/V)



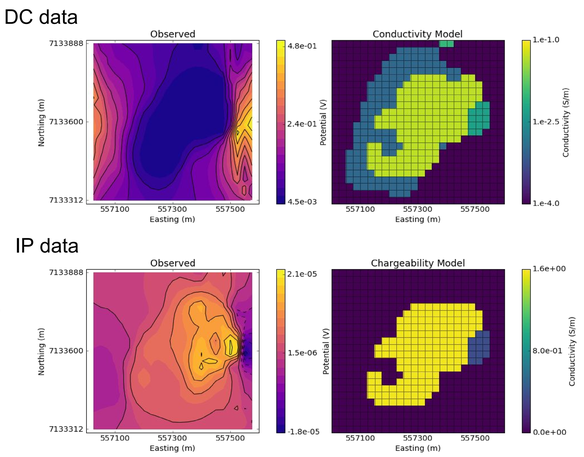
Survey & Data



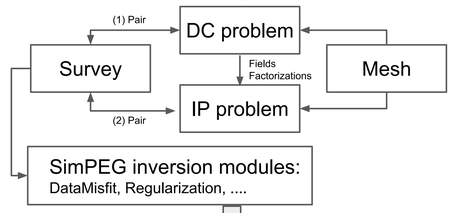


- DC data:
  $V_\infty = V_0 = F[\sigma]$ when $\eta = 0$
- IP data:
  $V_s(t=0) = V_0 - V_\infty \simeq -\frac{\partial F[\sigma]}{\partial log(\sigma)}\eta$

Sensitivity function for DC problem



Inversion Implementation



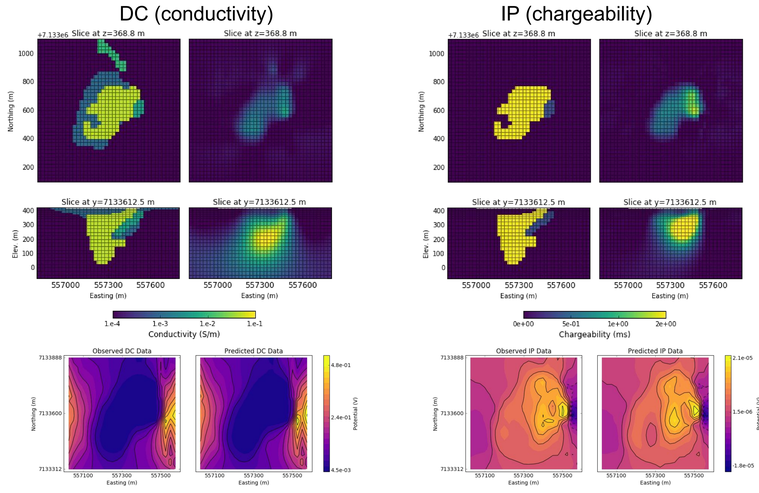
DC-IP inversion:

1. Invert DC data to obtain a conductivity model.
2. Use the conductivity to generate sensitivity function.
3. Invert IP data to obtain a chargeability model.

Mesh, Survey, Fields and Factorization shared between DC and IP

Results

- Recovered models fit the observed data
- Both inversions image PK unit (highest grade for diamonds)
- Depth resolution is limited
  - Depth weighting is used
  - Other survey designs may provide additional depth information



Summary

A 3D DC-IP inversion package is developed within the SimPEG framework. Synthetic DC and IP data are inverted. Both the recovered conductivity and chargeability models show a deep-rooted body of interest, narrowing our search for the diamonds.

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