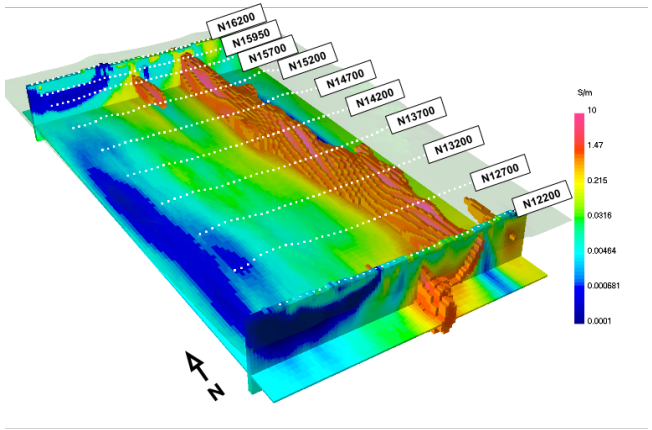
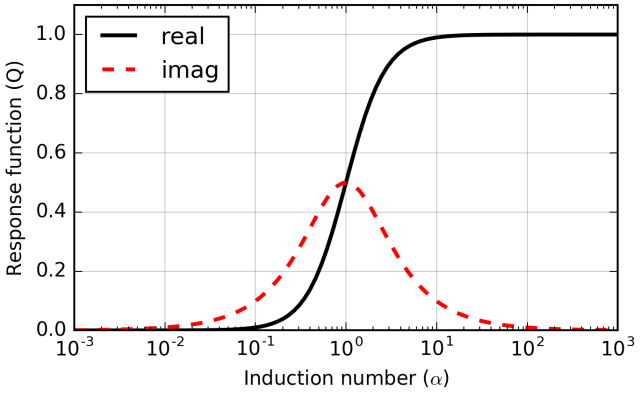
Summary and the Future

What have we covered?

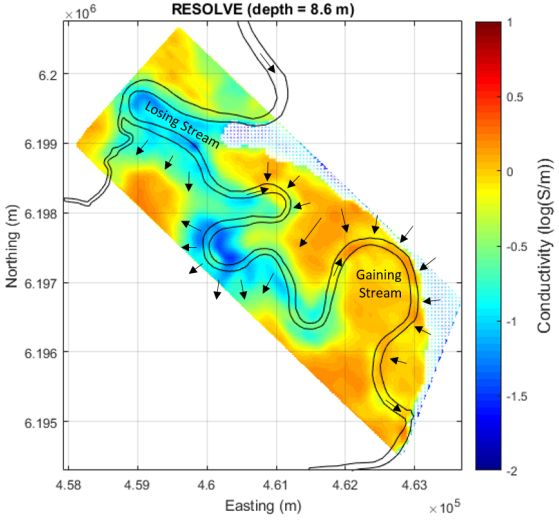
DC Resistivity



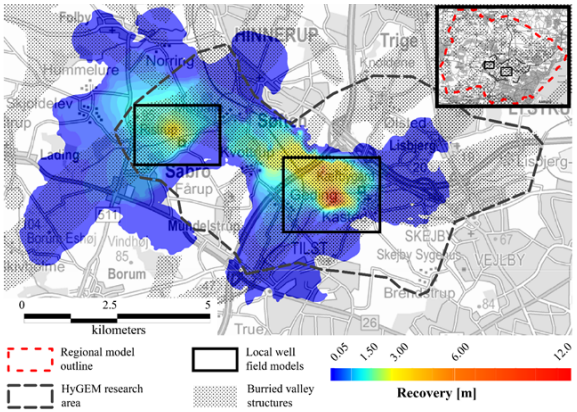
EM Fundamentals



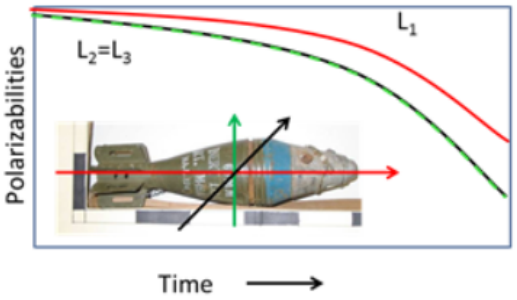
Inductive Sources: Frequency



Inductive Sources: Time

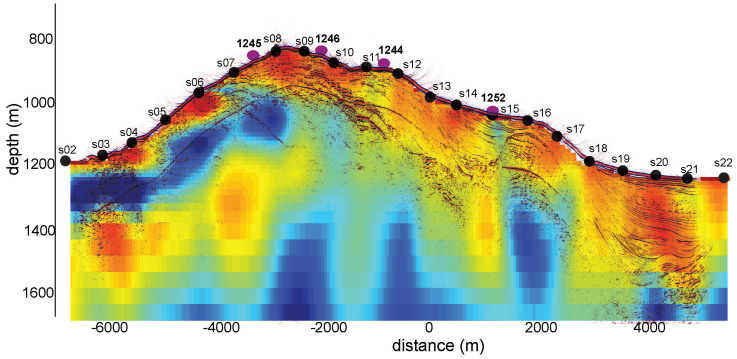


Inductive Sources: UXO

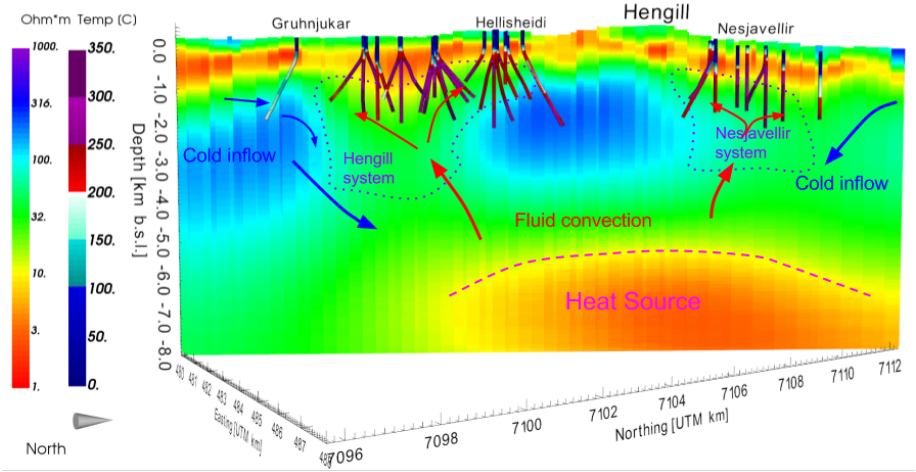


What have we covered?

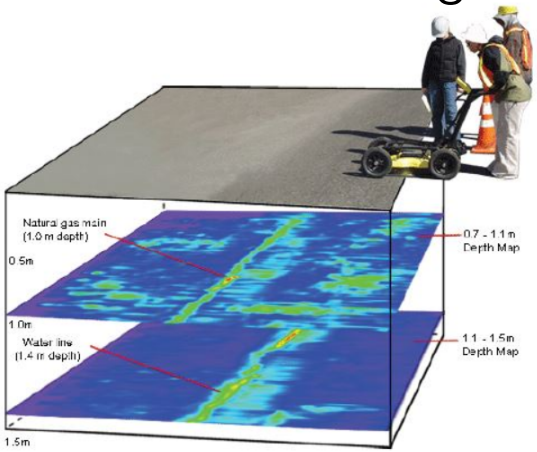
Grounded Sources



Natural Sources

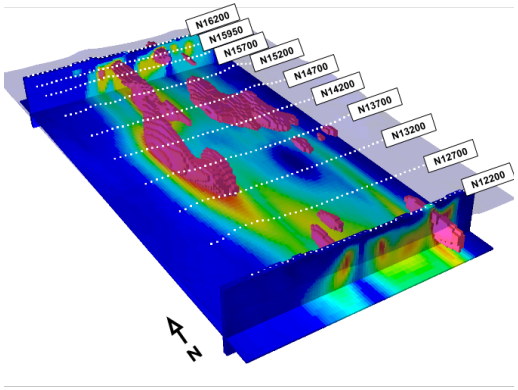


Ground Penetrating Radar

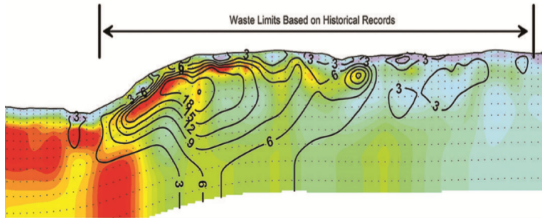


Induced Polarization:

Minerals



Landfills

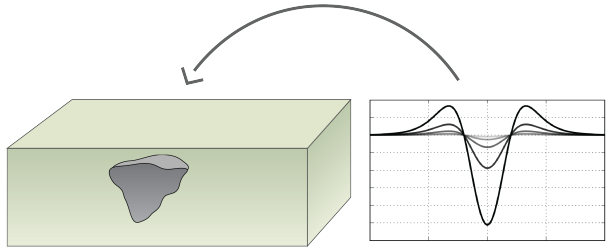


What does the future hold?

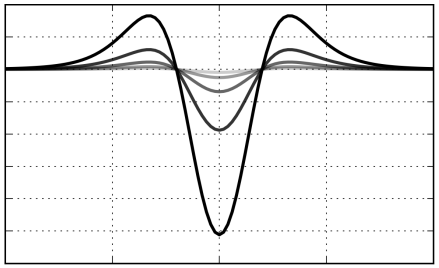
What does the future hold?

Problems

Inversion capabilities



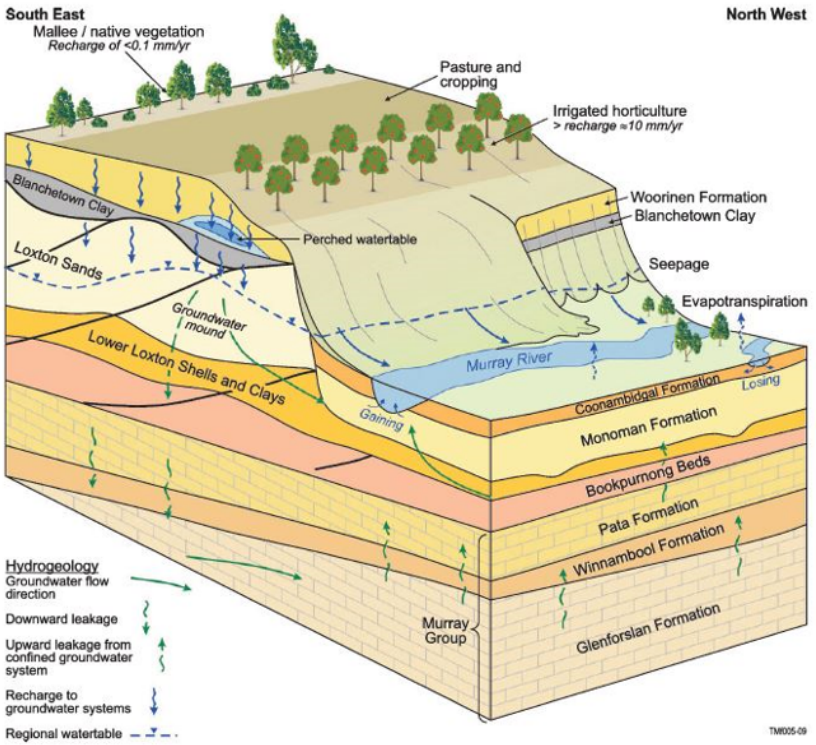
High quality data

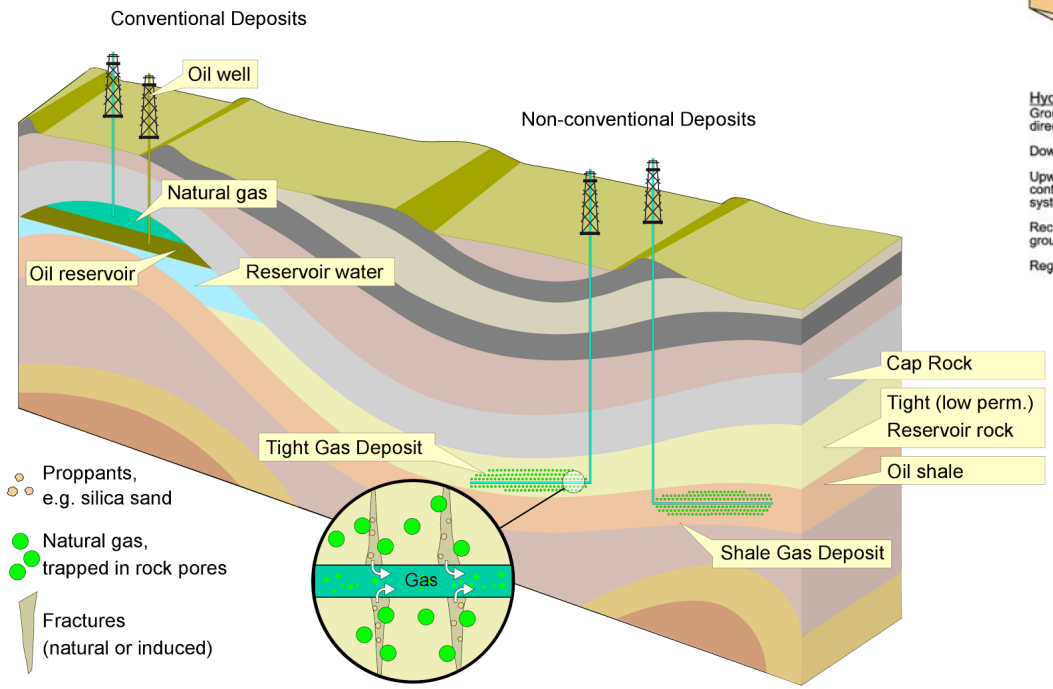


Web tools to communicate

The Future: Monitoring

- Aquifers
- Enhanced oil recovery
- Hydraulic Fracturing
- CO_2 sequestration
- Coal seam gas

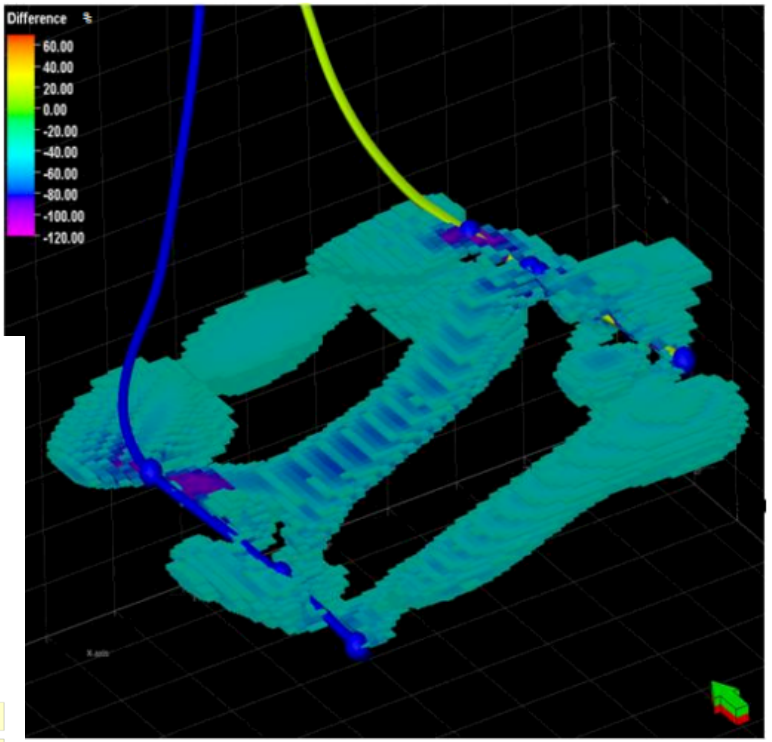




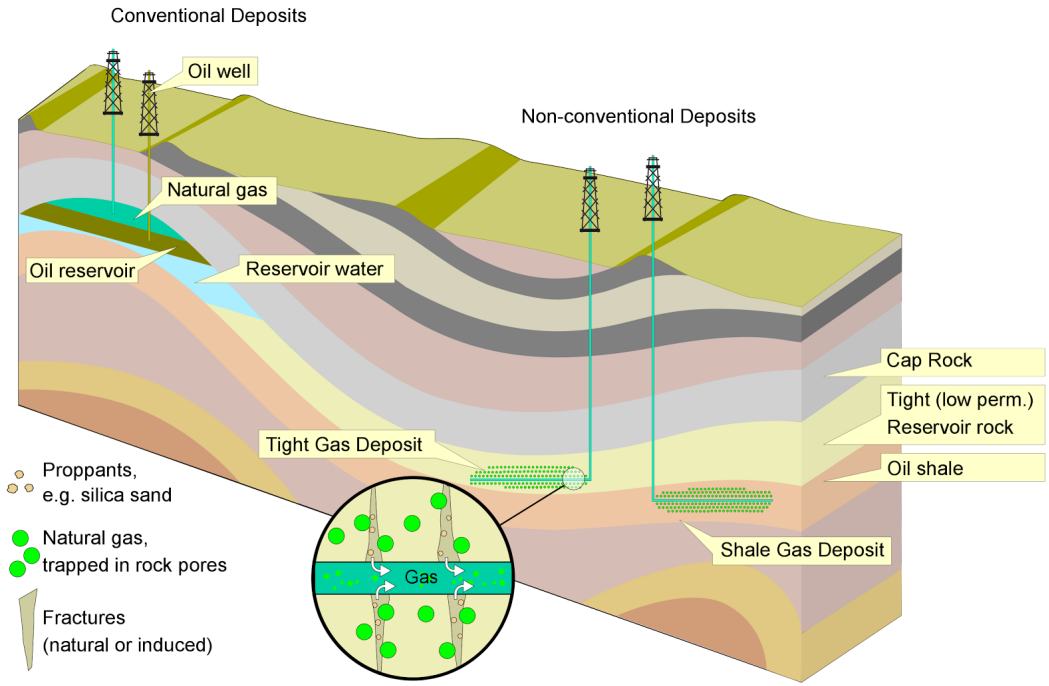
The Future: Monitoring

- Water flood
  - Cross-well EM
  - Image swept and missed regions of reservoir

Resistivity isosurface – water flood

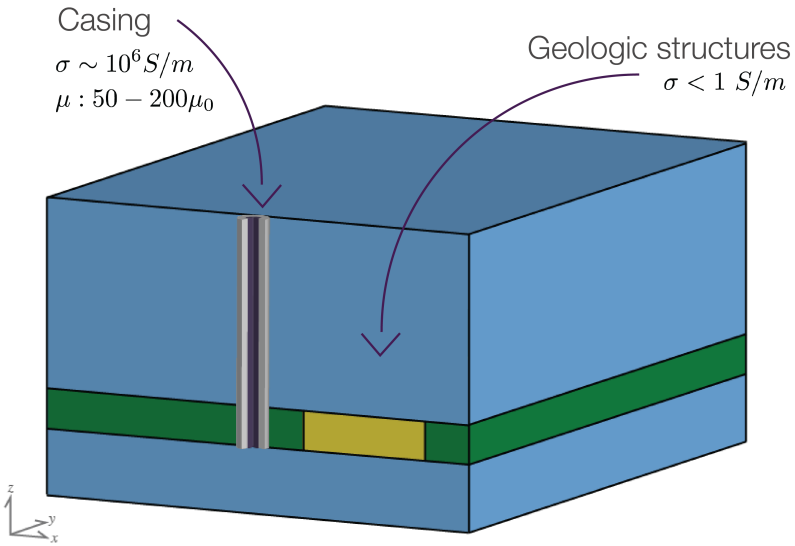


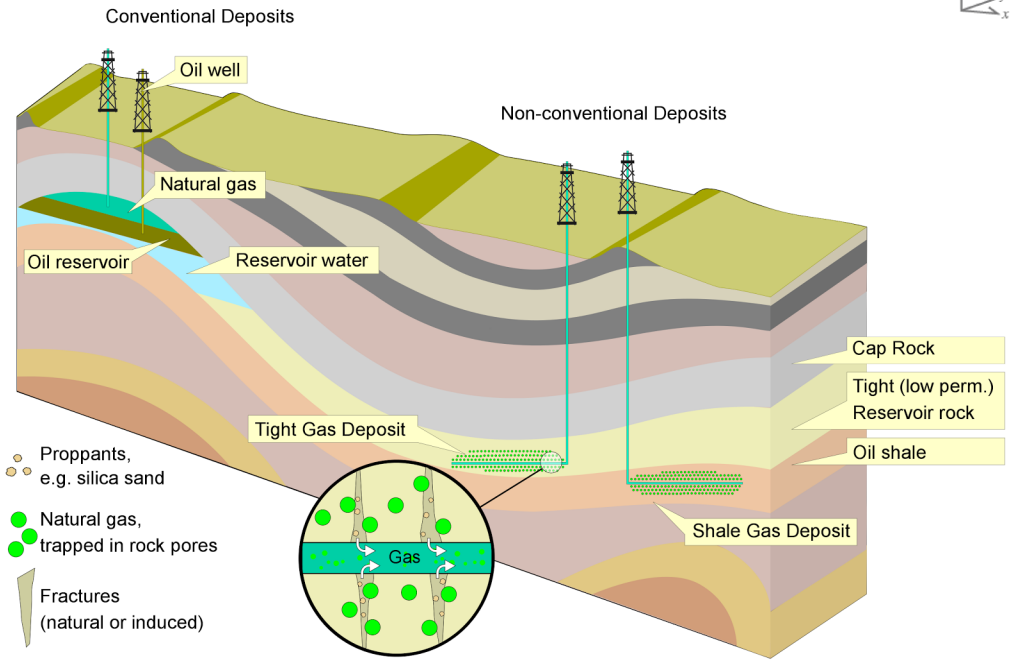
Saudi Arabia: Marsala et al., 2015

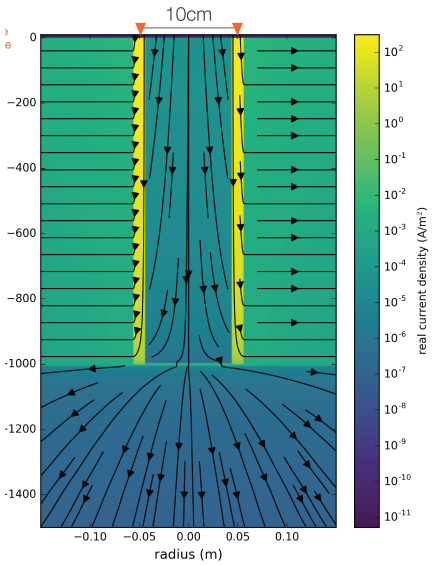


The Future: Monitoring

- Steel Casing
  - Mechanism for getting current to depth
  - Challenges:
    - Scales
    - Physical properties



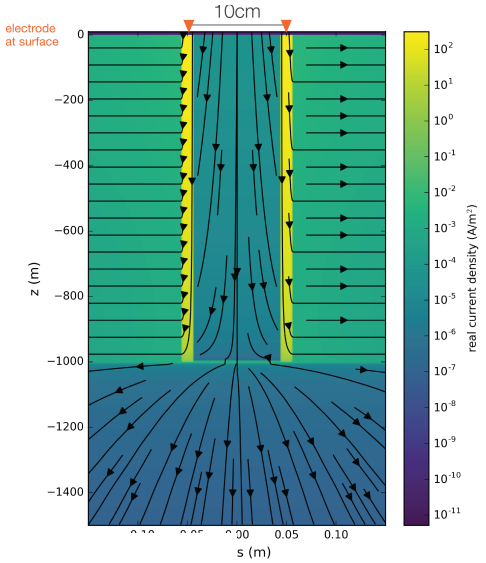


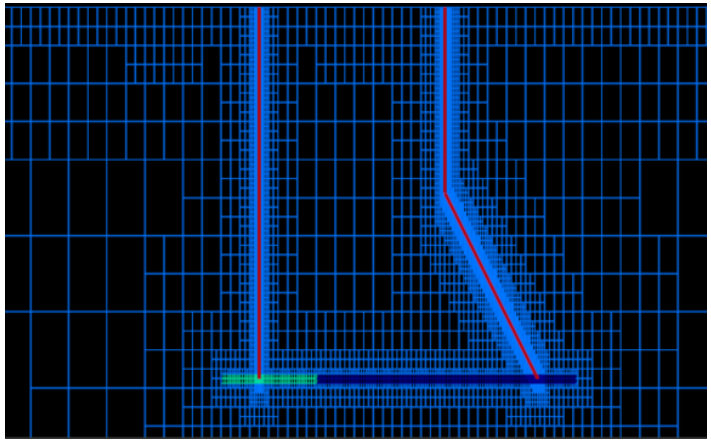


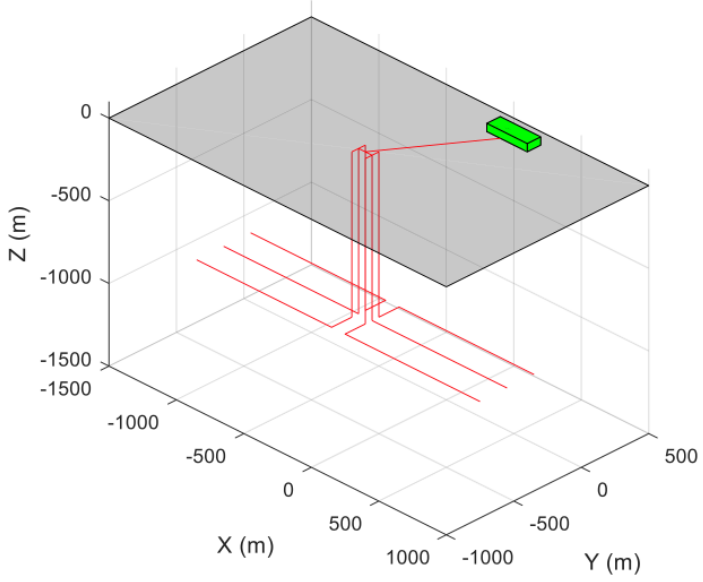
Corrosion

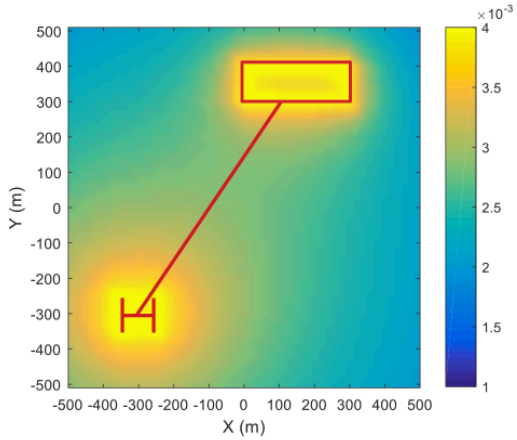
The Future: Monitoring

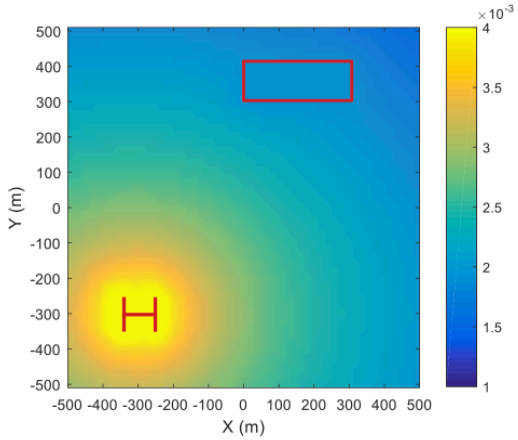
- Steel Casing







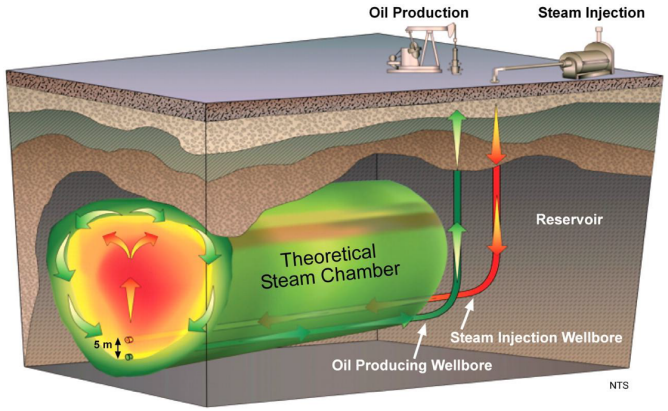


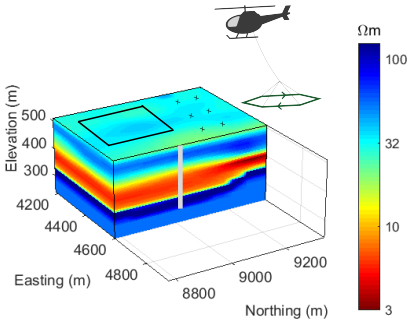


Monitoring: Choosing the appropriate survey

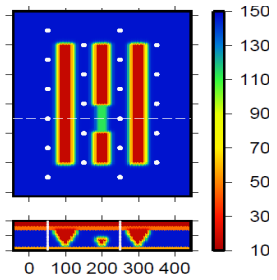
Different EM surveys needed to answer different questions

SAGD (Injection and monitoring steam flooding)

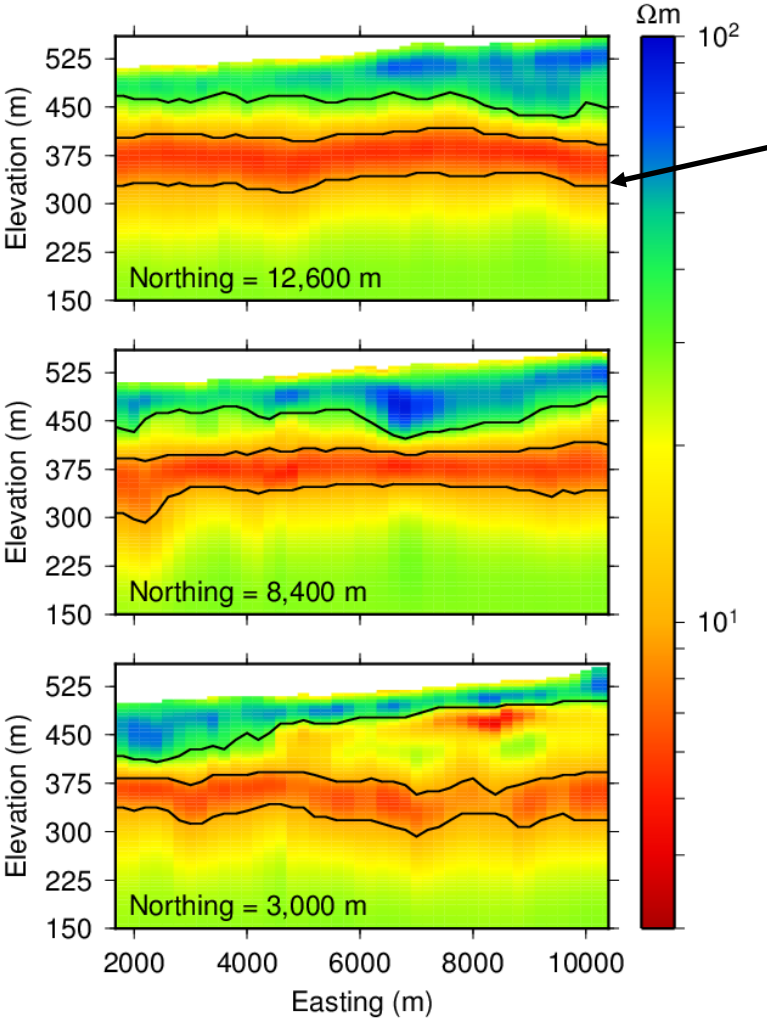


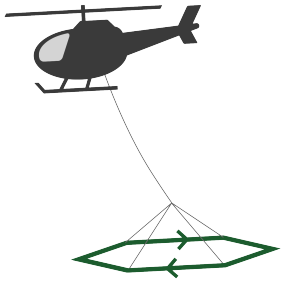


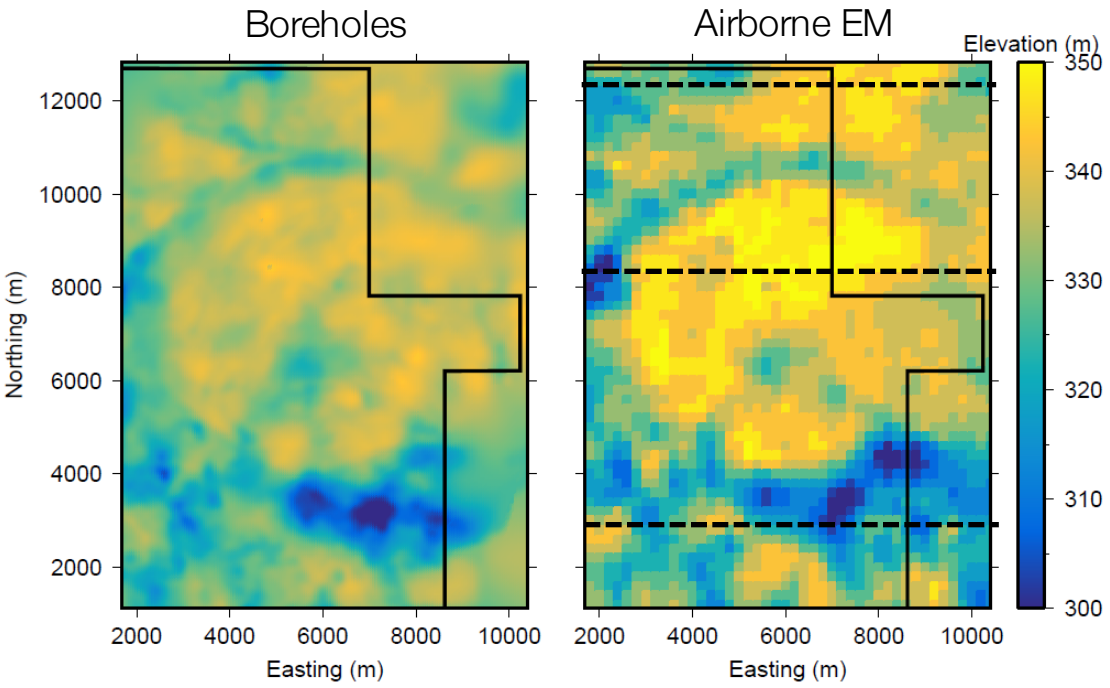
- Stage 1: Airborne reconnaissance survey
- Stage 2: Surface and borehole for pre-injection
- Stage 3: Monitoring array



SAGD: Large scale reconnaissance

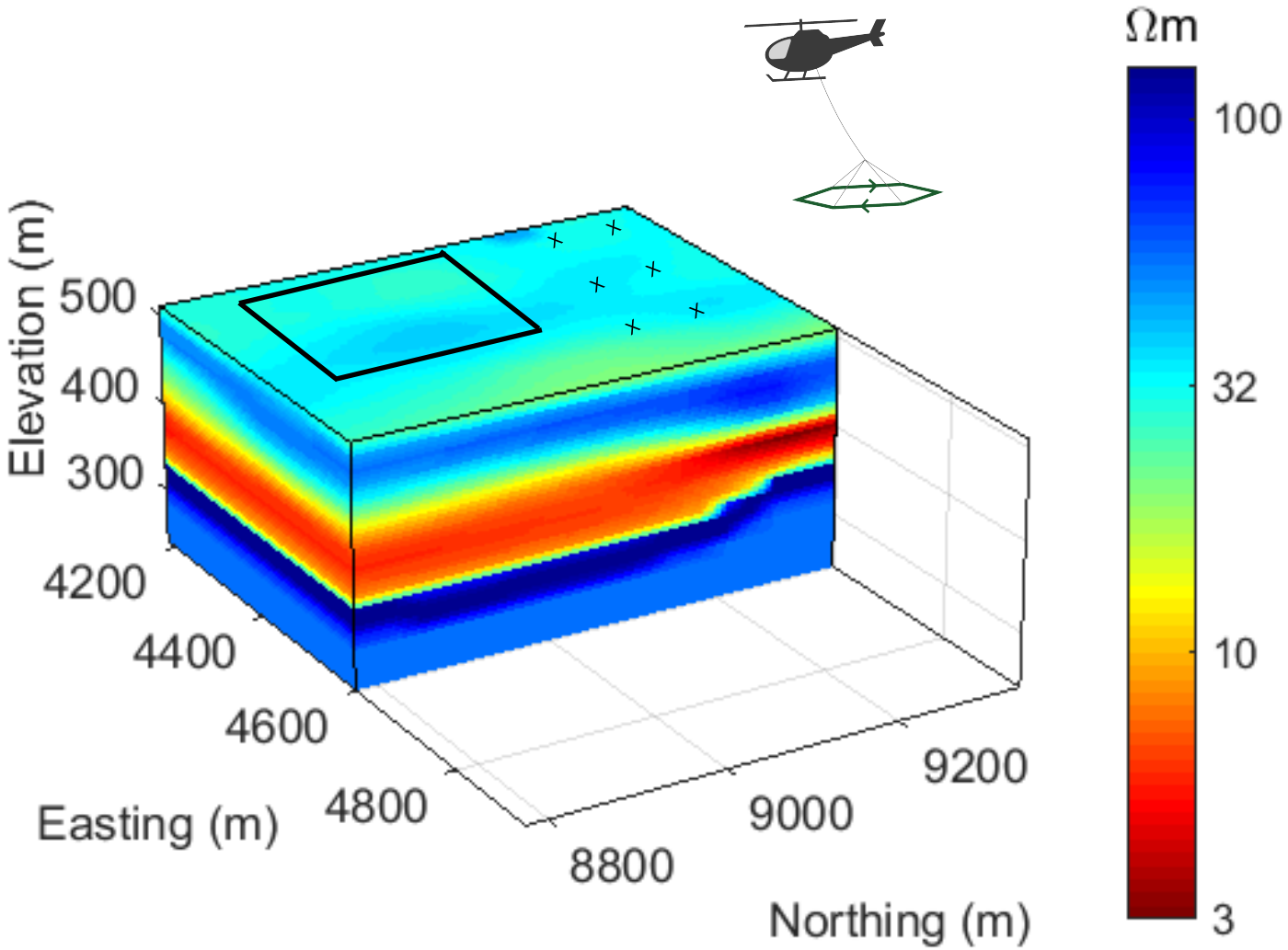






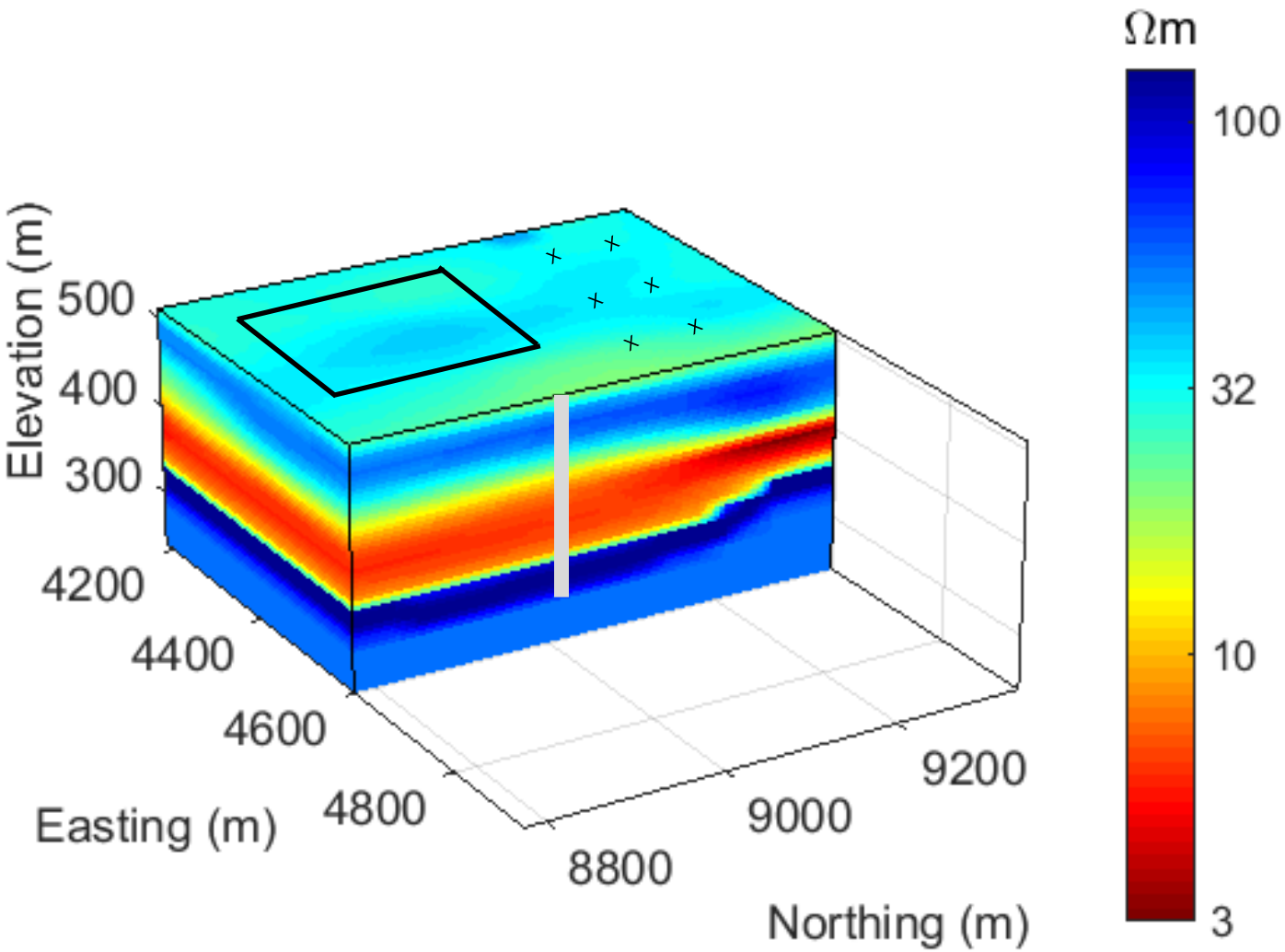
SAGD: Pre-injection

Local background: airborne + ground



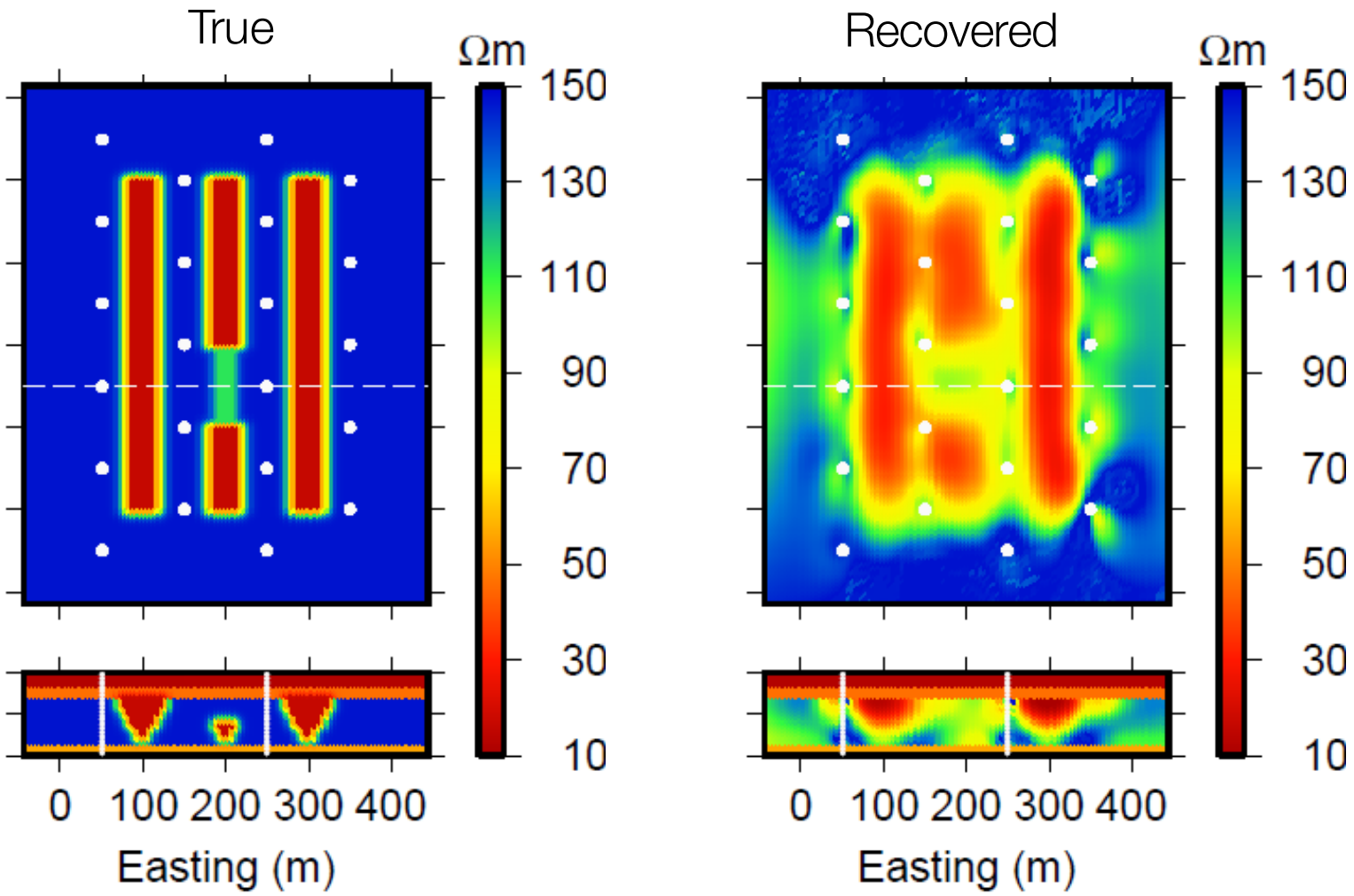
SAGD: monitoring array

Pre-injection: surface sources, borehole receivers



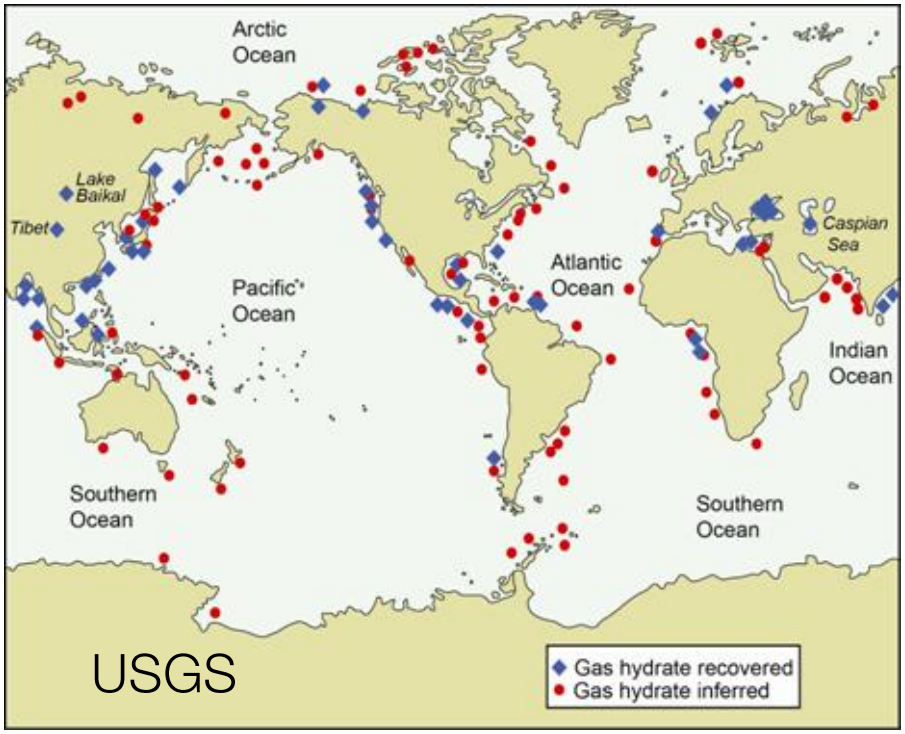
Multi-stage EM for monitoring

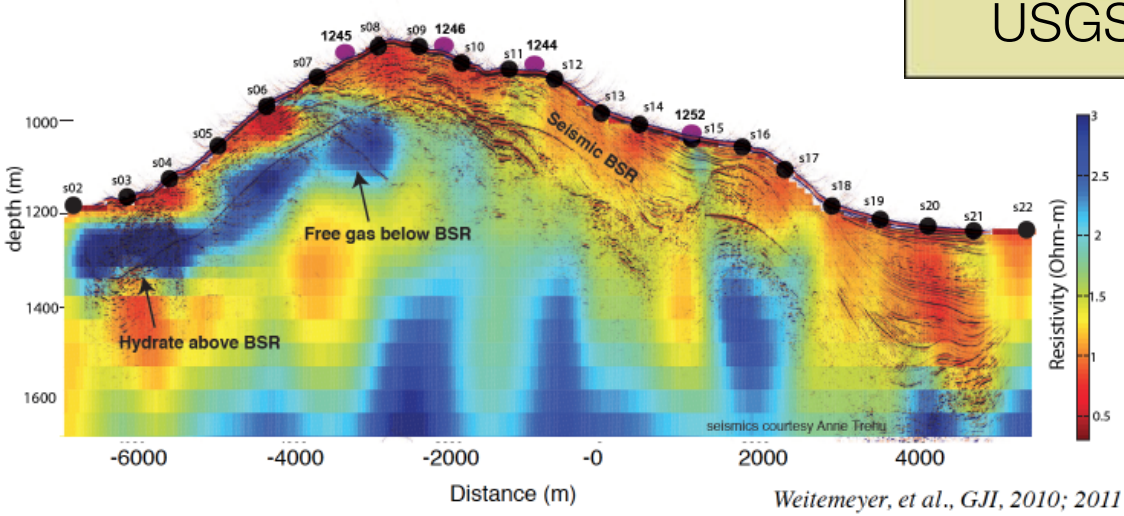
Post-injection: surface sources, borehole receivers



The Future: Marine EM

- Gas hydrates
  - Resistivity is diagnostic

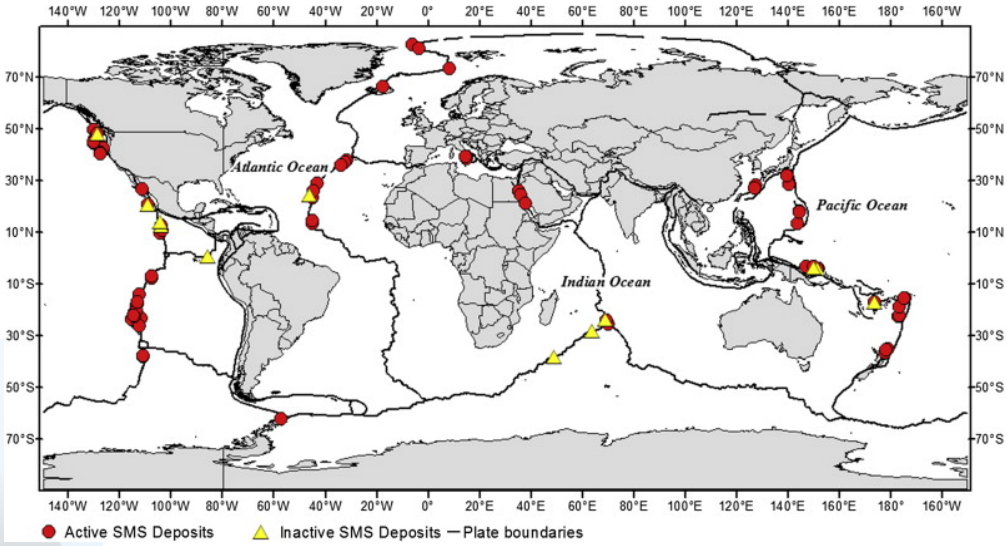


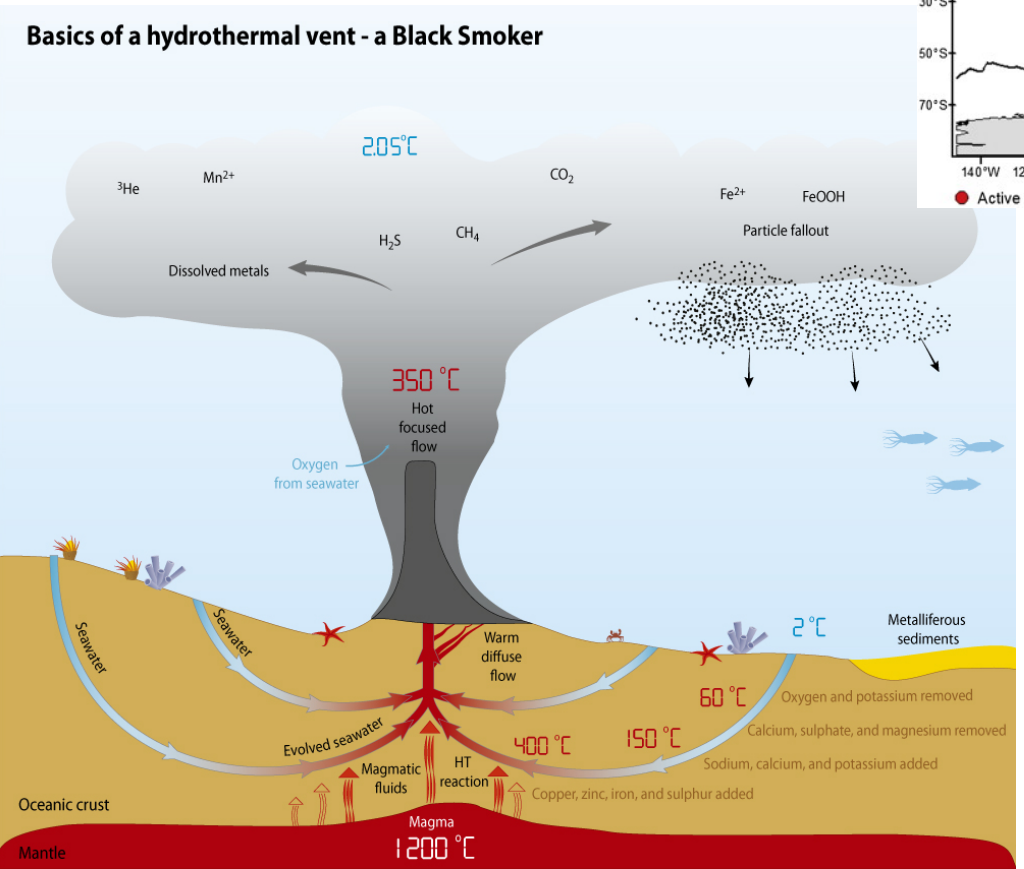


Weitemeyer, et al., GJI, 2010; 2011

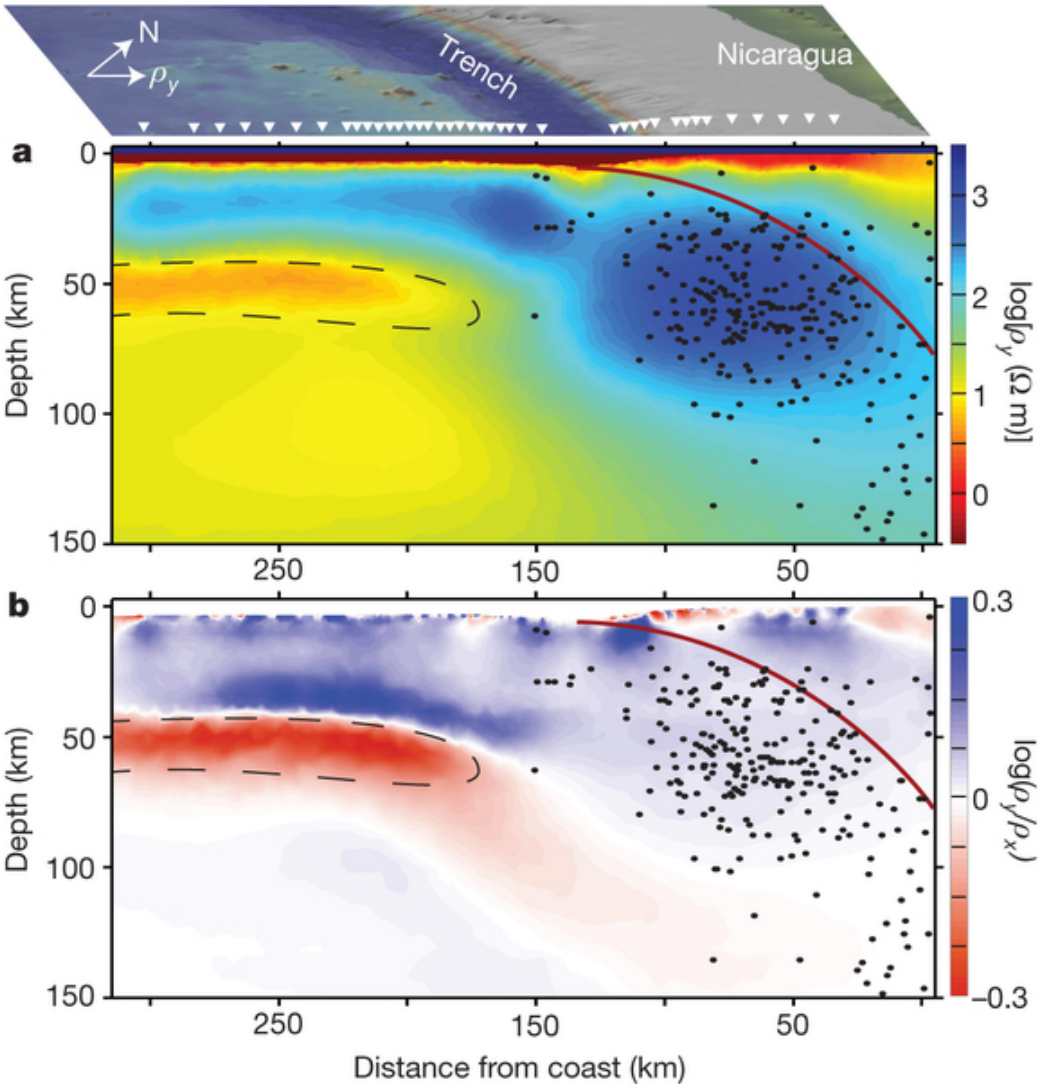
The Future: Marine EM

- Submarine massive sulfides
  - Conductive relative to background





The Future: Marine EM

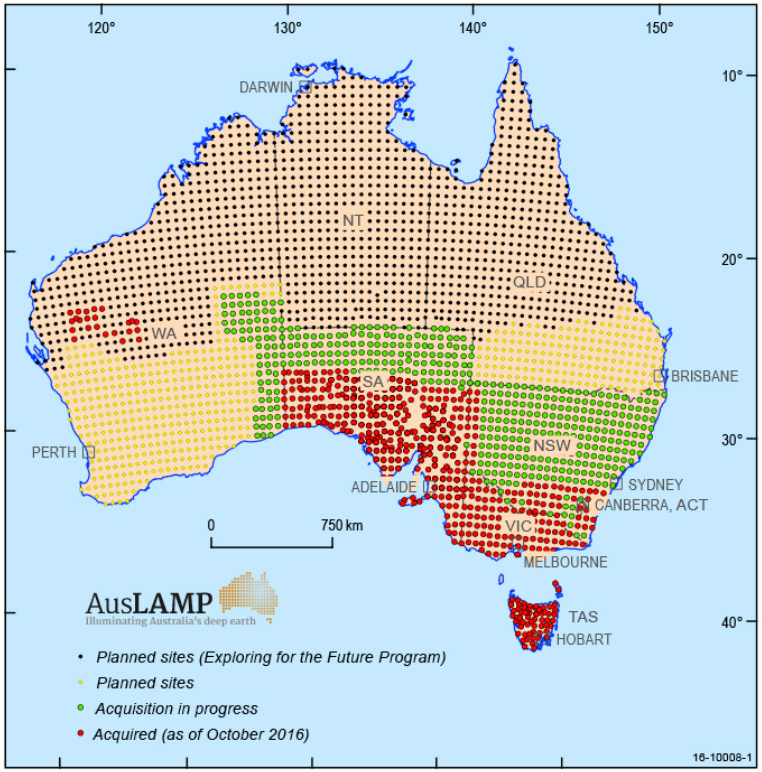


- Tectonic studies
- Natural Hazard
- Large anisotropy
  - indicative of melt-rich channel

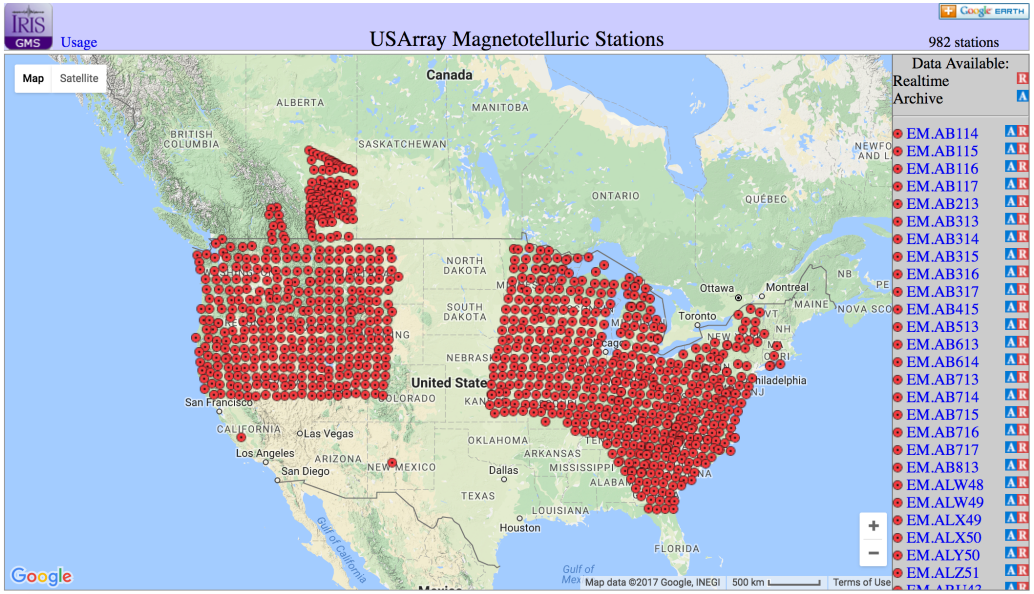
Naif et al., 2013

The Future: Large Scale MT

AusLamp

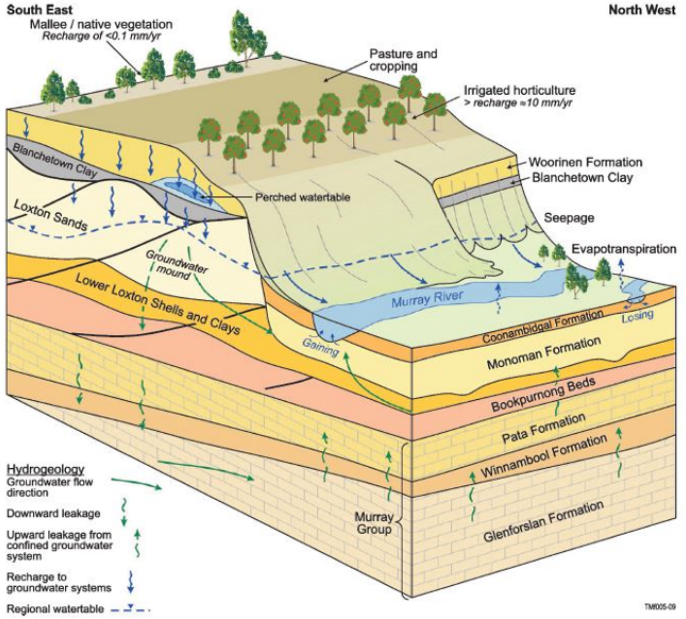


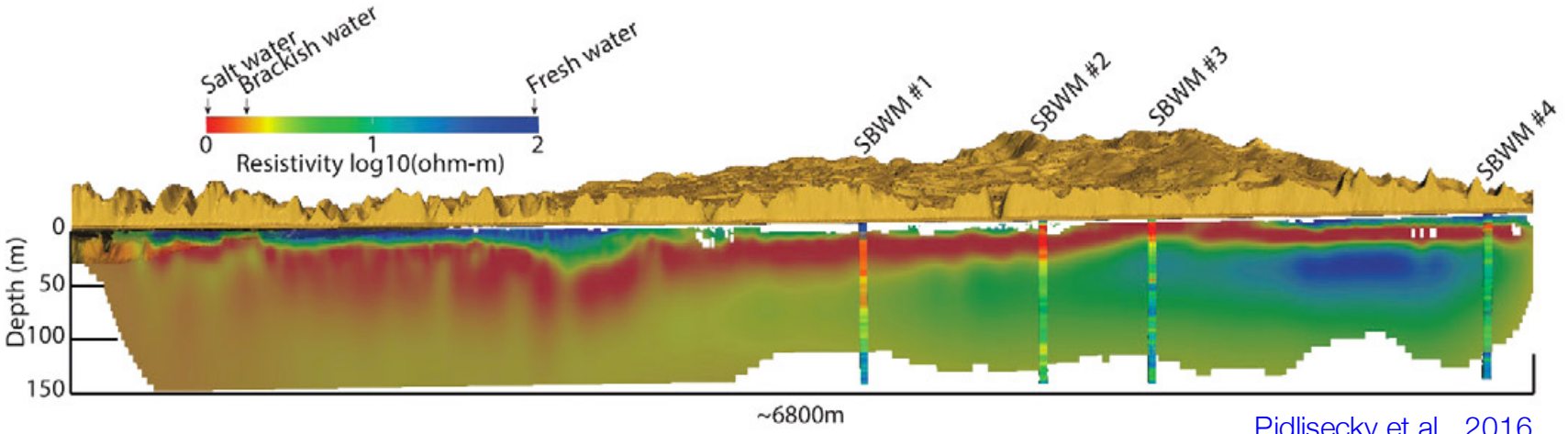
Earth scope



The Future: Water

- Finding and delineating water
- Aquifer monitoring and management
- Salt water intrusions
- Pollutants

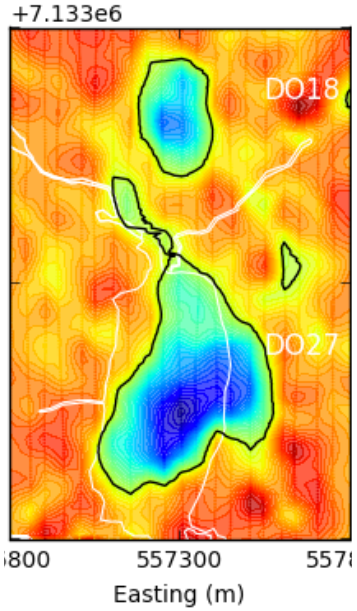




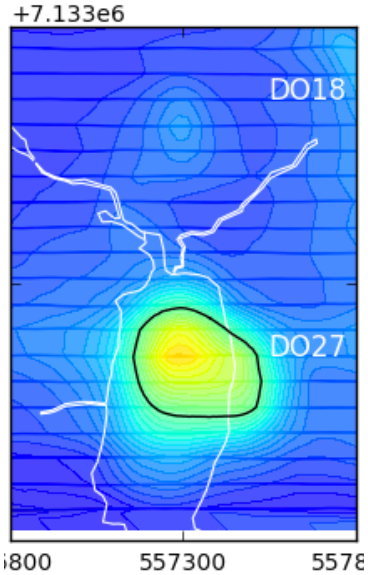
Pidlisecky et al., 2016

The Future: Data Integration & Multi-physics

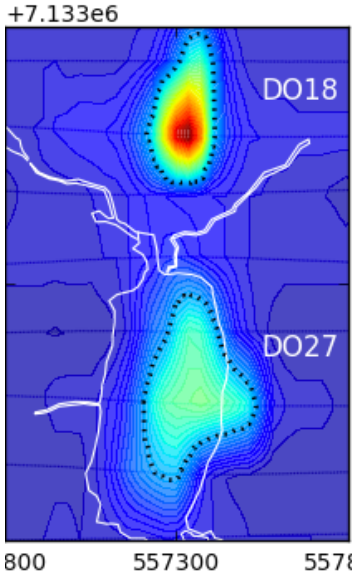
Gravity



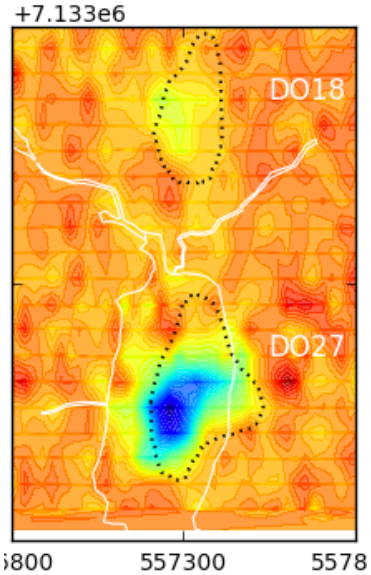
Magnetics



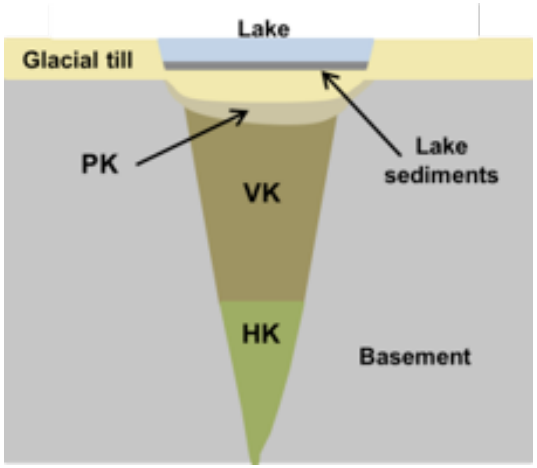
DIGHEM

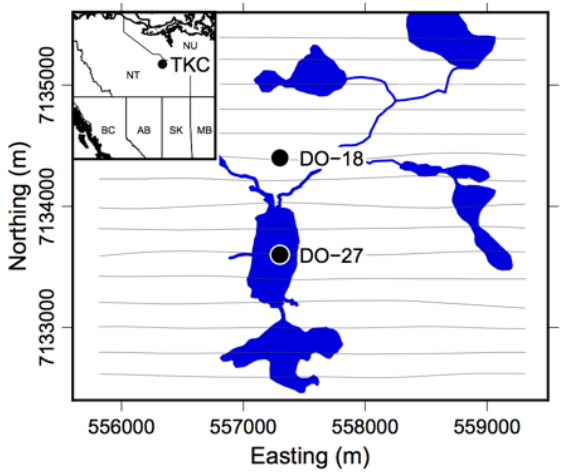


VTEM



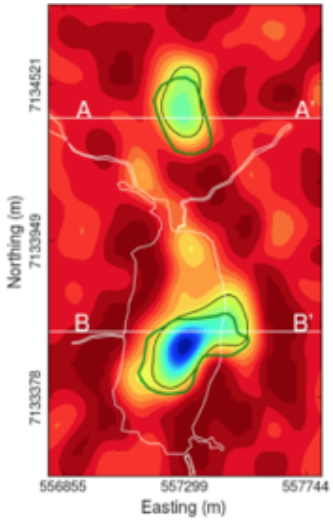
Kimberlite Model



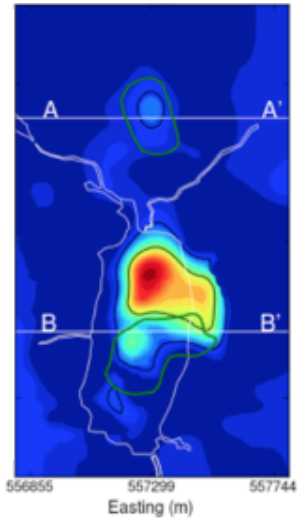


The Future: Data Integration & Multi-physics

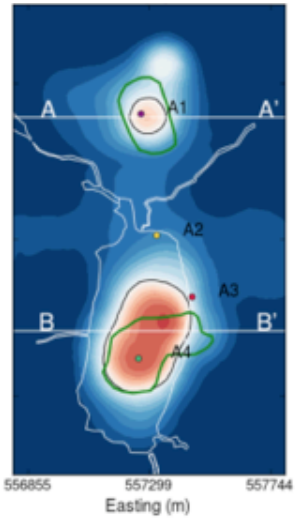
Density



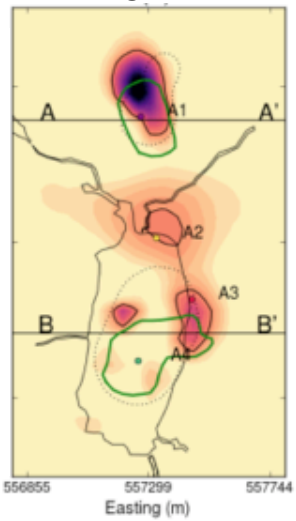
Susceptibility



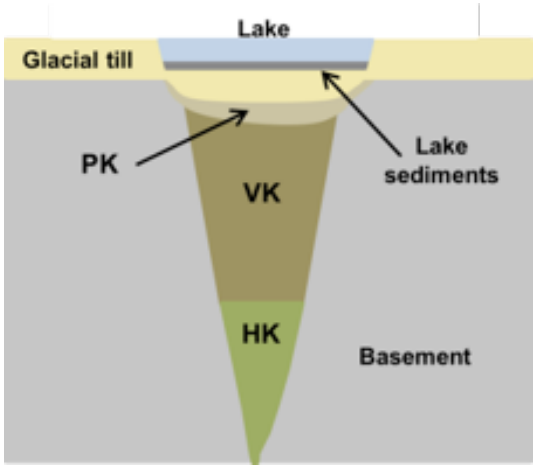
Conductivity



Chargeability

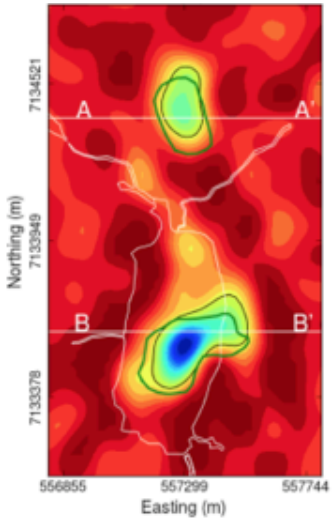


Kimberlite Model

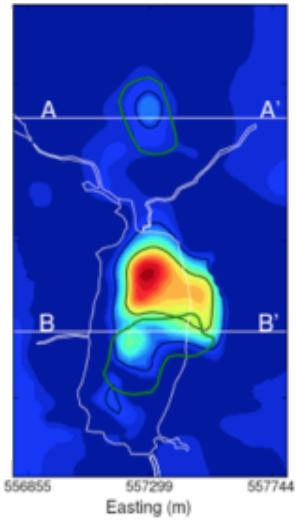


The Future: Data Integration & Multi-physics

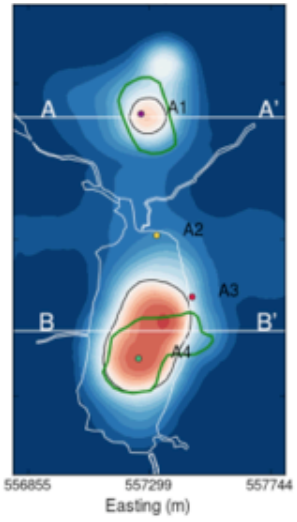
Density



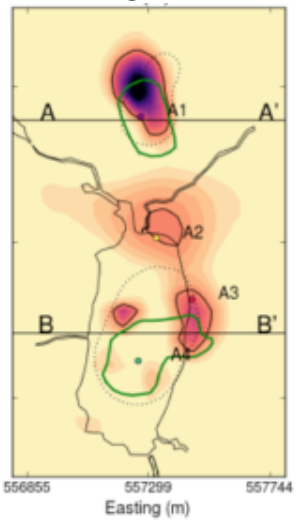
Susceptibility



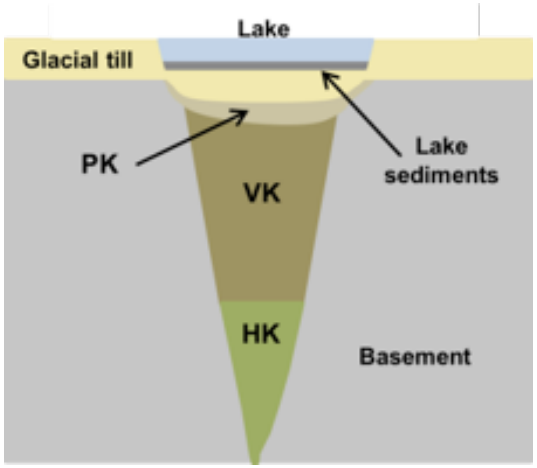
Conductivity



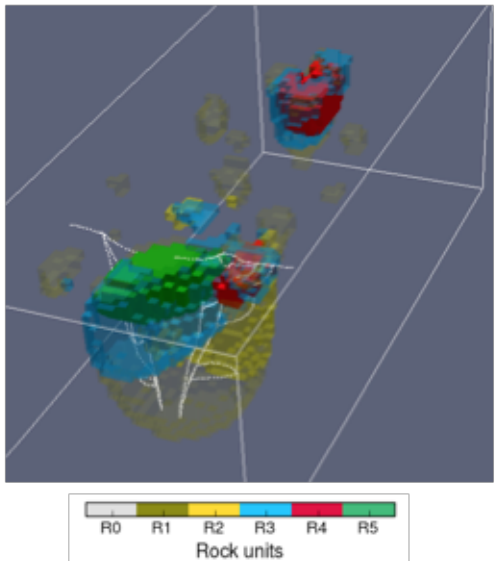
Chargeability



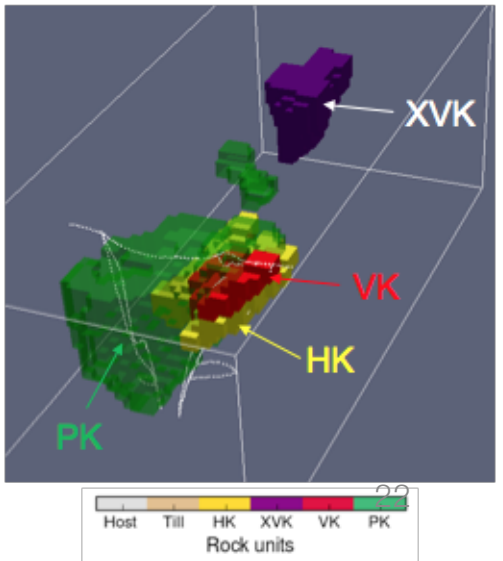
Kimberlite Model



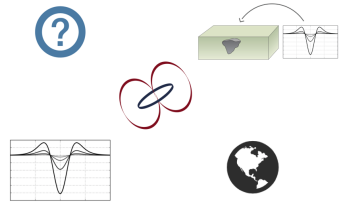
Rock Model from Geophysics



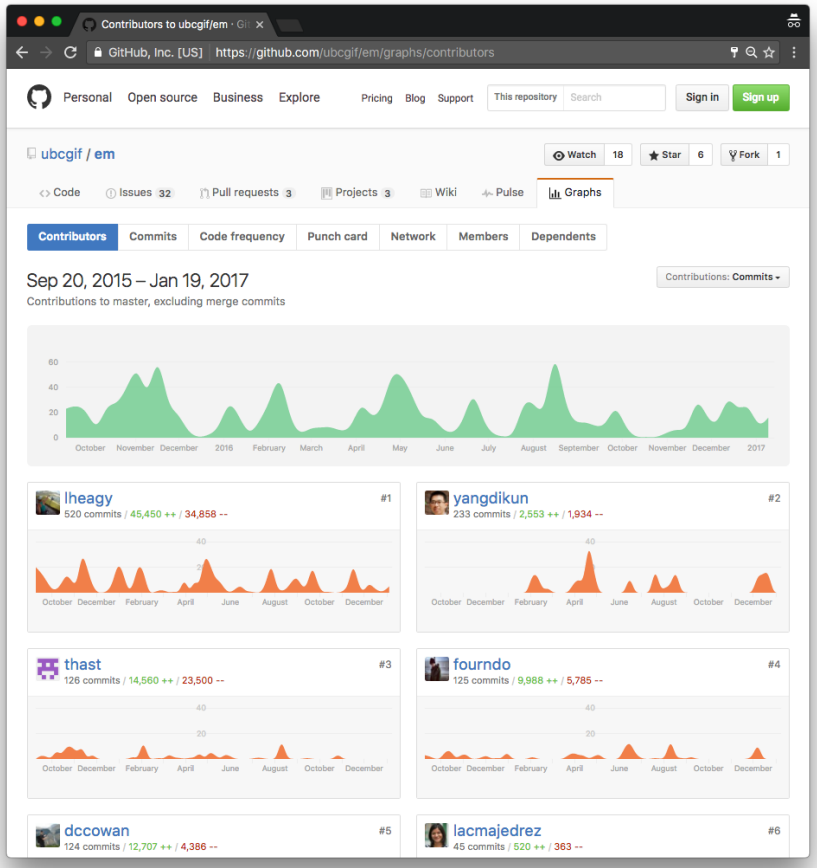
Rock Model from Drilling



The Future: Modelling and Inversion



- HPC, Cloud computing
- Collaborative development
- Open source



simpeg

Simulation and Parameter Estimation in Geophysics

http://simpeg.xyz

Github
versioning, collaborating

Travis CI
testing, deploy

Jupyter
interactive computing

Creative Commons
licensing, reuse

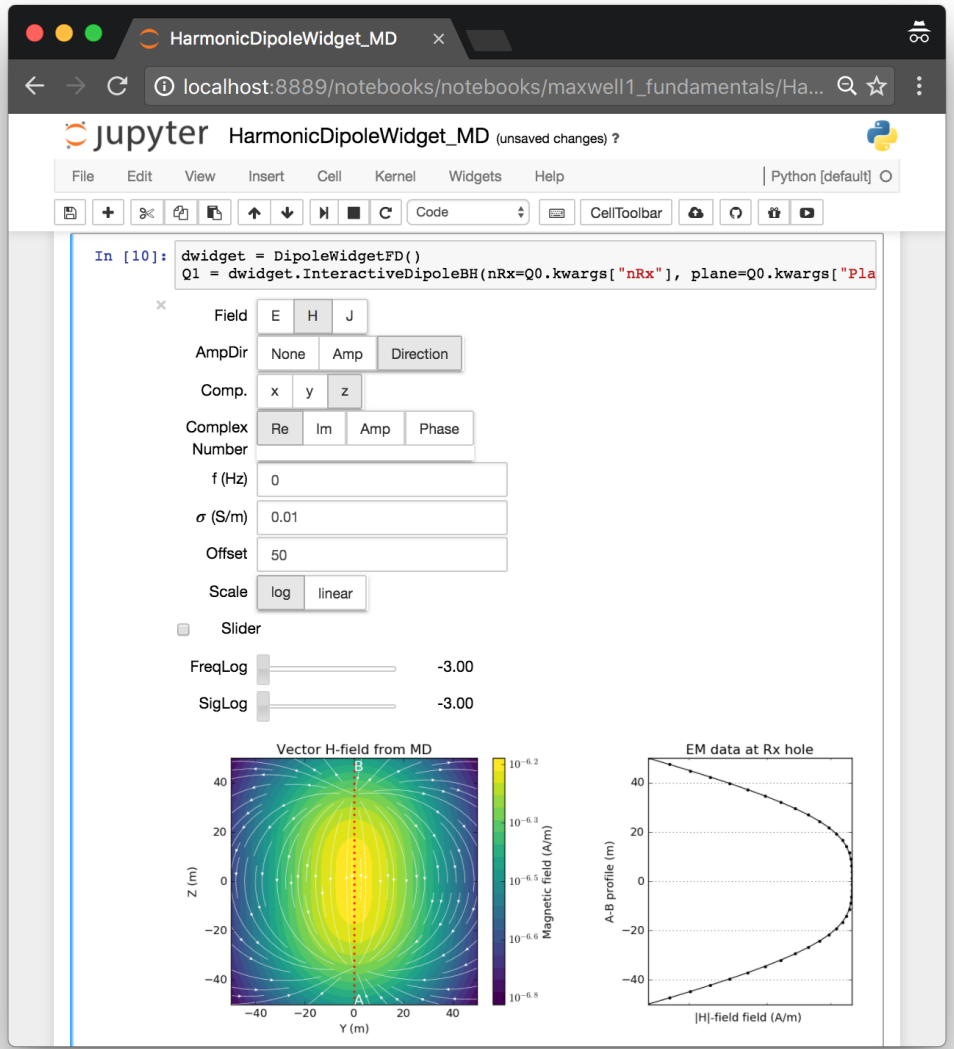
Python
computation

The Future: Modelling and Inversion

- Interactive computing
- Visualization

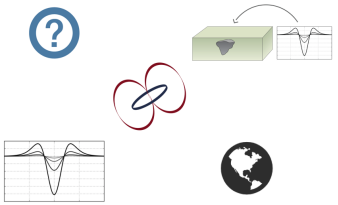
$$\nabla \times \mathbf{e} = -\frac{\partial \mathbf{b}}{\partial t}$$

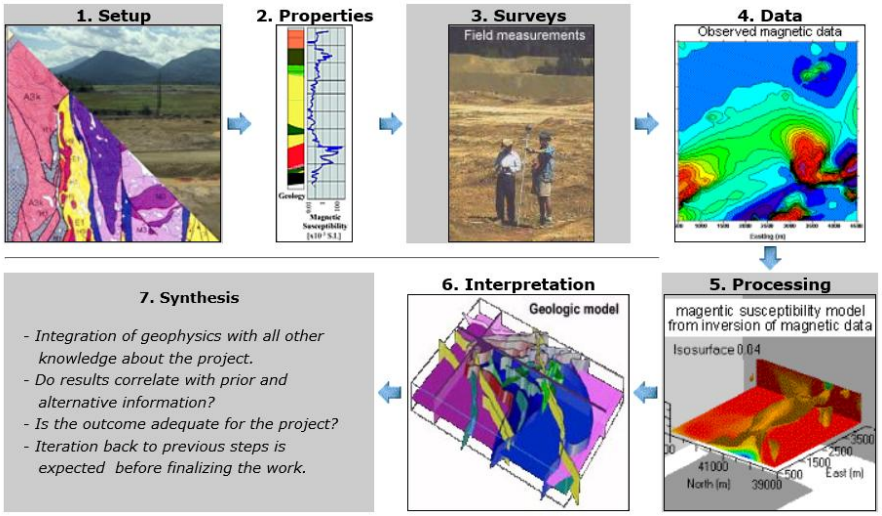
$$\nabla \times \mathbf{h} = \mathbf{j} + \frac{\partial \mathbf{d}}{\partial t}$$

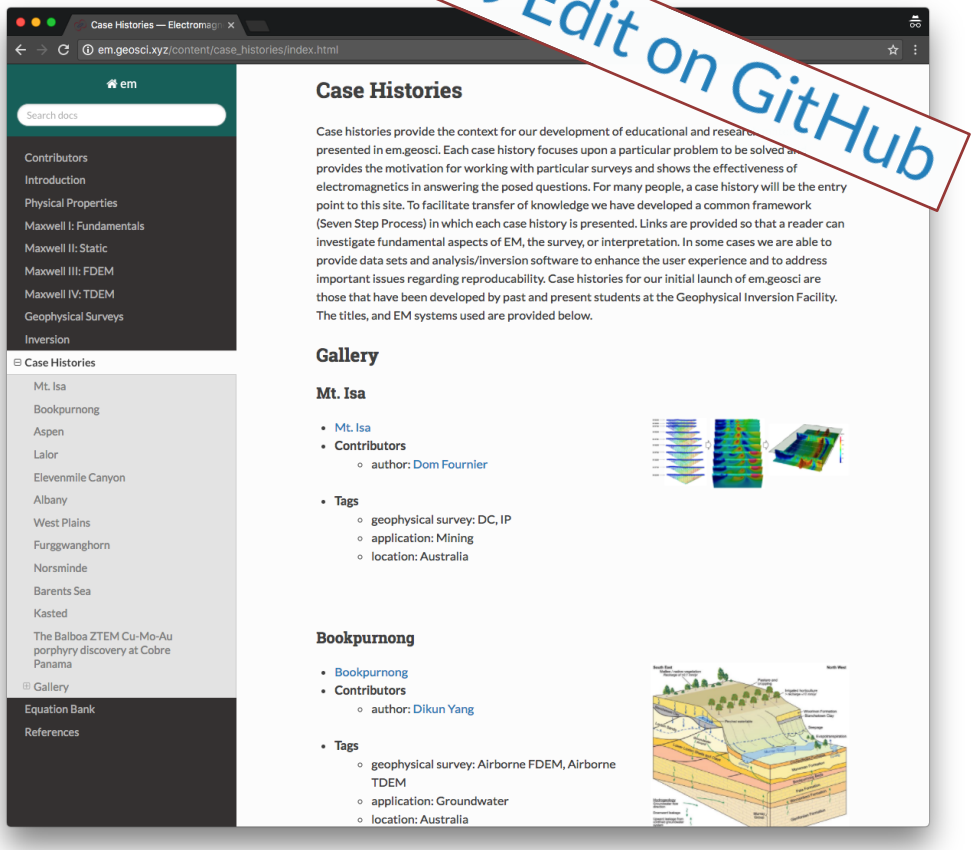


http://em.geosci.xyz/apps.html

The Future: Collaboration

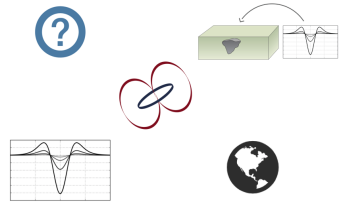






http://slack.geosci.xyz

Goals for the DISC



- Inspire
  - See the variety of potential applications
  - Illustrate effectiveness using case histories
- Build a foundation
  - Basic principles of EM
  - Exploration and visualization with Interactive apps
  - Open source resource: http://em.geosci.xyz
- Set realistic expectations
- Promote development of an EM community
  - Open source software
  - Capturing case histories world-wide

Resources

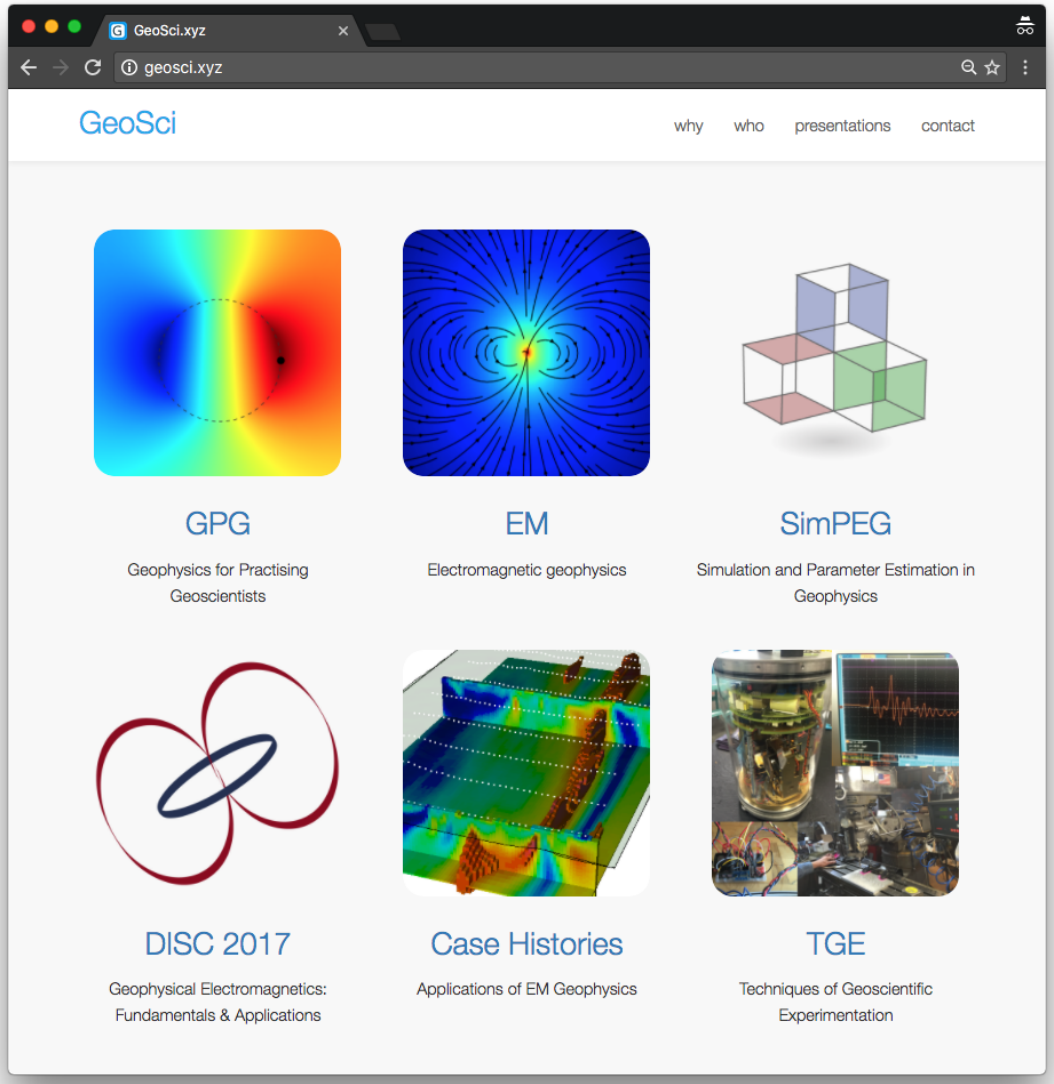
- GeoSci

  http://geosci.xyz

  - Web-textbooks
  - Software
  - Apps

- Apps:

  http://em.geosci.xyz/apps.html



GIF DISC Team


doug


lindsey


seogi

UBC GIF Team


Thibaut


Patrick


Rowan

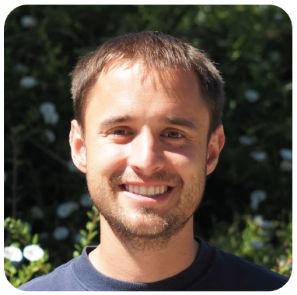

Devin


Kris


Sarah


Dom


Mike


Mike


Gudni


Dikun

Join us tomorrow at DISC Lab

- Tell us what you are doing
- How EM is (or could!) play a role in the solution
- Continue the conversations
- Connect with other geoscientists
- Contribute to the development of a community

http://disc2017.geosci.xyz


minerals


contaminants


water


geothermal


geotechnical


slope stability


hydrocarbons


unexploded ordnance

Thank You!

http://disc2017.geosci.xyz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