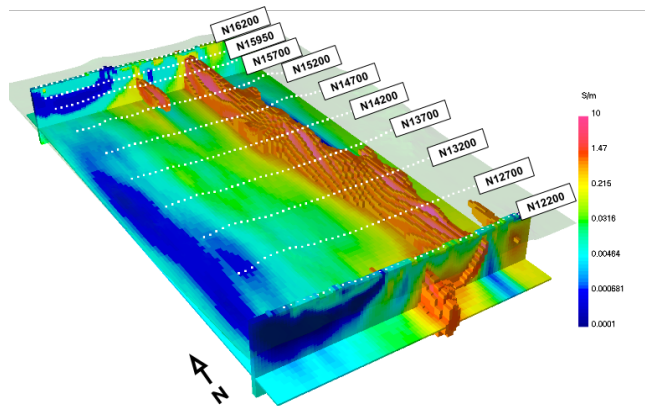


Summary and the Future

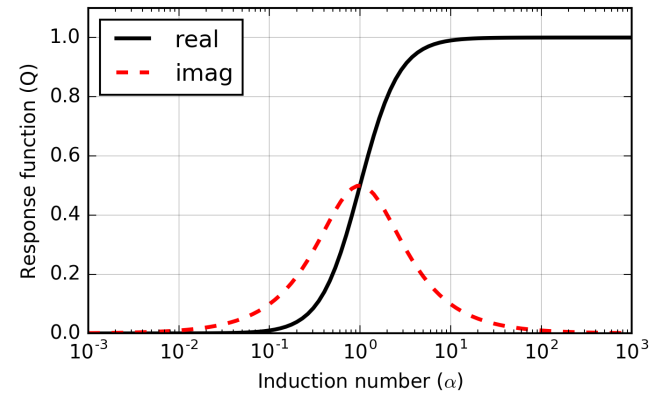


What have we covered?

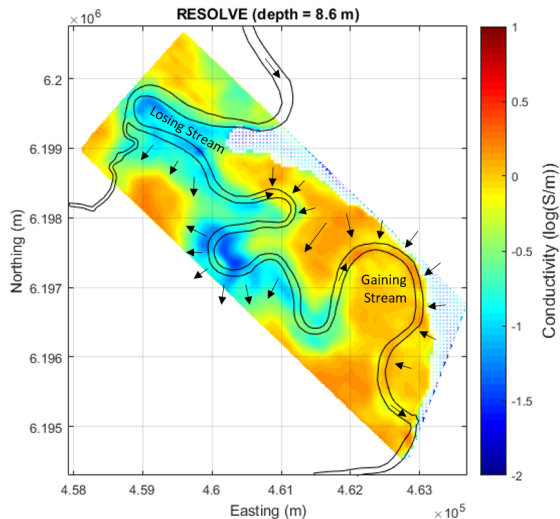
DC Resistivity



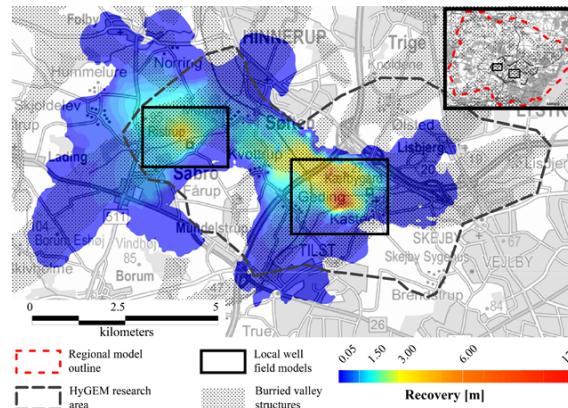
EM Fundamentals



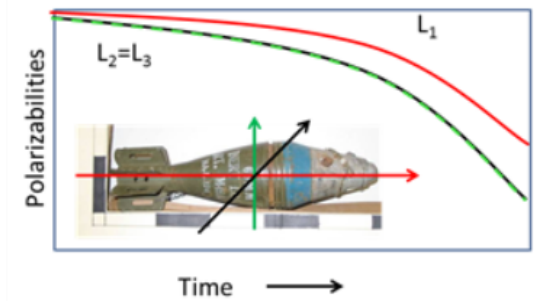
Inductive Sources: Frequency



Inductive Sources: Time

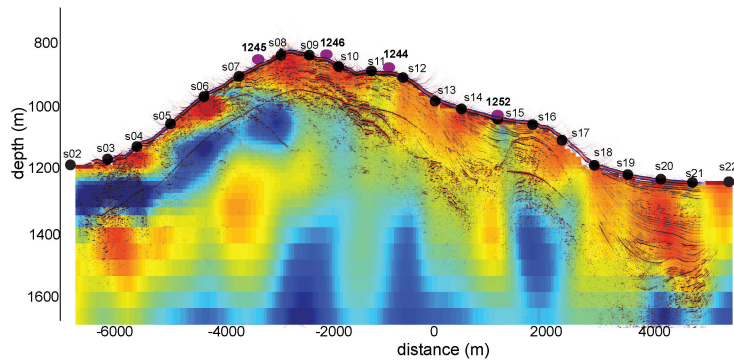


Inductive Sources: UXO

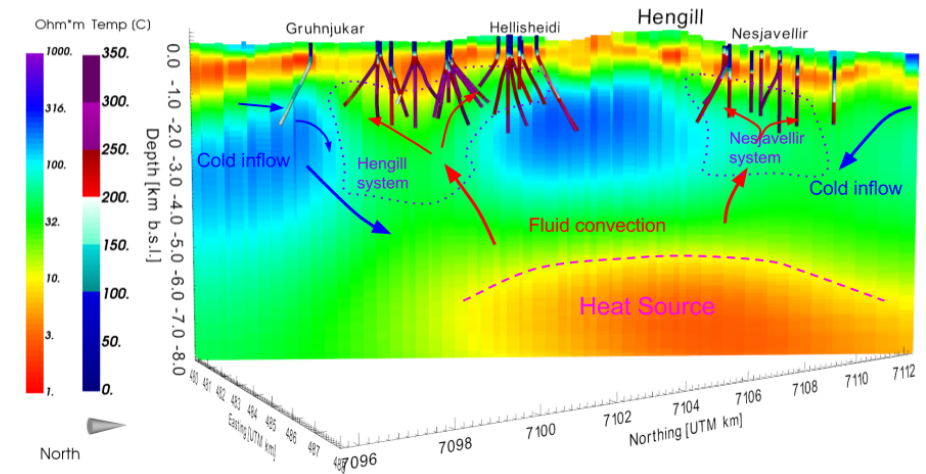


What have we covered?

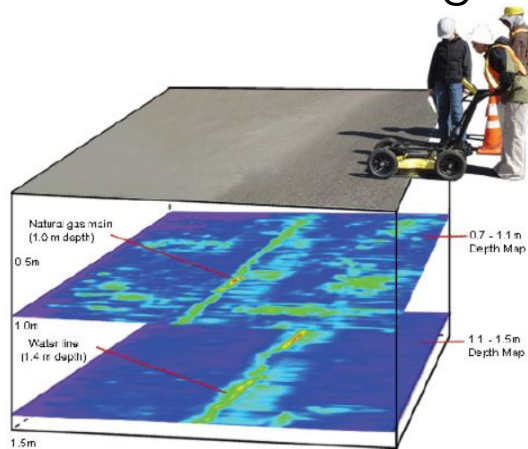
Grounded Sources



Natural Sources

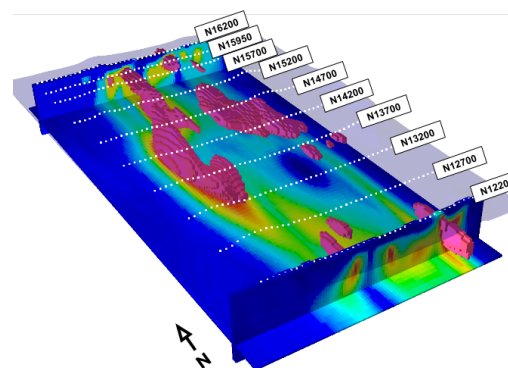


Ground Penetrating Radar

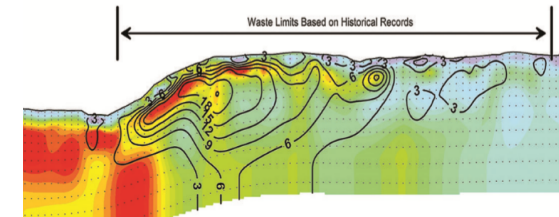


Induced Polarization:

Minerals



Landfills



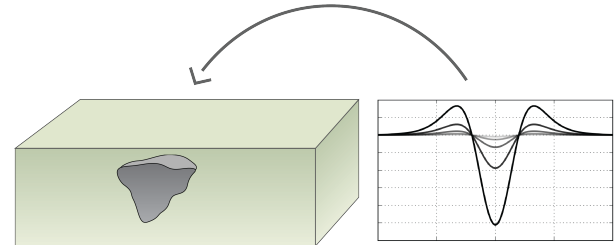
What does the future hold?

What does the future hold?

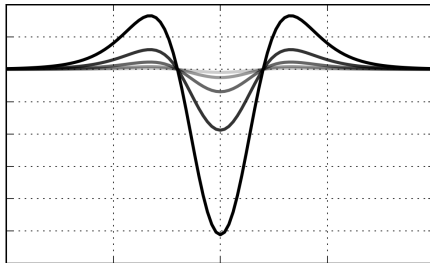
Problems



Inversion capabilities



High quality data

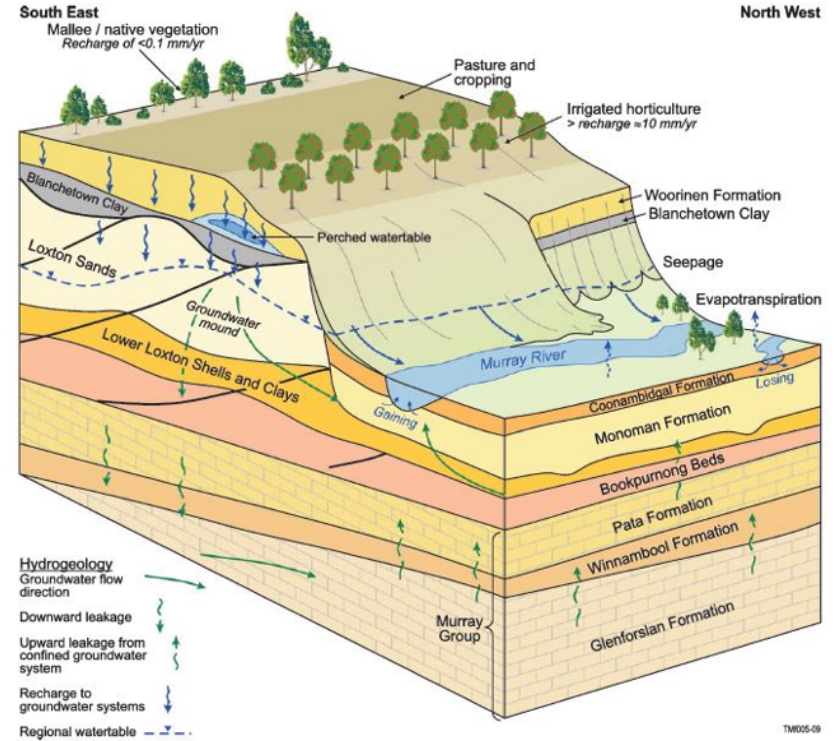
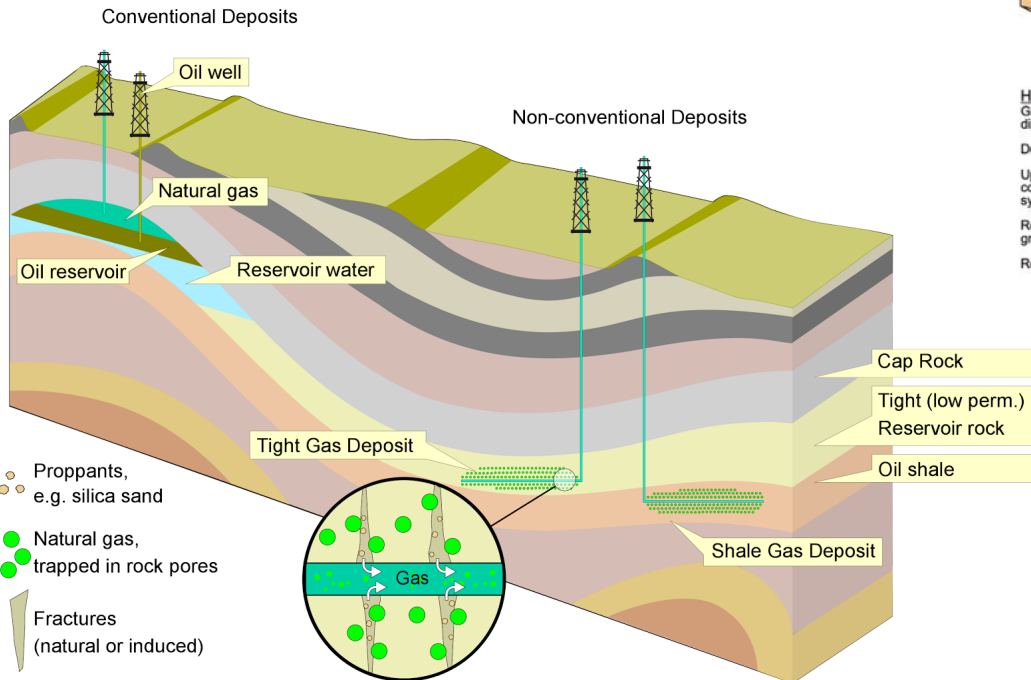


Web tools to
communicate



The Future: Monitoring

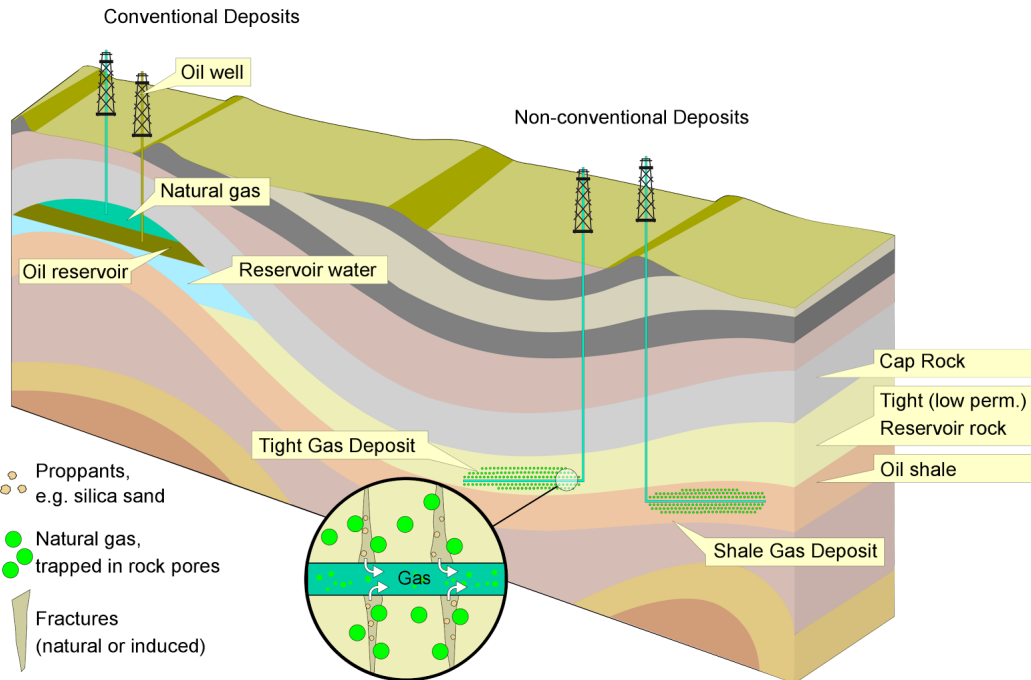
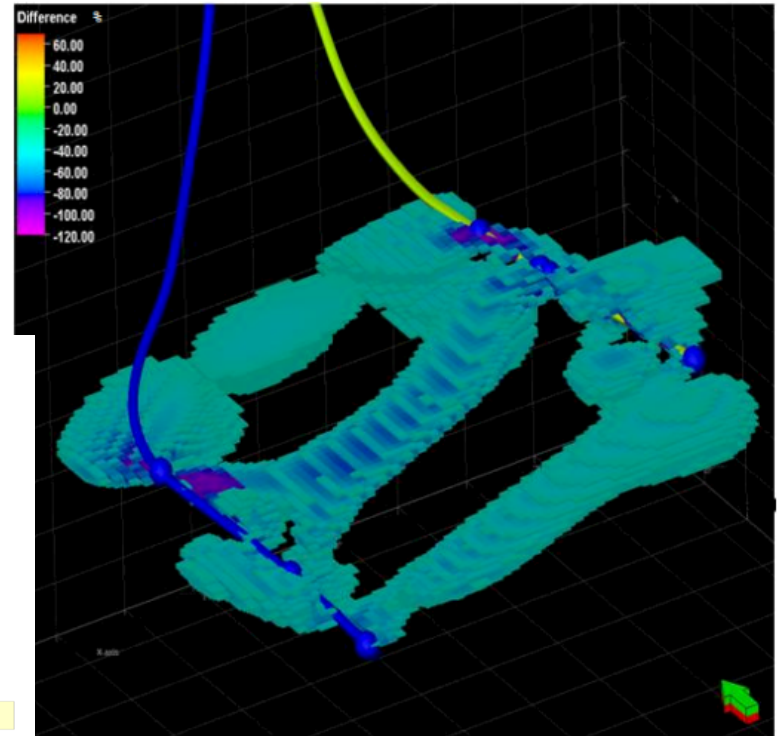
- Aquifers
- Enhanced oil recovery
- Hydraulic Fracturing
- CO₂ sequestration
- Coal seam gas



The Future: Monitoring

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

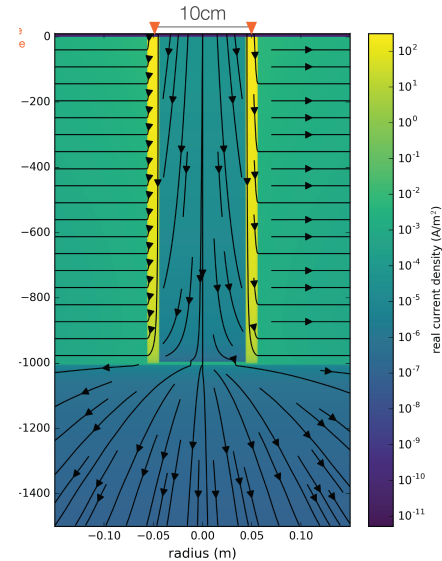
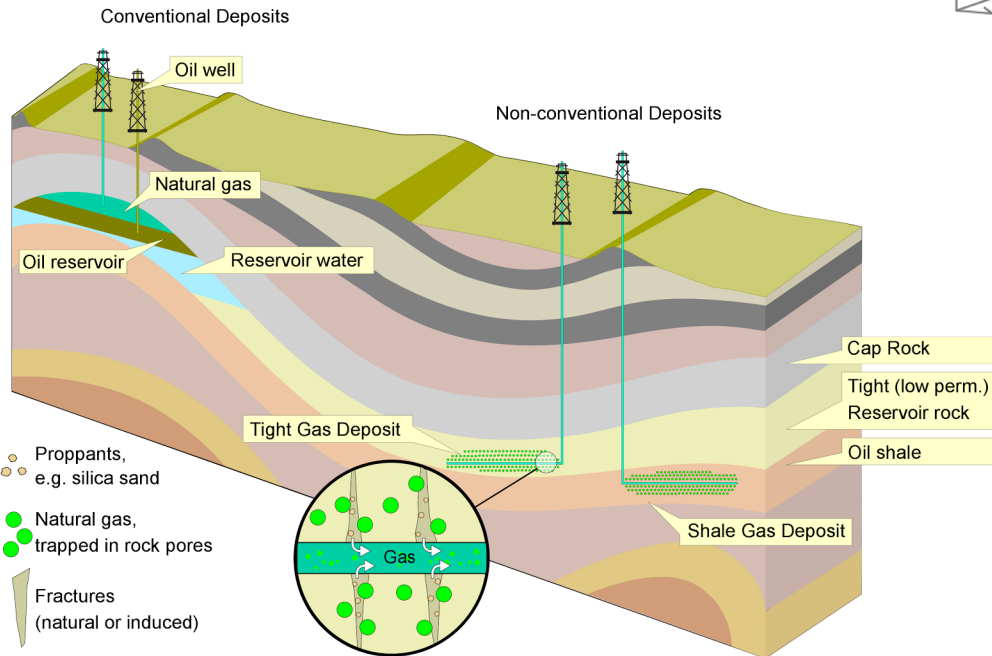
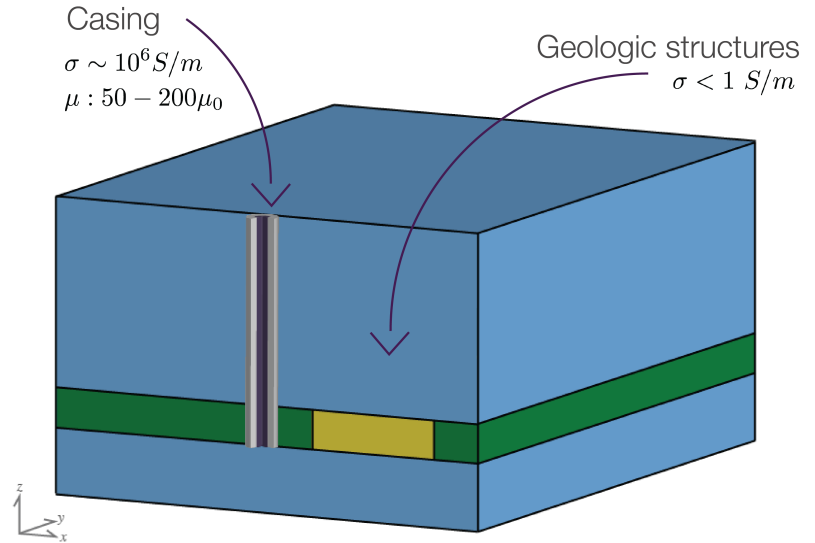
Resistivity isosurface – water flood



Saudi Arabia: Marsala et al., 2015

The Future: Monitoring

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

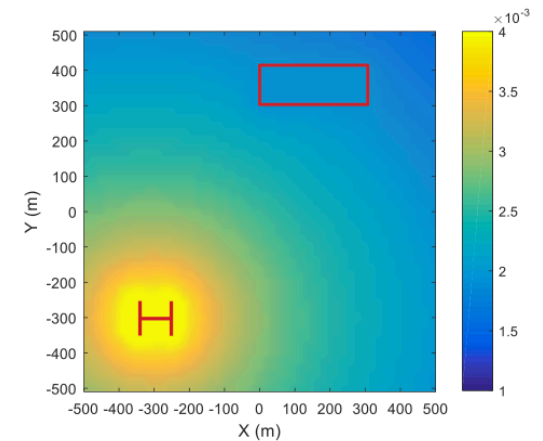
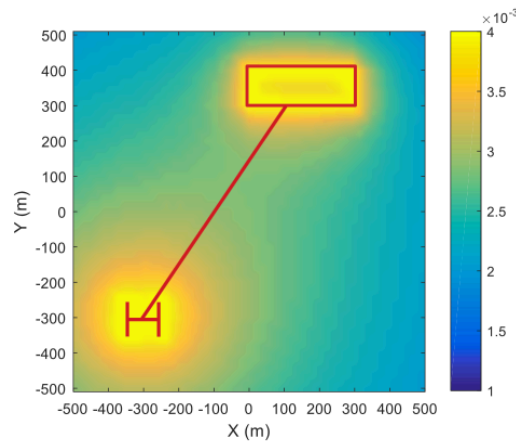
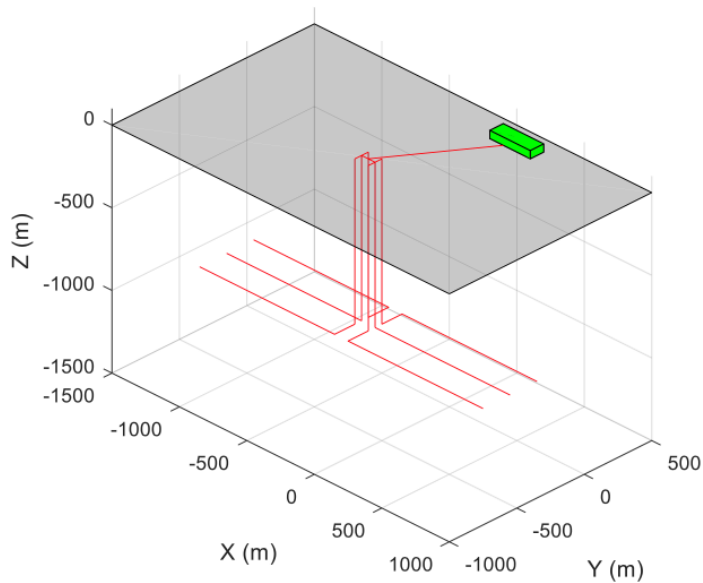
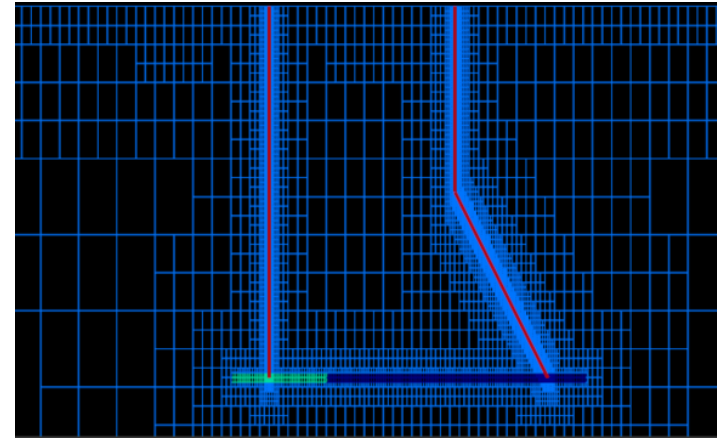
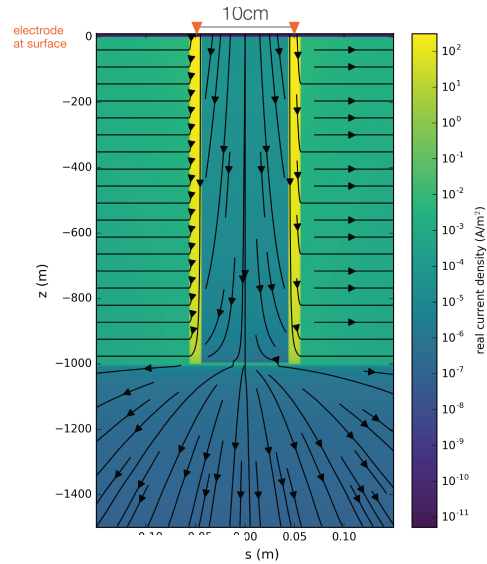


Corrosion



The Future: Monitoring

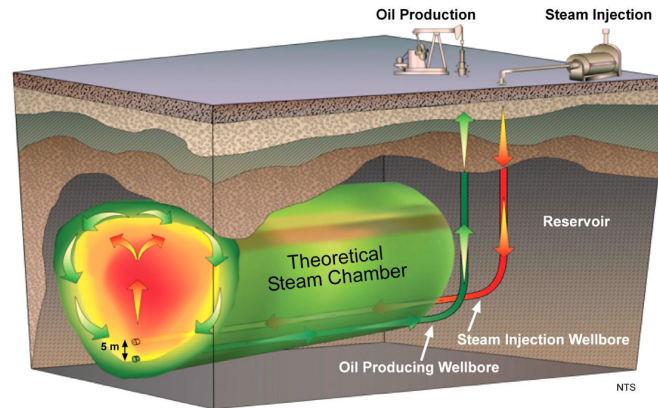
- Steel Casing



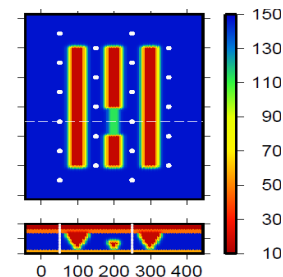
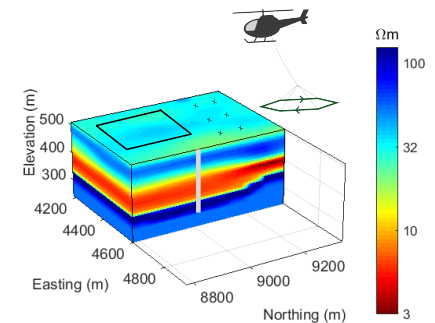
Monitoring: Choosing the appropriate survey

Different EM surveys needed to answer different questions

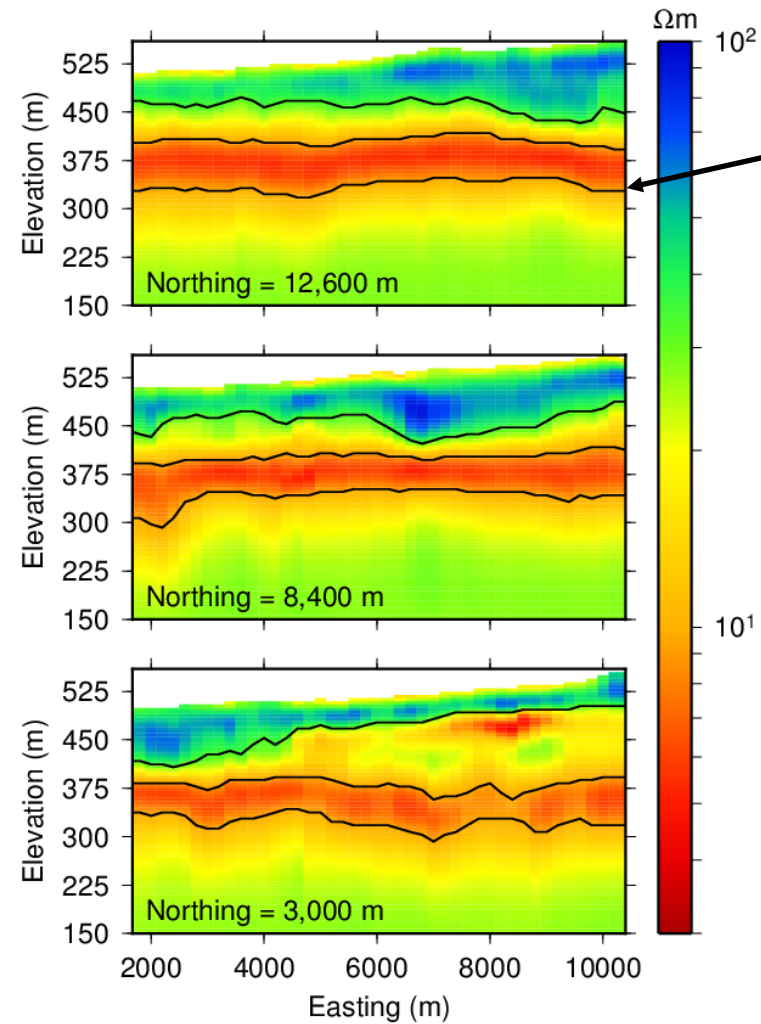
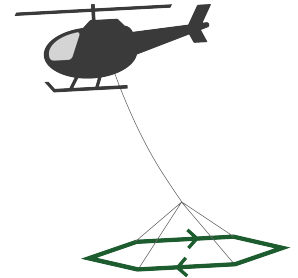
SAGD (Injection and monitoring steam flooding)



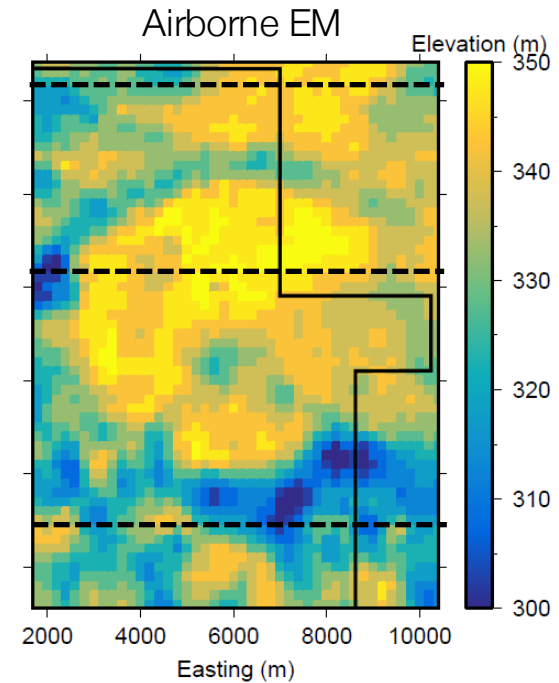
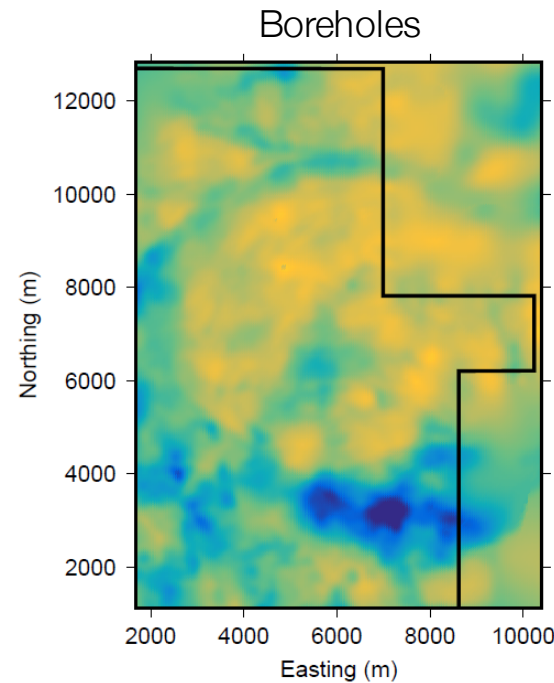
- Stage 1: Airborne reconnaissance survey
- Stage 2: Surface and borehole for pre-injection
- Stage 3: Monitoring array



SAGD: Large scale reconnaissance

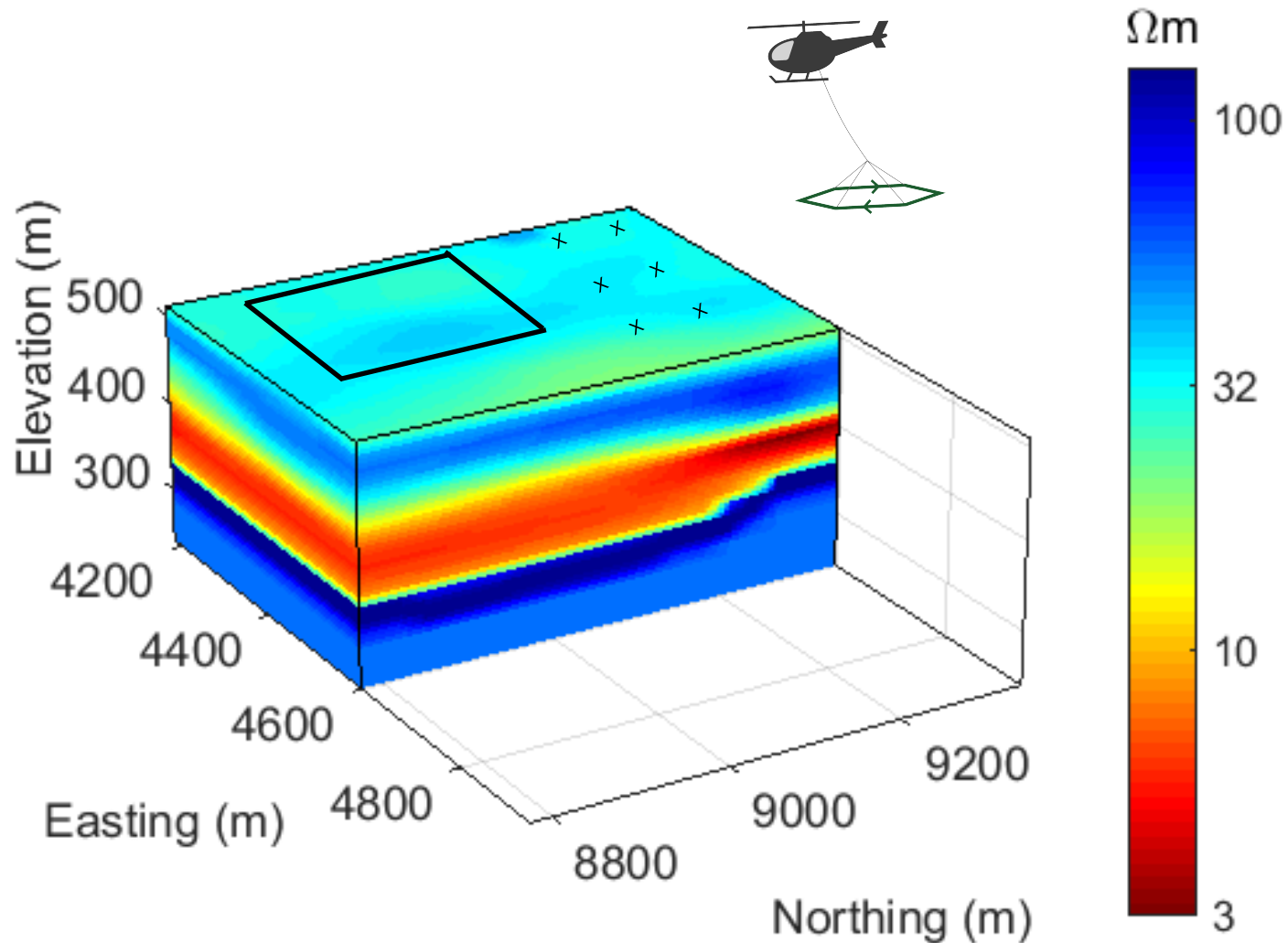


Top of McMurray



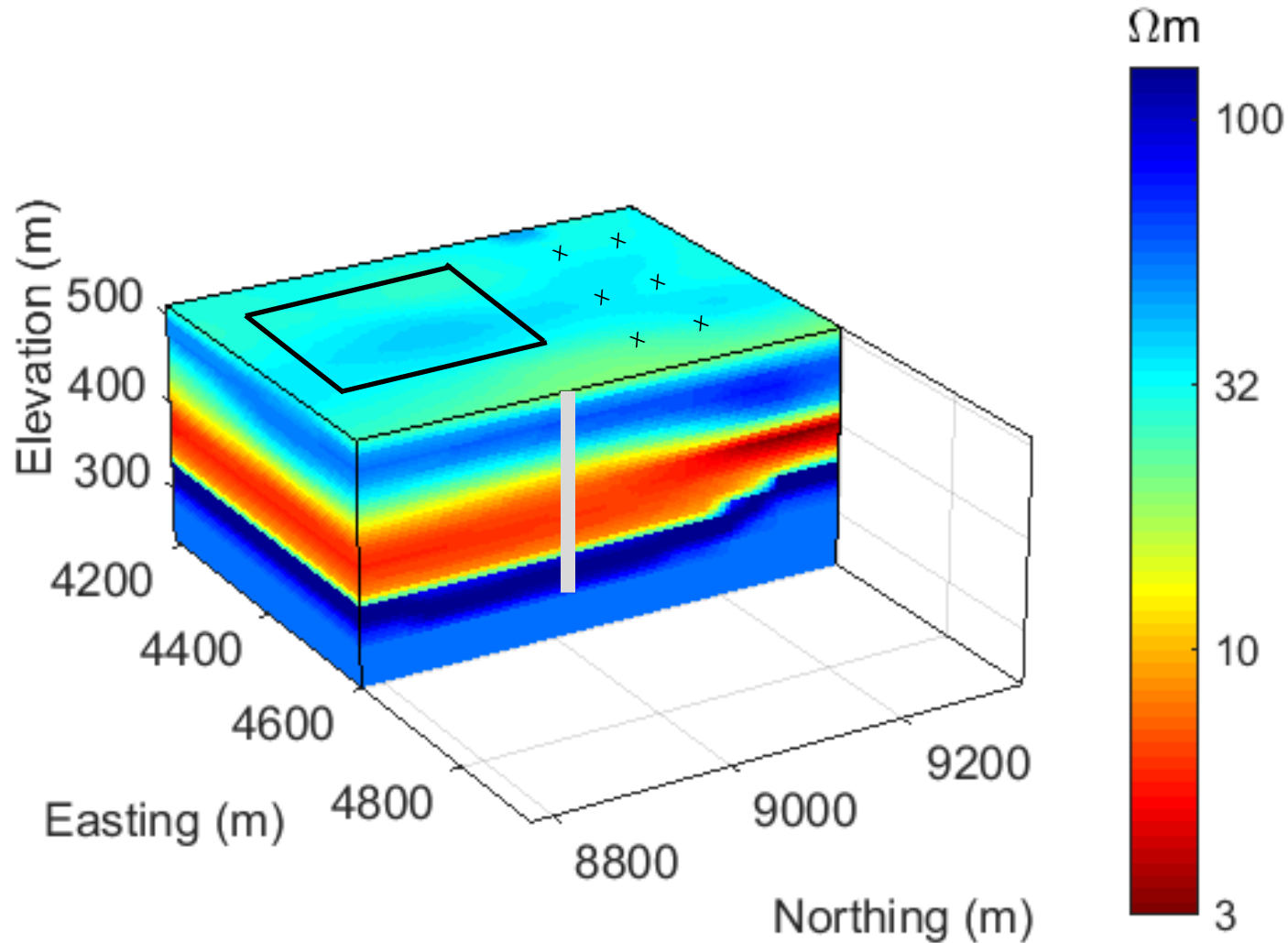
SAGD: Pre-injection

Local background: airborne + ground



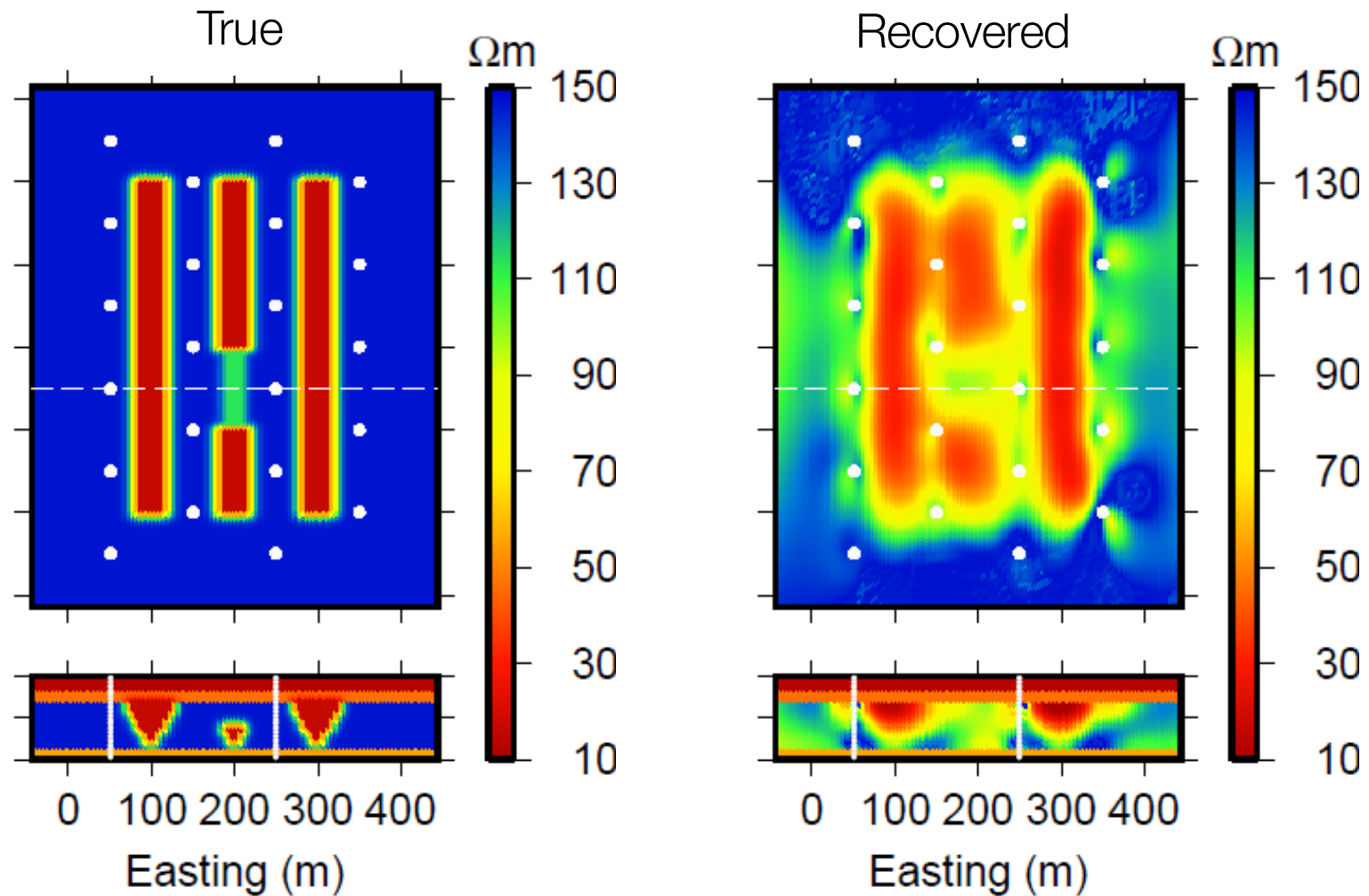
SAGD: monitoring array

Pre-injection: surface sources, borehole receivers



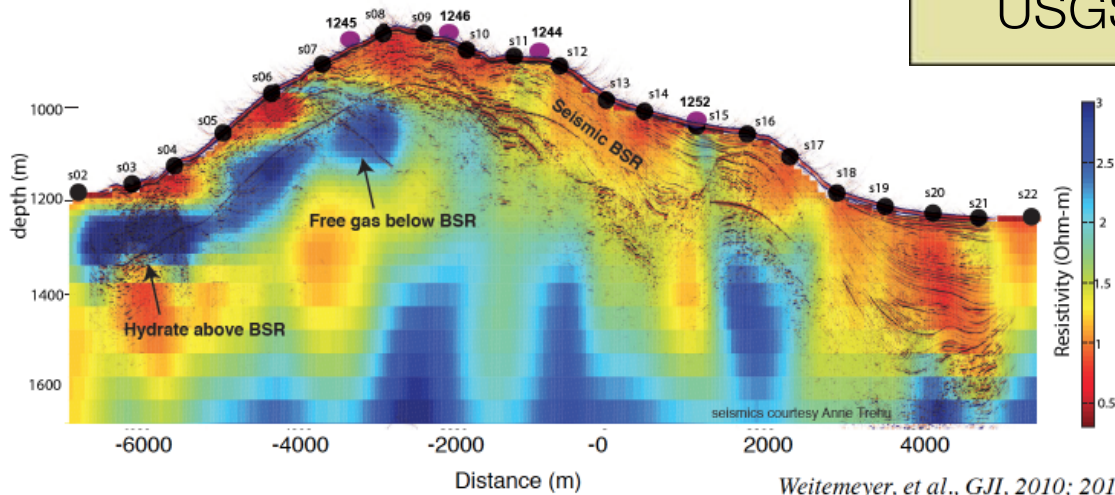
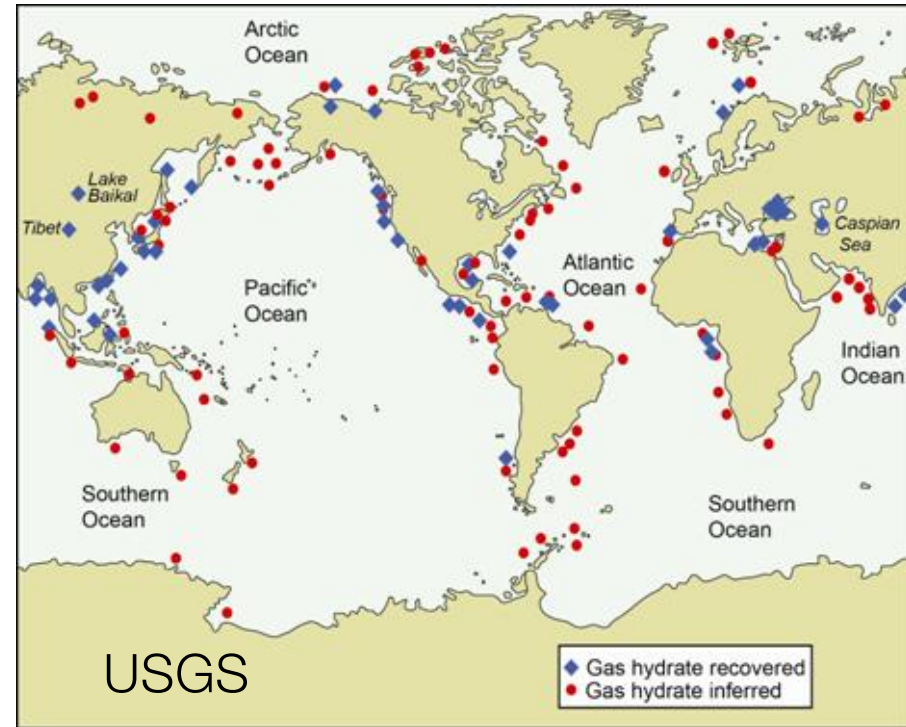
Multi-stage EM for monitoring

Post-injection: surface sources, borehole receivers



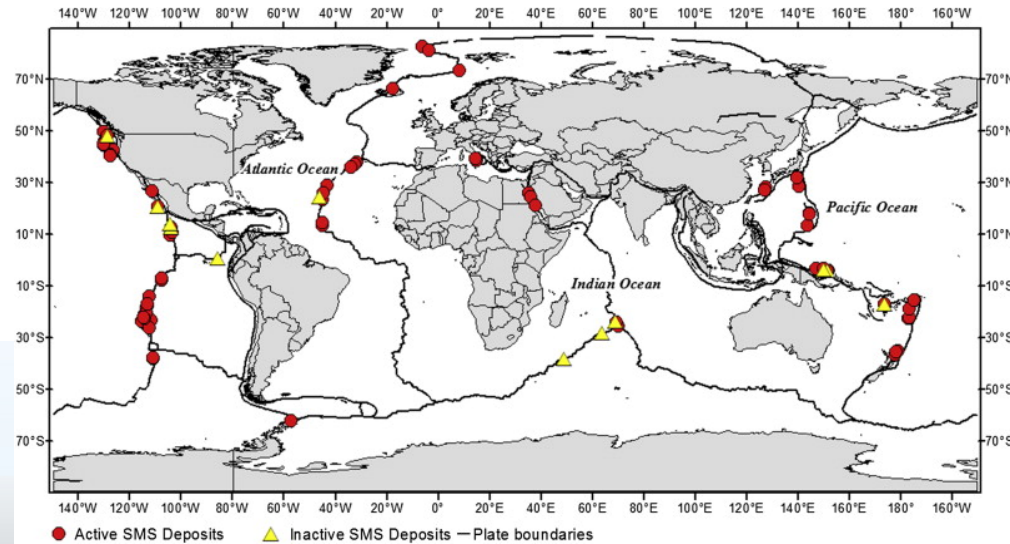
The Future: Marine EM

- Gas hydrates
 - Resistivity is diagnostic

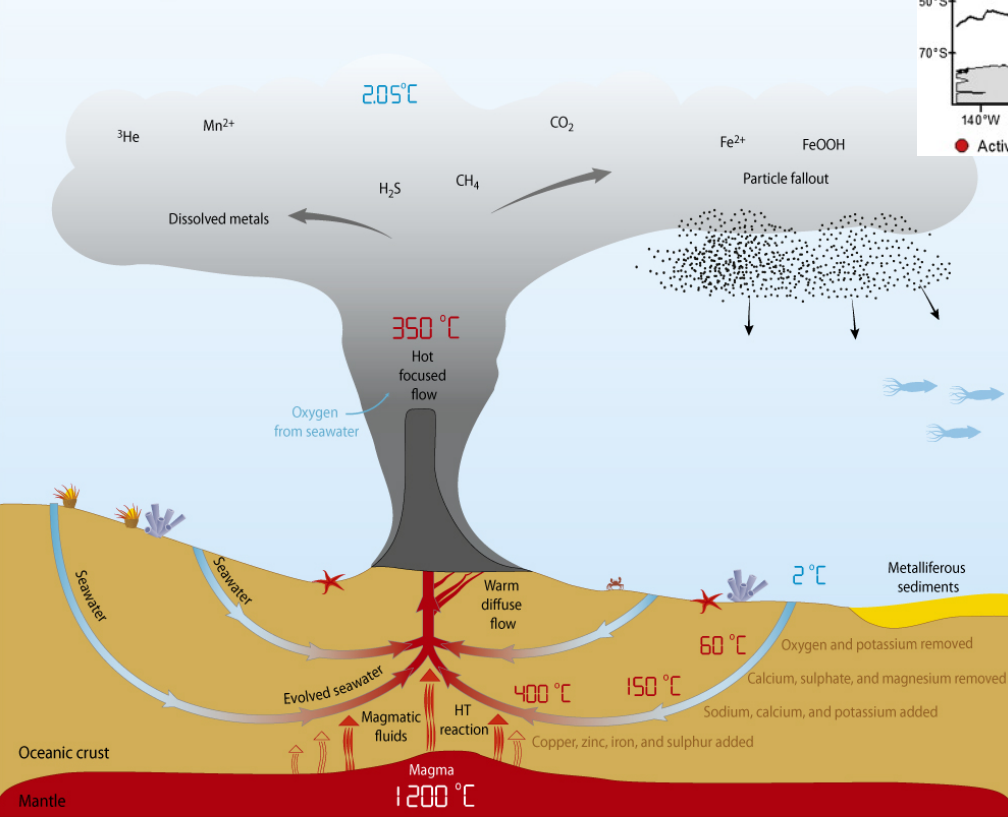


The Future: Marine EM

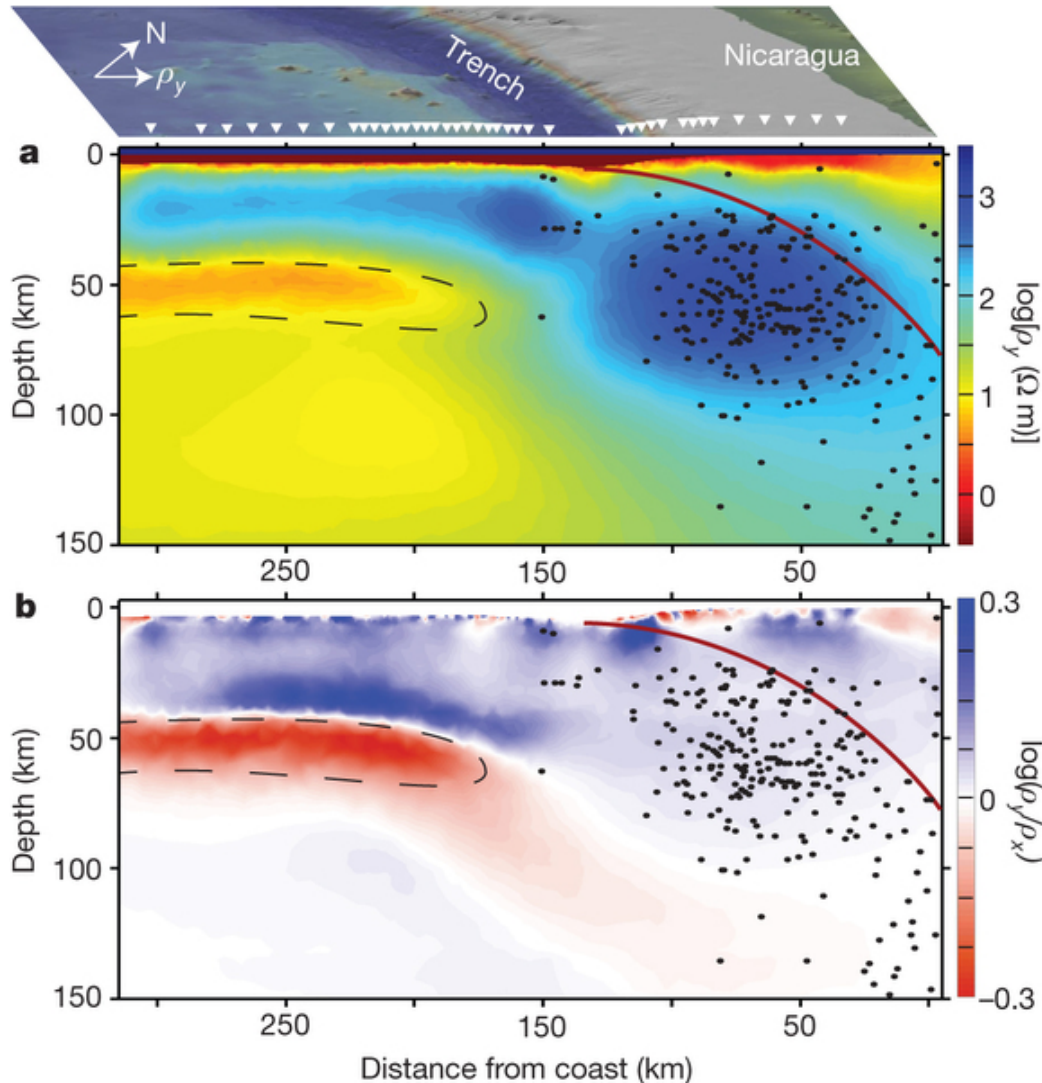
- Submarine massive sulfides
 - Conductive relative to background



Basics of a hydrothermal vent - a Black Smoker



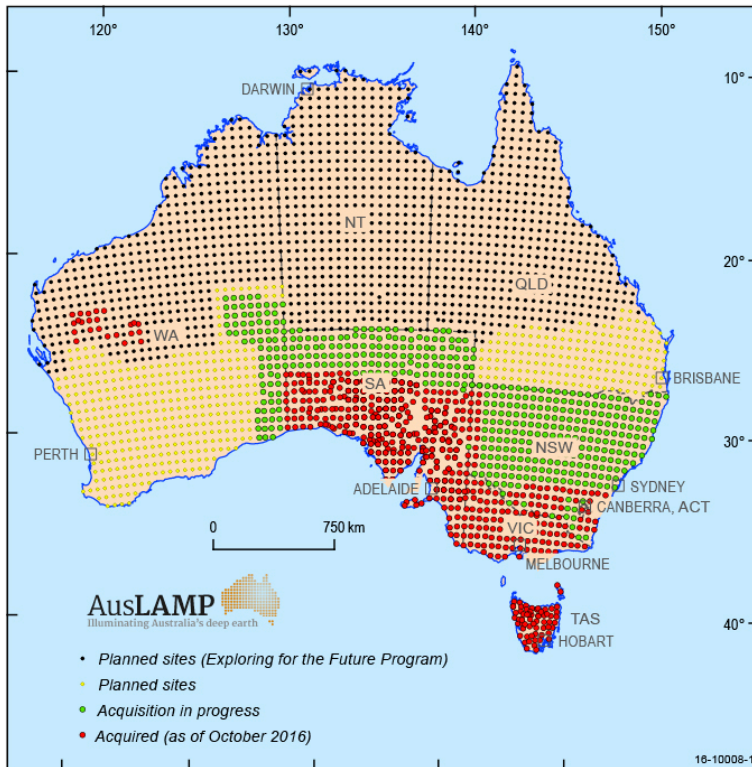
The Future: Marine EM



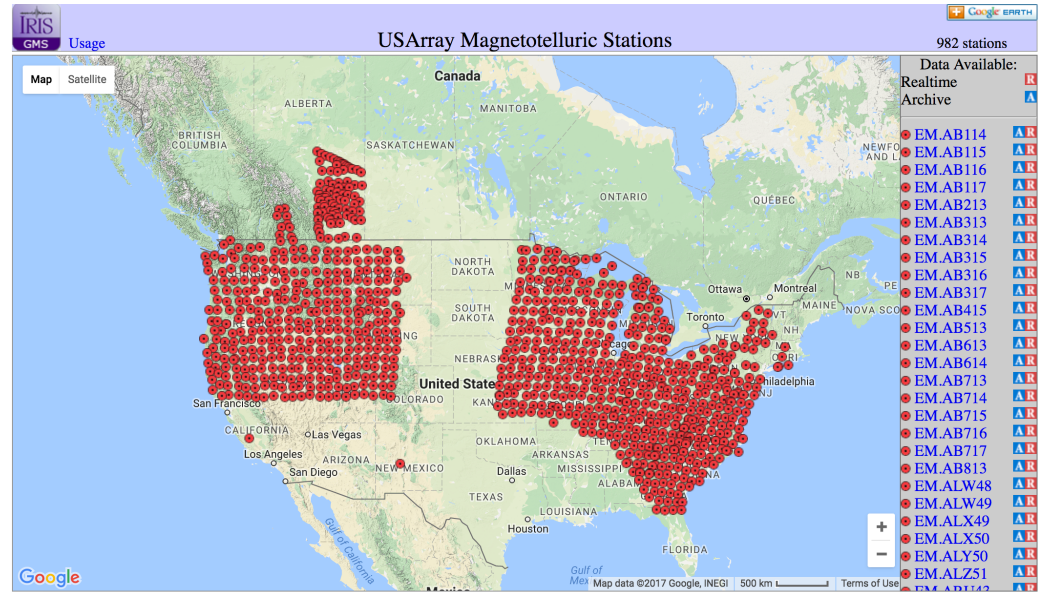
- Tectonic studies
- Natural Hazard
- Large anisotropy
 - indicative of melt-rich channel

The Future: Large Scale MT

AusLamp

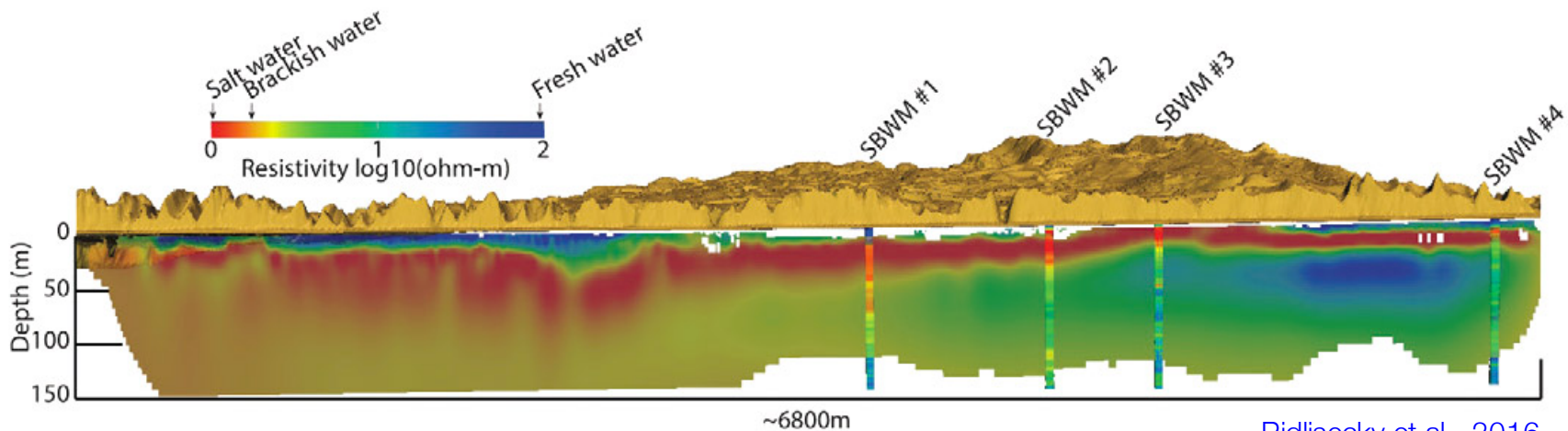
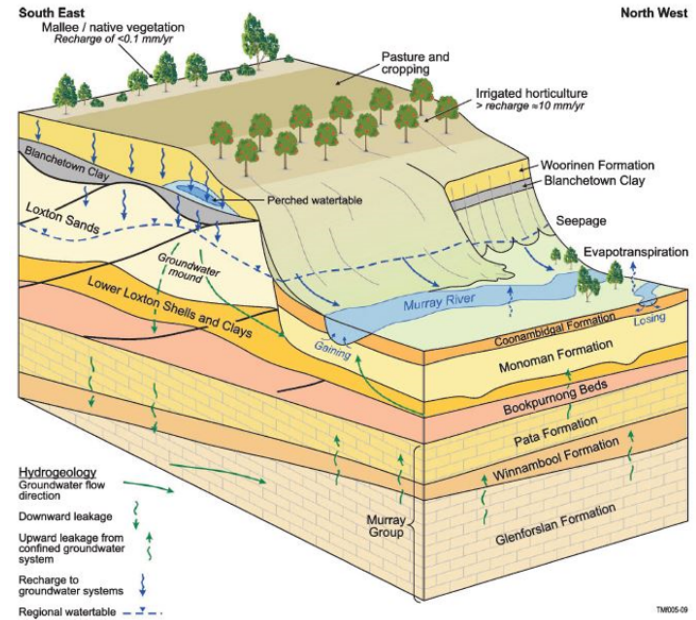


Earth scope

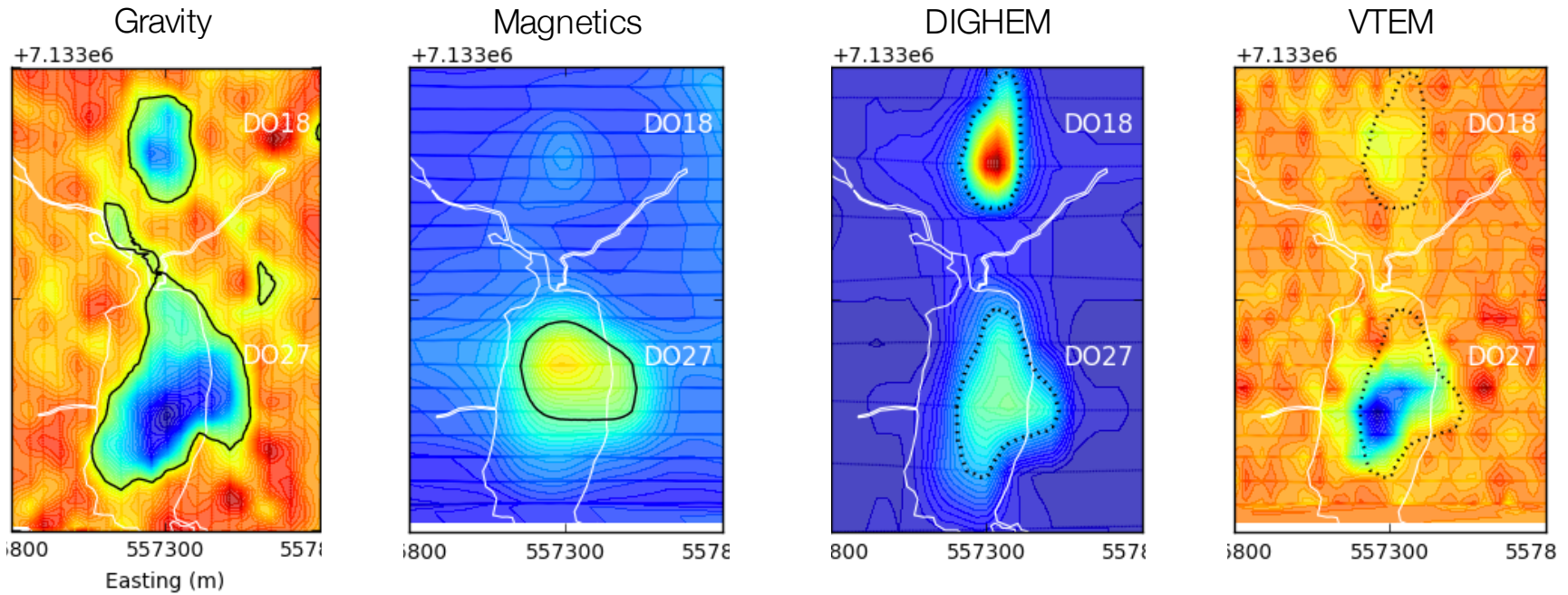


The Future: Water

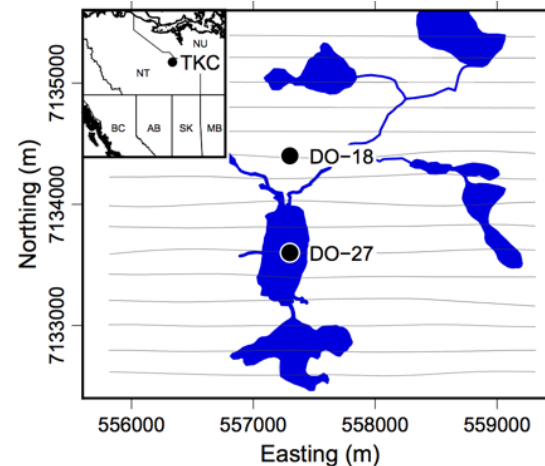
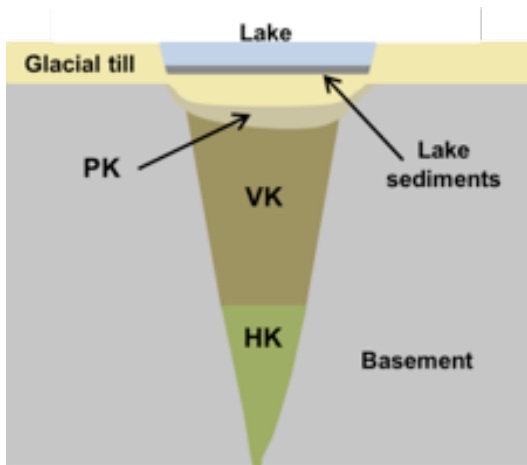
- Finding and delineating water
- Aquifer monitoring and management
- Salt water intrusions
- Pollutants



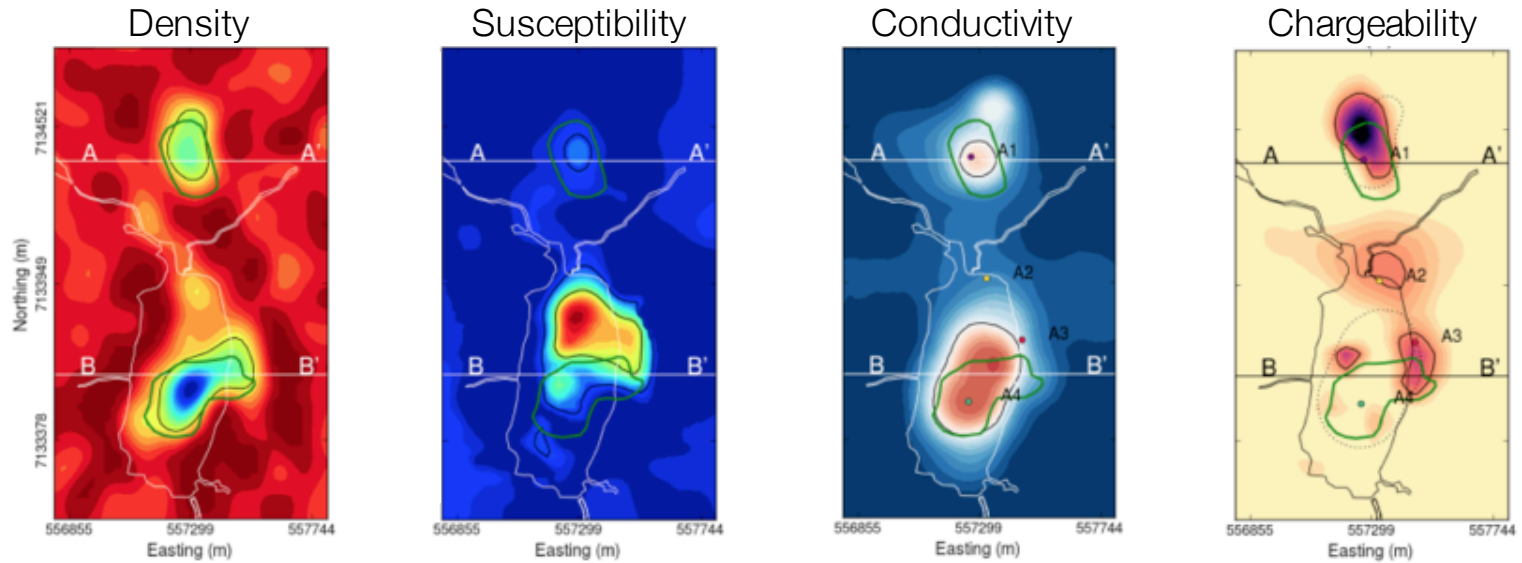
The Future: Data Integration & Multi-physics



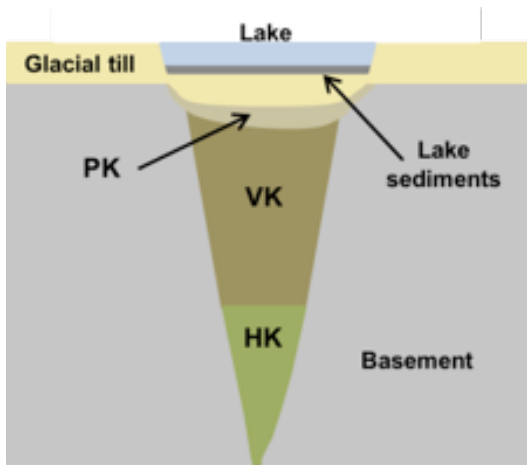
Kimberlite Model



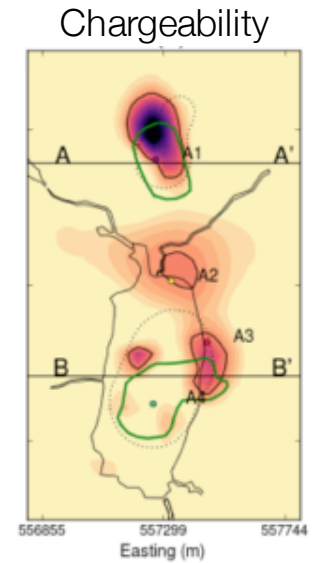
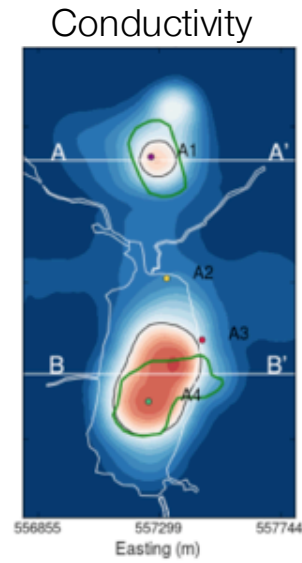
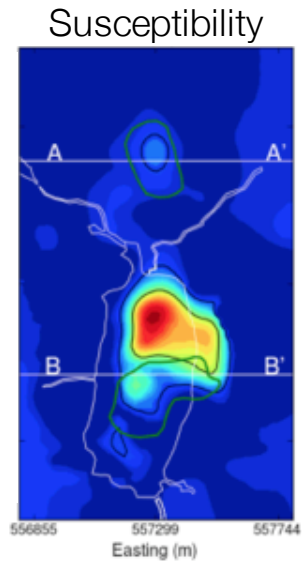
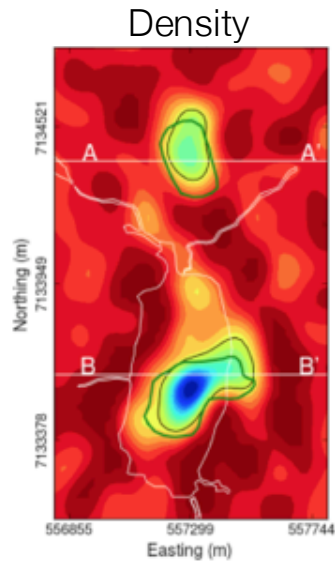
The Future: Data Integration & Multi-physics



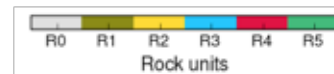
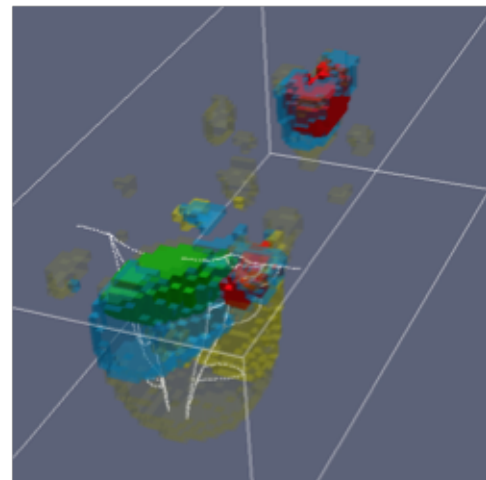
Kimberlite Model



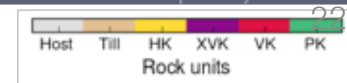
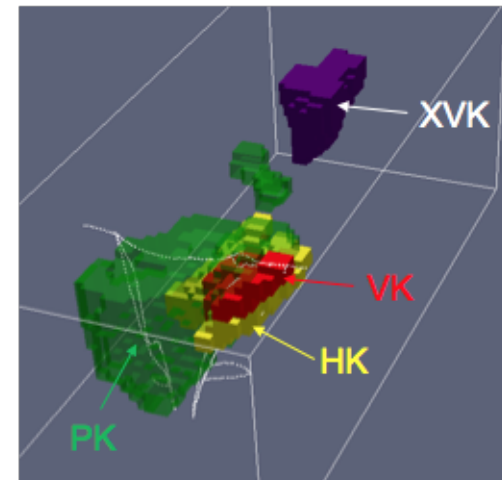
The Future: Data Integration & Multi-physics



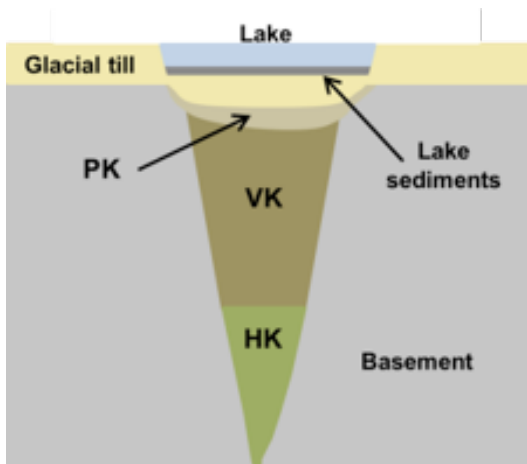
Rock Model from Geophysics



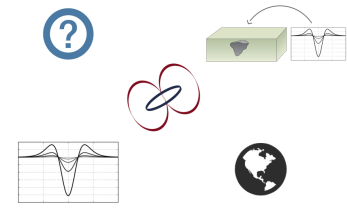
Rock Model from Drilling



Kimberlite Model



The Future: Modelling and Inversion

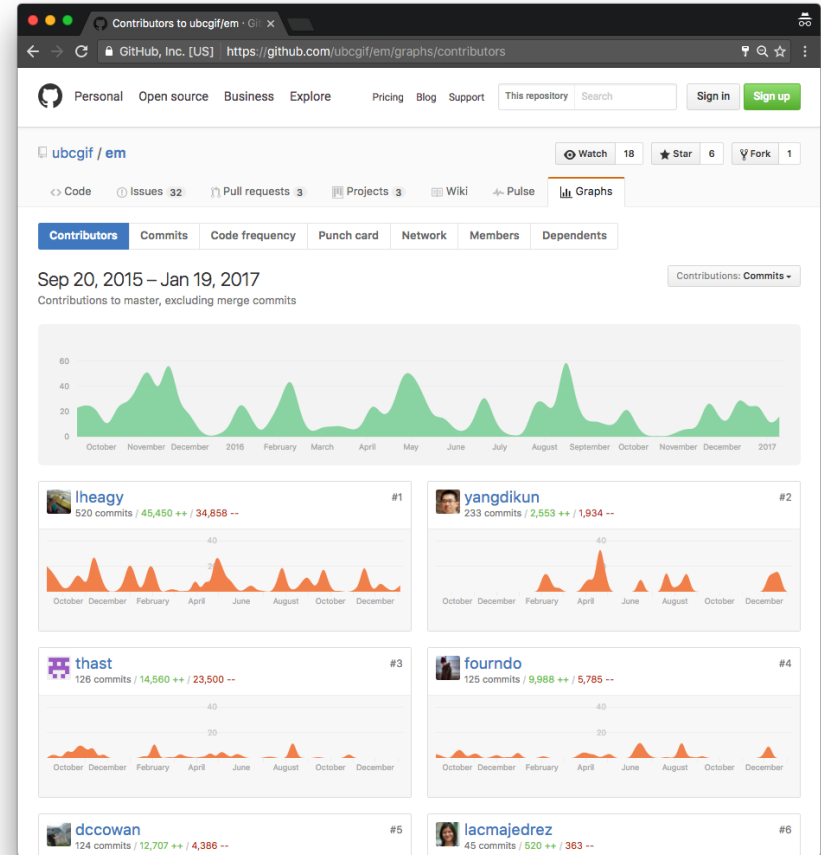


- HPC, Cloud computing
- Collaborative development
- Open source



Simulation and Parameter Estimation in Geophysics

<http://simpeg.xyz>



Github
versioning, collaborating



Travis CI
testing, deploy



Jupyter
interactive computing

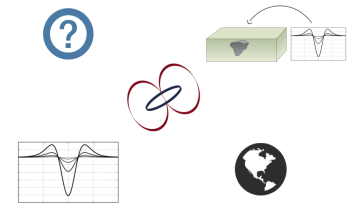


Creative Commons
licensing, reuse



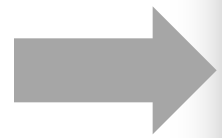
Python
computation

The Future: Modelling and Inversion



- Interactive computing
- Visualization

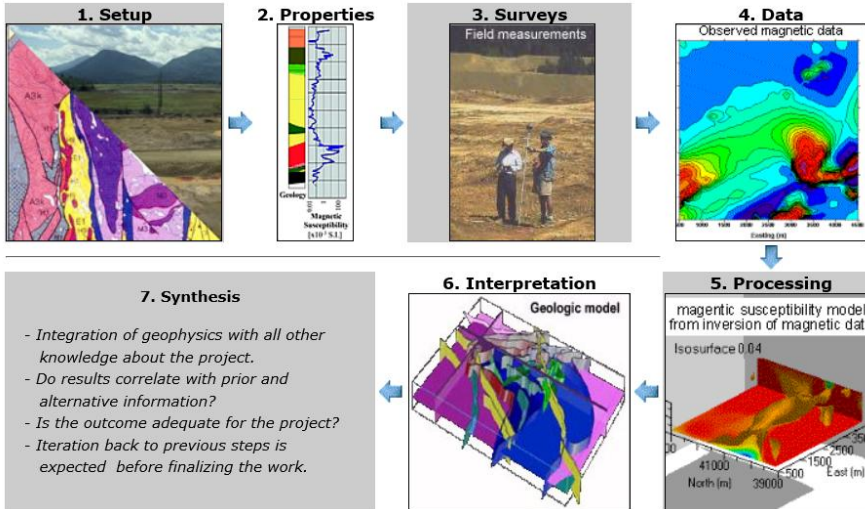
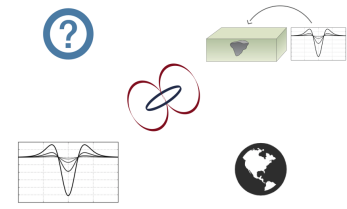
$$\nabla \times \mathbf{e} = - \frac{\partial \mathbf{b}}{\partial t}$$



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

```
In [10]: dwidget = DipoleWidgetFD()
Q1 = dwidget.InteractiveDipoleBH(nRx=Q0.kwarg["nRx"], plane=Q0.kwarg["Pla...
```


The Future: Collaboration



Case Histories — Electromag

em.geosci.xyz/content/case_histories/index.html

em

Search docs

Contributors

Introduction

Physical Properties

Maxwell I: Fundamentals

Maxwell II: Static

Maxwell III: FDEM

Maxwell IV: TDEM

Geophysical Surveys

Inversion

Case Histories

- Mt. Isa
- Bookpurnong
- Aspen
- Lalor
- Elevenmile Canyon
- Albany
- West Plains
- Furggwanhorn
- Norsminde
- Barents Sea
- Kasted
- The Balboa ZTEM Cu-Mo-Au porphyry discovery at Cobre Panama

Gallery

Equation Bank

References

Case Histories

Case histories provide the context for our development of educational and research materials presented in em.geosci. Each case history focuses upon a particular problem to be solved and provides the motivation for working with particular surveys and shows the effectiveness of electromagnetics in answering the posed questions. For many people, a case history will be the entry point to this site. To facilitate transfer of knowledge we have developed a common framework (Seven Step Process) in which each case history is presented. Links are provided so that a reader can investigate fundamental aspects of EM, the survey, or interpretation. In some cases we are able to provide data sets and analysis/inversion software to enhance the user experience and to address important issues regarding reproducibility. Case histories for our initial launch of em.geosci are those that have been developed by past and present students at the Geophysical Inversion Facility. The titles, and EM systems used are provided below.

Gallery

Mt. Isa

- Contributors
 - author: Dom Fournier
- Tags
 - geophysical survey: DC, IP
 - application: Mining
 - location: Australia

Bookpurnong

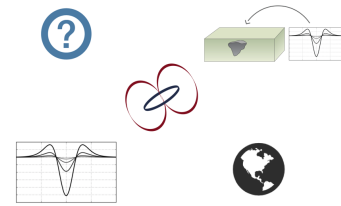
- Bookpurnong
- Contributors
 - author: Dikun Yang
- Tags
 - geophysical survey: Airborne FDEM, Airborne TDEM
 - application: Groundwater
 - location: Australia

Edit on GitHub



<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

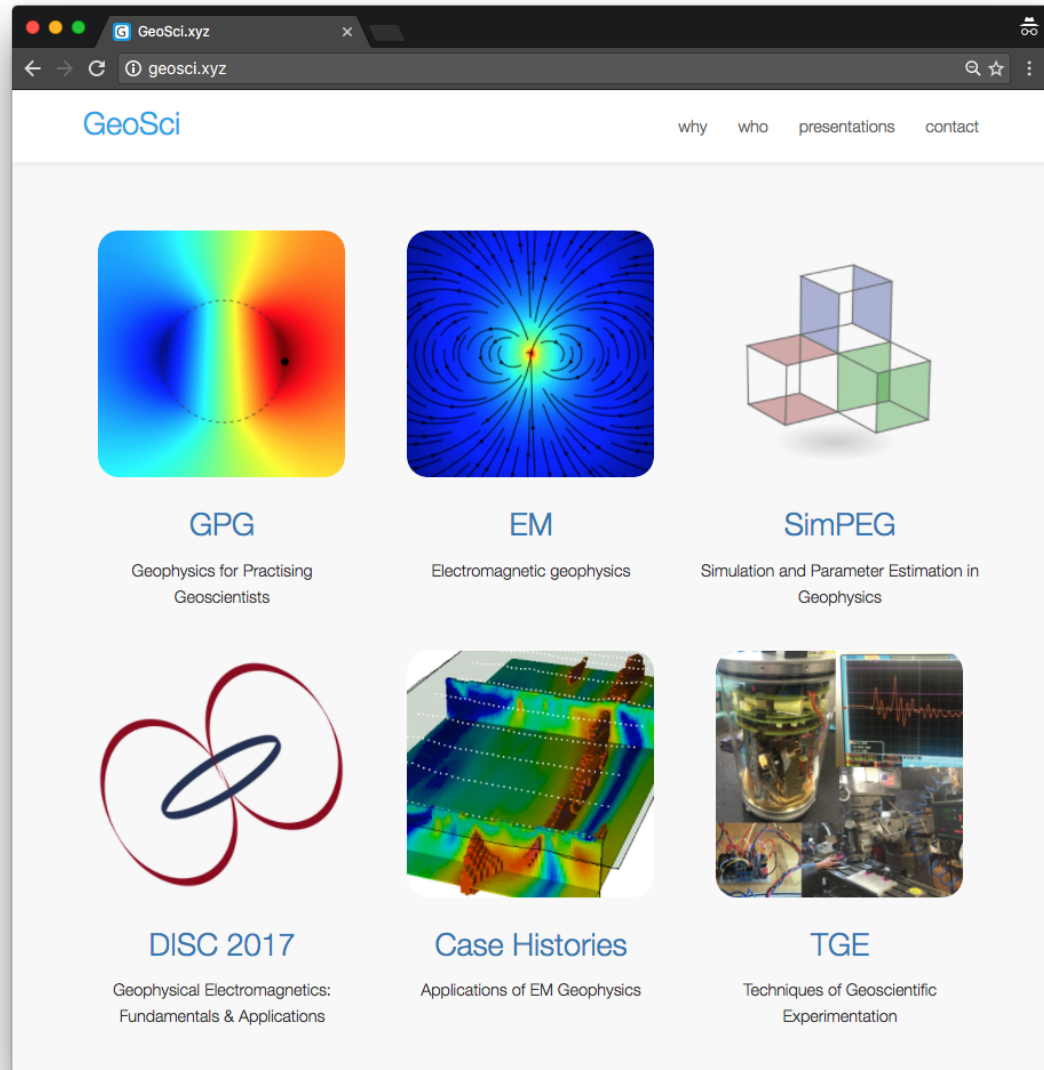
- GeoSci

<http://geosci.xyz>

- Web-textbooks
- Software
- Apps

- Apps:

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



GIF DISC Team



doug



lindsey



seogi

UBC GIF Team



Thibaut



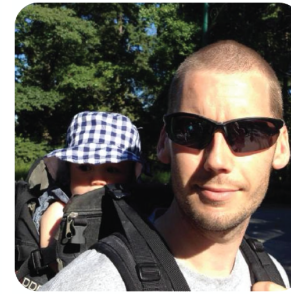
Patrick



Rowan



Devin



Kris



Sarah



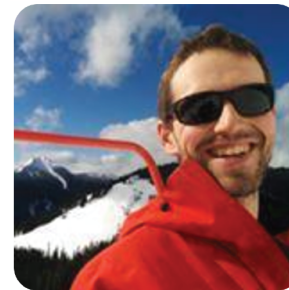
Dom



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

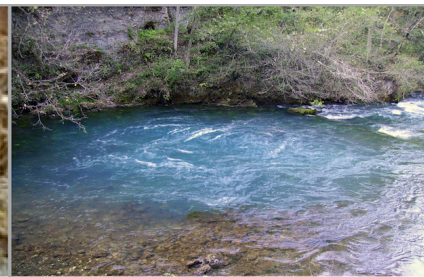
<http://disc2017.geosci.xyz>



minerals



contaminants



water



geothermal



geotechnical



slope stability



hydrocarbons



unexploded ordnance

Thank You!

<http://disc2017.geosci.xyz>



minerals



contaminants



water



geothermal



geotechnical



slope stability



hydrocarbons



unexploded ordnance