Summary and the Future

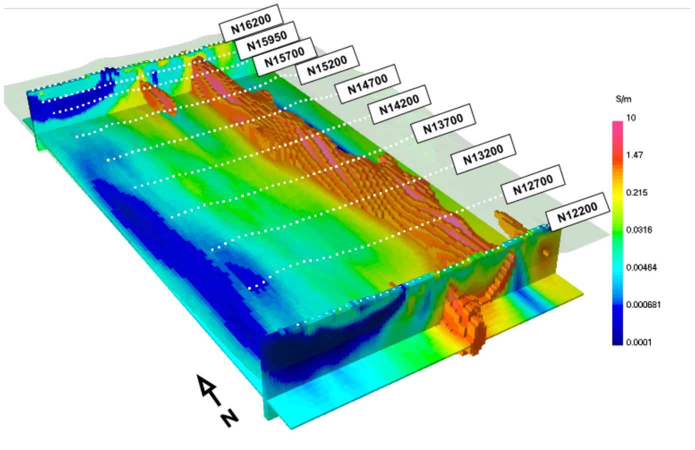
DISC

2017

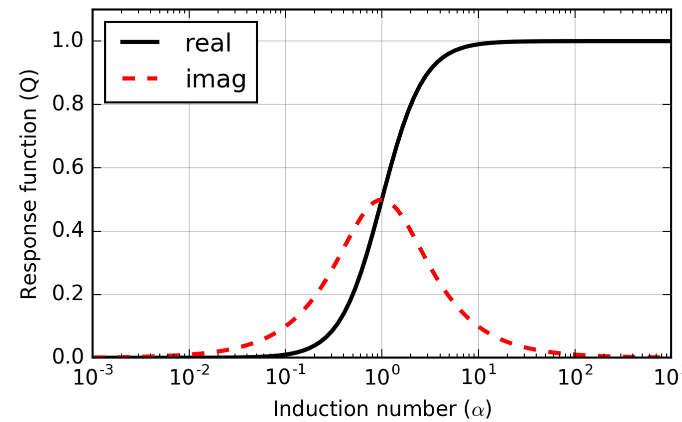
Electromagnetics
Fundamentals and Applications

What have we covered?

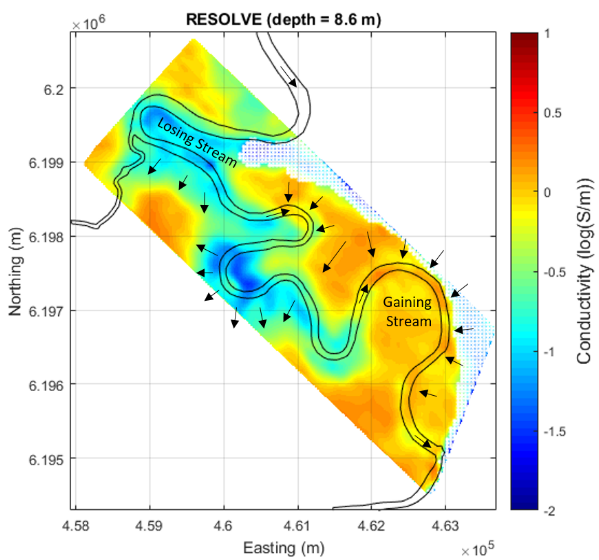
DC Resistivity



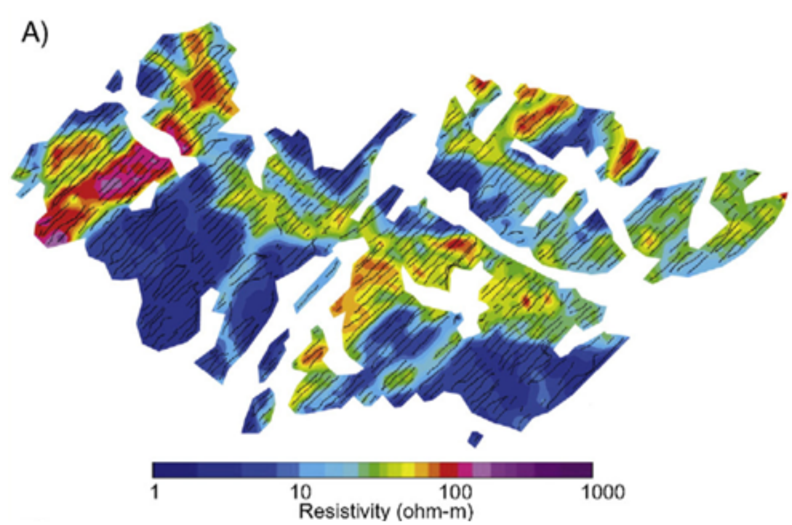
EM Fundamentals



Inductive Sources: Frequency

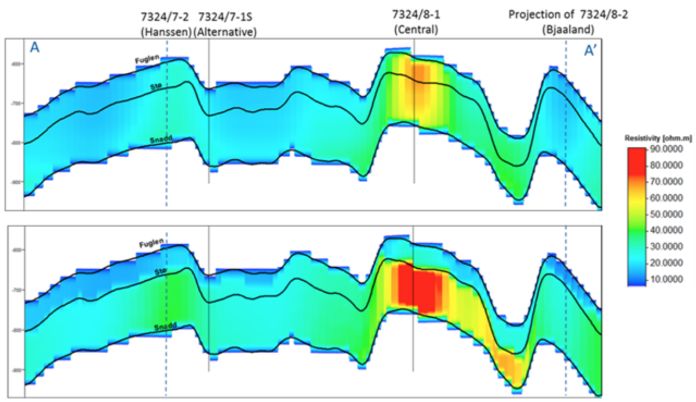


Inductive Sources: Time

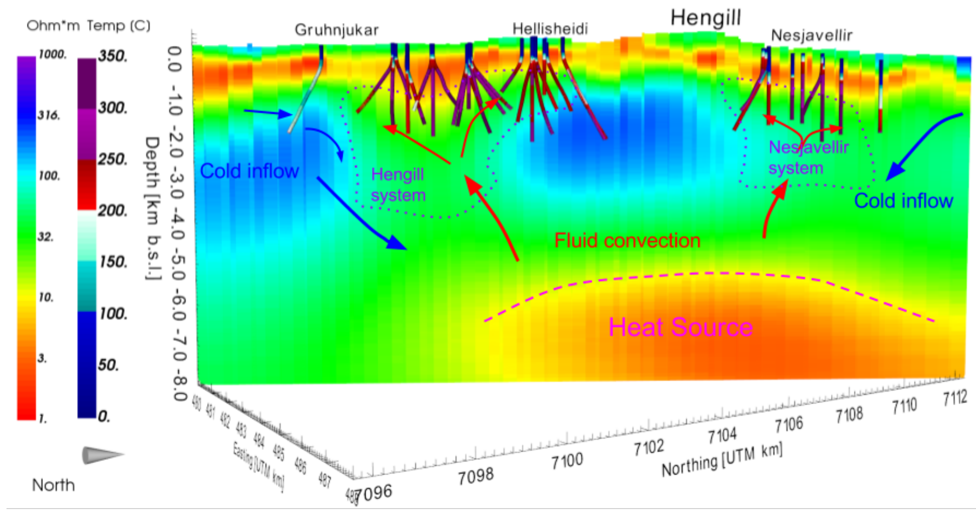


What have we covered?

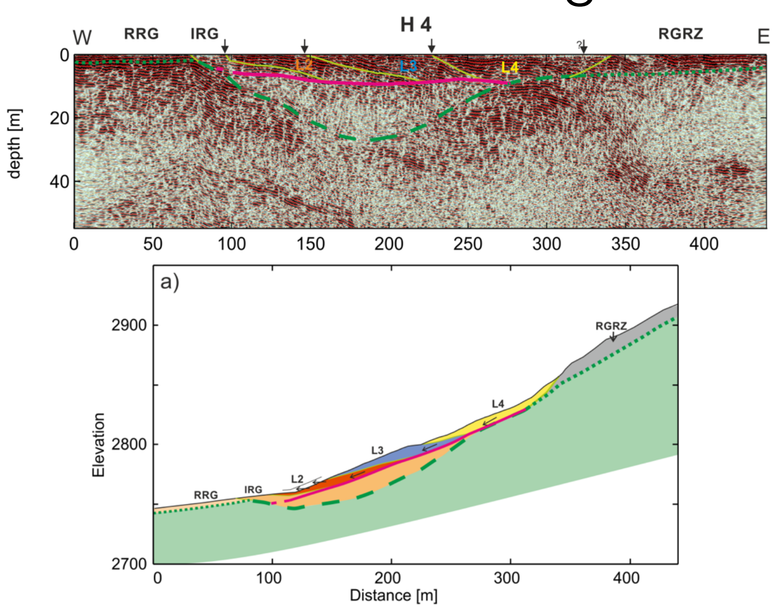
Grounded Sources



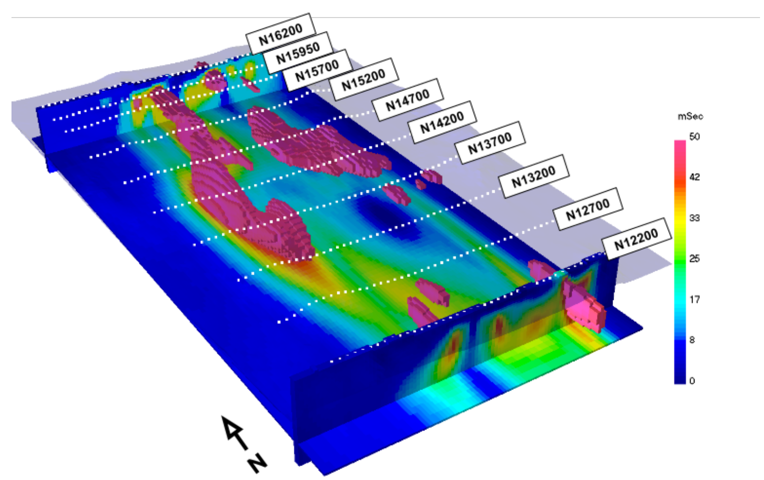
Natural Sources



Ground Penetrating Radar



Induced Polarization

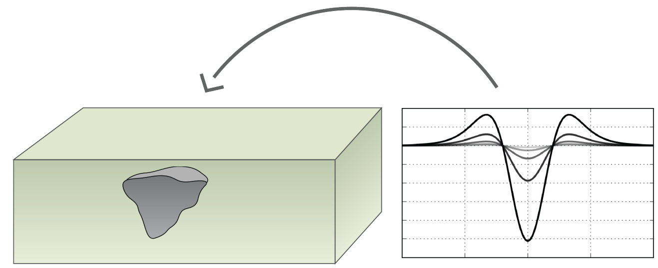


What does the future hold?

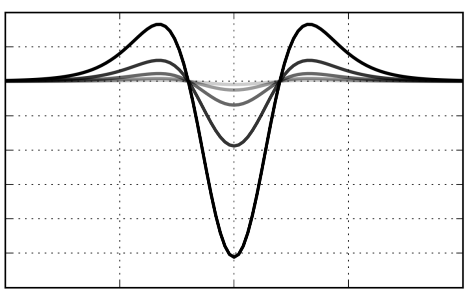
What does the future hold?

Problems

Inversion capabilities



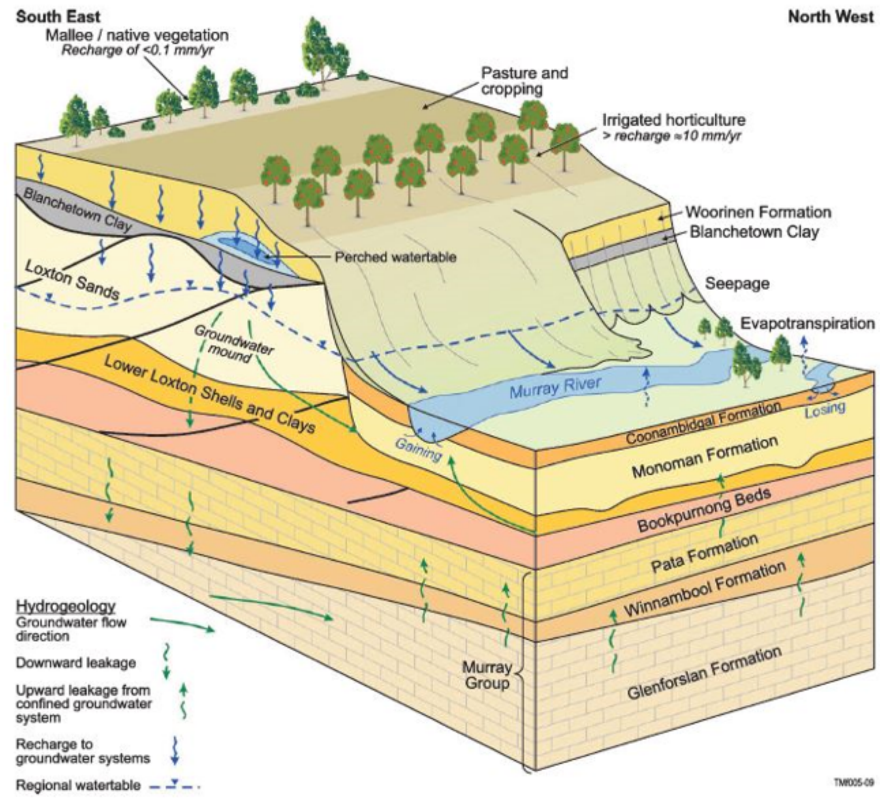
High quality data

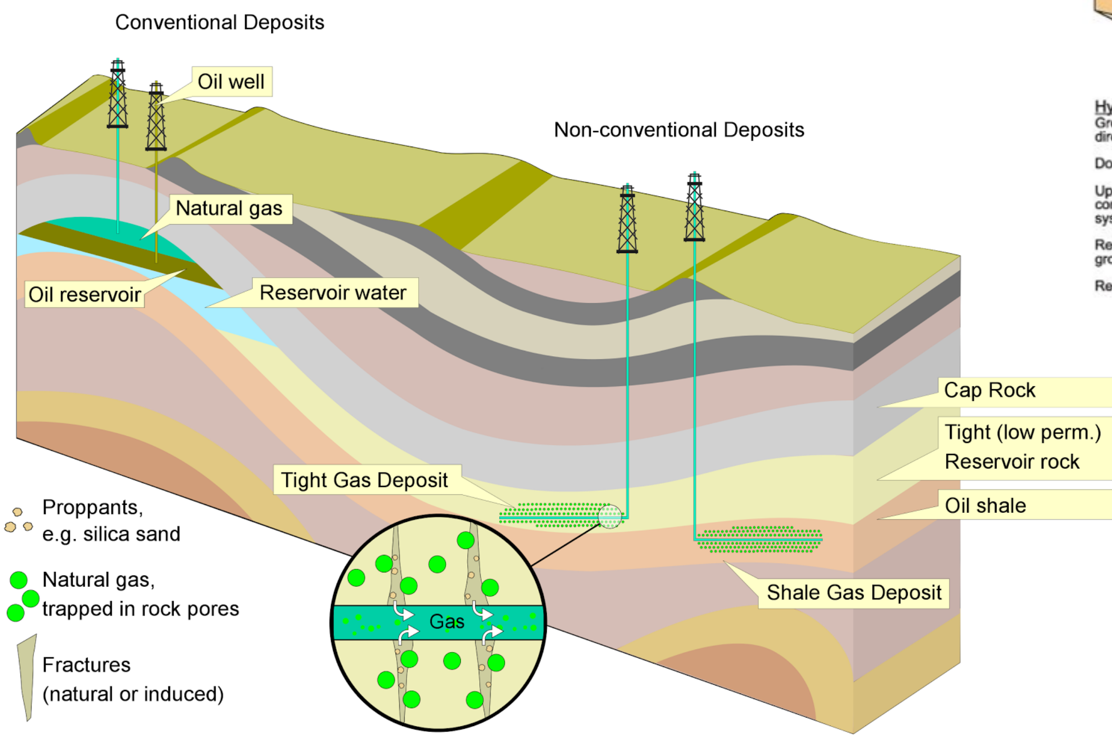


Web tools to communicate

The Future: Monitoring

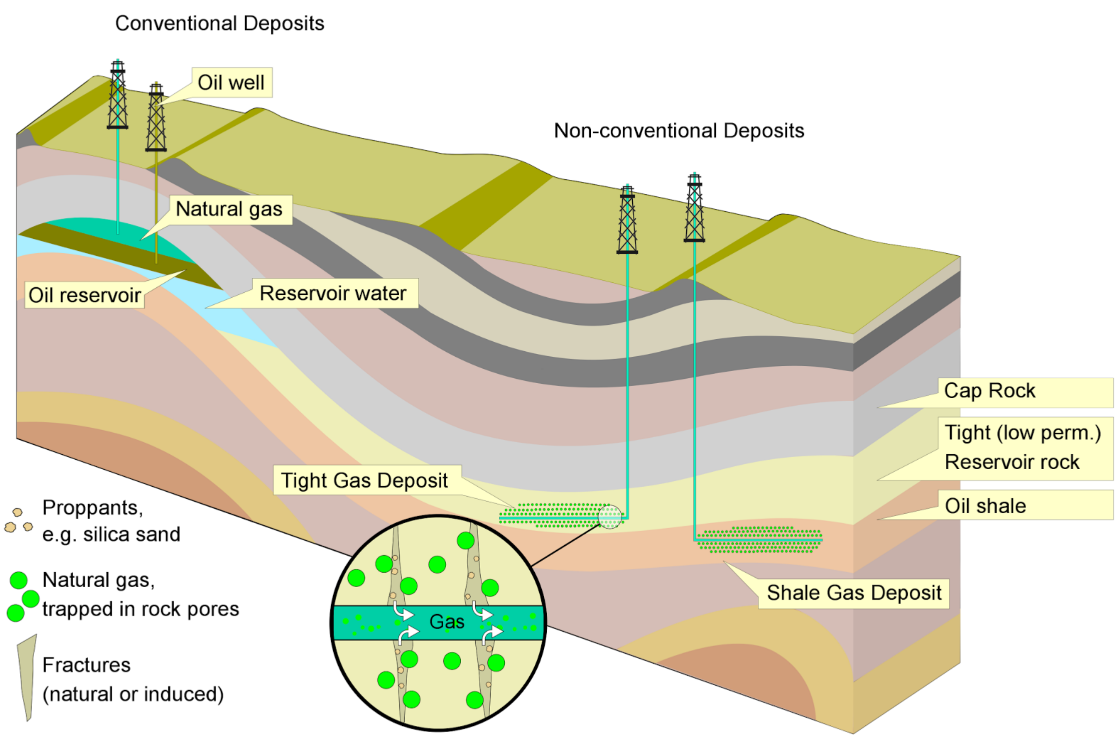
- Aquifers
- Enhanced oil recovery
- Hydraulic Fracturing
- CO_2 sequestration
- Coal seam gas



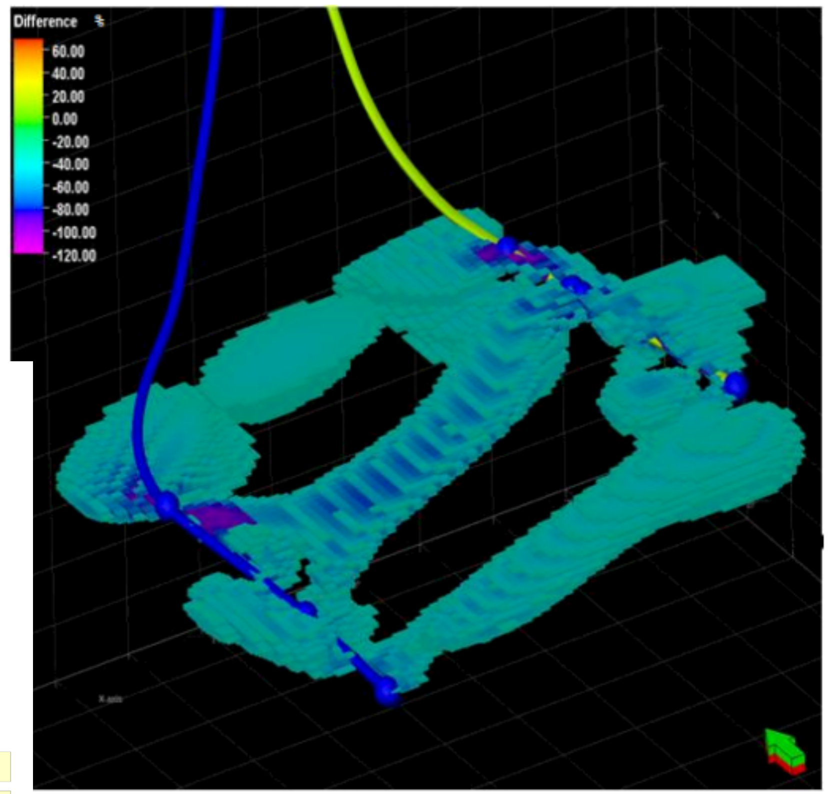


The Future: Monitoring

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



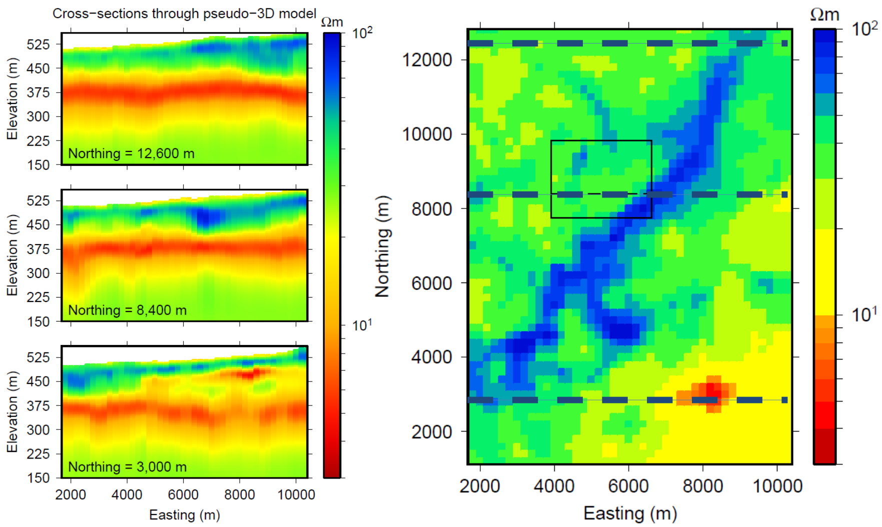
Resistivity isosurface – water flood



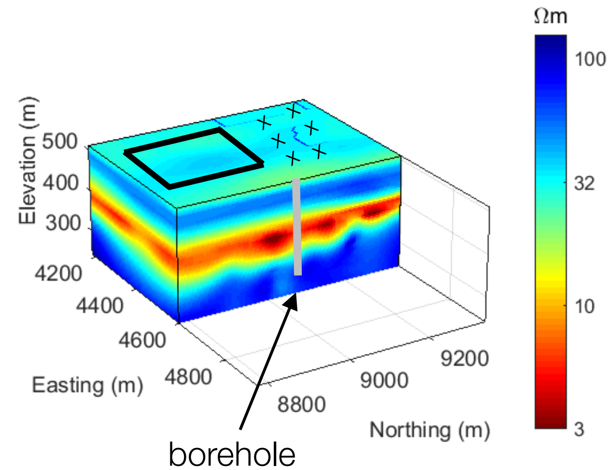
Saudi Arabia: Marsala et al., 2015

Multi-stage EM for monitoring

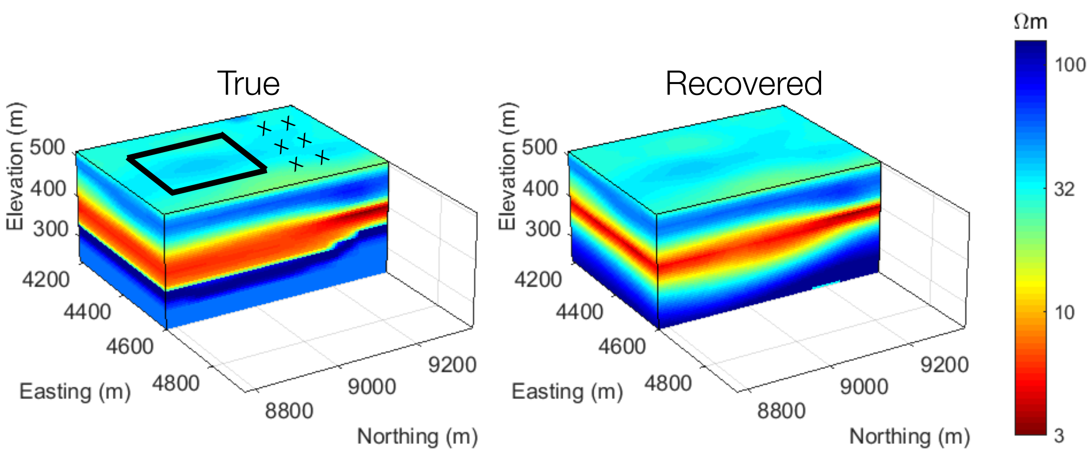
1. Large-scale: airborne EM



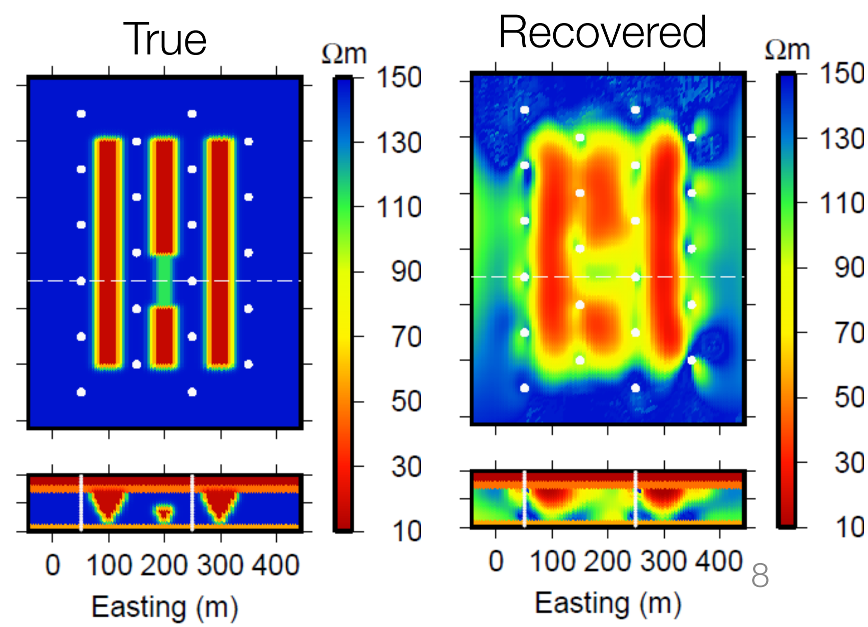
3. Pre-injection: surface TXs and borehole RXs



2. Local structures: ground EM

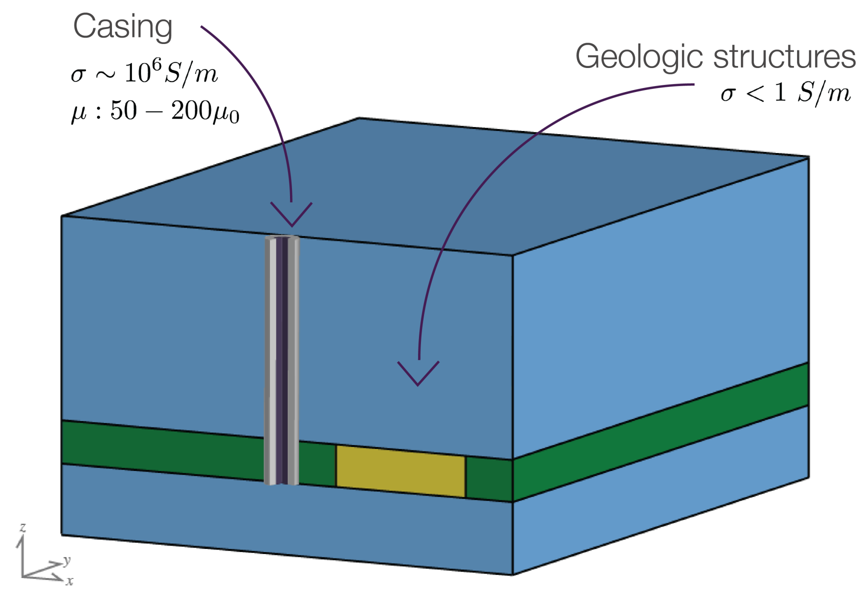


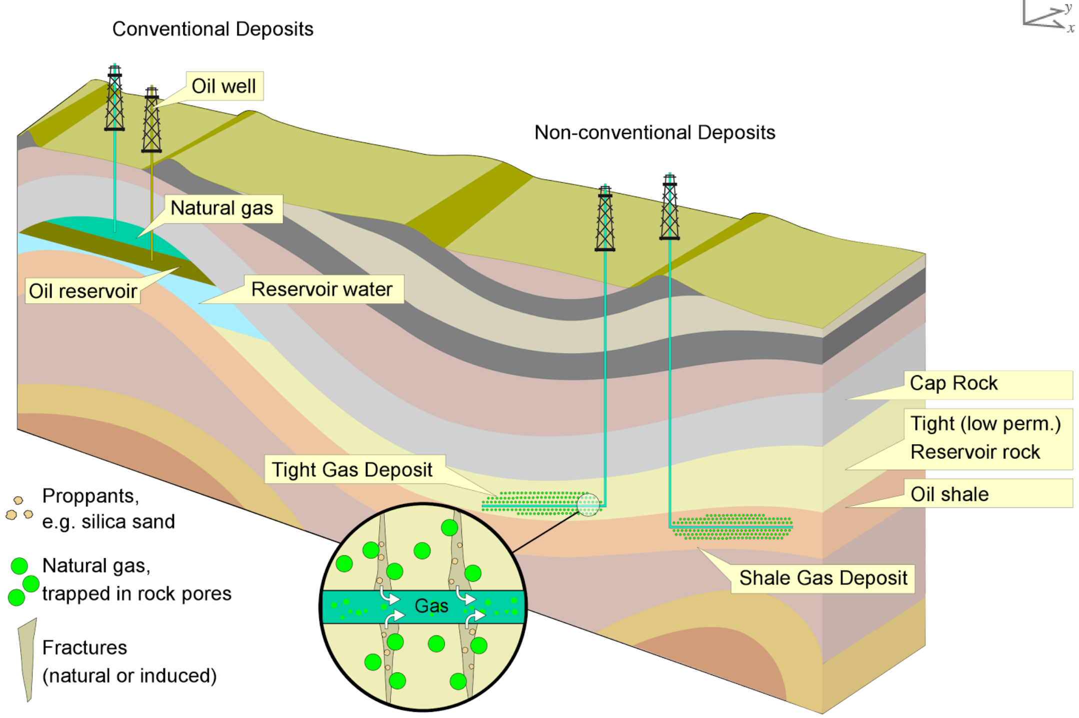
4. Post-injection: surface TXs and borehole RXs

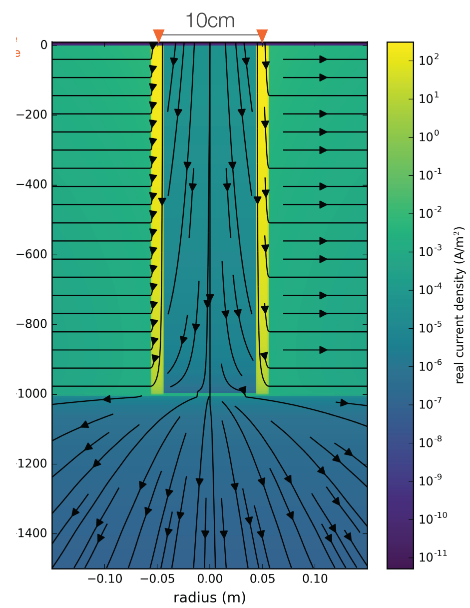


The Future: Monitoring

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



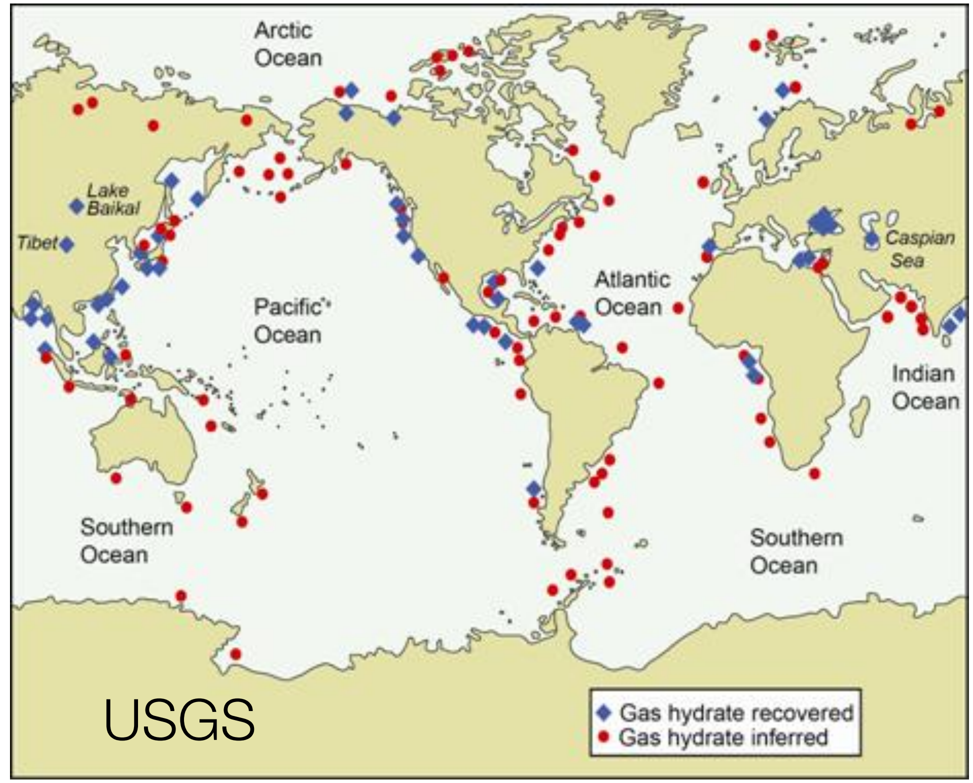


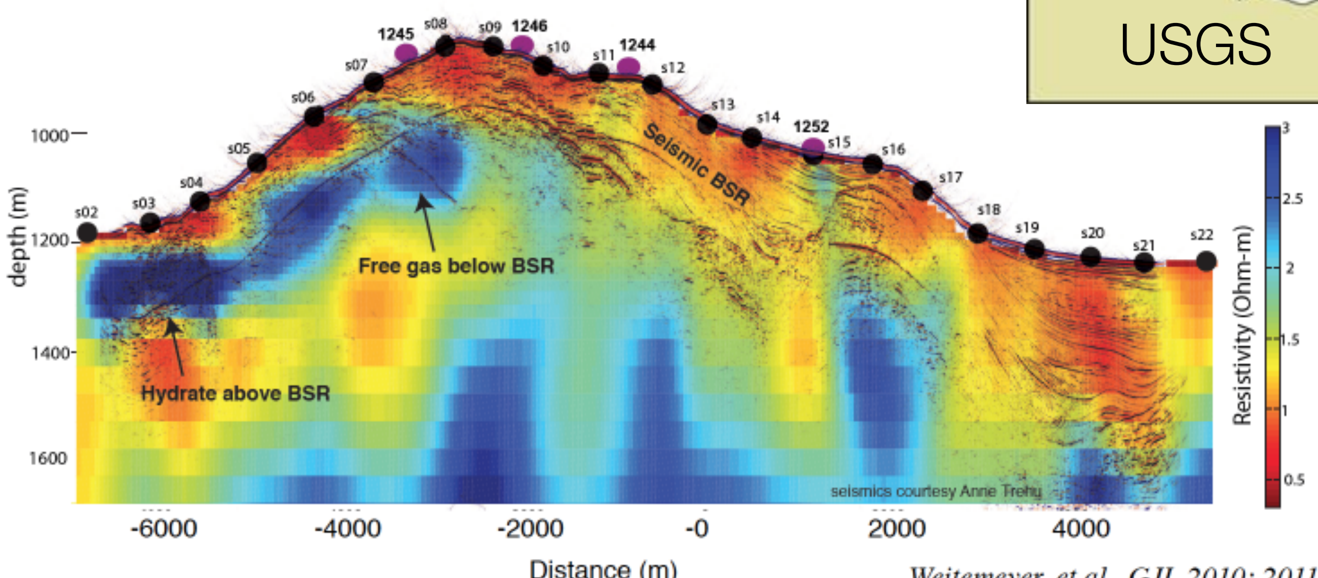


Corrosion

The Future: Marine EM

- Gas hydrates
  - Resistivity is diagnostic

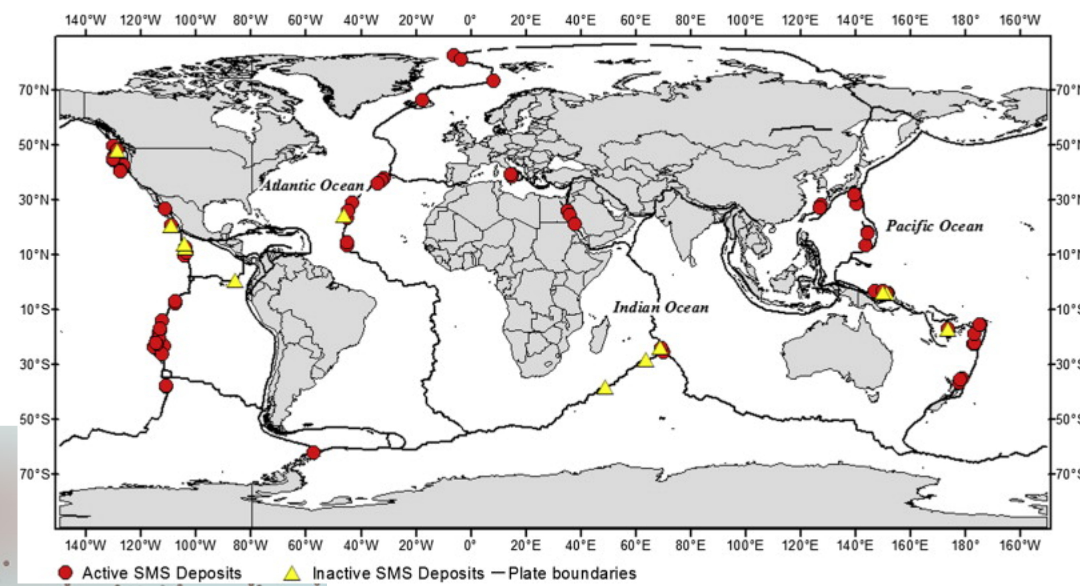


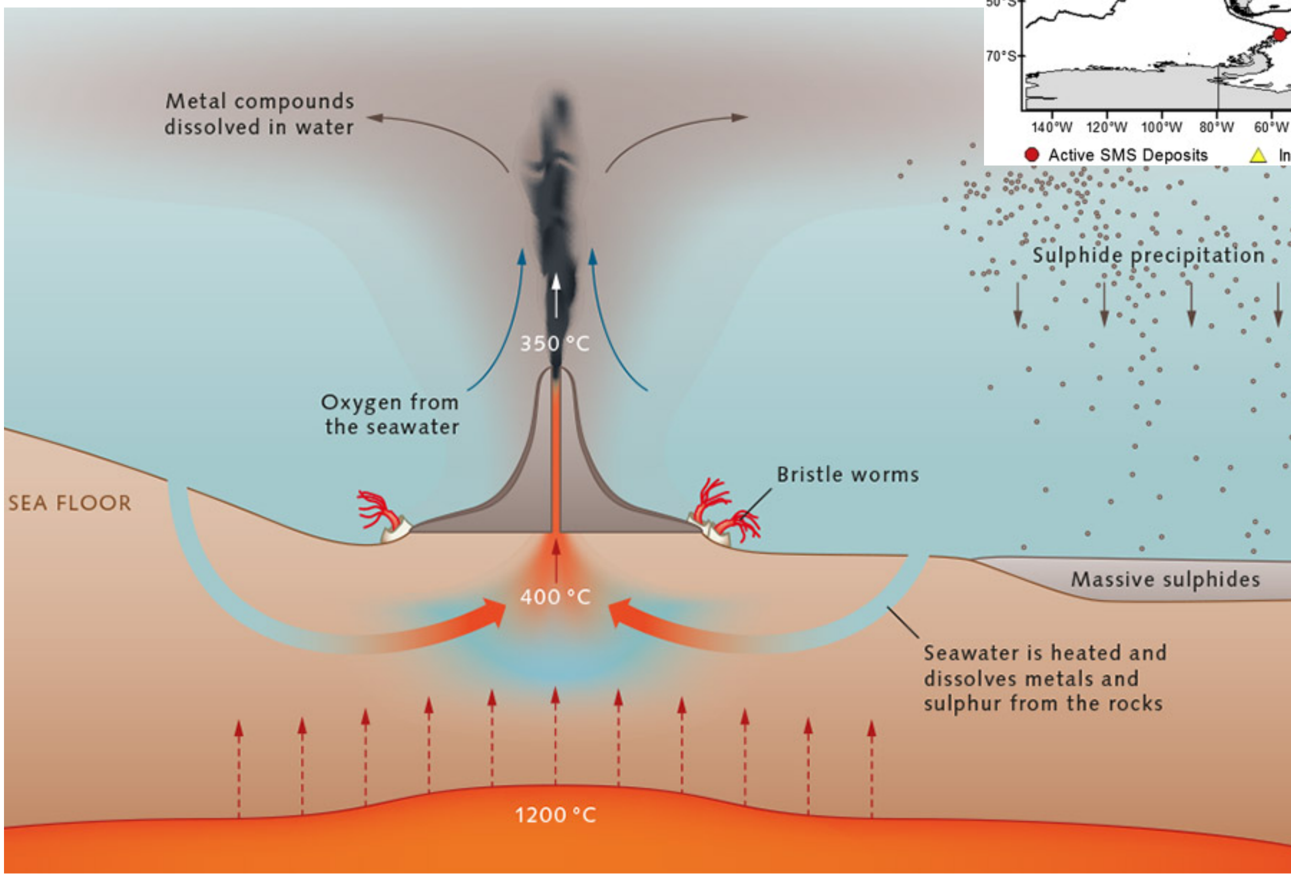


Weitemeyer, et al., GJI, 2010; 2011

The Future: Marine EM

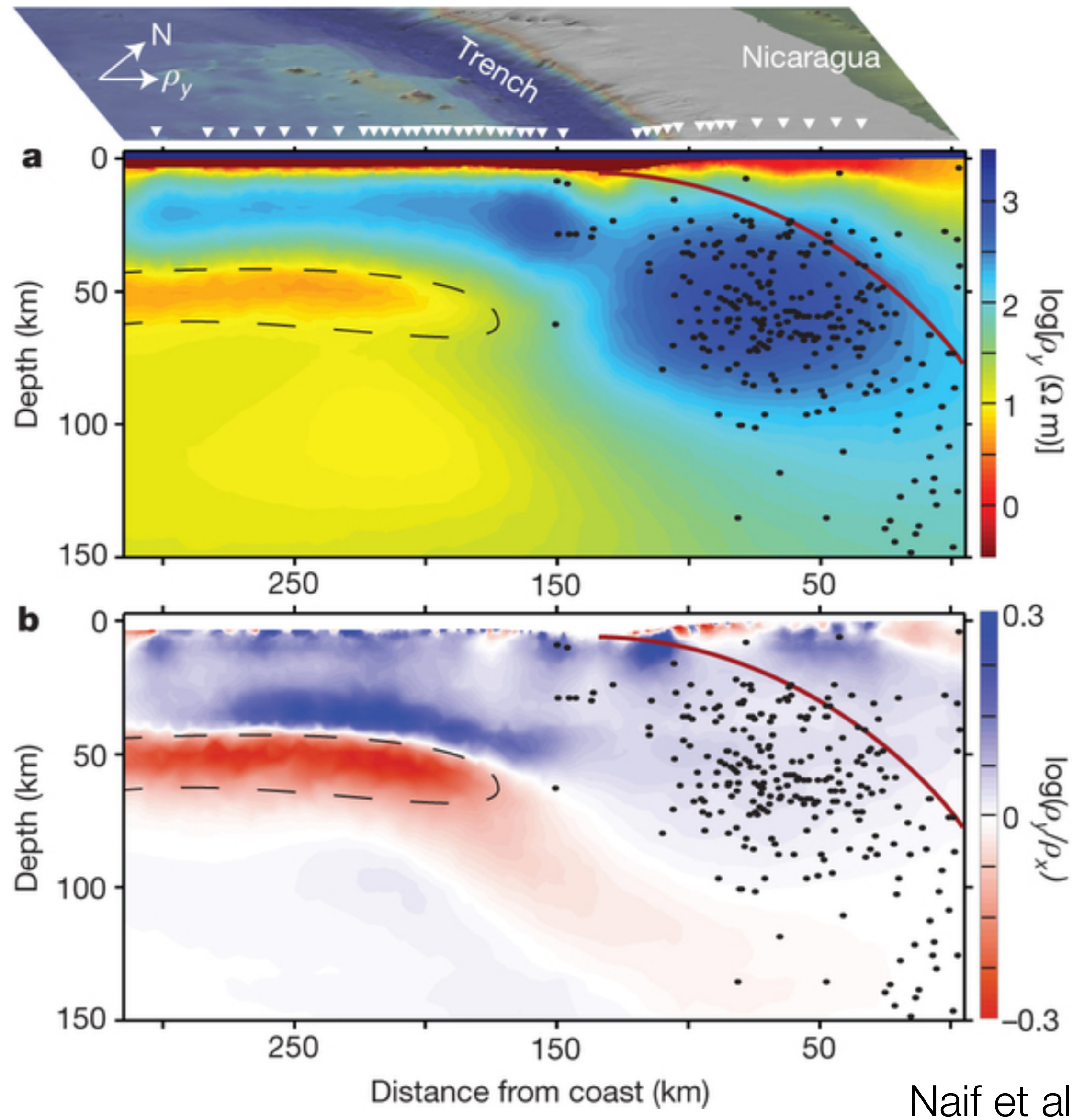
- Submarine massive sulfides
  - Conductive relative to background





The Future: Marine EM

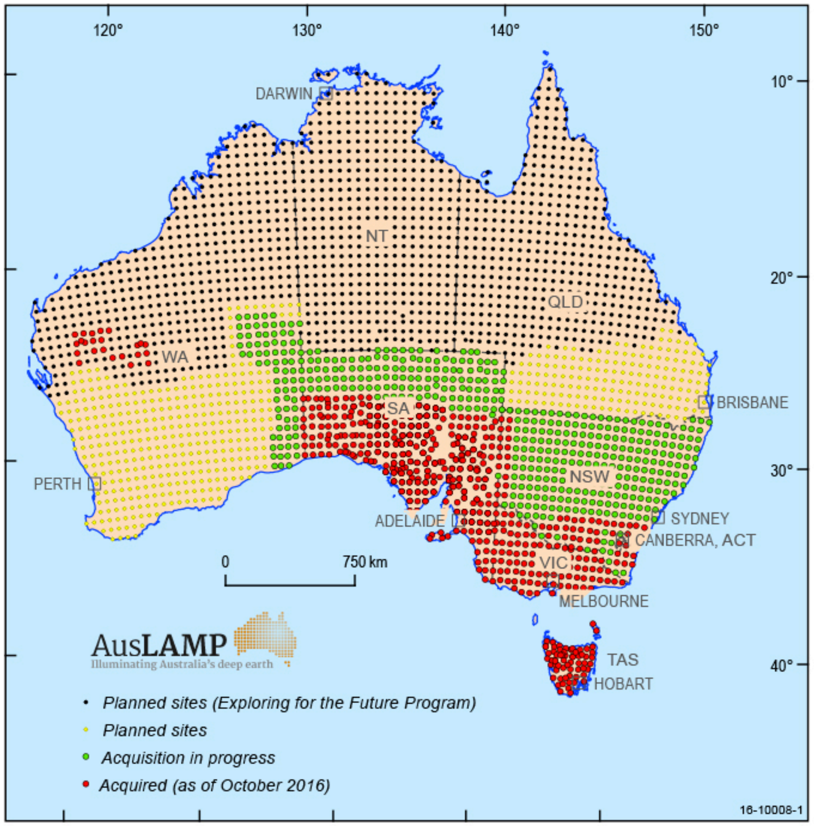
- Tectonic studies
- Large anisotropy
  - indicative of melt-rich channel



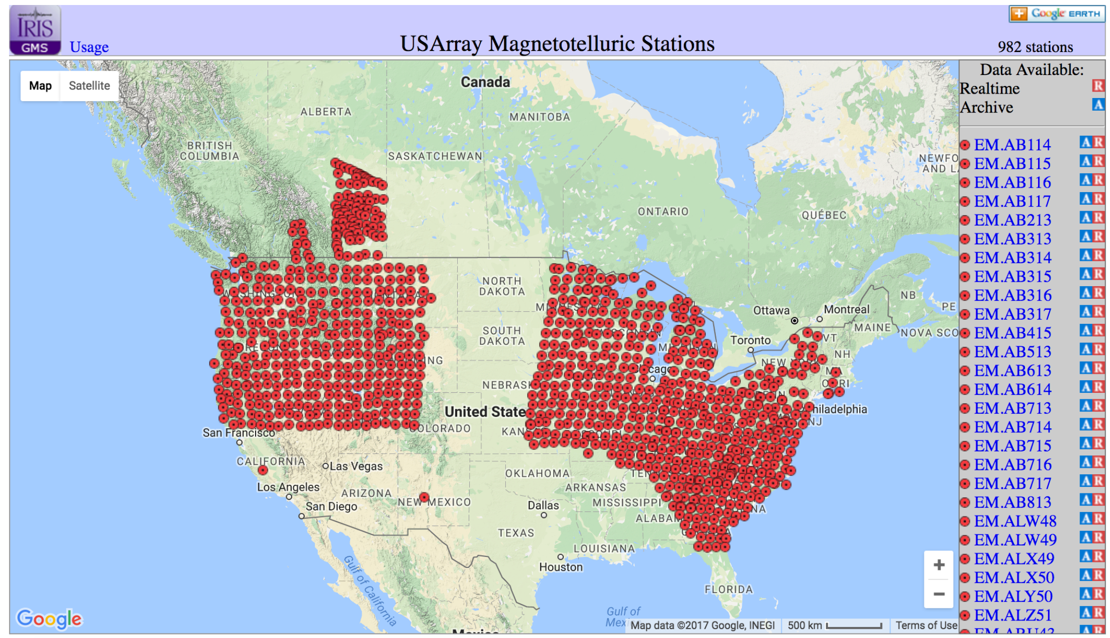
Naif et al., 2013

The Future: Large Scale MT

AusLamp

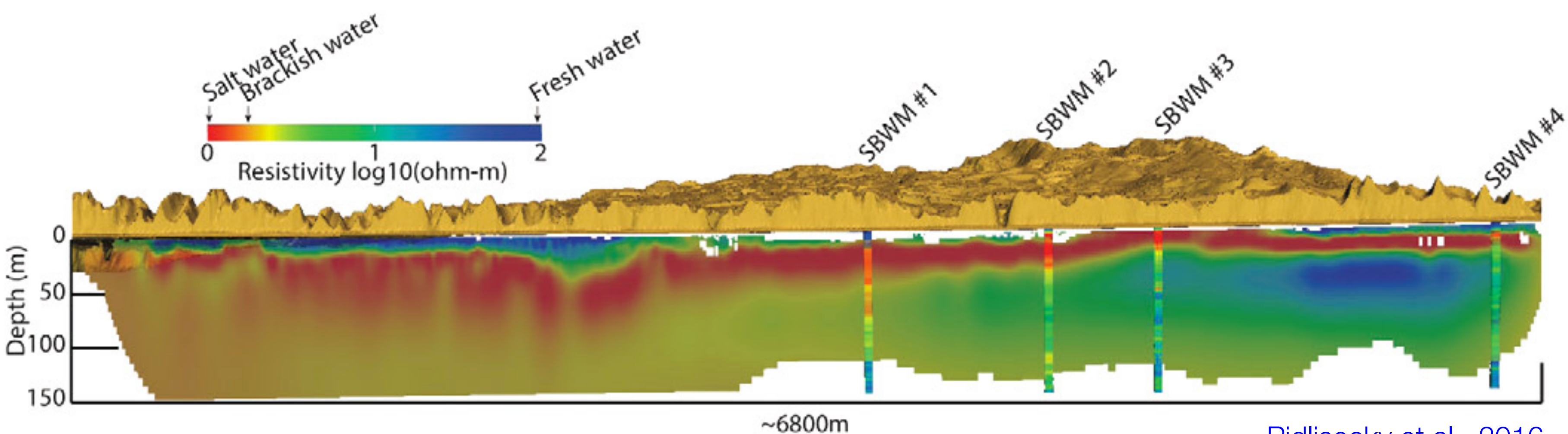


Earth scope



The Future: Water

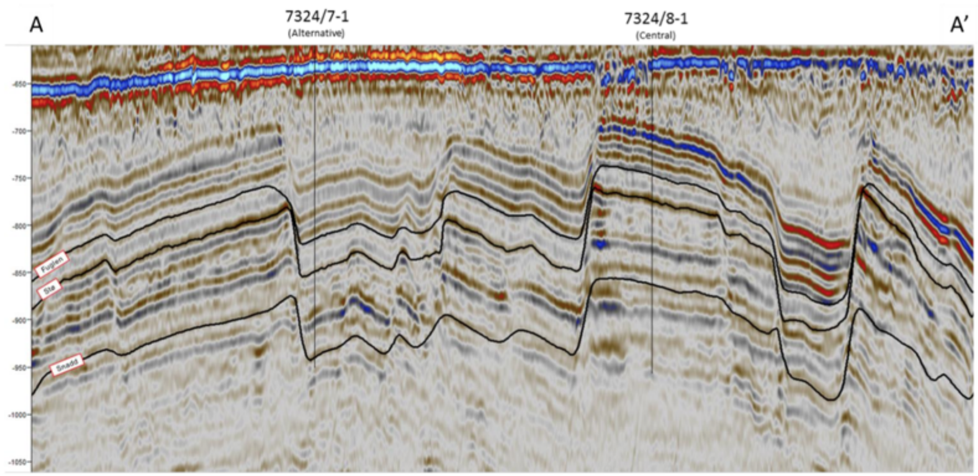
- Finding and delineating water
- Aquifer monitoring and management
- Salt water intrusions
- Pollutants



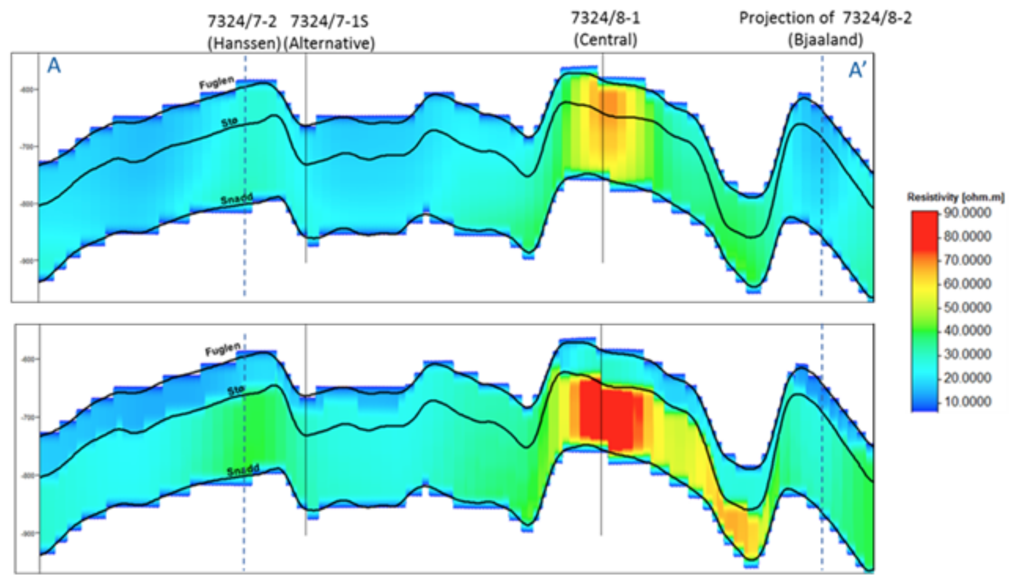
Pidlisecky et al., 2016

The Future: Data Integration & Multi-physics

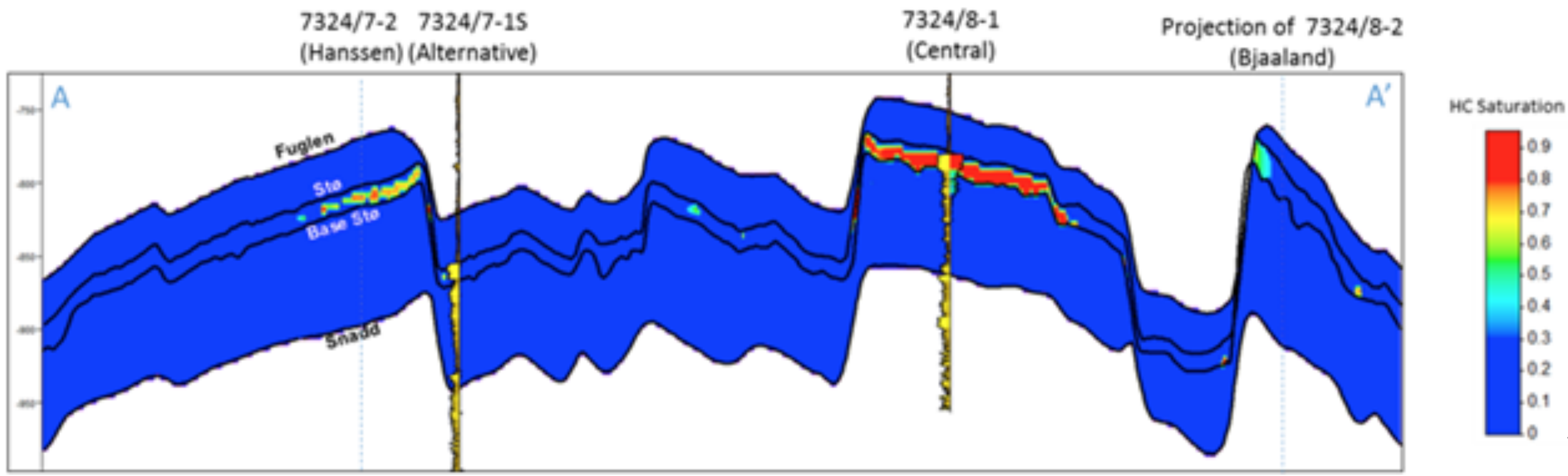
Seismic



EM

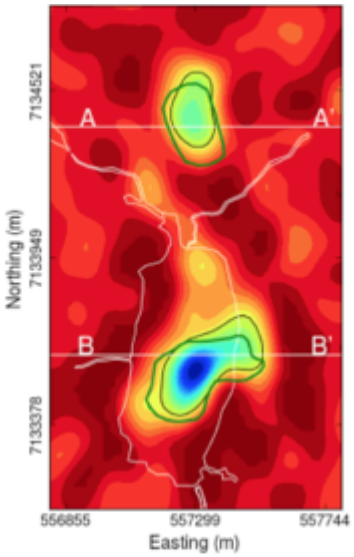


Final hydrocarbon saturation model

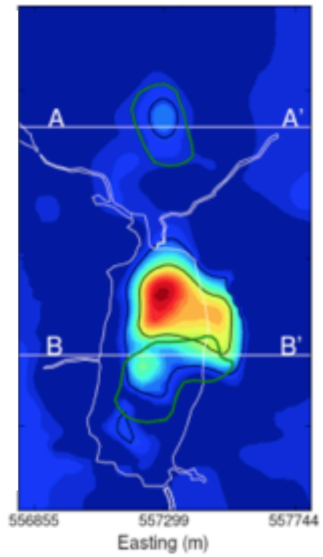


The Future: Data Integration & Multi-physics

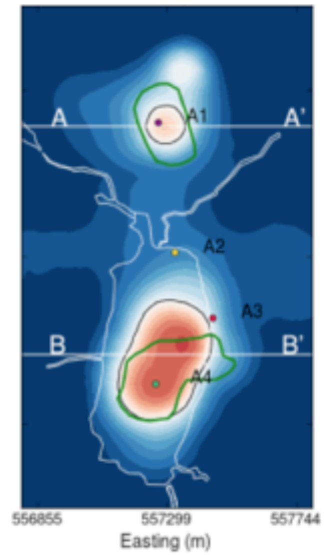
Density



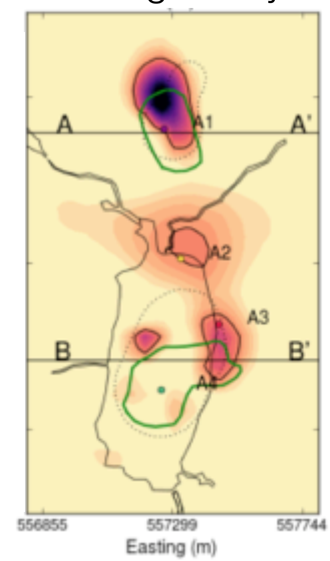
Susceptibility



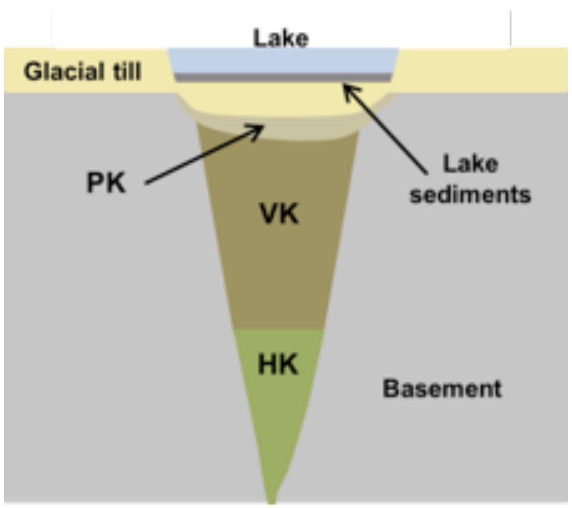
Conductivity



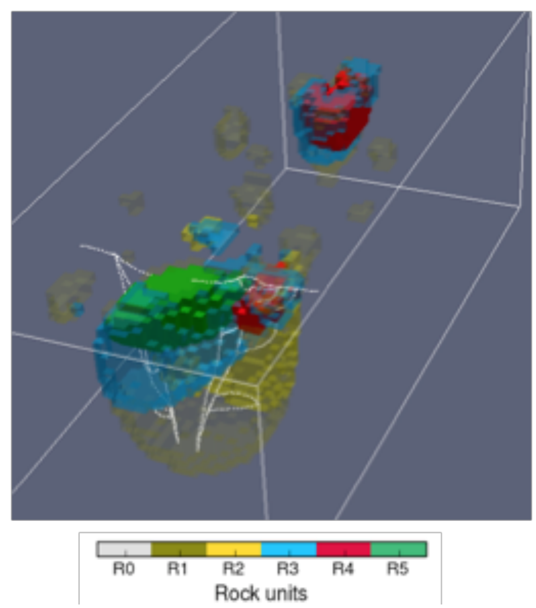
Chargeability



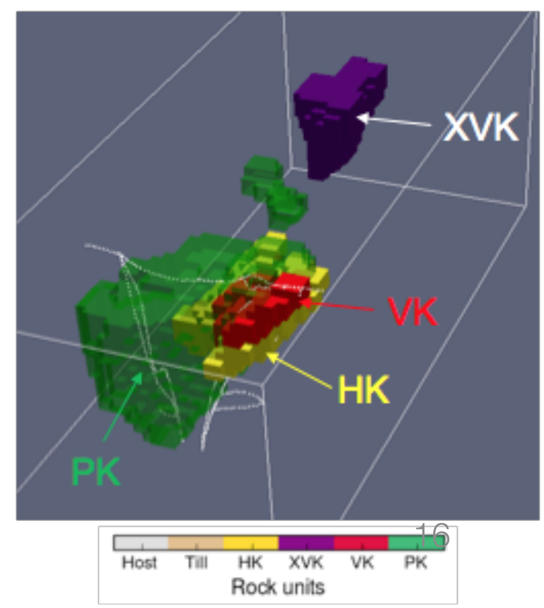
Kimberlite Model



Rock Model from Geophysics



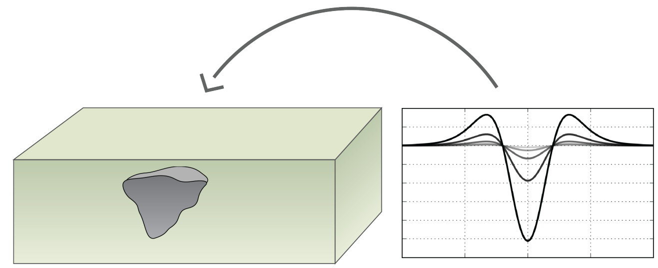
Rock Model from Drilling



DISC can take advantage of a Perfect Storm

Problems

Inversion capabilities



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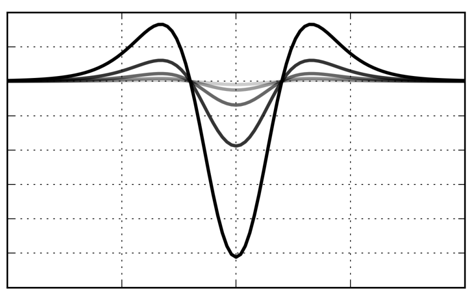
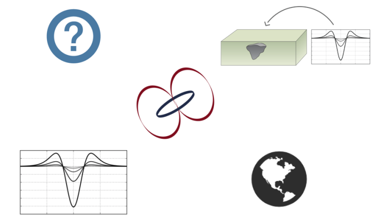
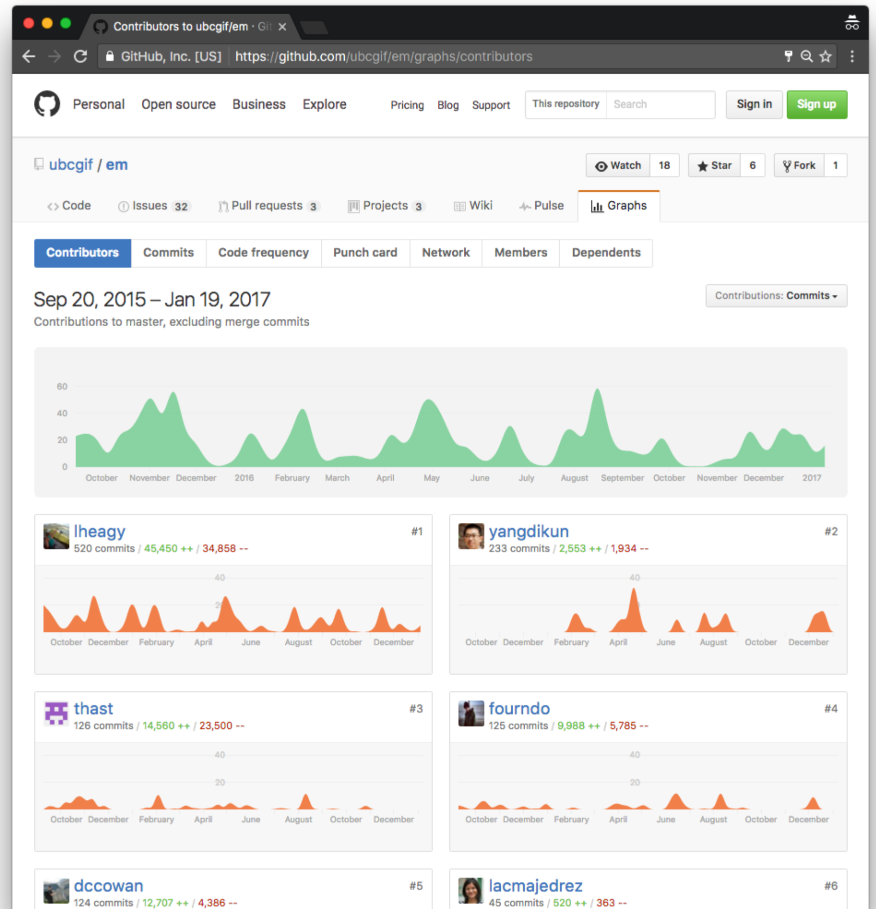


Web tools to communicate

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

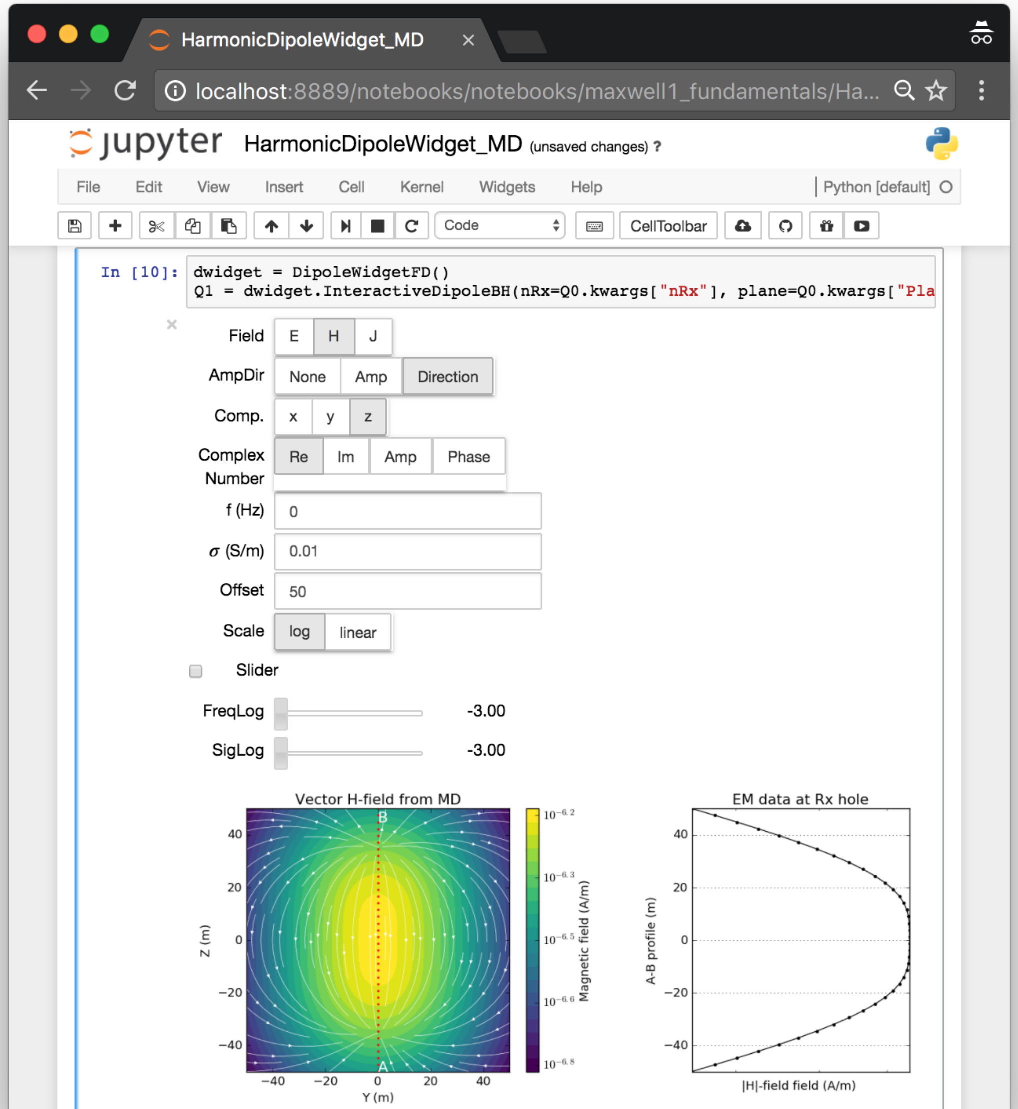
Python
computation

The Future: Modelling and Inversion

- Interactive computing
- Visualization

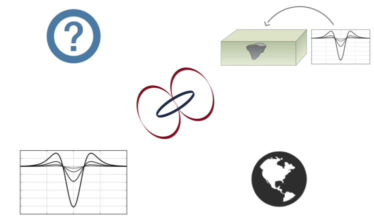
$$\nabla \times \mathbf{e} = -\frac{\partial \mathbf{b}}{\partial t}$$

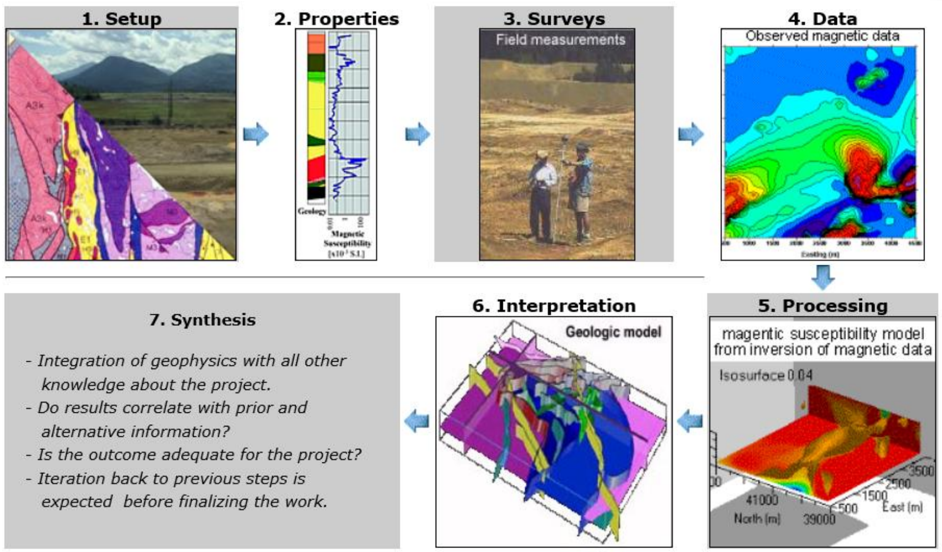
$$\nabla \times \mathbf{h} = \mathbf{j} + \frac{\partial \mathbf{d}}{\partial t}$$

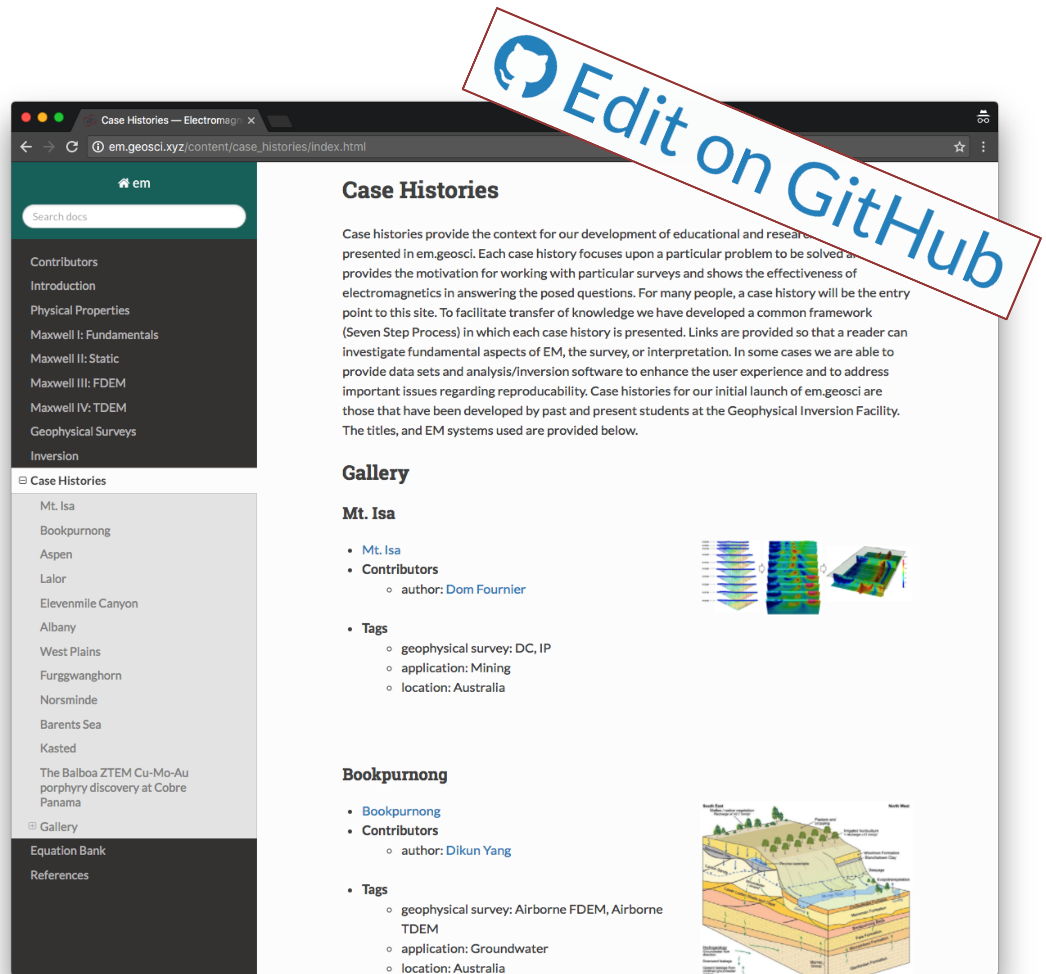


http://em.geosci.xyz/apps.html

The Future: Collaboration

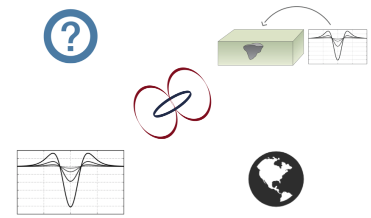






http://slack.geosci.xyz

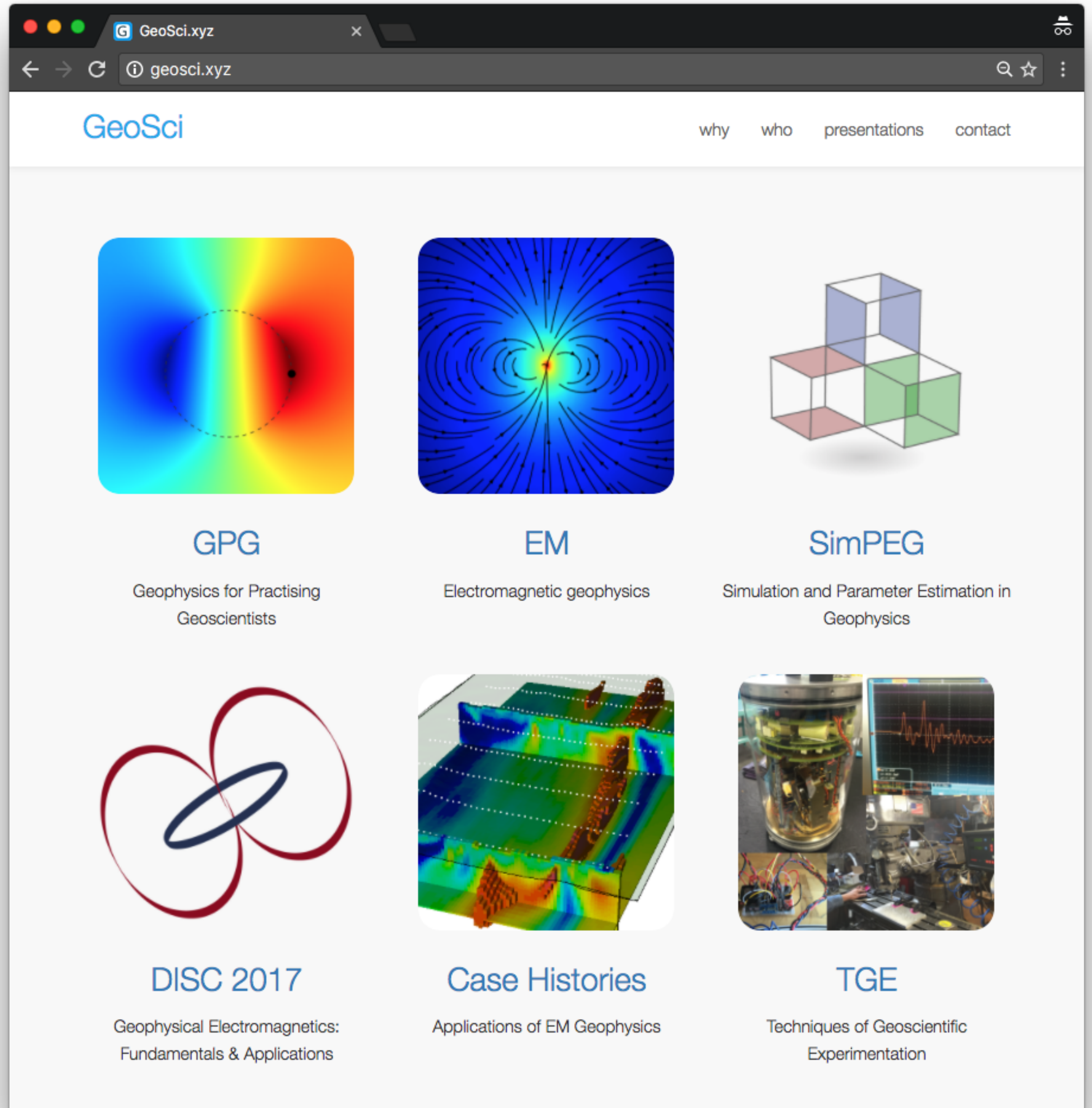
Goals for the DISC



- 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

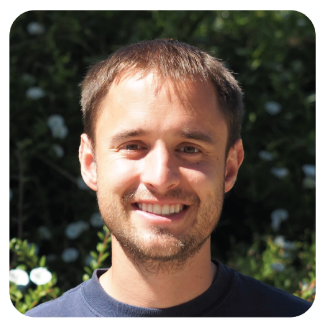

Devin


Kris


Sarah


Dom


Mike


Mike

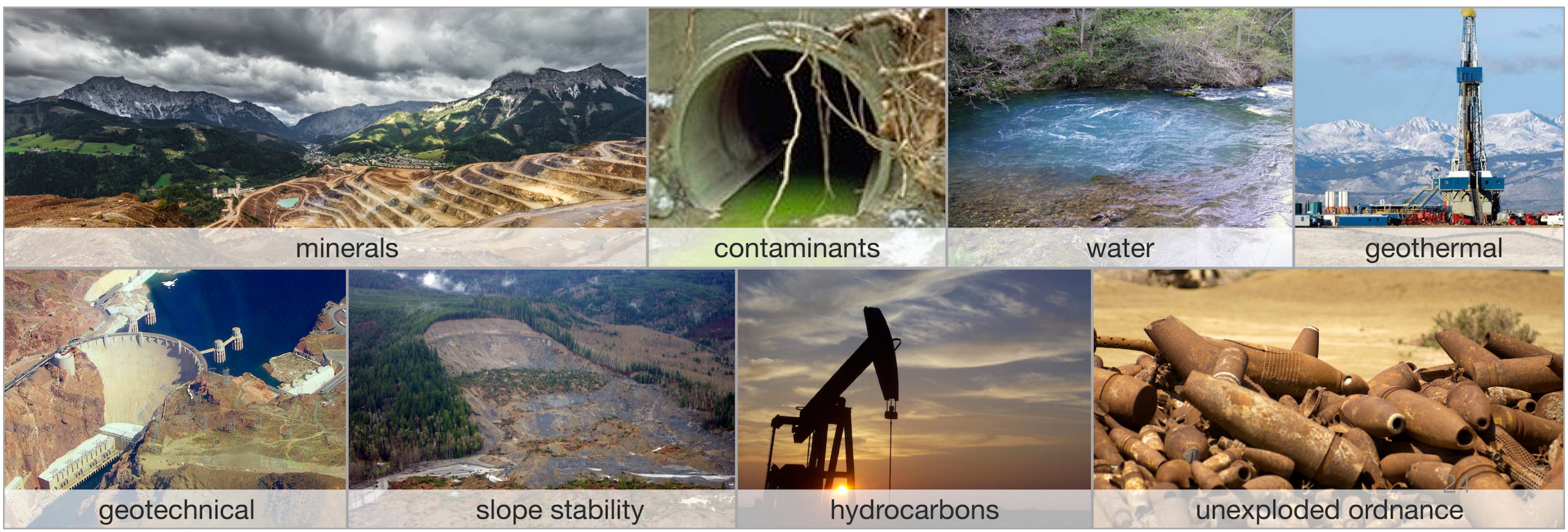

Gudni


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



Thank You!

http://disc2017.geosci.xyz