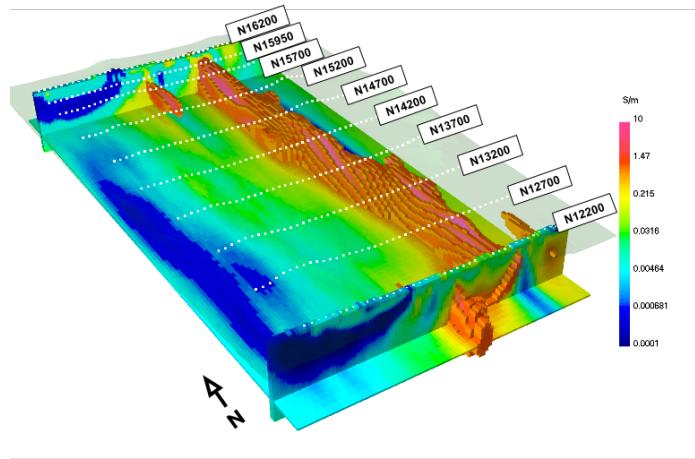


Summary and the Future

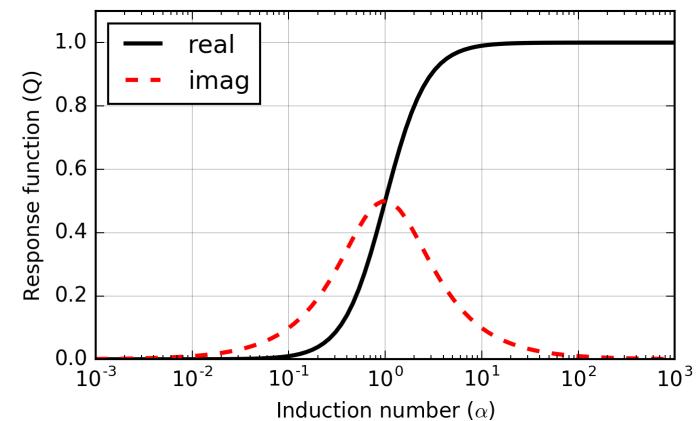


What have we covered?

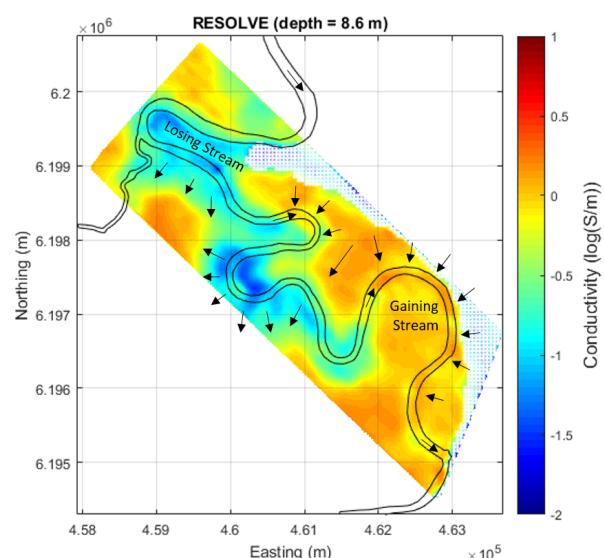
DC Resistivity



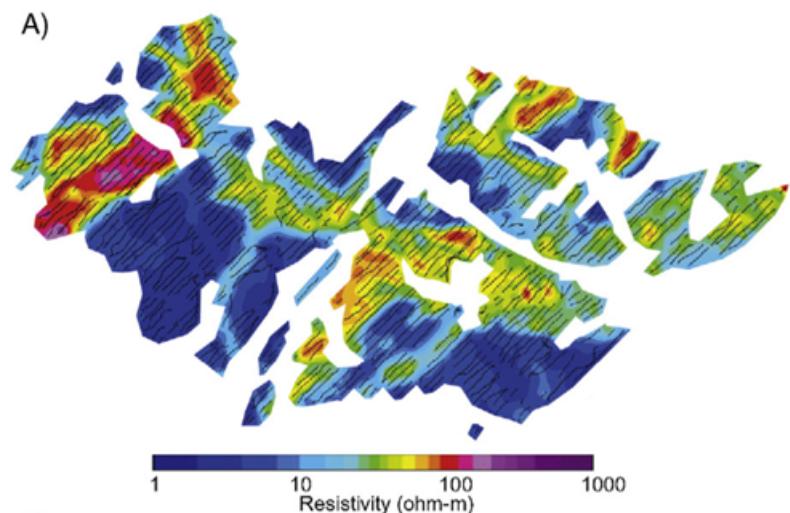
EM Fundamentals



Inductive Sources: Frequency

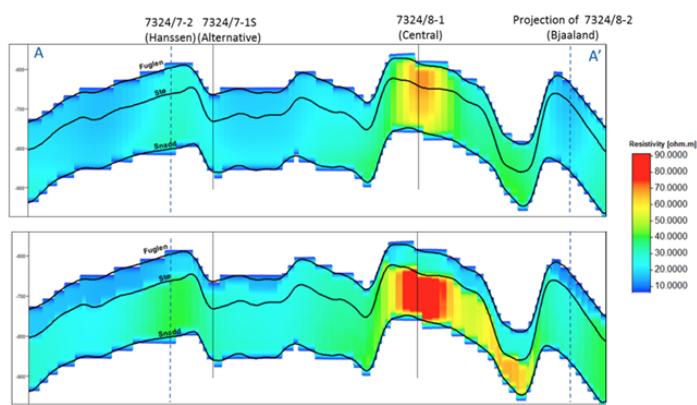


Inductive Sources: Time

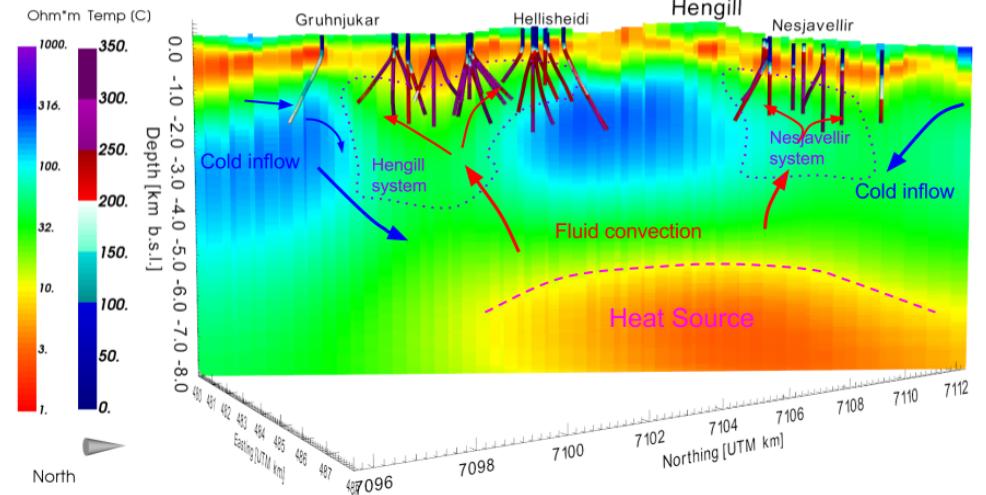


What have we covered?

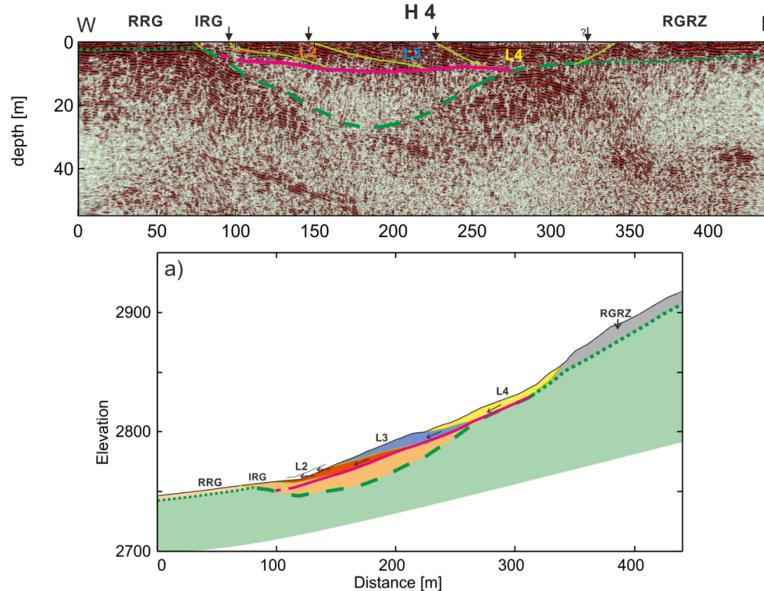
Grounded Sources



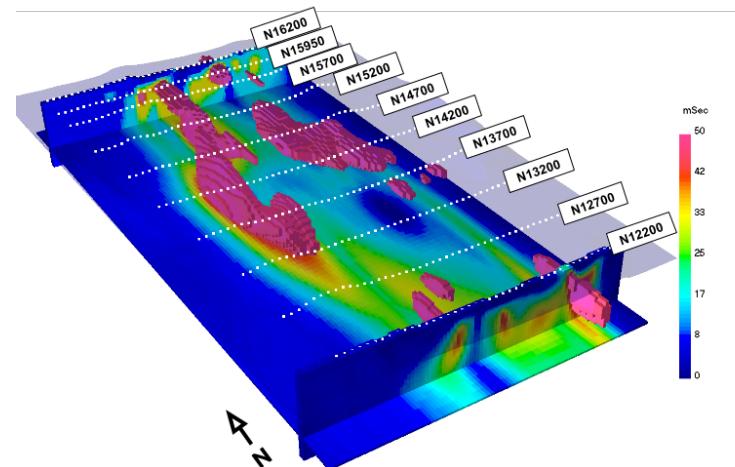
Natural Sources



Ground Penetrating Radar



Induced Polarization



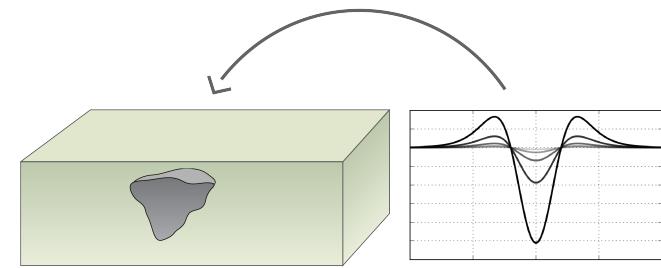
What does the future hold?

What does the future hold?

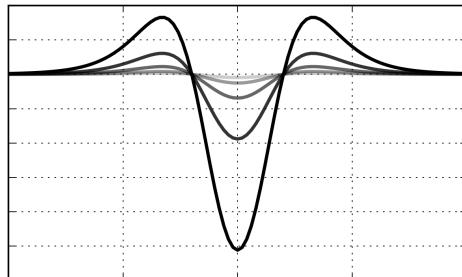
Problems



Inversion capabilities



High quality data

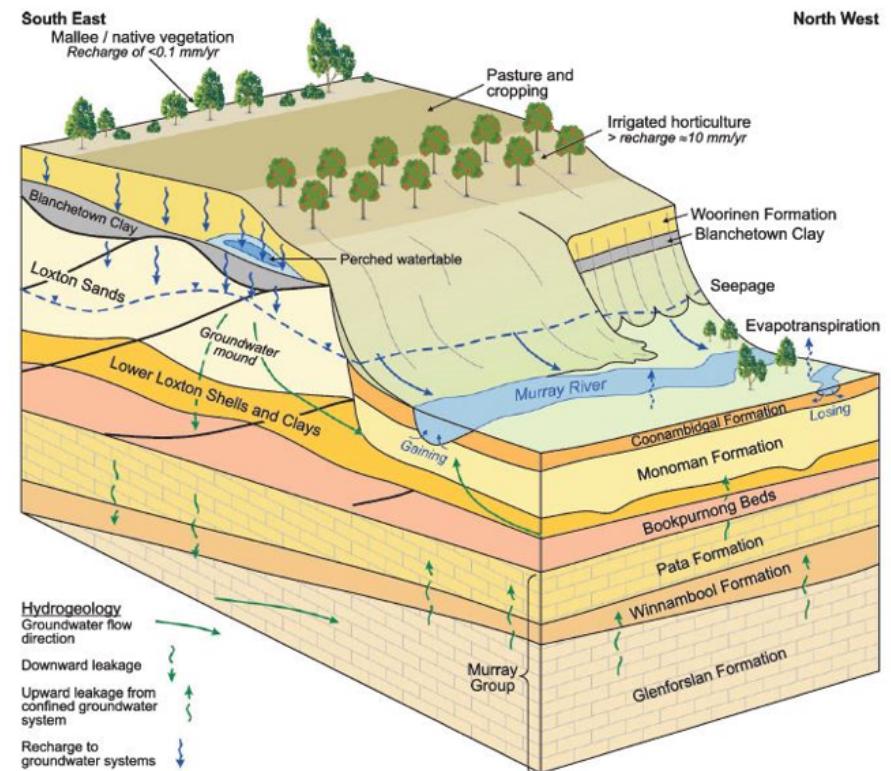
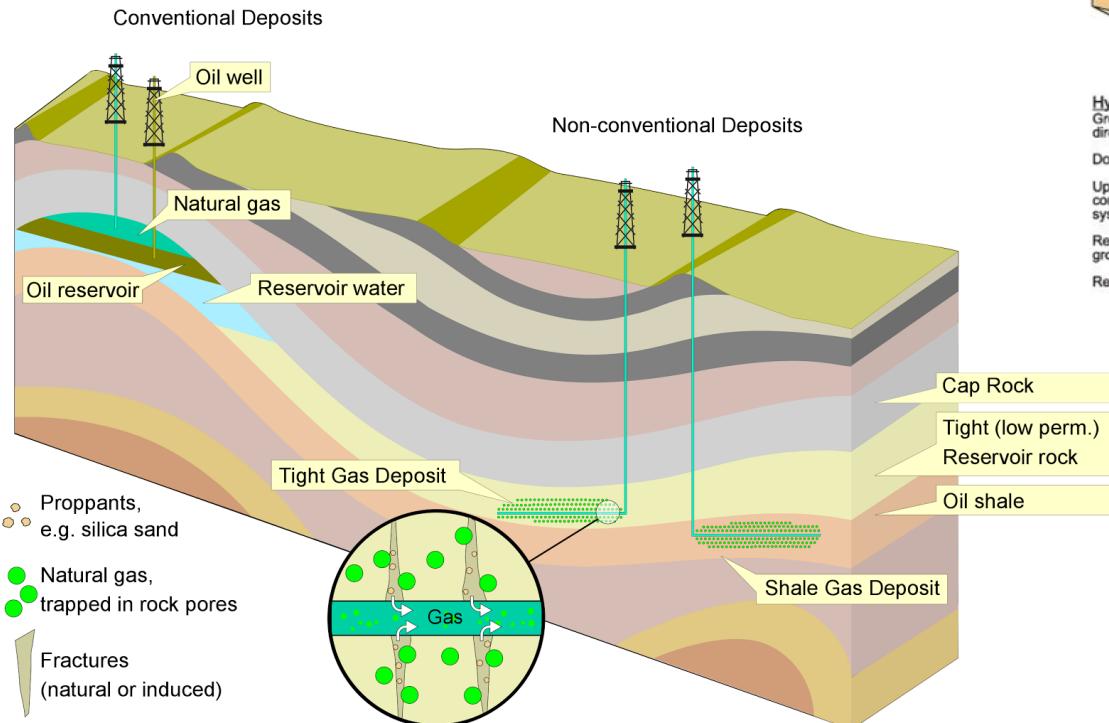


Web tools to communicate



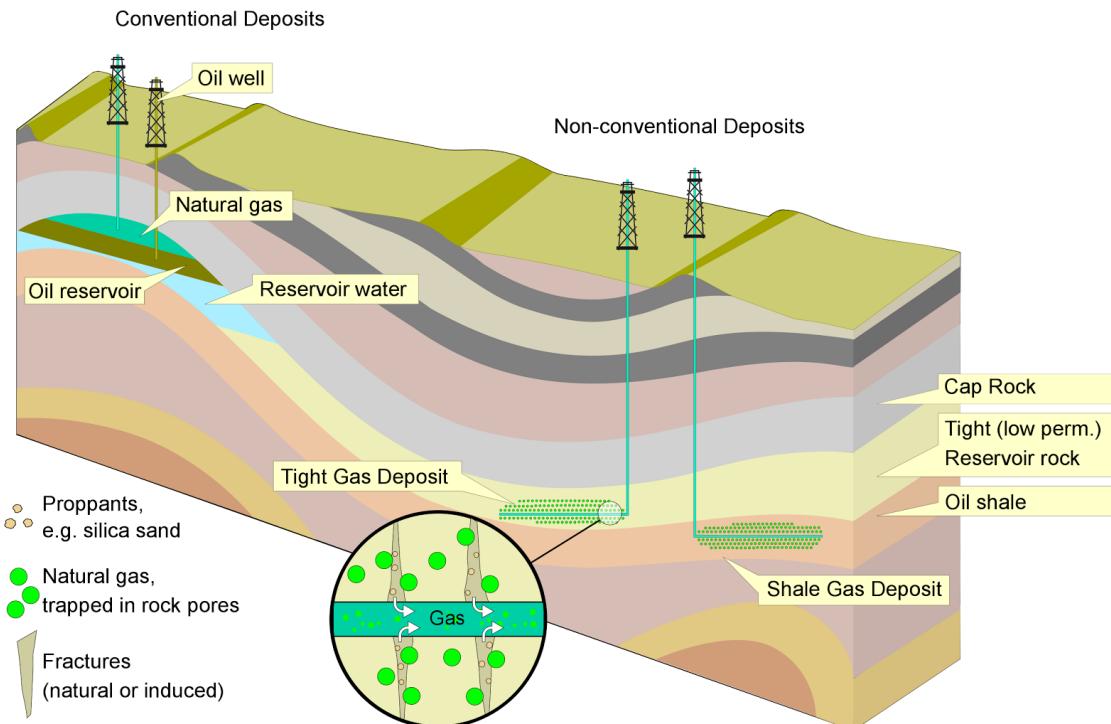
The Future: Monitoring

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

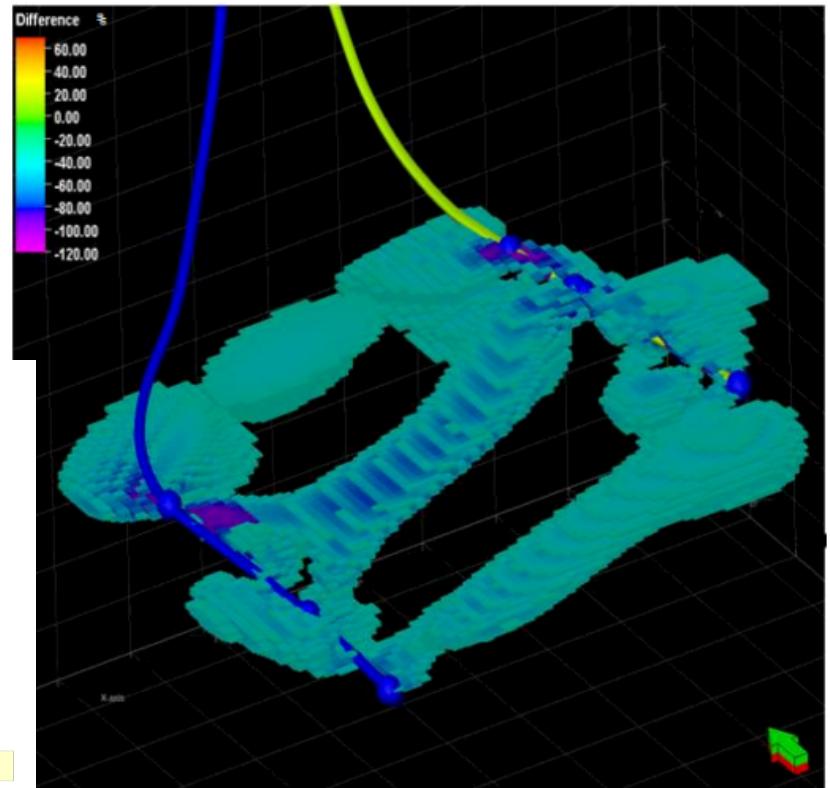


The Future: Monitoring

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



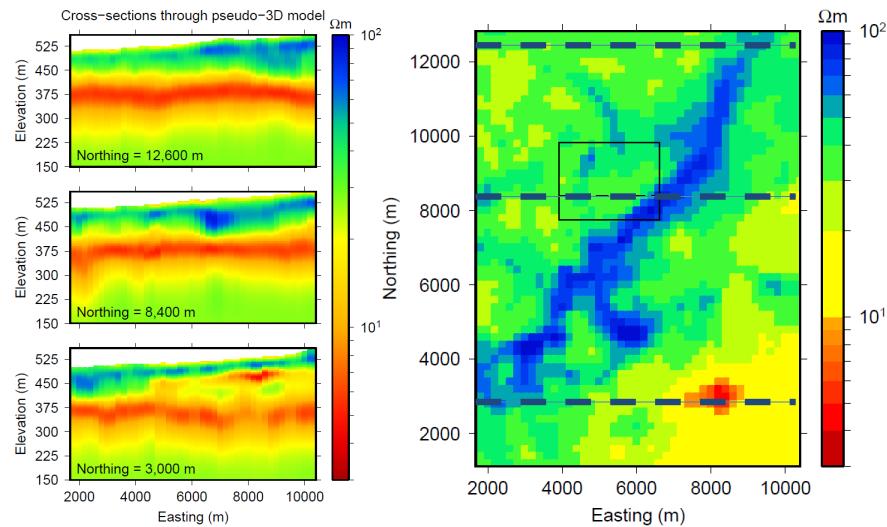
Resistivity isosurface – water flood



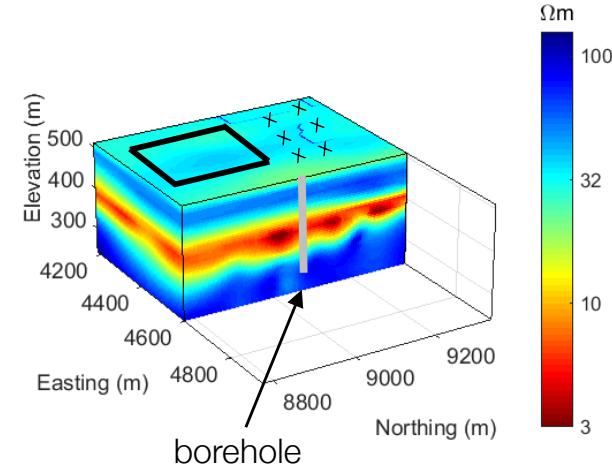
Saudi Arabia: Marsala et al., 2015

Multi-stage EM for monitoring

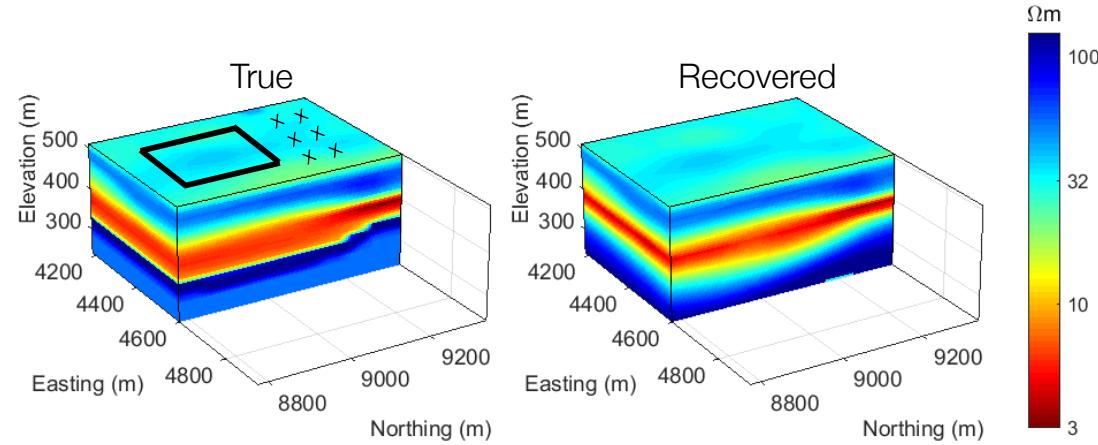
1. Large-scale: airborne EM



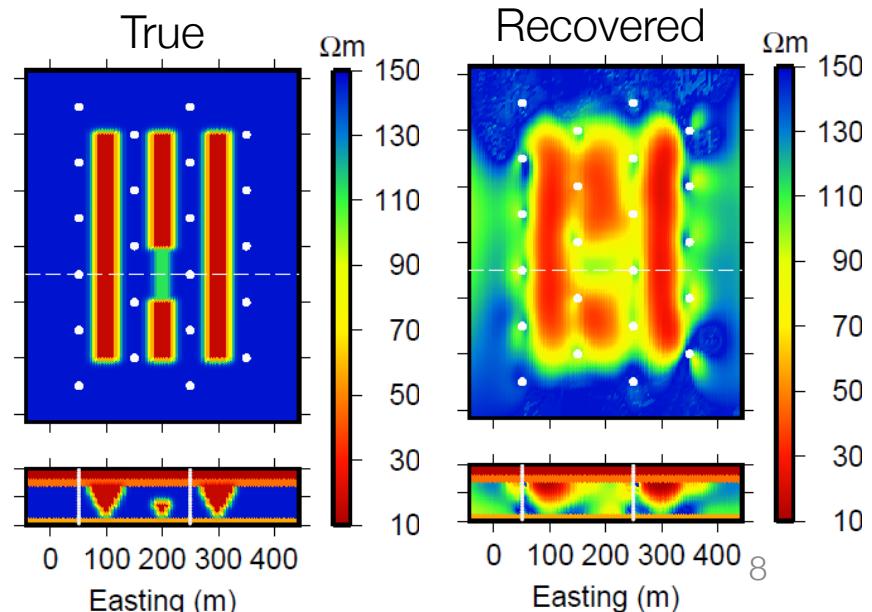
3. Pre-injection: surface TXs and borehole RXs



2. Local structures: ground EM

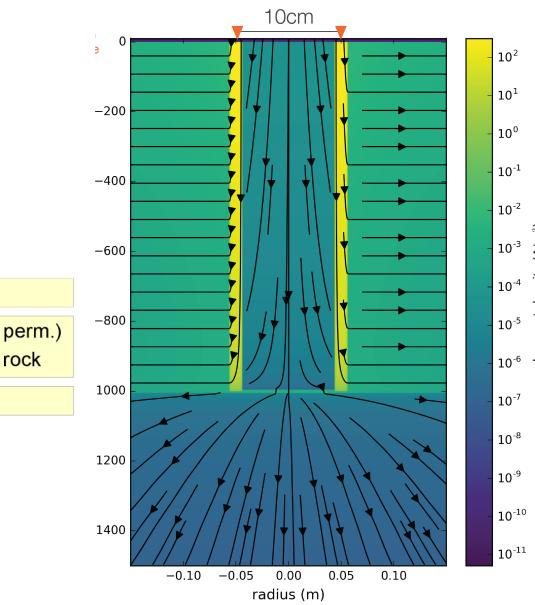
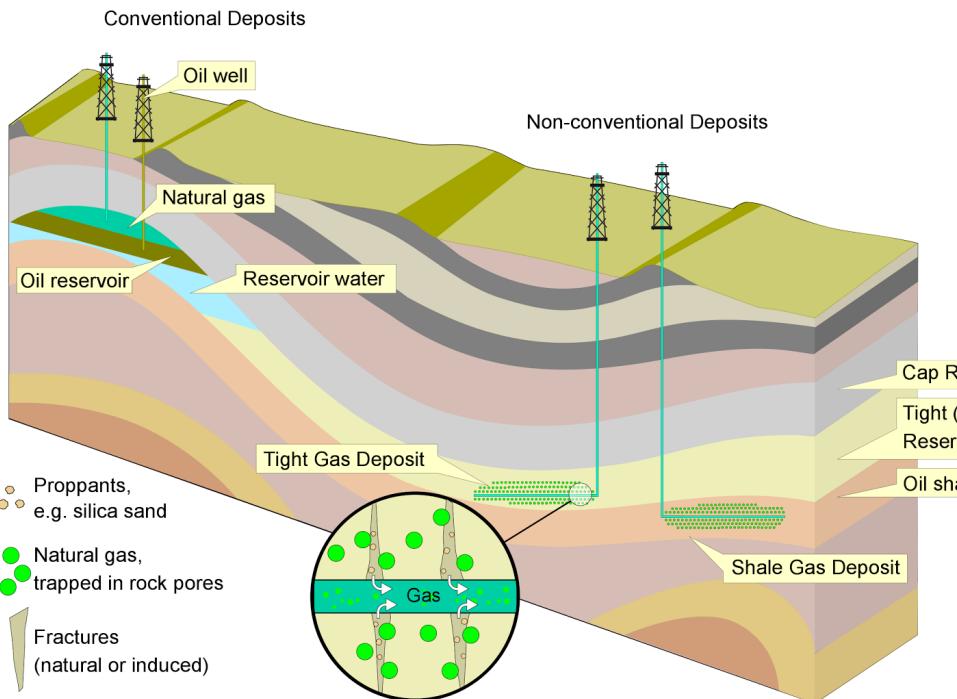
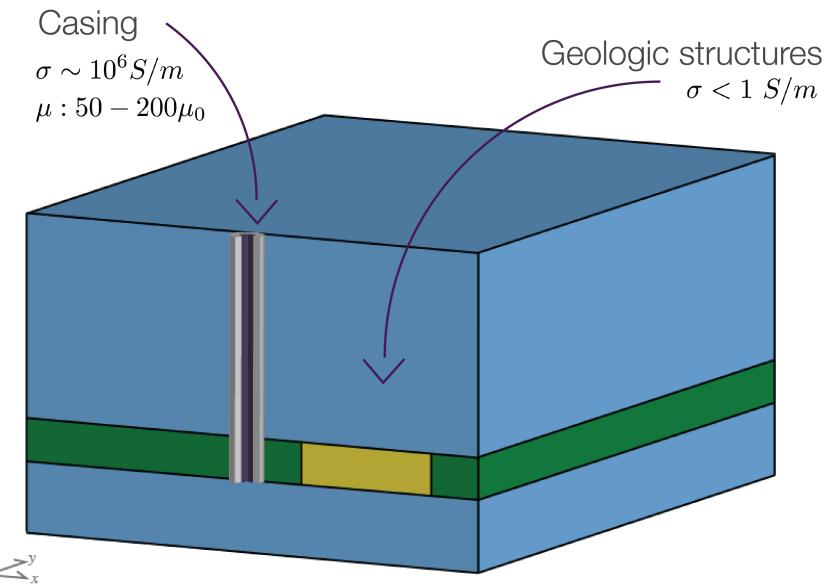


4. Post-injection: surface TXs and borehole RXs



The Future: Monitoring

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

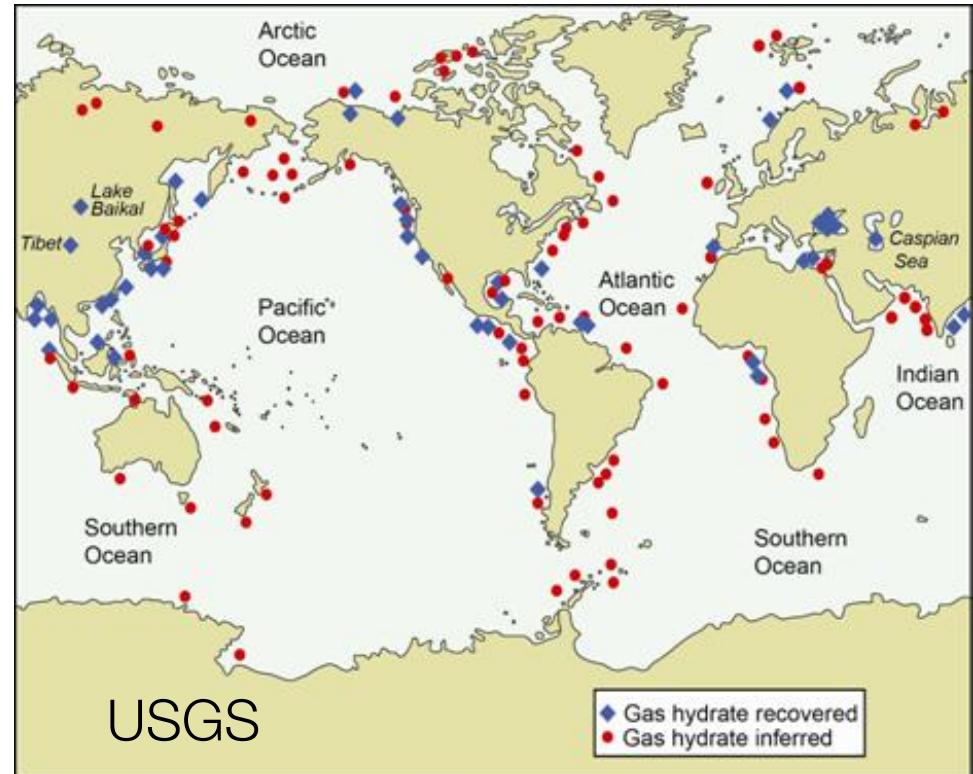
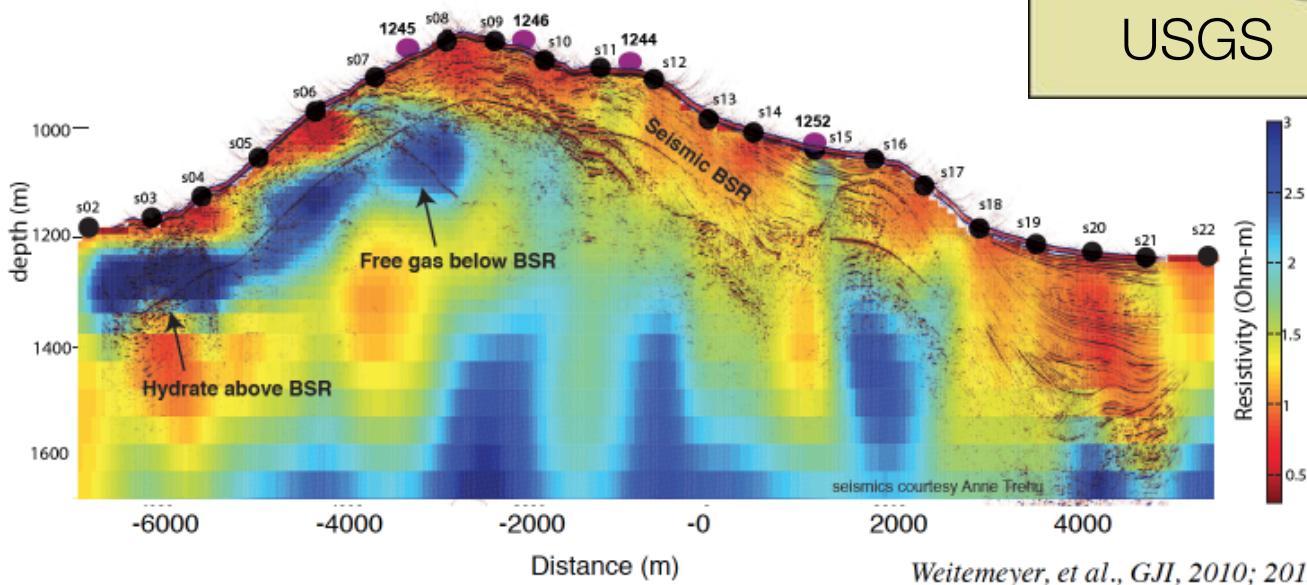


Corrosion



The Future: Marine EM

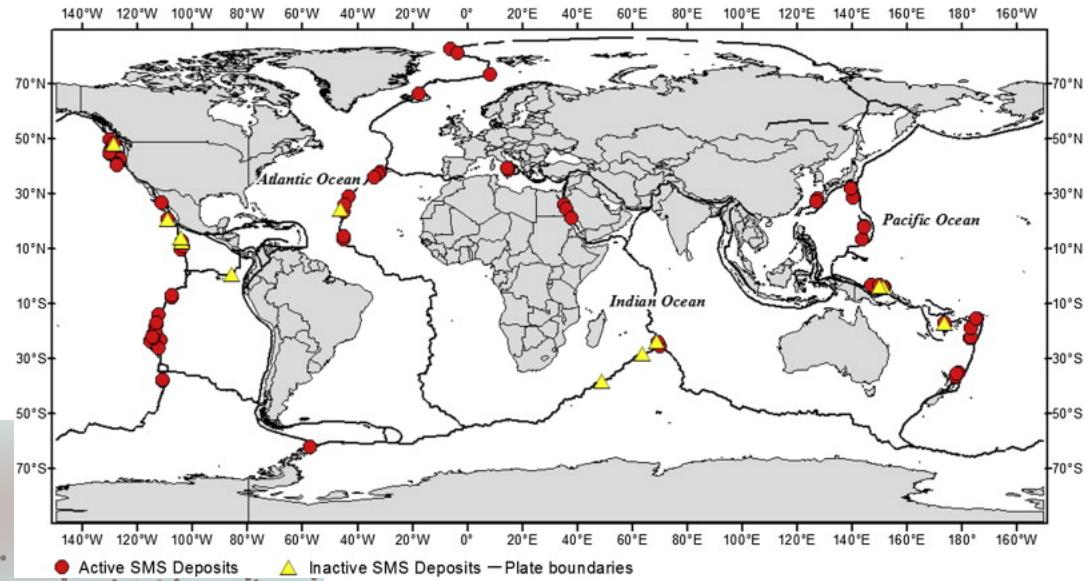
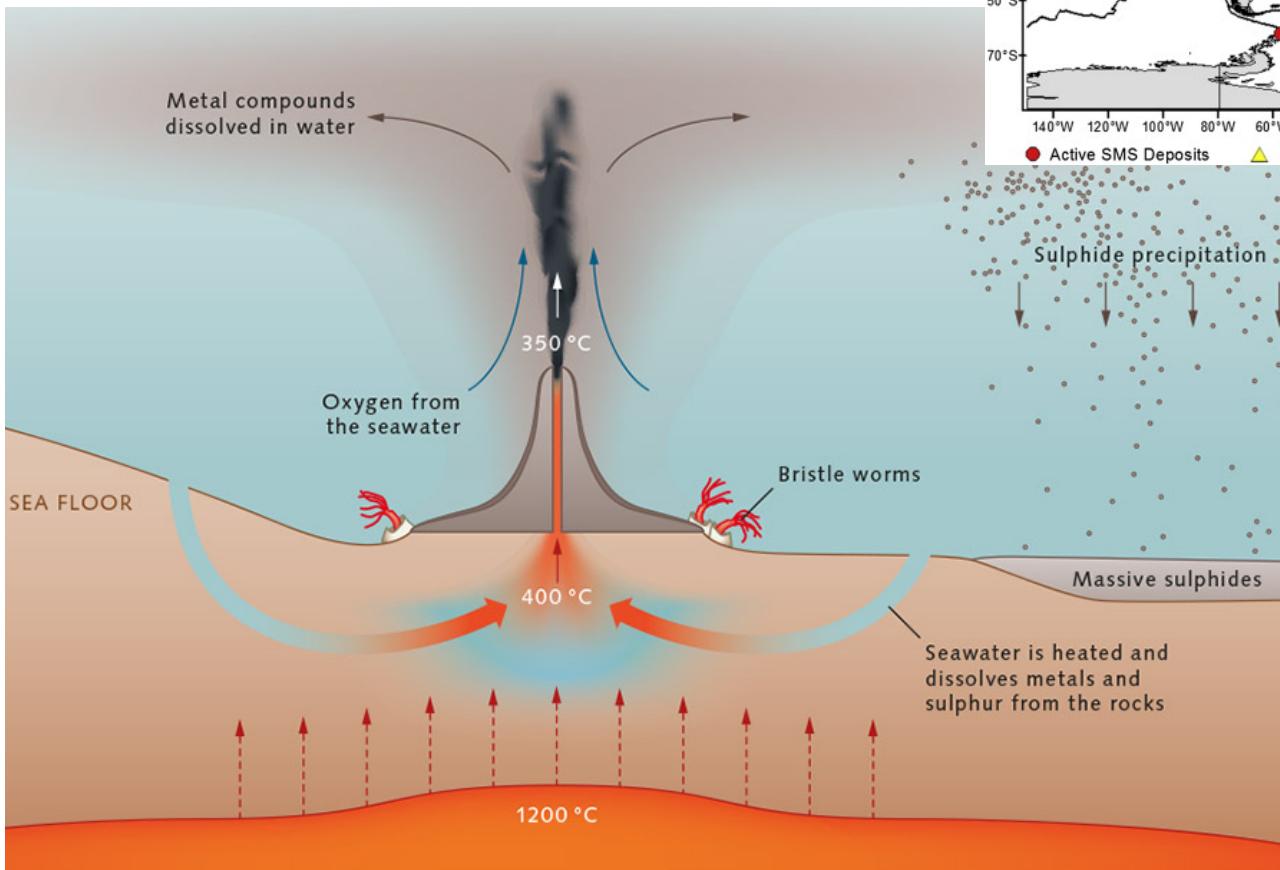
- Gas hydrates
 - Resistivity is diagnostic



Weitemeyer, et al., GJI, 2010; 2011

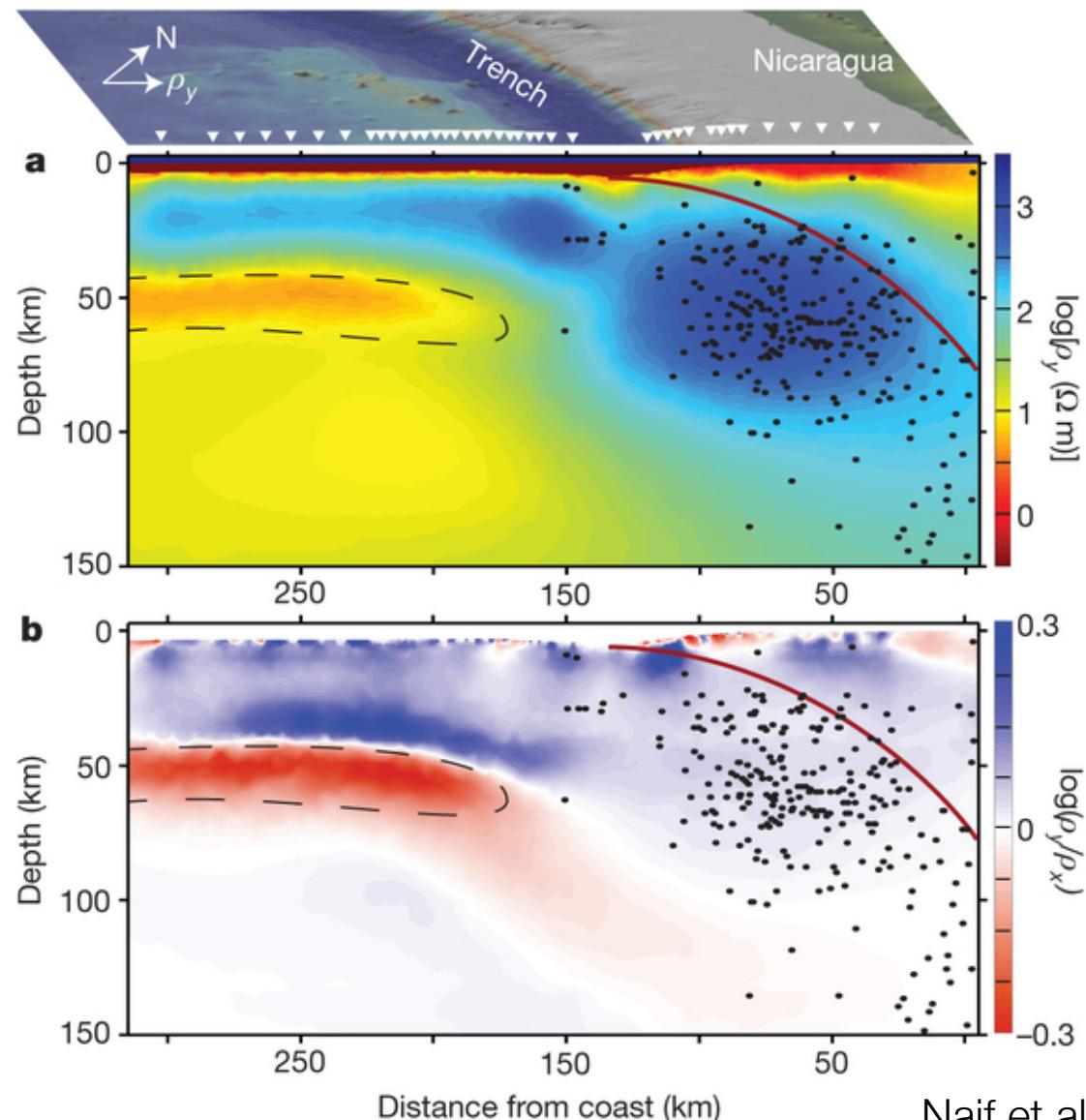
The Future: Marine EM

- Submarine massive sulfides
 - Conductive relative to background



The Future: Marine EM

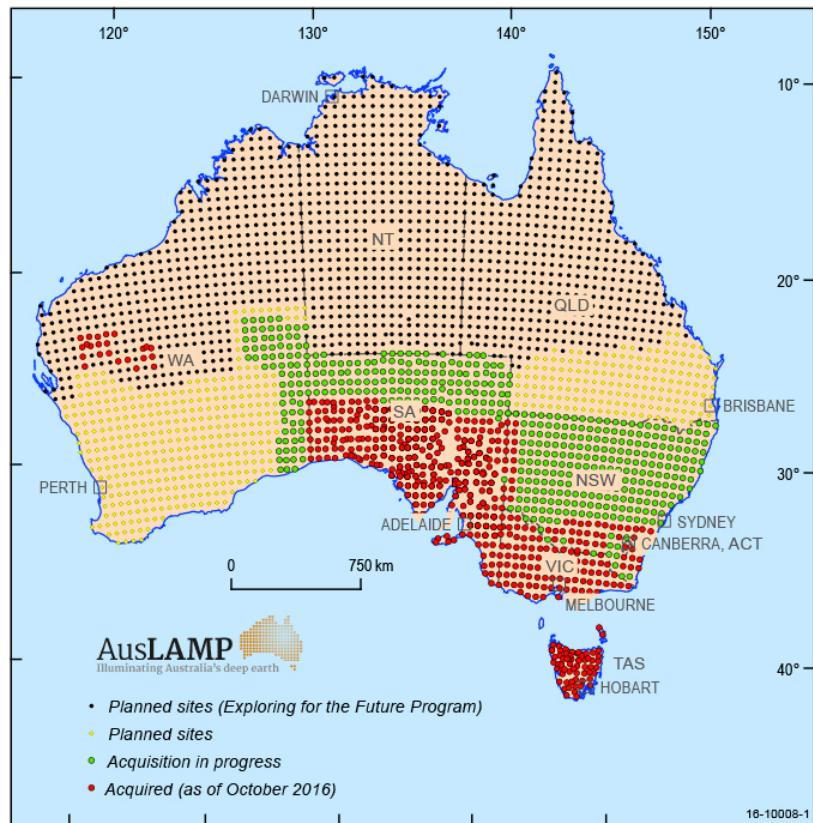
- Tectonic studies
- Large anisotropy
 - indicative of melt-rich channel



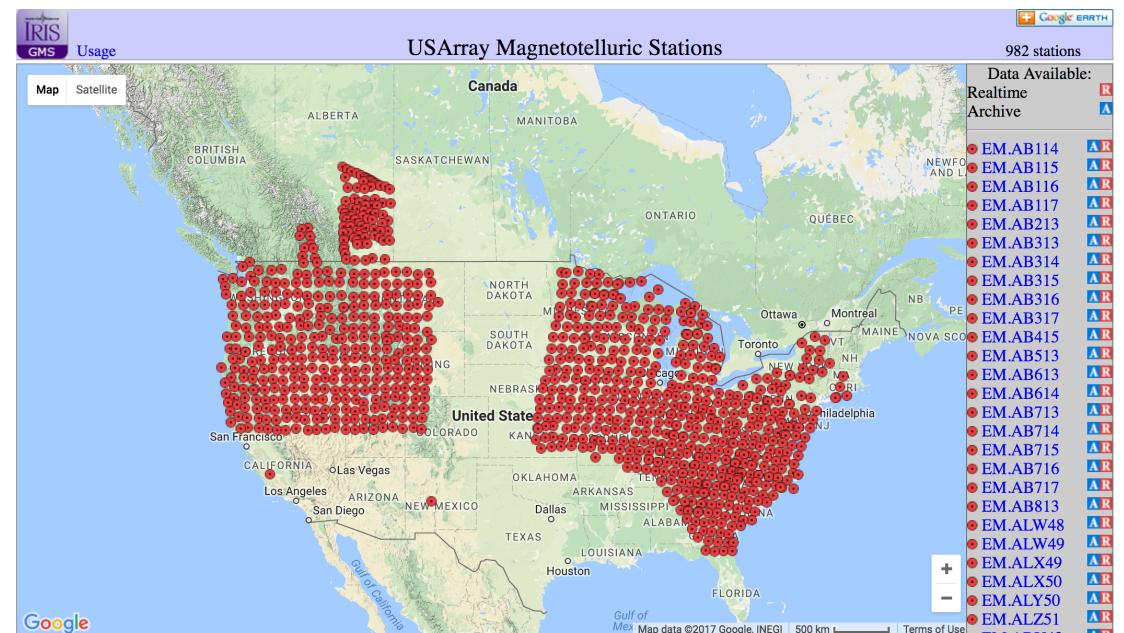
Naif et al., 2013

The Future: Large Scale MT

AusLamp

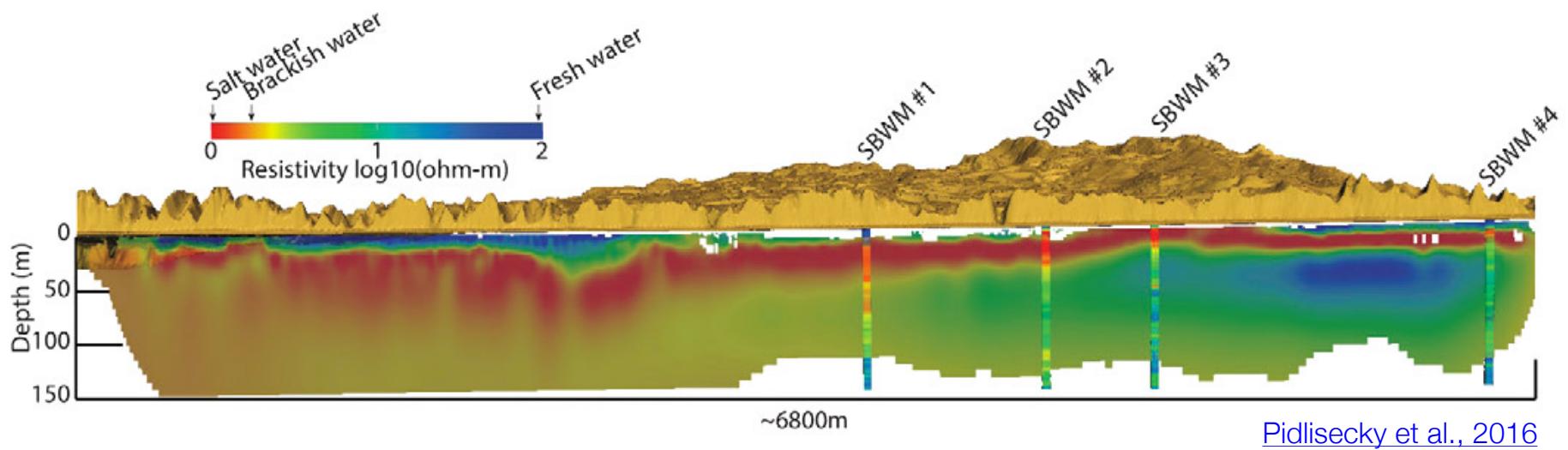


Earth scope



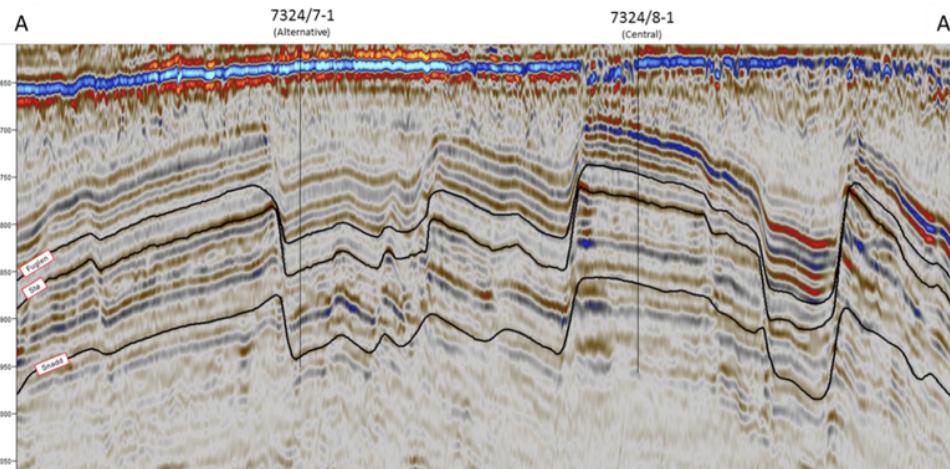
The Future: Water

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

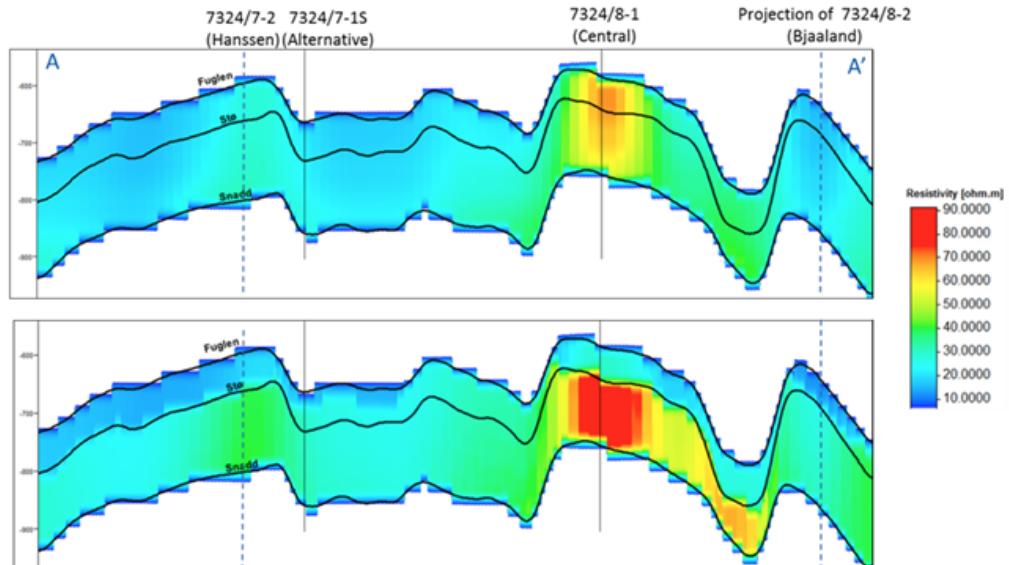


The Future: Data Integration & Multi-physics

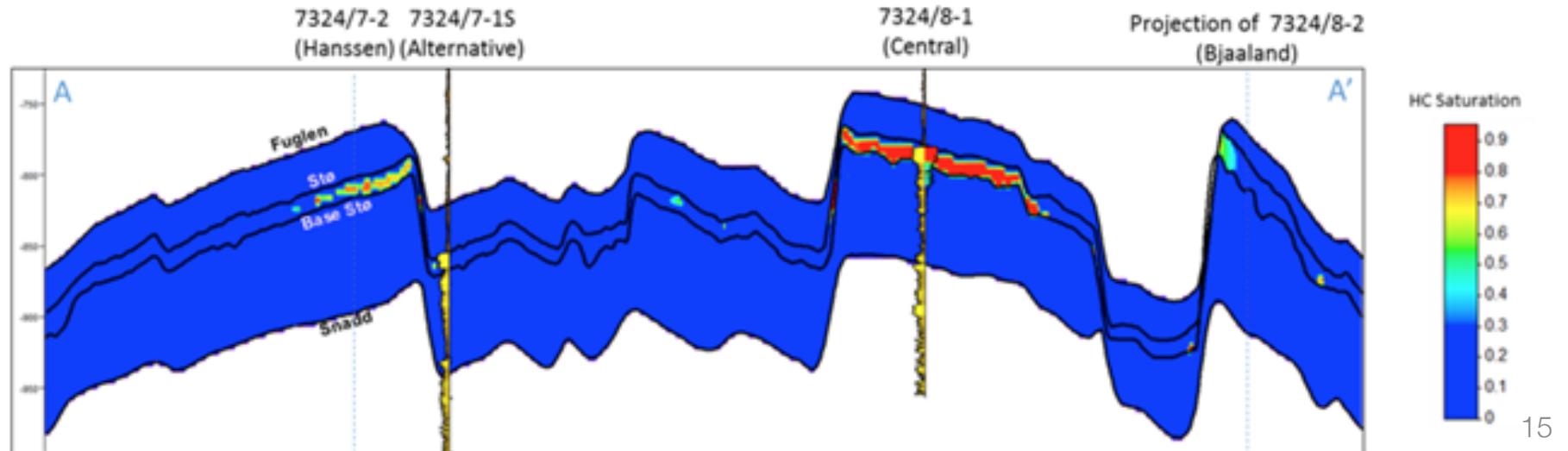
Seismic



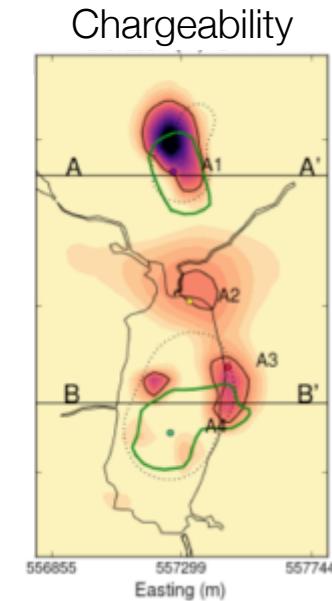
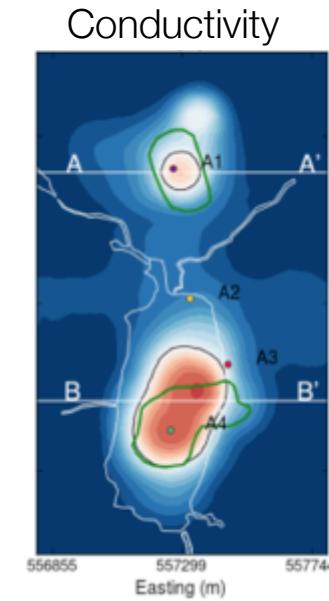
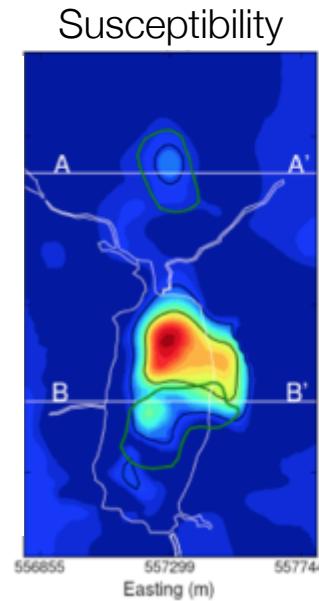
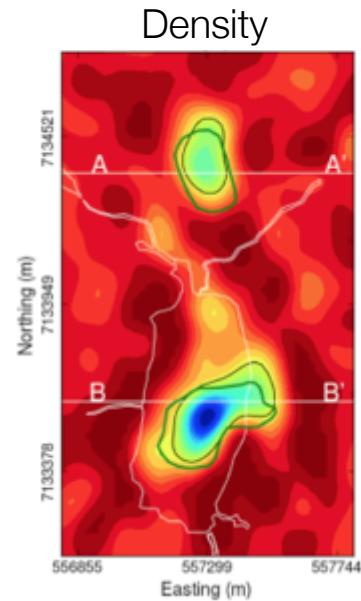
EM



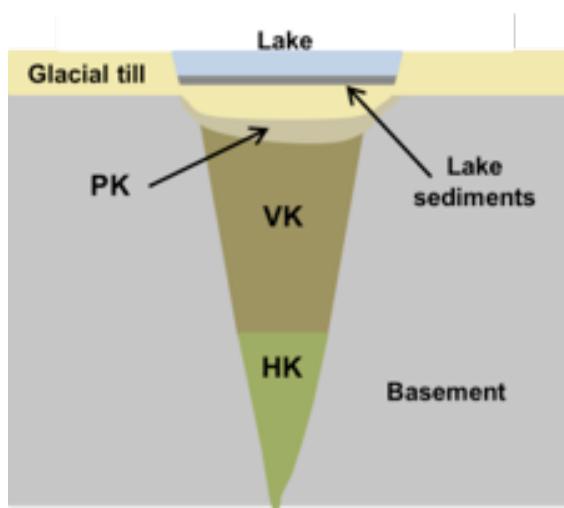
Final hydrocarbon saturation model



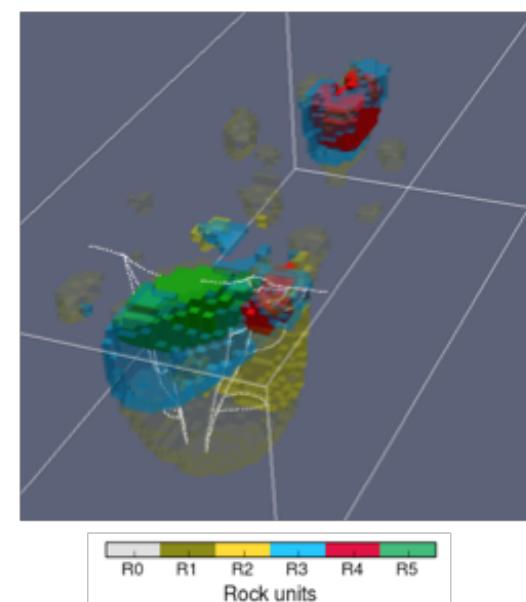
The Future: Data Integration & Multi-physics



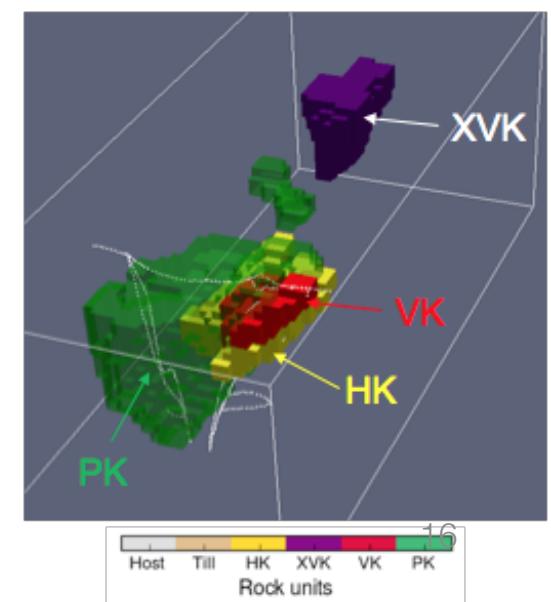
Kimberlite Model



Rock Model from Geophysics



Rock Model from Drilling

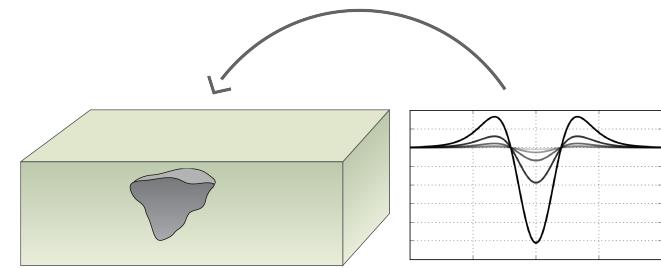


DISC can take advantage of a Perfect Storm

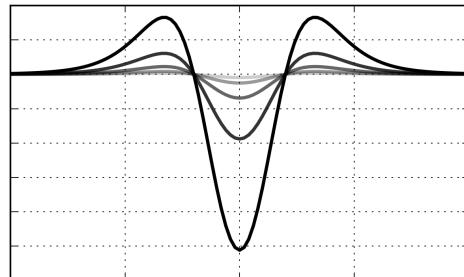
Problems



Inversion capabilities



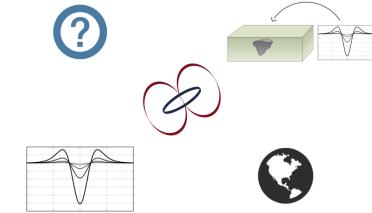
High quality data



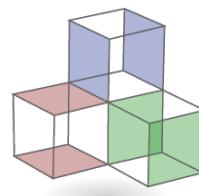
Web tools to communicate



The Future: Modelling and Inversion



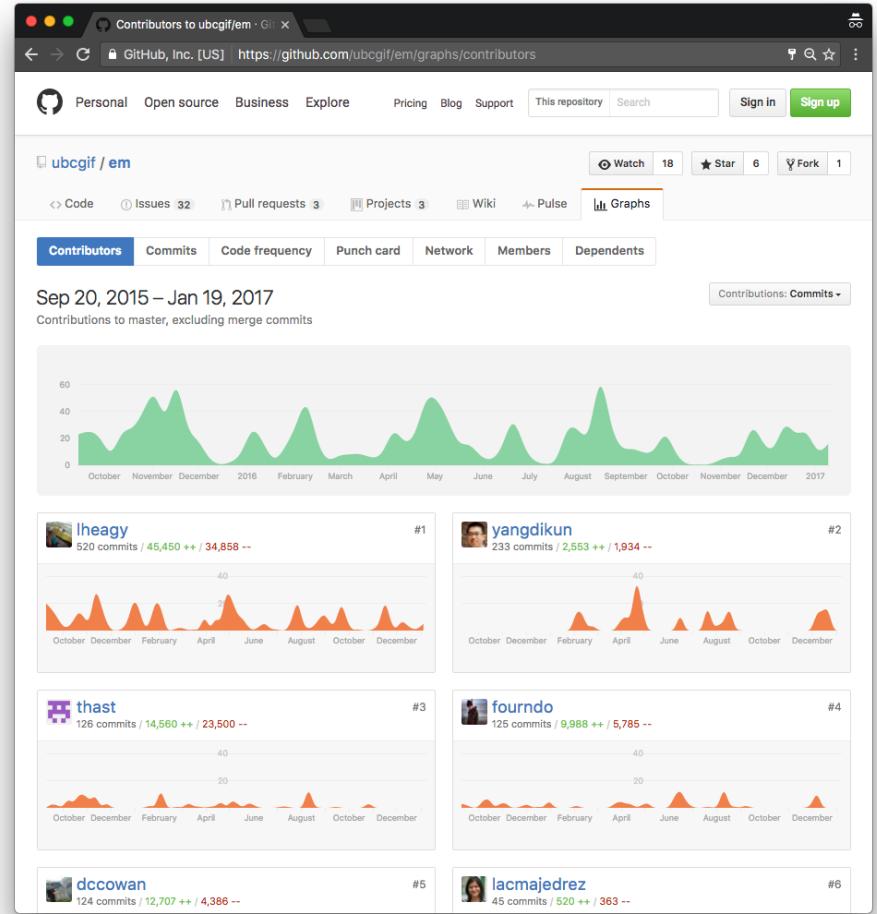
- HPC, Cloud computing
- Collaborative development
- Open source



simpeg

Simulation and Parameter Estimation in Geophysics

<http://simpeg.xyz>



GitHub
versioning, collaborating



Travis CI
testing, deploy



Jupyter
interactive computing

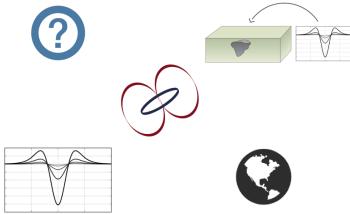


Creative Commons
licensing, reuse



Python
computation

The Future: Modelling and Inversion

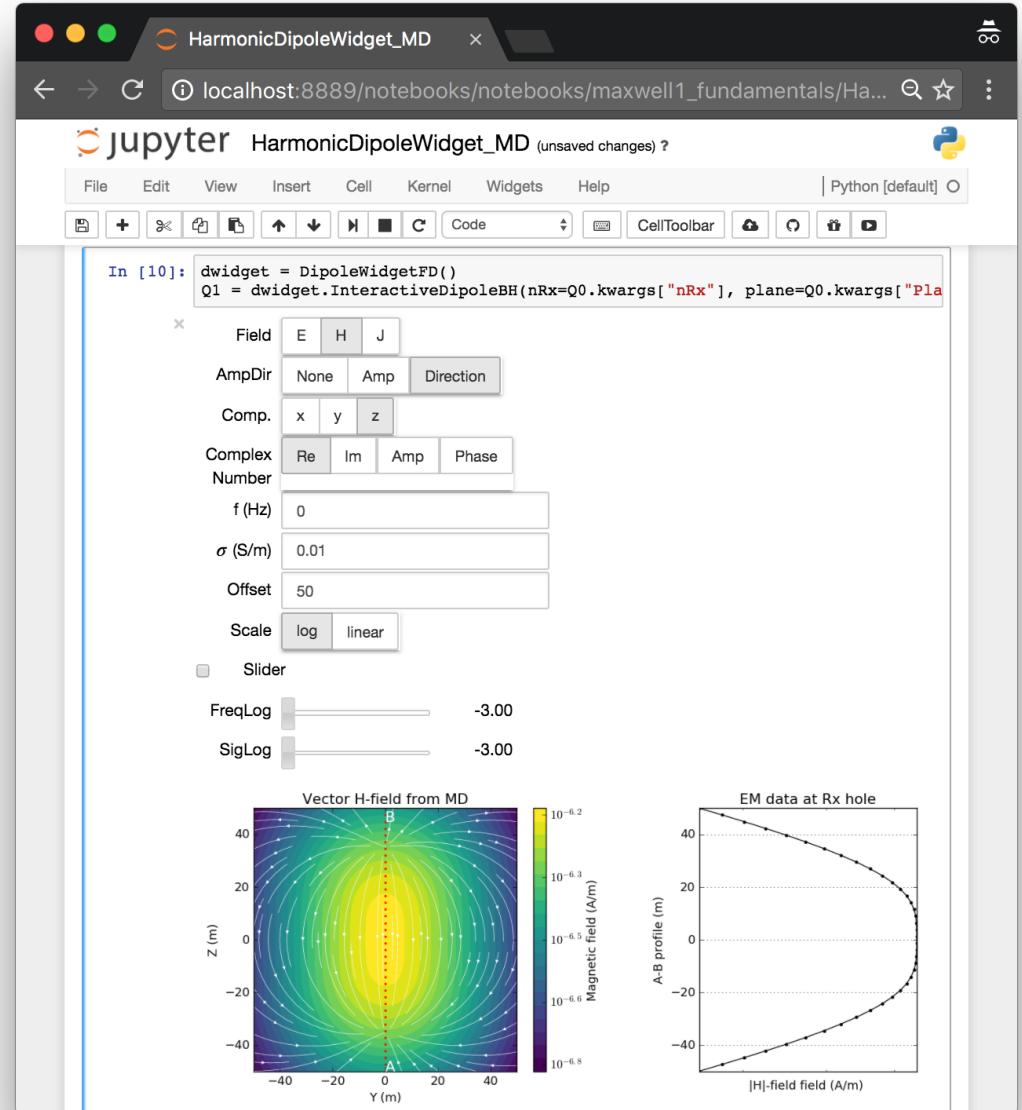


- Interactive computing
- Visualization

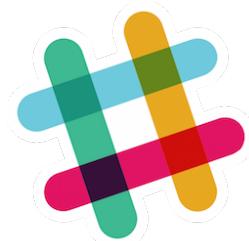
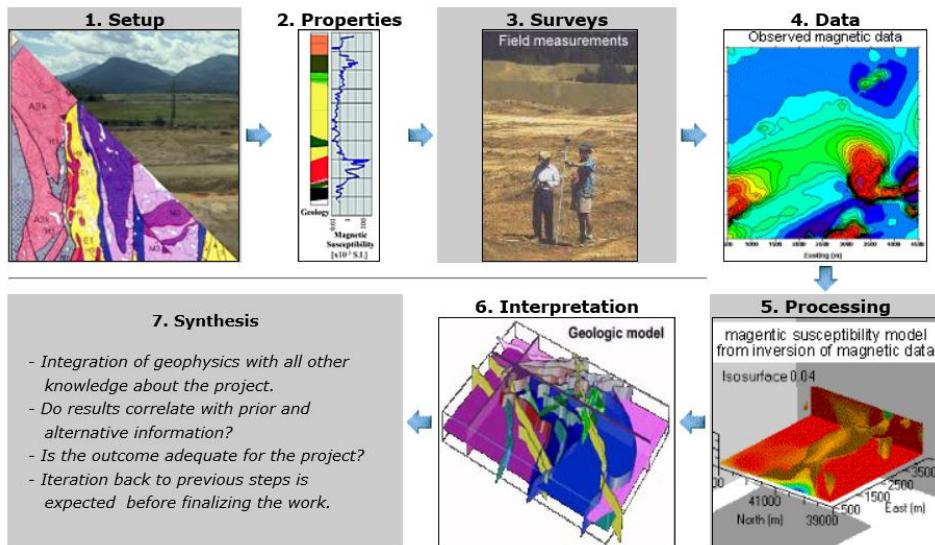
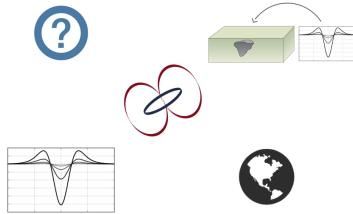
$$\nabla \times \mathbf{e} = - \frac{\partial \mathbf{b}}{\partial t}$$



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



The Future: Collaboration



<http://slack.geosci.xyz>

[Edit on GitHub](#)

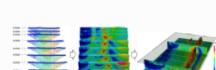
Case Histories

Case histories provide the context for our development of educational and research tools presented in em.geosci. Each case history focuses upon a particular problem to be solved or 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 reproducability. 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

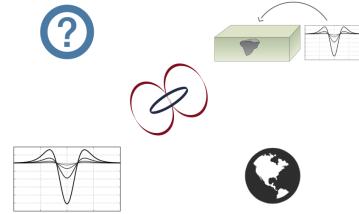
- Mt. Isa
- Contributors
 - author: Dom Fournier
- Tags
 - geophysical survey: DC, IP
 - application: Mining
 - location: Australia



Bookpurnong

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





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

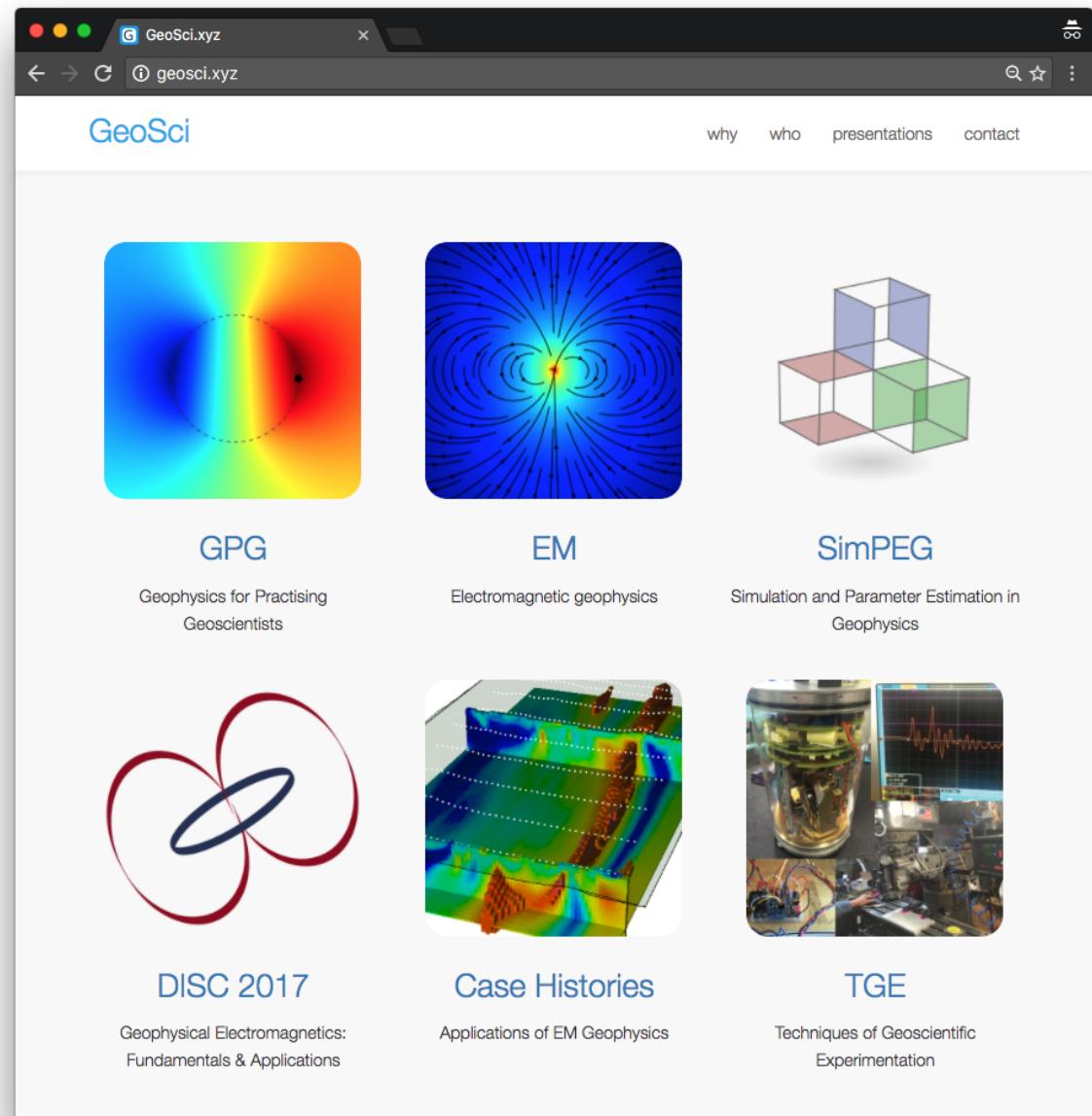
- GeoSci

<http://geosci.xyz>

- Web-textbooks
- Software
- Apps

- Apps:

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



GIF DISC Team



doug



lindsey



seogi

UBC GIF Team



Thibaut



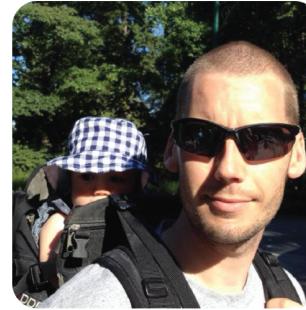
Patrick



Rowan



Devin



Kris



Sarah



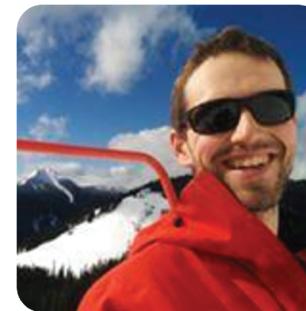
Dom



Mike



Mike



Gudni

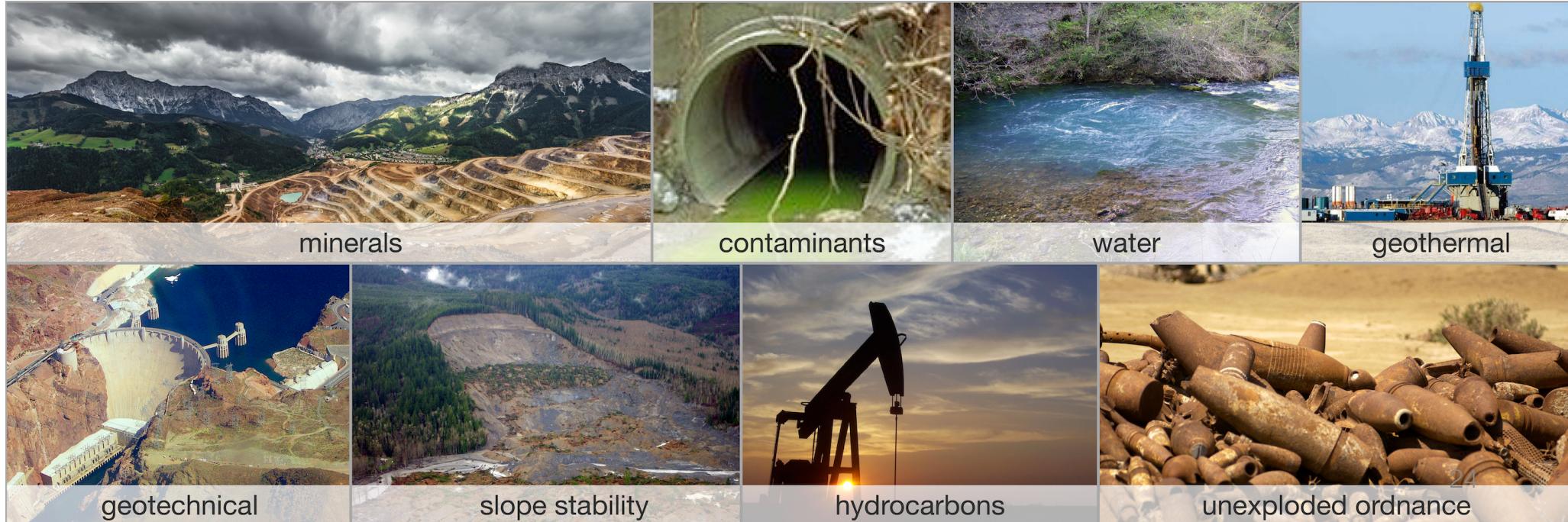


Dikun

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>



minerals



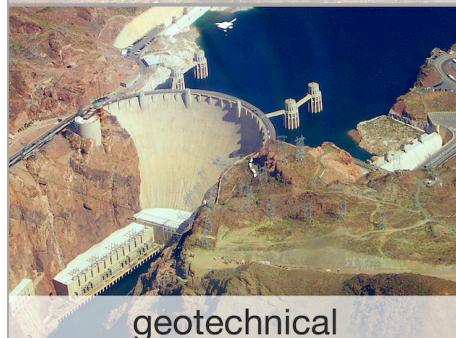
contaminants



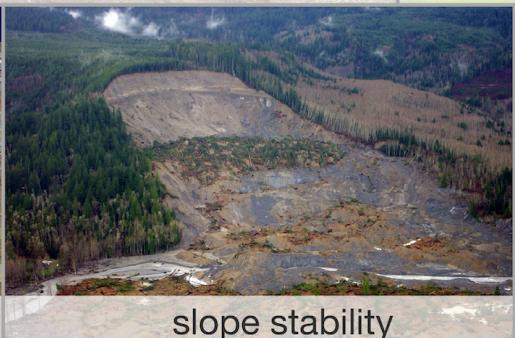
water



geothermal



geotechnical



slope stability



hydrocarbons



unexploded ordnance