Exploration of the Geneva Basin for geothermal resources:
An integrated approach with classical and unconventional methods

Group of Crustal Deformation and Fluid Flow in Geneva

Matteo.Lupi@unige.ch

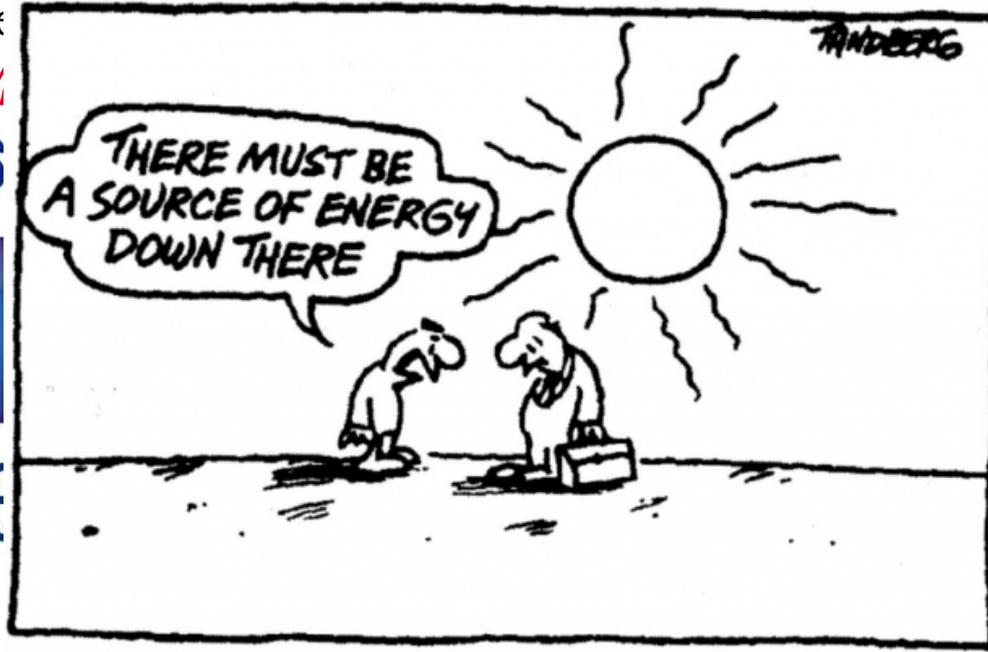# Whatever the methods at some point data will have to be treated

Commercial well-established ($!) software

Why M

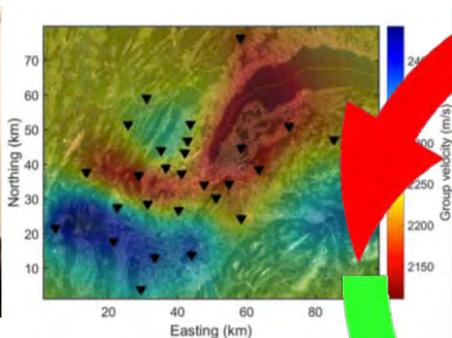ECLIPS

ECL

Petre

python

Academic monsters

A common platform accessible to everyone to promote geothermal energy
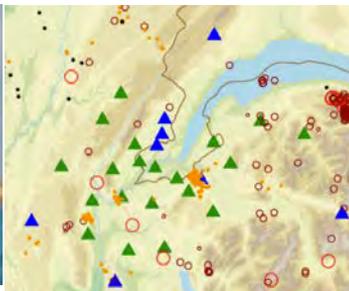

Ambient noise tomography of the Geneva Basin

Thomas Planès

(Micro)seismicity in the Geneva Basin
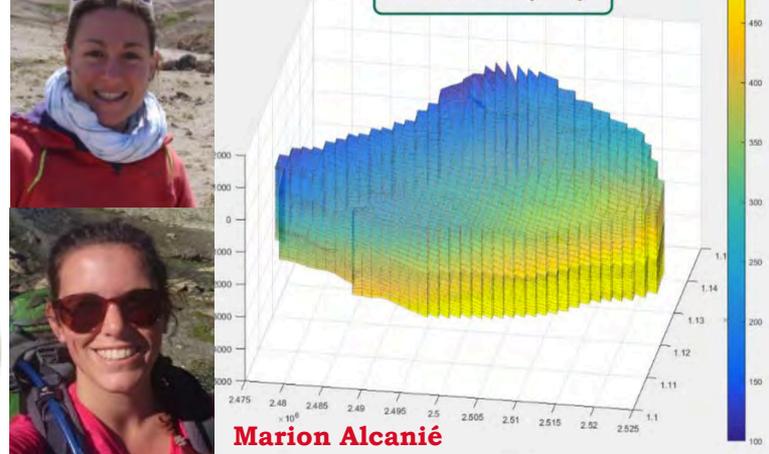
Verónica Antunes

Numerical Fluid Flow modeling of the Geneva Basin
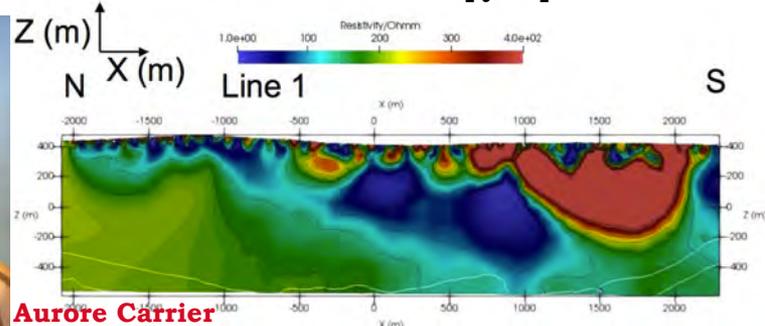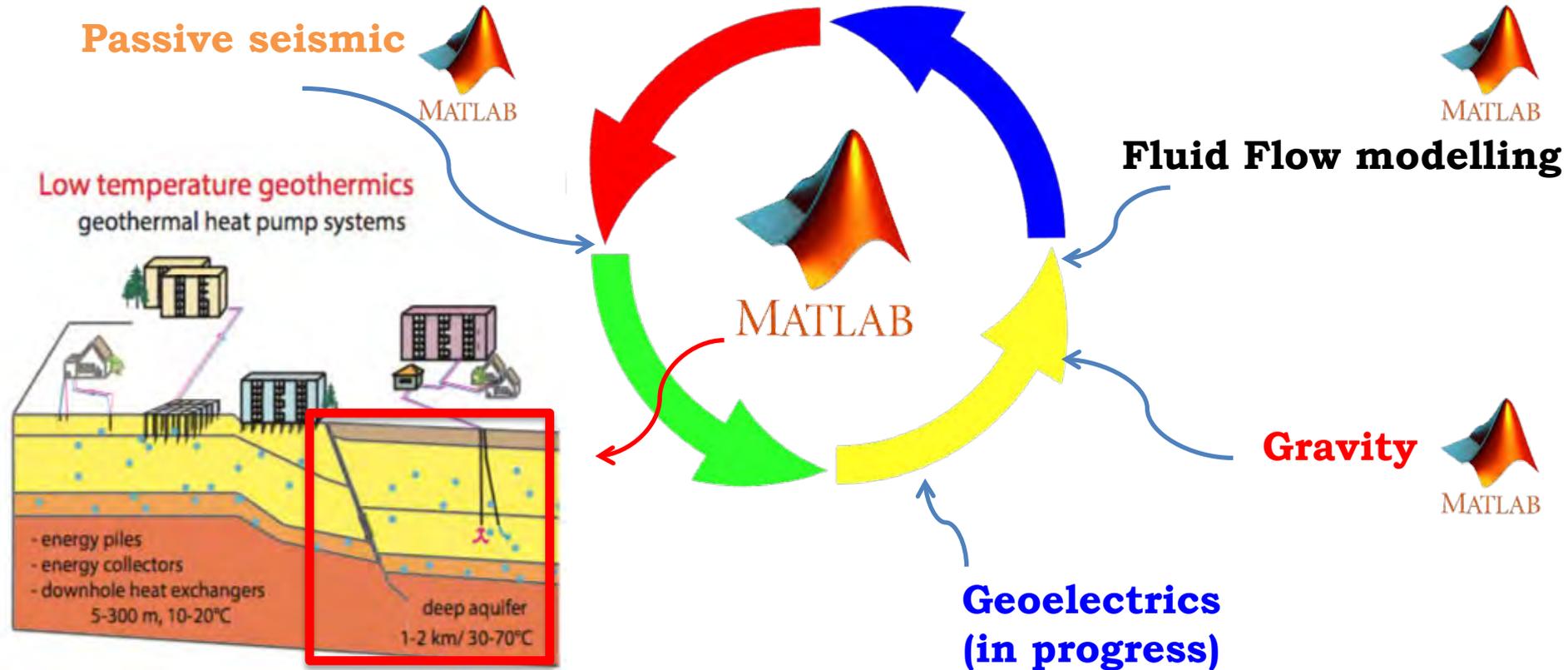
Marine Collignon

Pressure (bar)

Marion Alcanié

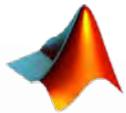**Gravity and geoelectrical methods for middle enthalpy explorations**

Aurore Carrier

Passive seismic

Low temperature geothermics
geothermal heat pump systems

- energy piles
- energy collectors
- downhole heat exchangers
5-300 m, 10-20°C

deep aquifer
1-2 km/ 30-70°C

Hirschberg, Wiemer, Burgherr, Energy from the Earth, 2015

MATLAB

Fluid Flow modelling

Gravity

Geoelectrics (in progress)

SCCER SoE
SWISS COMPETENCE CENTER for ENERGY RESEARCH
SUPPLY of ELECTRICITY

An example of integrated workflow….

GRAVITY

GeoMol
Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources

- GeoMol interprets Quaternary and Tertiary together
- GeoMol processed the data by introducing a 500 m datum plane

The depths of the key horizons (at least for the Geneva Basin) are misplaced.

GRAVITY

Affordable gravity prospection calibrated on improved time-to-depth conversion of old seismic profiles for exploration of geothermal resources.

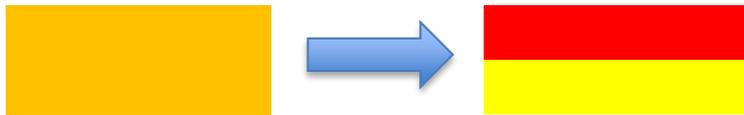A. CARRIER[a,2], C. NAWRATIL DE BONO[b], M. LUPI[a]

[a]Department of earth Sciences, University of Geneva, GENEVA, Switzerland
[b]Industrial Services of Geneva, GENEVA, Switzerland

1) Use GeoMol model as a-priori information

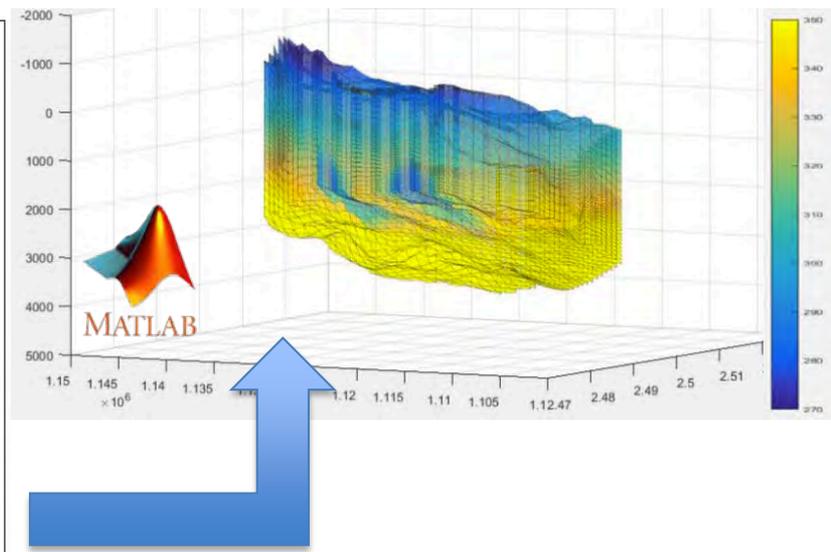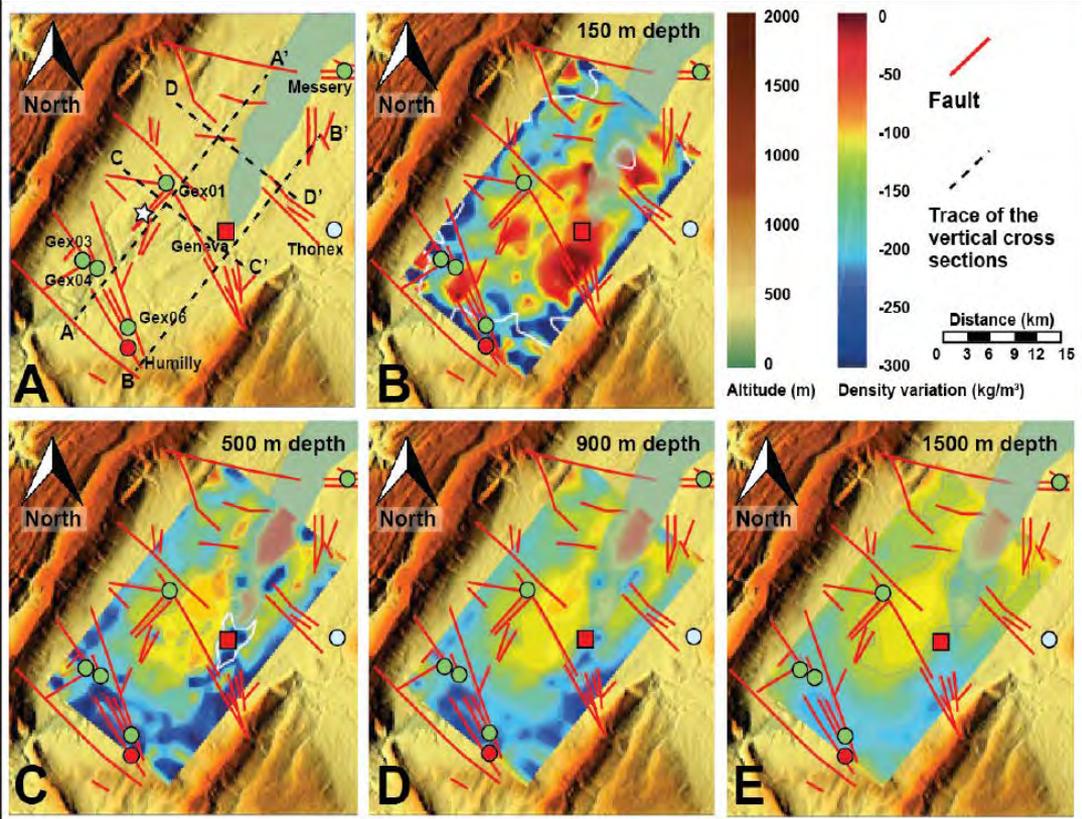Use existing wells to separate Quaternary from Molasse + Introduce DEM

Use swisstopo gravity data and perform a gravity inversion

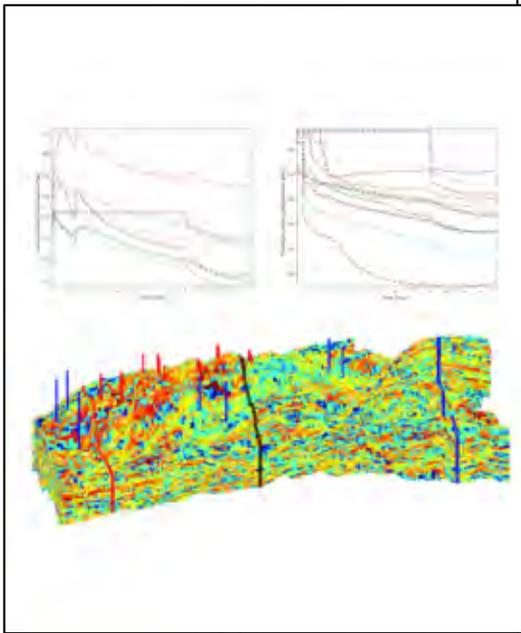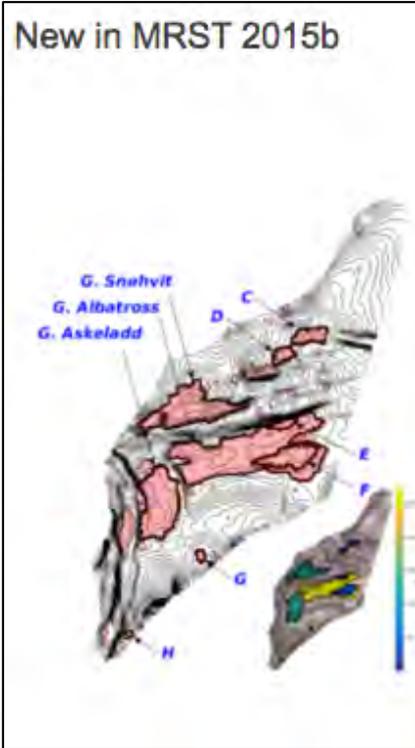Subtract the Gravity model from the Geomol model

GRAVITY

Carrier et al., Submitted (Geothermics)

FLUID FLOW MODELLING


The **MATLAB Reservoir Simulation Toolbox** (MRST) is primarily developed by the *Computational Geosciences* group in the *Department of Mathematics and Cybernetics* at SINTEF Digital. However, there are several third-party modules developed by Heriot-Watt University, NTNU, TNO, and TU Delft.

New in MRST 2015b

Geothermal Module:
Numerical Fluid Flow modeling of the Geneva Basin

Pressure (bar)

G. Snøhvit
G. Albatross
G. Askeladd

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The MsRSB method is
implemented in the
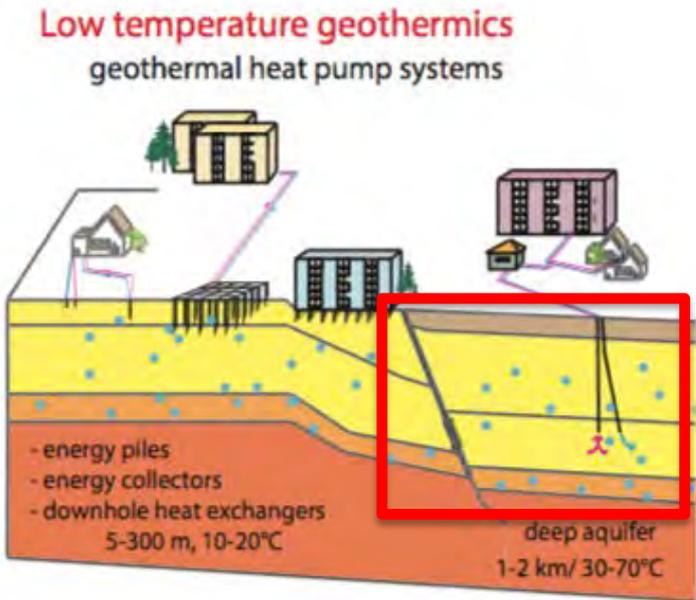INTERSECT R&P simulator.

By: Olav Møyner (SINTEF)

efficiency.

By: Rebecca Allen, SINTEF
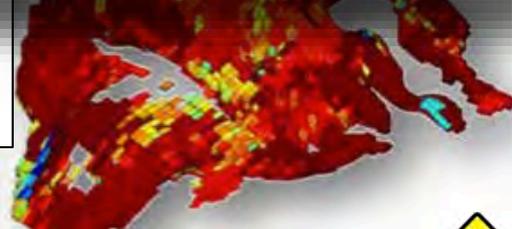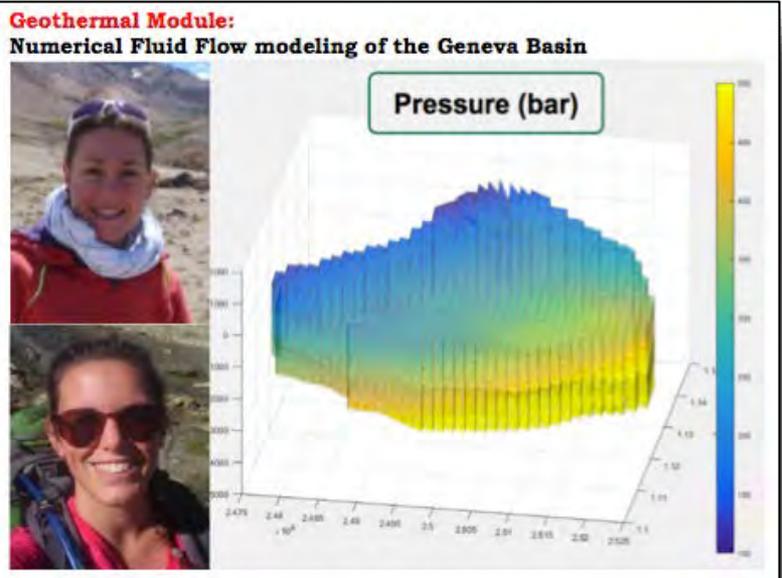
Simulation of Hydrocarbon Reservoirs ✓   **CO$_2$ storage** ✓   **Geothermal Reservoirs** ⚠
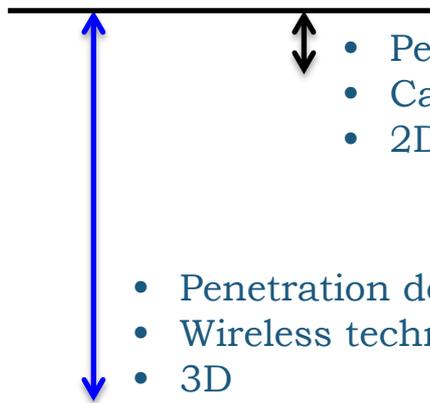
NEW GEOELECTRICAL METHODS...... DEEP (!!!)

Hirschberg, Wiemer, Burgherr, Energy from the Earth, 2015

NEW (!!!) (LOW COST!!!) GEOELECTRICAL METHODS

- • Penetration depth of old geoelectrical methods 10 to 30 m
- • Cabled technology
- • 2D

- • Penetration depth of new geoelectrical method 500 to 1200 m
- • Wireless technology (suited for urban areas)
- • 3D

SCCER SoE
SWISS COMPETENCE CENTER for ENERGY RESEARCH
SUPPLY of ELECTRICITY

High-resolution imaging of middle-enthalpy systems with an AFFORDABLE and FAST approach

Geothermie2020.ch

Performed studies

Legend:
- Deep geoelectrics
- Gravity cross section
- 3D Gravity surveyed area (not presented)
- Shallow active seismic
- Well Geo-01

Active shallow seismic (about 600 m) NOT MIGRATED YET
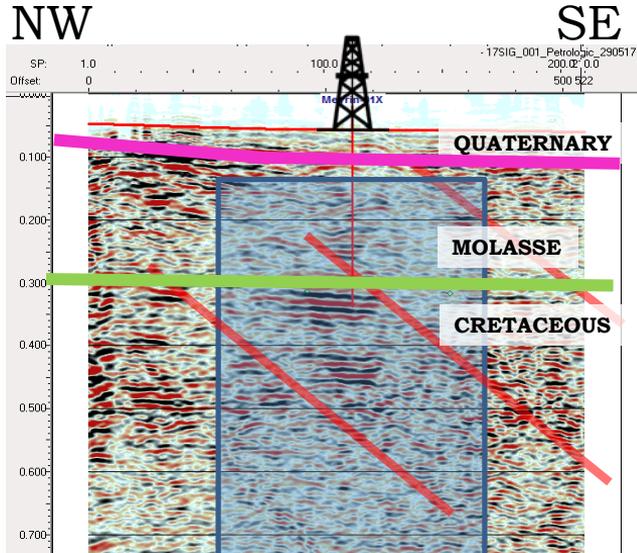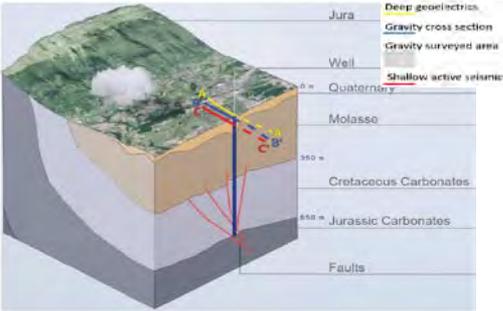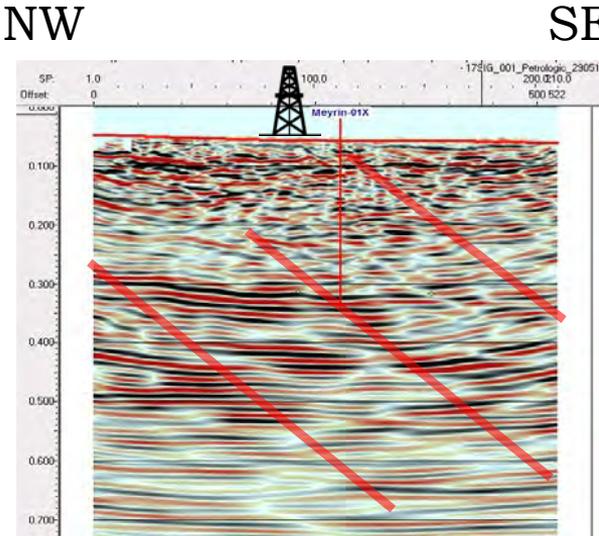

Acquired with: GEO2X Geophysics for Geology

UNIL | Université de Lausanne

Then interpreted by: GGE GENEVA GEO ENERGY

Carrier et al., in prep

Active shallow seismic (Interpreted)
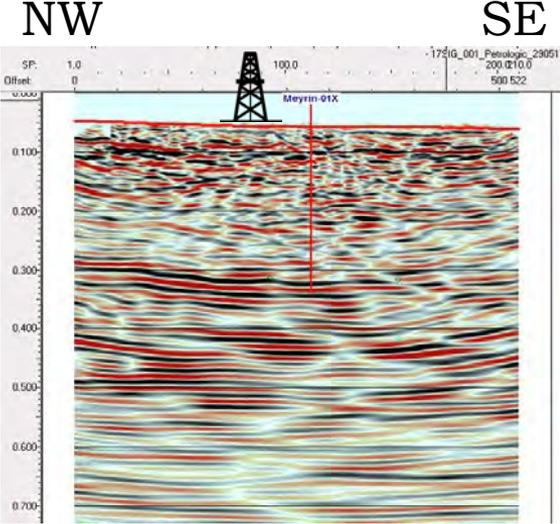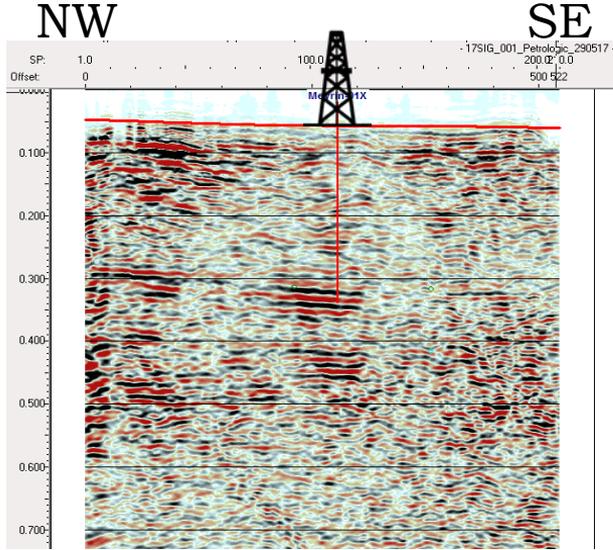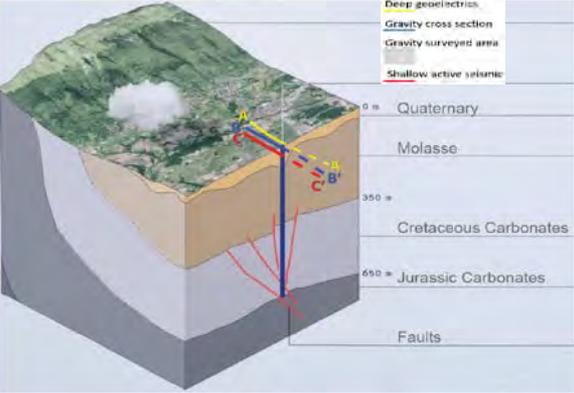
Damage zone

Acquired with:

Then interpreted by:

Carrier et al., in prep

Gravity inversion – Vertically exaggerated
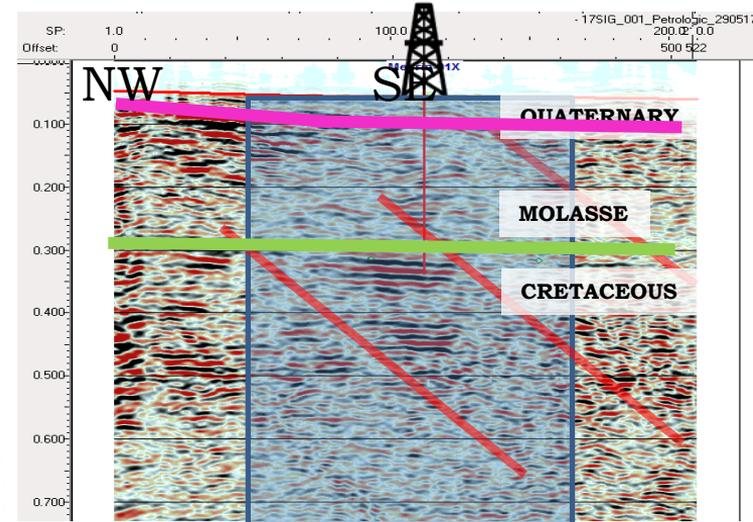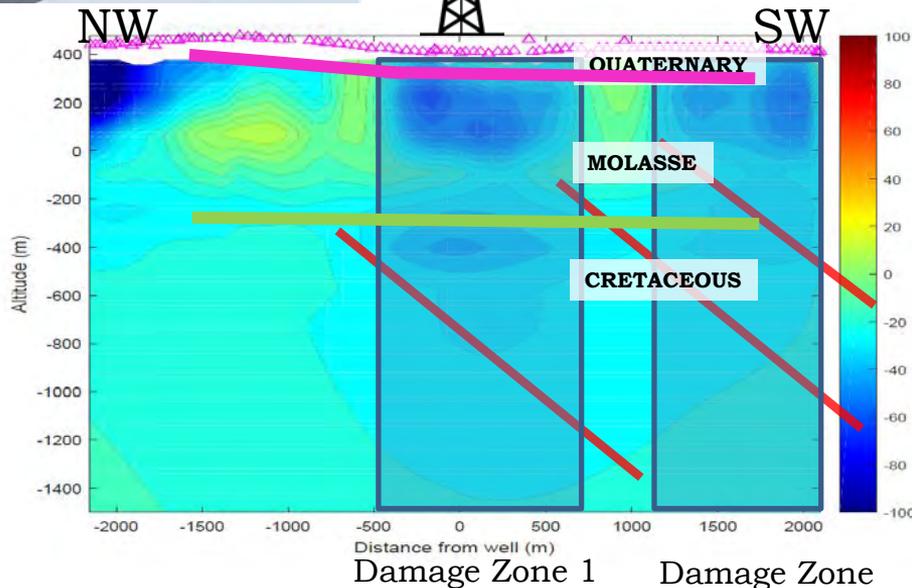

Carrier et al., in prep

NW   SE

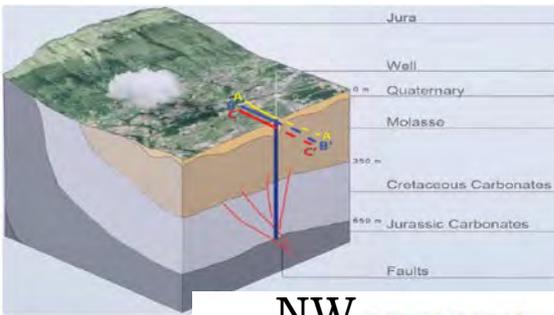QUATERNARY

MOLASSE

CRETACEOUS

Damage zone

NW   SW

Carrier et al., submitted

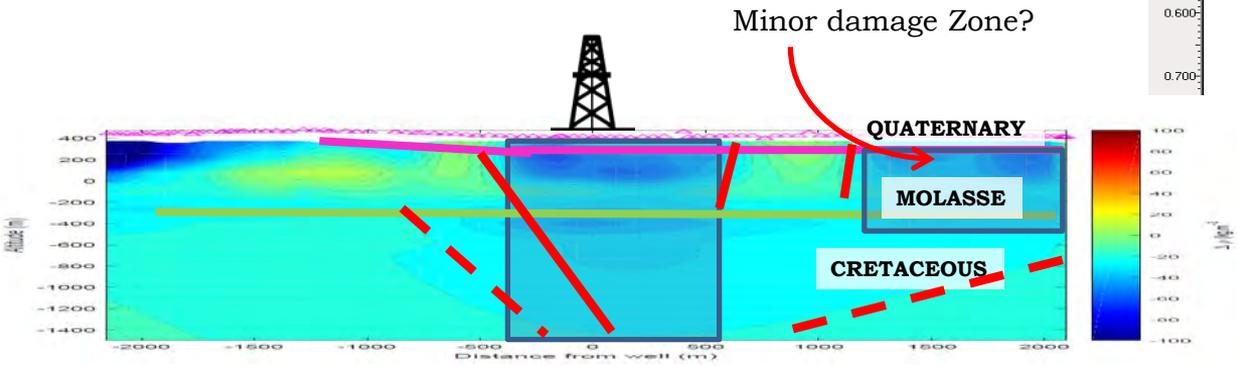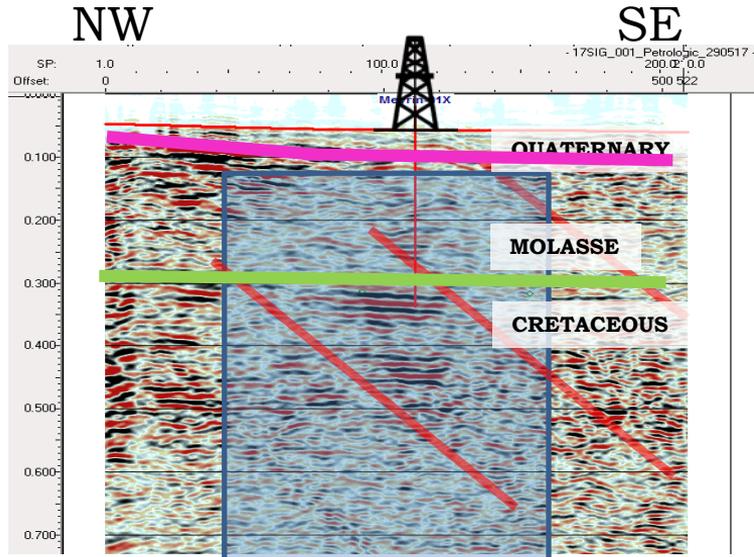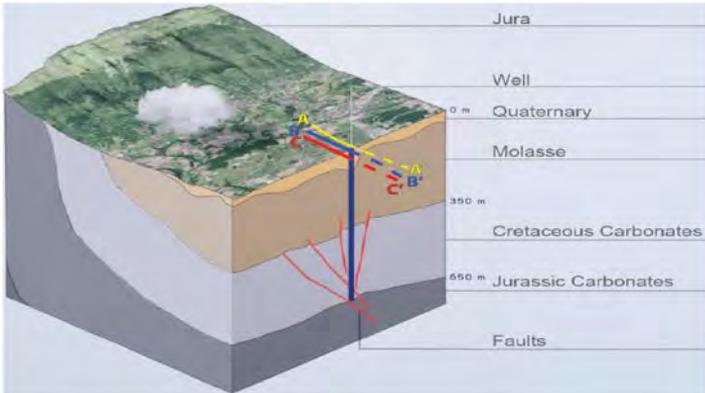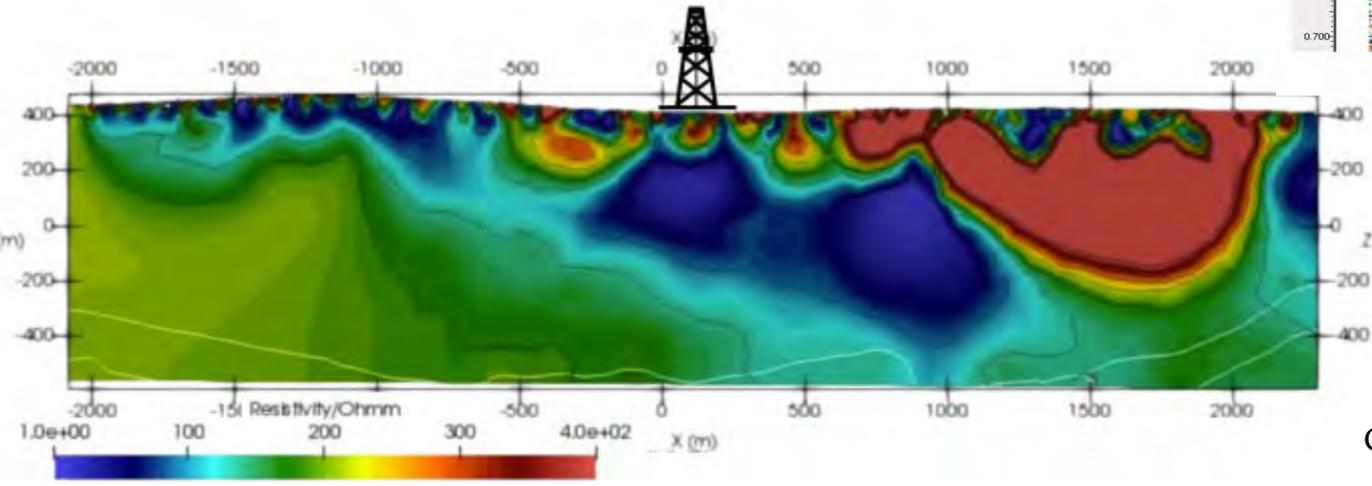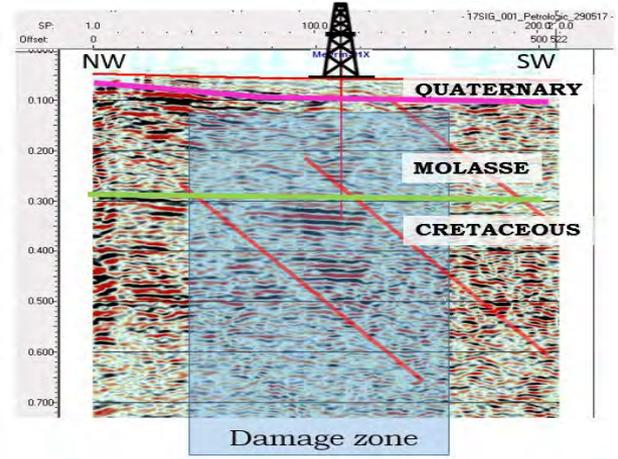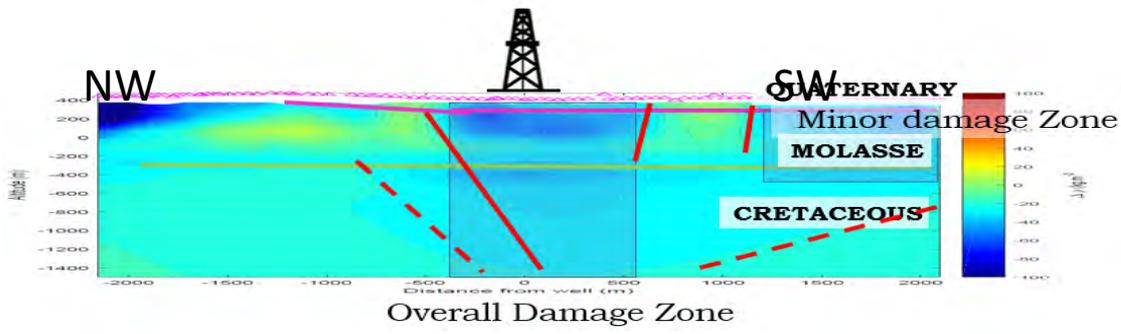# Gravity inversion (interpreted) – Vertically exaggerated

Damage zone

Damage Zone 1   Damage Zone 2

Gravity inversion (interpreted)

NW SE

QUATERNARY

MOLASSE

CRETACEOUS

Damage zone

Minor damage Zone?

QUATERNARY

MOLASSE

CRETACEOUS

Carrier et al., in prep   Overall Damage Zone

In collaboration with:

Overall Damage Zone

Damage zone

Carrier et al., in prep

Geoelectrical inversion (Interpreted)
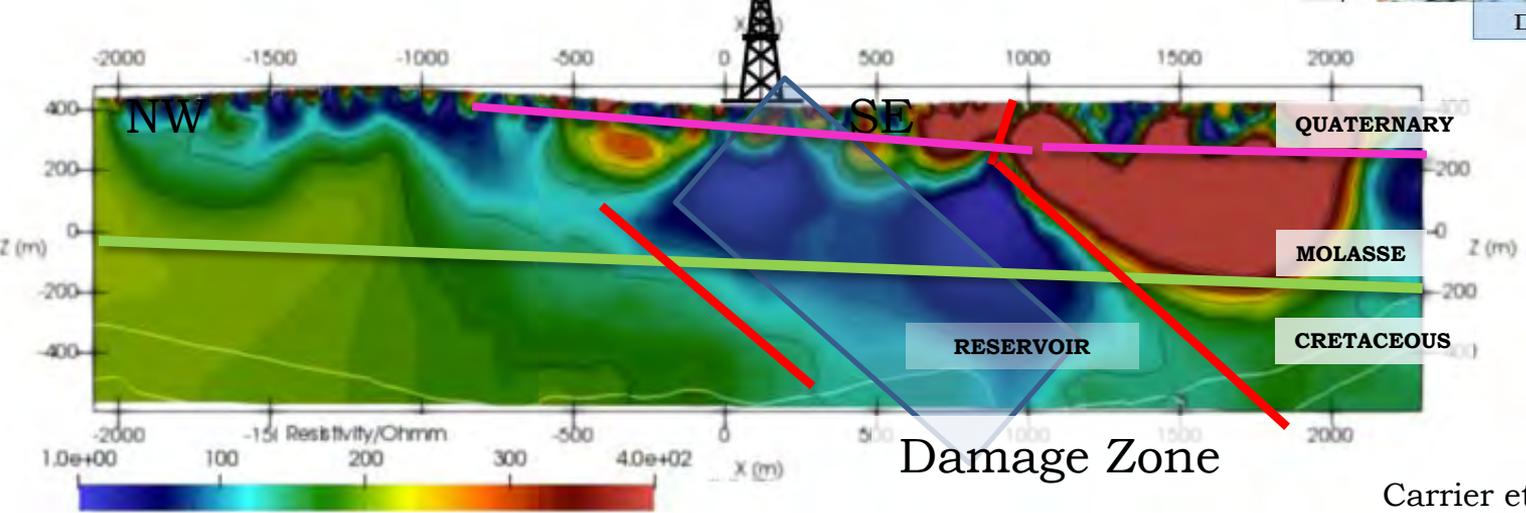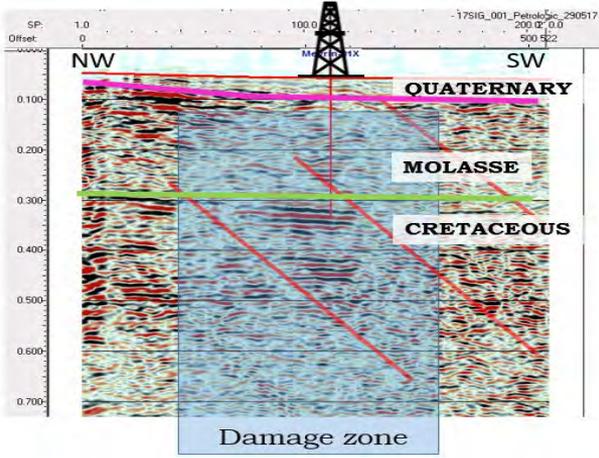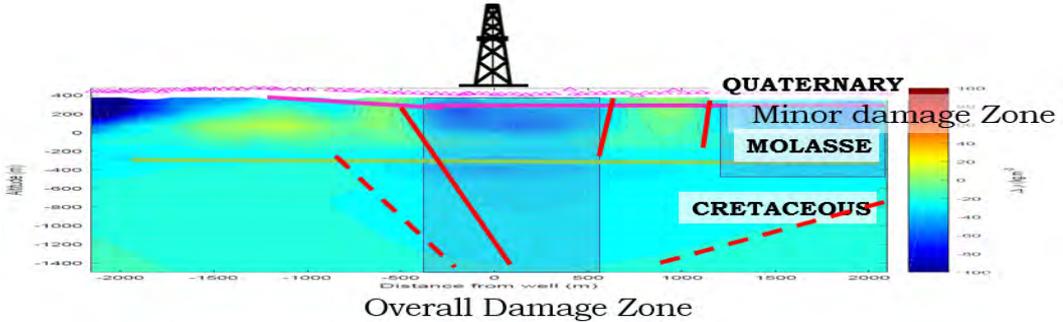
Carrier et al., in prep

Conceptual Model

GEo-01

NW

SE

Quaternary

Molasse

H_2O

Cretaceous
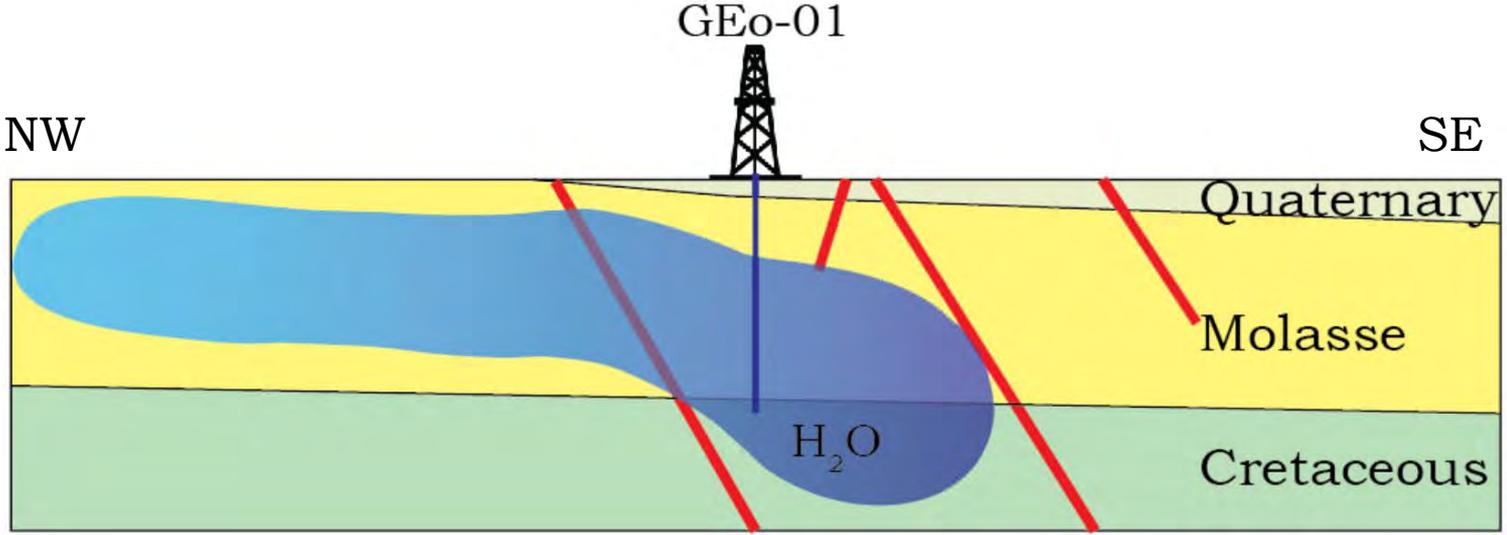
Carrier et al., in prep

Conclusion

- Our vision: an Integrated, Accessible, Open-source workflow to promote easy access to geothermal studies

- **E**lectrical **R**esistivity **T**omography is a powerful, affordable and fast non-invasive prospection method that can be used for the exploration of shallow (i.e. about 1km depth) systems.

- Fulfilling SCCER's spirit of making exploration cheaper, faster and easy to do!!!

Thank you