



UNIVERSITÉ
DE GENÈVE

FACULTÉ DES SCIENCES

Earth and Environmental Sciences



Geothermal exploration in Western Switzerland

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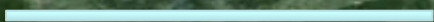
Where is “Western Switzerland” ?



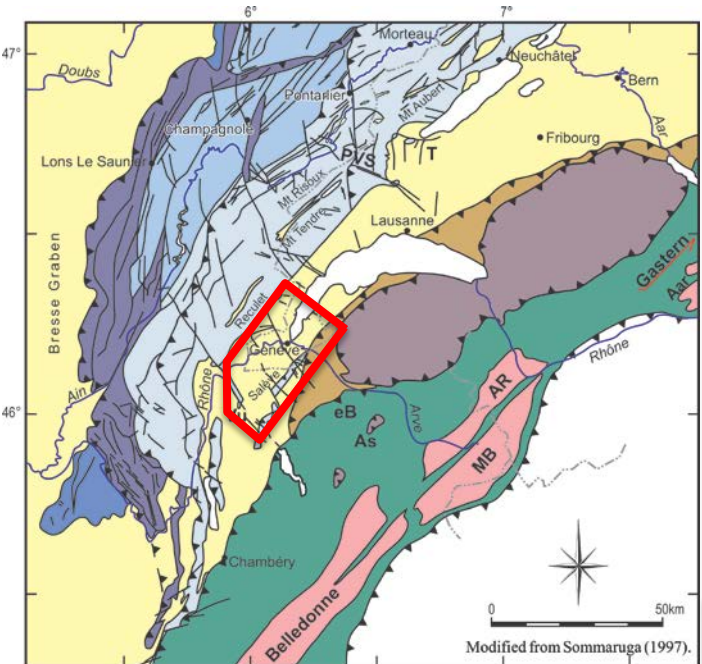
← You are here



10 km



Greater Geneva Basin (GGB)

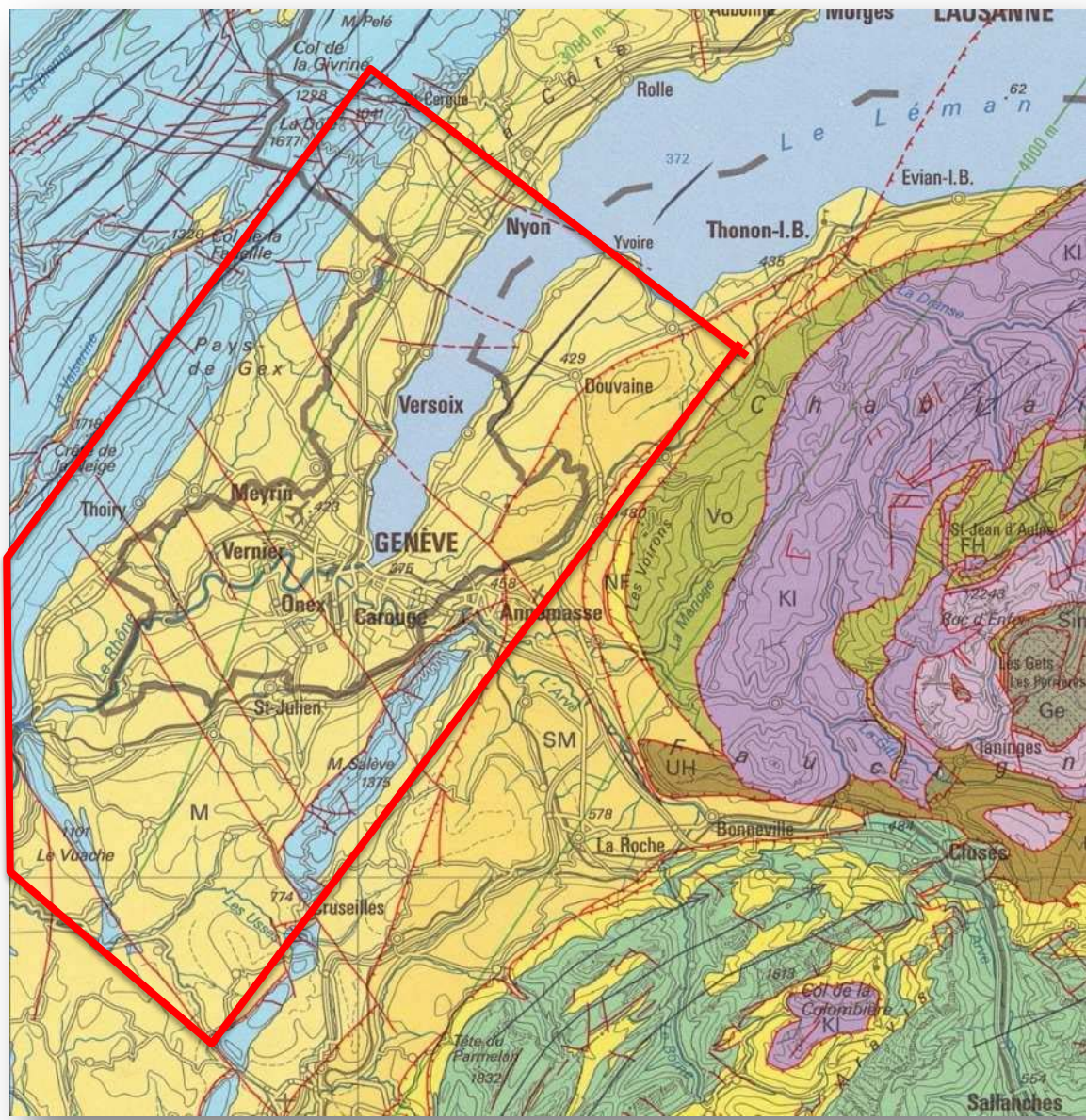


■ Tabular Jura ■ Haute Chaîne (Internal Jura) ■ Prealps
 ■ Faisceau Jura ■ Tertiary Basins ■ External crystalline massifs
 ■ Plateau Jura ■ Subalpine Molasse ■ Subalpine Chains & Helvetic nappes

AR=Aiguilles Rouges, **As**=Aravis, **eB**=external Bornes, **MB**=Mont Blanc
Vu=Vuache fault zone, **PVS**=Pontarlier-Dent de Vaulion-La Sarraz fault area, **T**=Treycovagnes fault zone

↗ Thrust & Major unit contact ↘ Strike-slip fault

Modified from Sommaruga (1997).

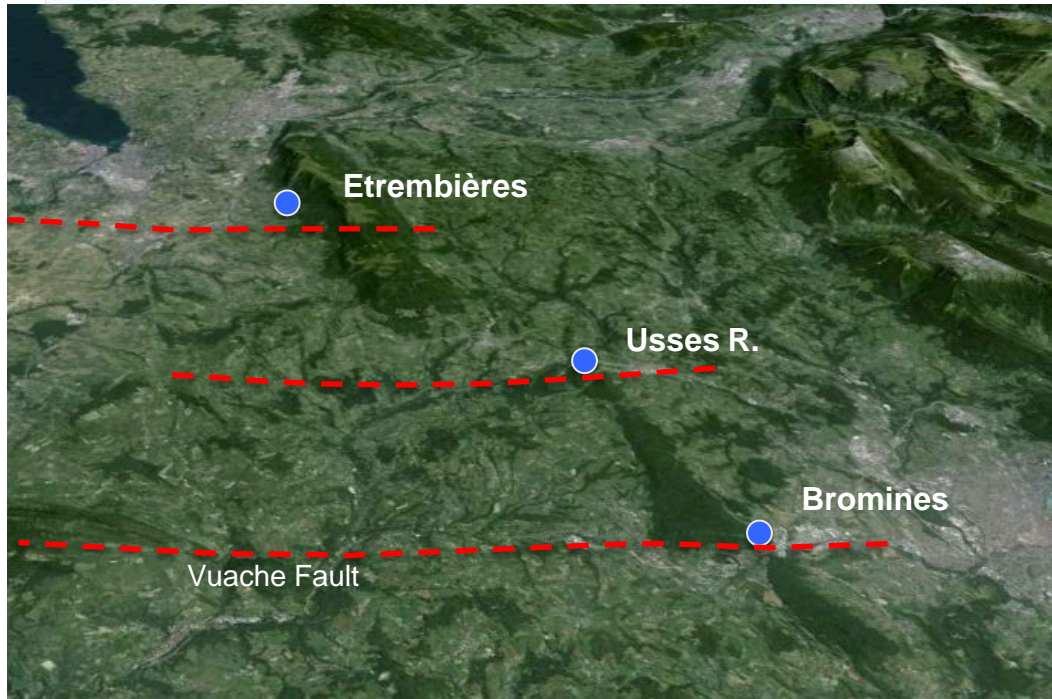


“Western Switzerland” Geological framework

GGB Geothermal Exploration: a glance into the past

Hydrothermal sources associated with mineral-rich hot springs (up to 23° C at surface) have been known since the **XVth century**.

Likely associated with large fault systems as indicated by the effects on Bromines spring following the Vuache Fault reactivation in 1996 (**M1:5.3**)



GGB Geothermal Exploration: a glance into the past

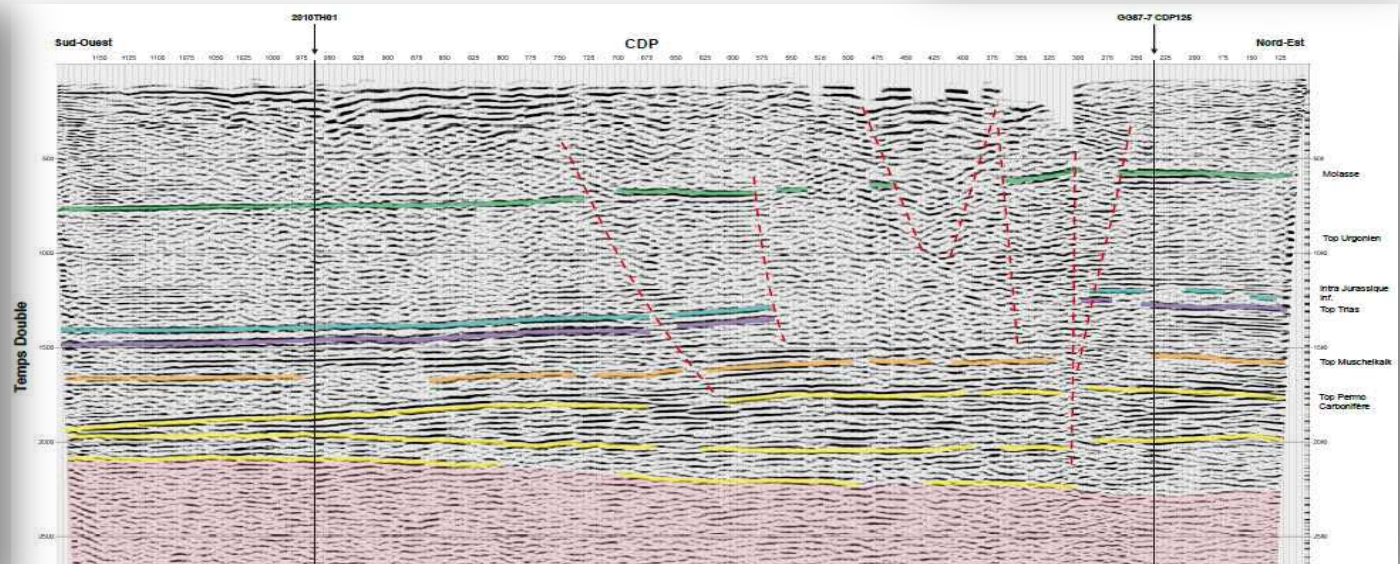
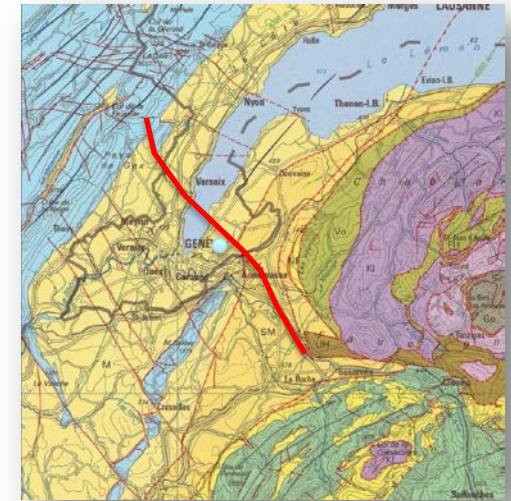
Early 1990's the Canton of Geneva acquired several seismic lines and then drilled an exploratory geothermal well Thônex-1 (1993).

TD: 2690 m bdf; Upper Jurassic (Malm).

Reservoir $T^{\circ} C = 75 \pm 10$ - Gradient $34.5^{\circ} C/km$

Long transit time (10-15k years)

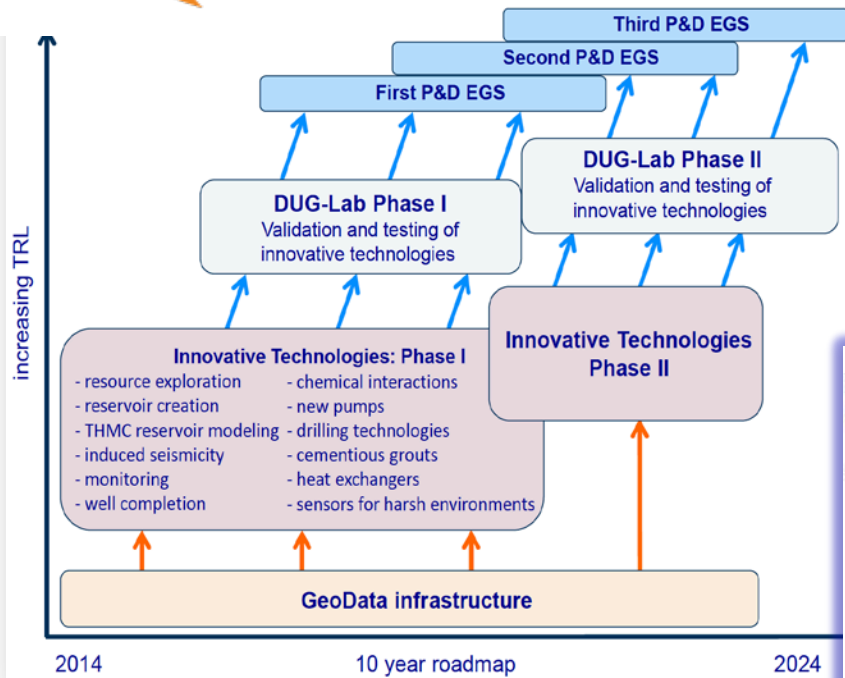
Basin: extensive low-K reservoir, likely not connected with deep geothermal fluxes connected to large faults.



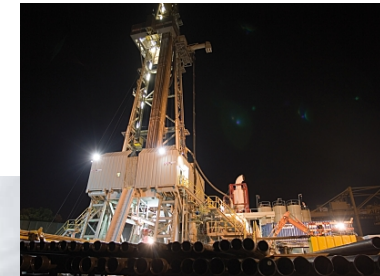
Swiss Geothermal Journey...



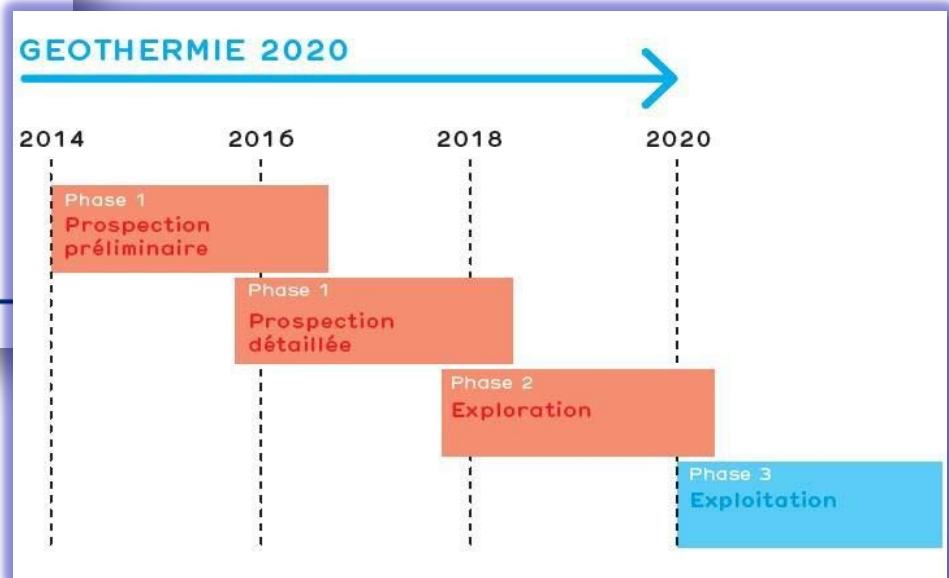
Roadmap DGE 2014



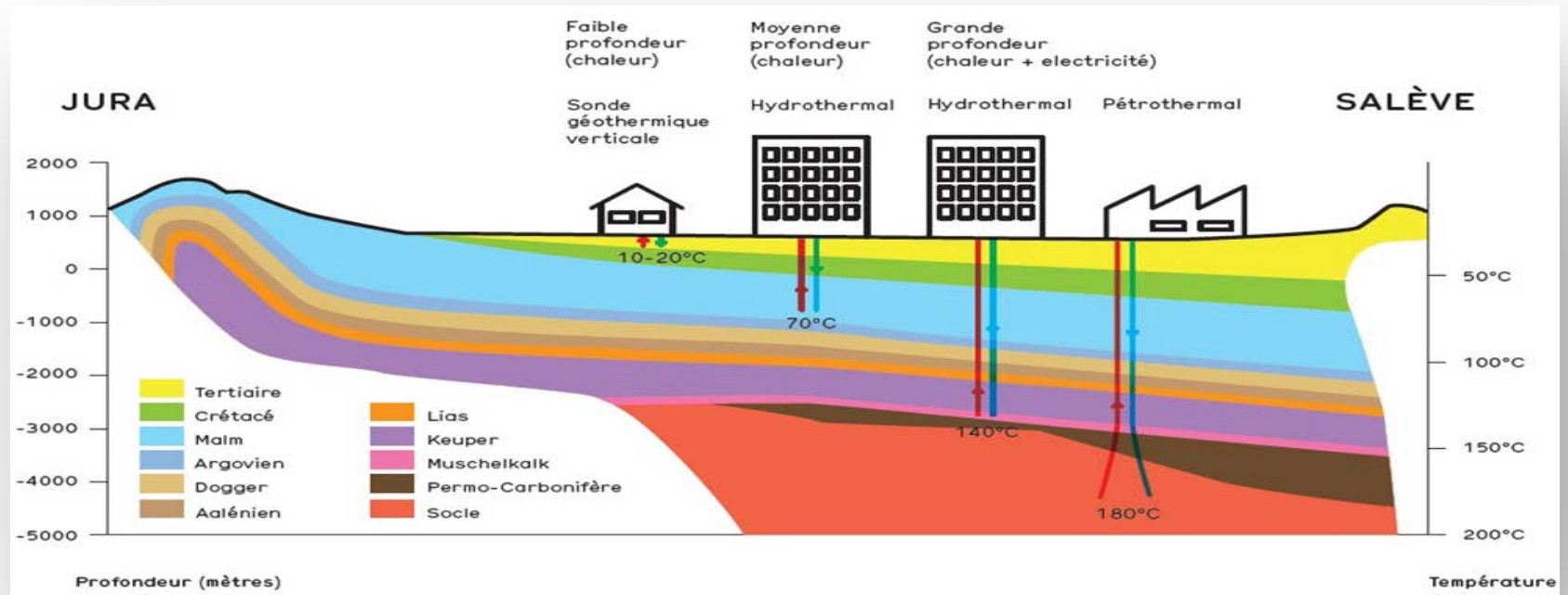
Bildraum des St. Galler Geothermiewerks (Archiv/Parsons)



- 1994 Riehen
- 2006 Bale
- 2011 Schlattingen
- 2012 St. Gallen



GEothermie 2020: What do we know and what can we do?



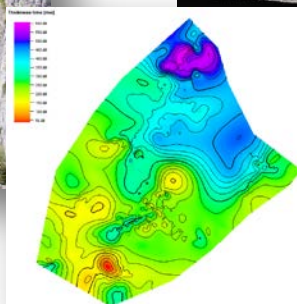
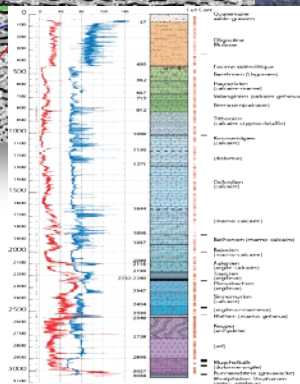
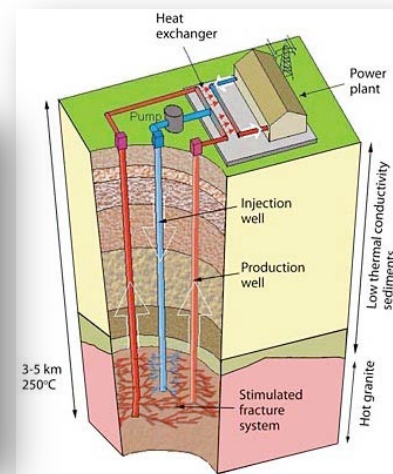
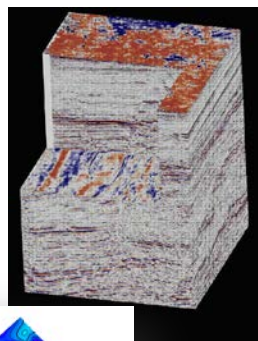
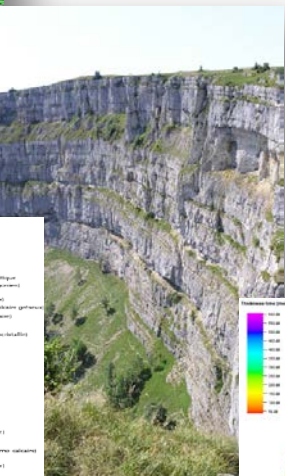
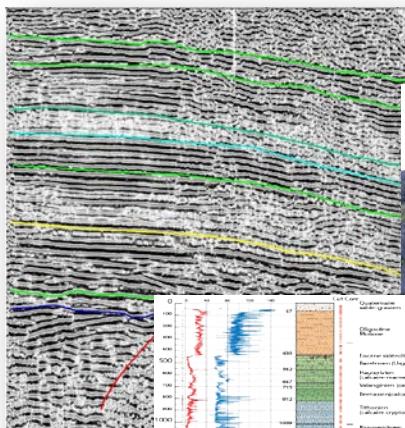
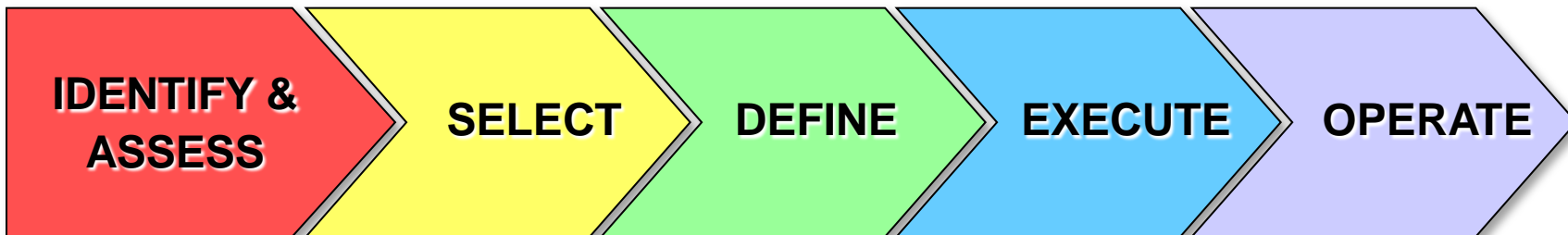
What are our options ?

Is Deep Geothermal Energy the only way forward ?

What about other geo-resources / risks or opportunities?

etc...

Geo-energy journey

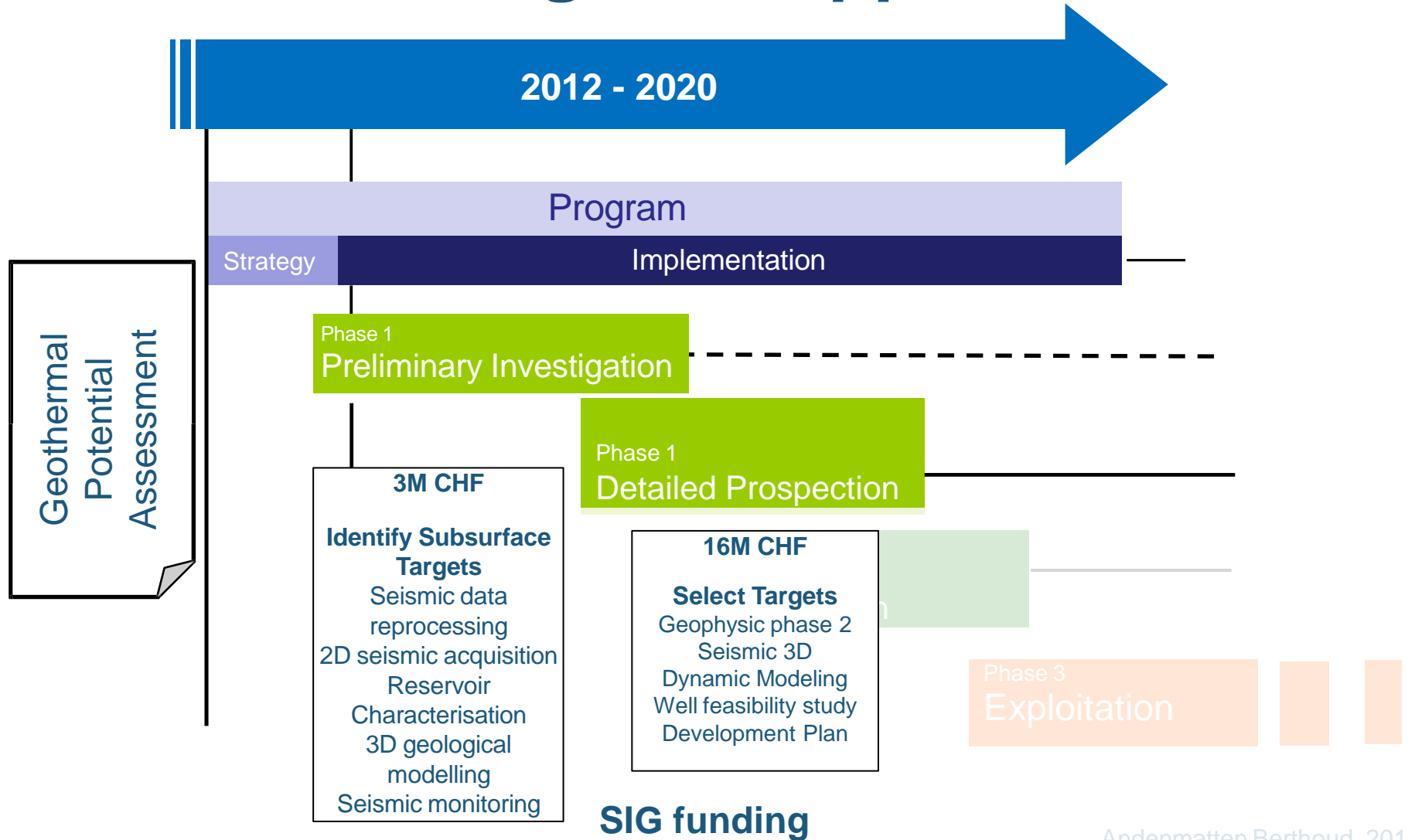


← Where we are now →

Geothermal Energy



“GEothermie 2020” program: an integrated approach



Andenmatten Berthoud, 2014

“GEothermie 2020” & SCCER-SoE task force



Dr. Michel Meyer, Dr. Carole Nawratil De Bono



**Nathalie Andenmatten Berthoud, Sabrina Serier,
Gabriel De Los Cobos, Jacques Martelain (GESDEC)**

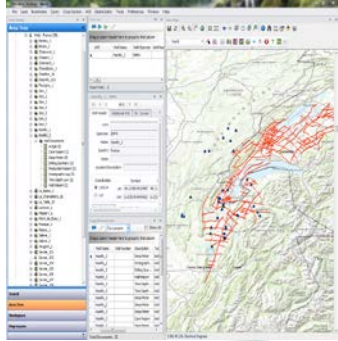


**Aurélie Angéloz, Maud Brentini, Nicolas Clerc,
Stephanie Favre, Elme Rusillon,**

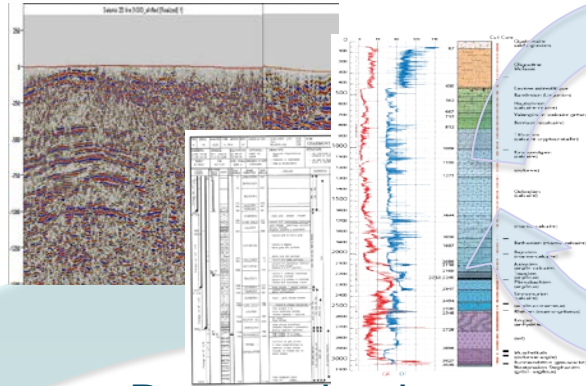
**Dr. Cyril Chelle-Michou, Dr. Damien Do Couto, Dr.
Branimir Segvic**

**Prof. Andrea Moscariello, Prof. Matteo Lupi,
Dr. Elias Samankassou, Dr. Gregory Giuliani, Dr.
Mario Sartori, Prof. Anthony Lehmann, Prof. Bernard
Lachal, Dr. Jérôme Faessler.**

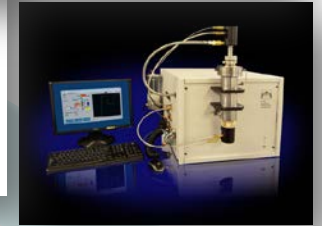
UNIGE WORKFLOW



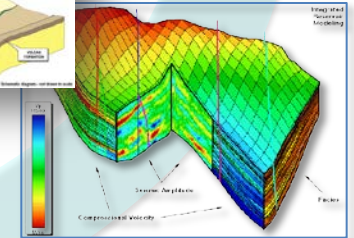
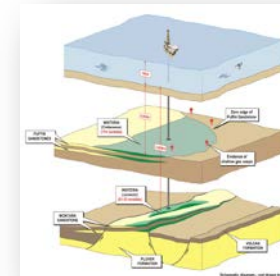
Knowledge Base



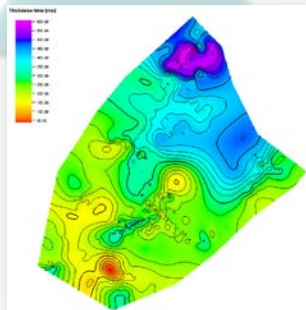
Data evaluation



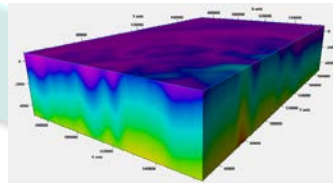
Data acquisition



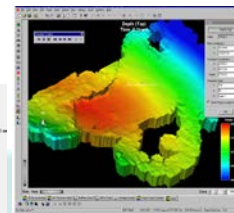
Conceptual Geological Model (rocks & properties)



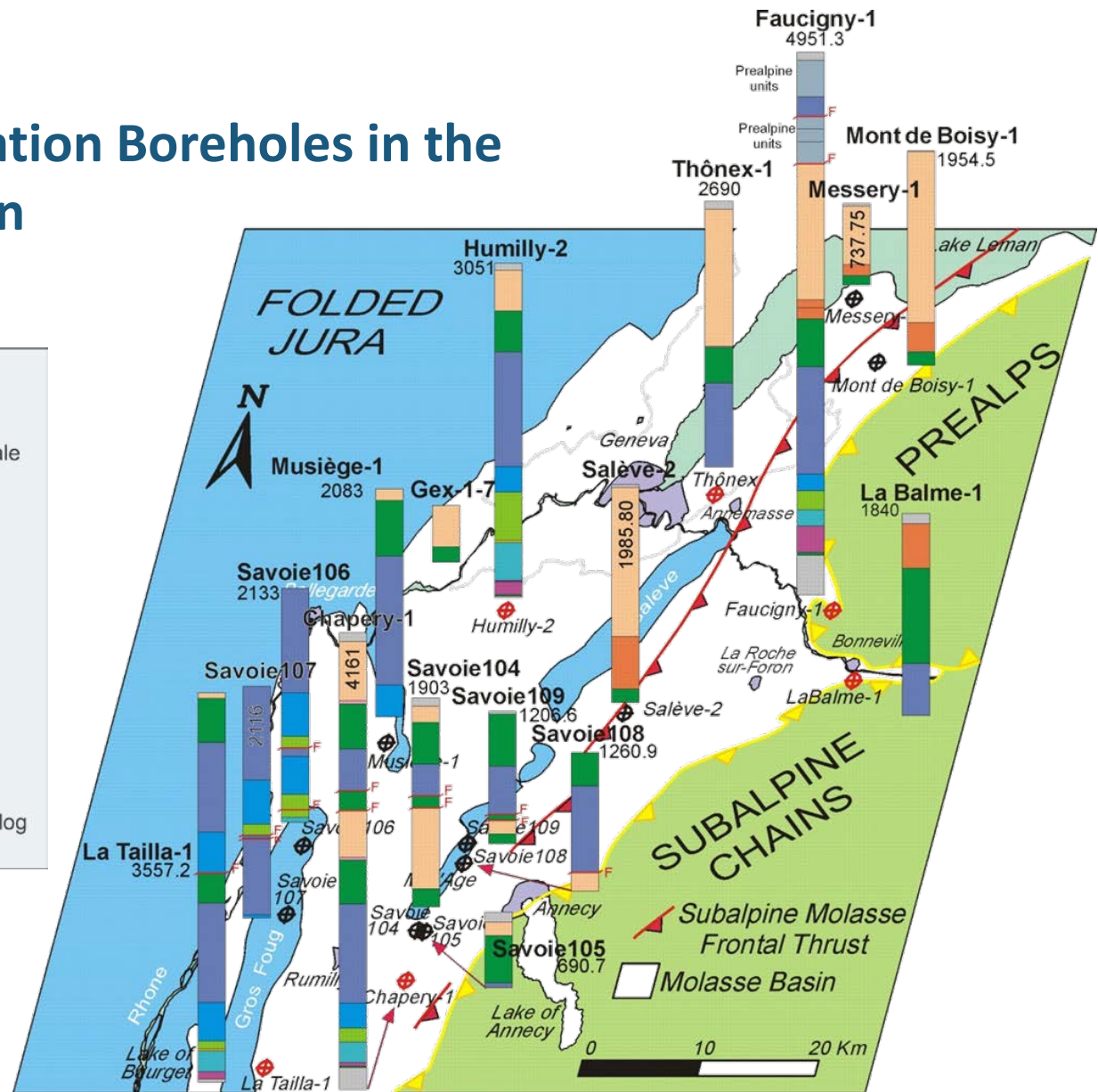
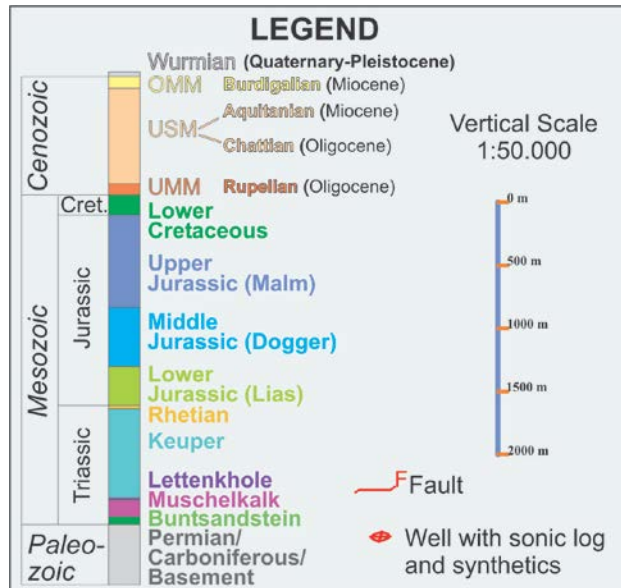
Prospect Identification and Assessment



Basin and Reservoir Modeling



DATA BASE: Hydrocarbon Exploration Boreholes in the Greater Geneva Basin



Paolacci, 2012 unpublished

Knowledge & Data Base

- Data & documents: knowledge of > 50 years of field work and data acquisition

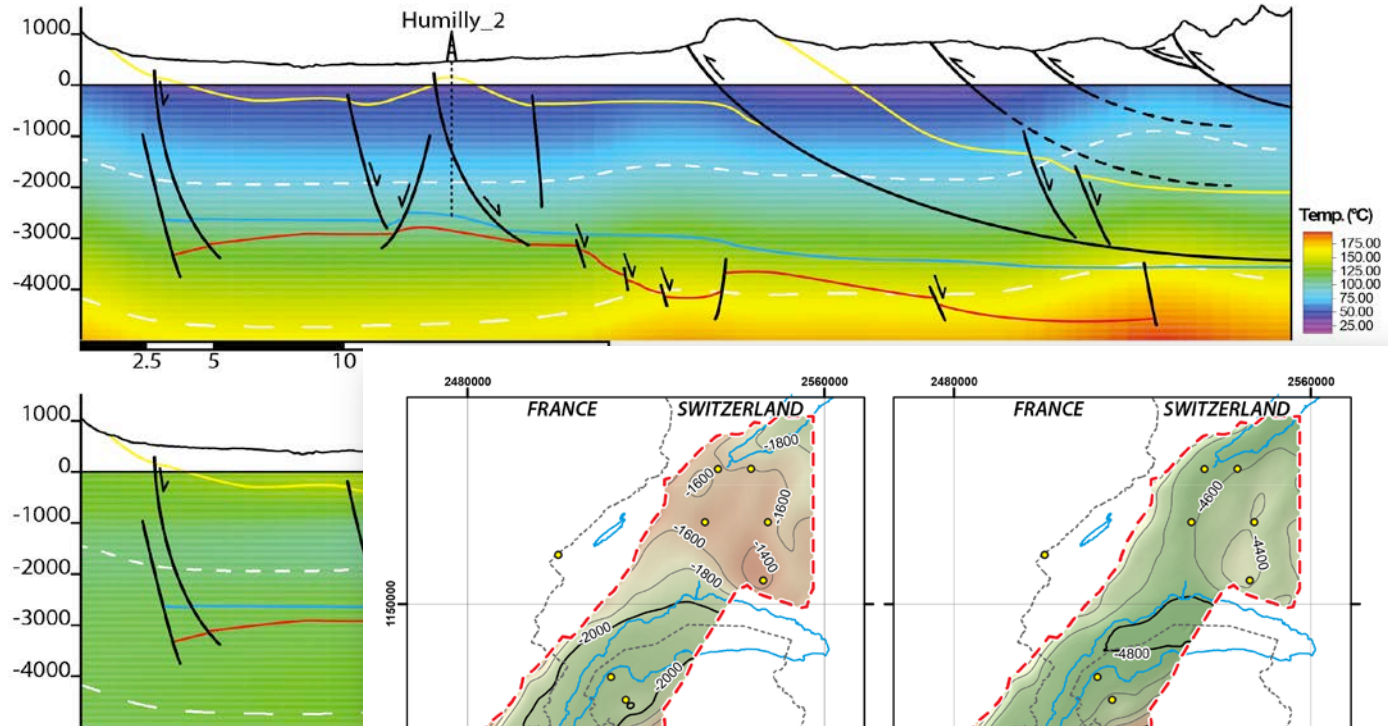
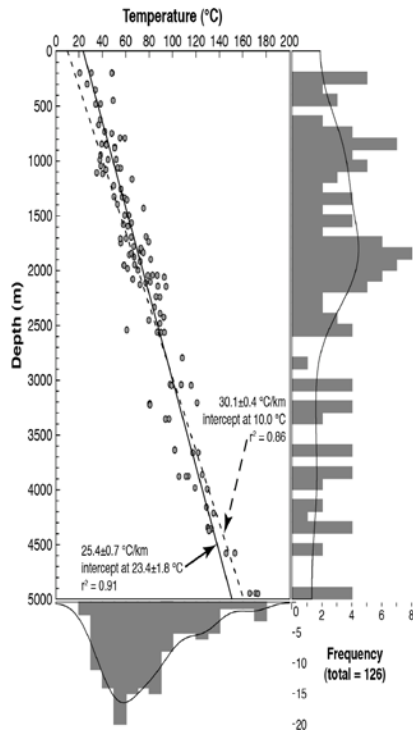
The screenshot displays a complex software interface for geological data management. It features several overlapping windows:

- Area Tree:** A hierarchical tree view on the left side, listing wells and documents such as 'Wells - France (38)', 'Bron_1', 'Charente_1', and 'Savoie_307'.
- Well View:** A central window showing detailed information for a selected well, including 'Well Name', 'Well Number', 'Description', and 'Type'. It also displays coordinates and location details.
- Log/Document View:** A window showing a list of logs and documents associated with the well, such as 'Core Report (1)', 'Deep Meter (6)', and 'Stratigraphic Log (1)'.
- Seismic Data View:** A window on the right displaying a 2D seismic image with a color scale ranging from 0 to 4000. The image shows complex geological patterns.
- Identify/Processing Panel:** A panel on the right side of the seismic view, providing options for 'Identify', 'Processing', and 'Display Mode'.

At the bottom right of the seismic image, there is a purple text box listing the types of data available:

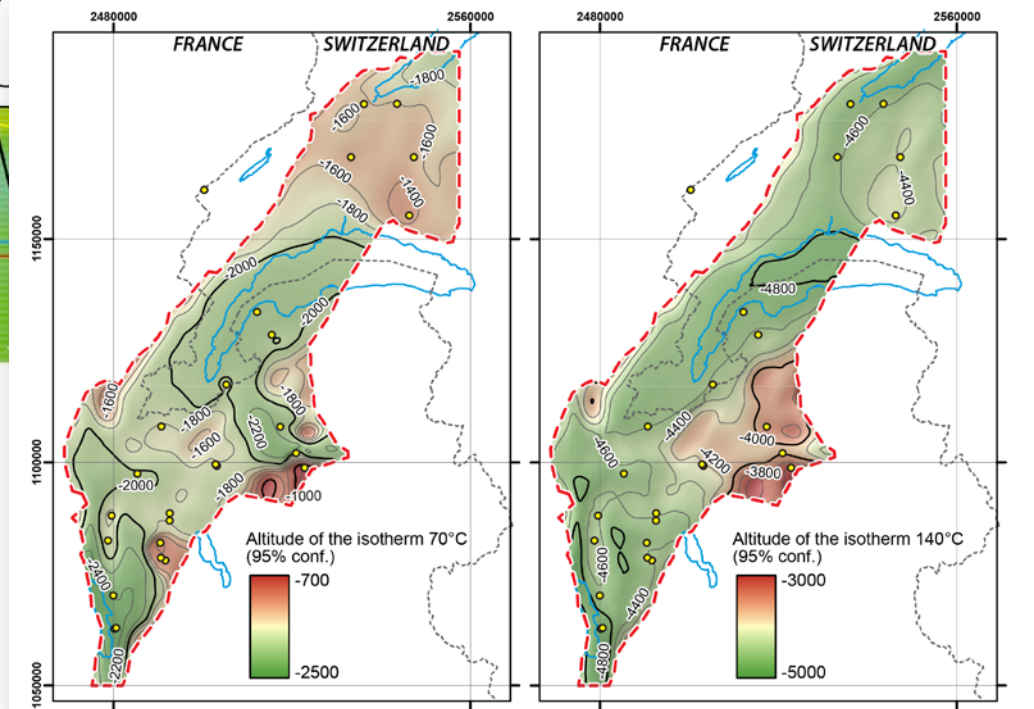
- Well completion logs
- Digital E-logs
- 2D seismic (image & .sgy)
- Core photos
- Conventional Core Analysis
- Temperature and fluid data
- TOC and %Ro

Is the GGB subsurface hot enough ?



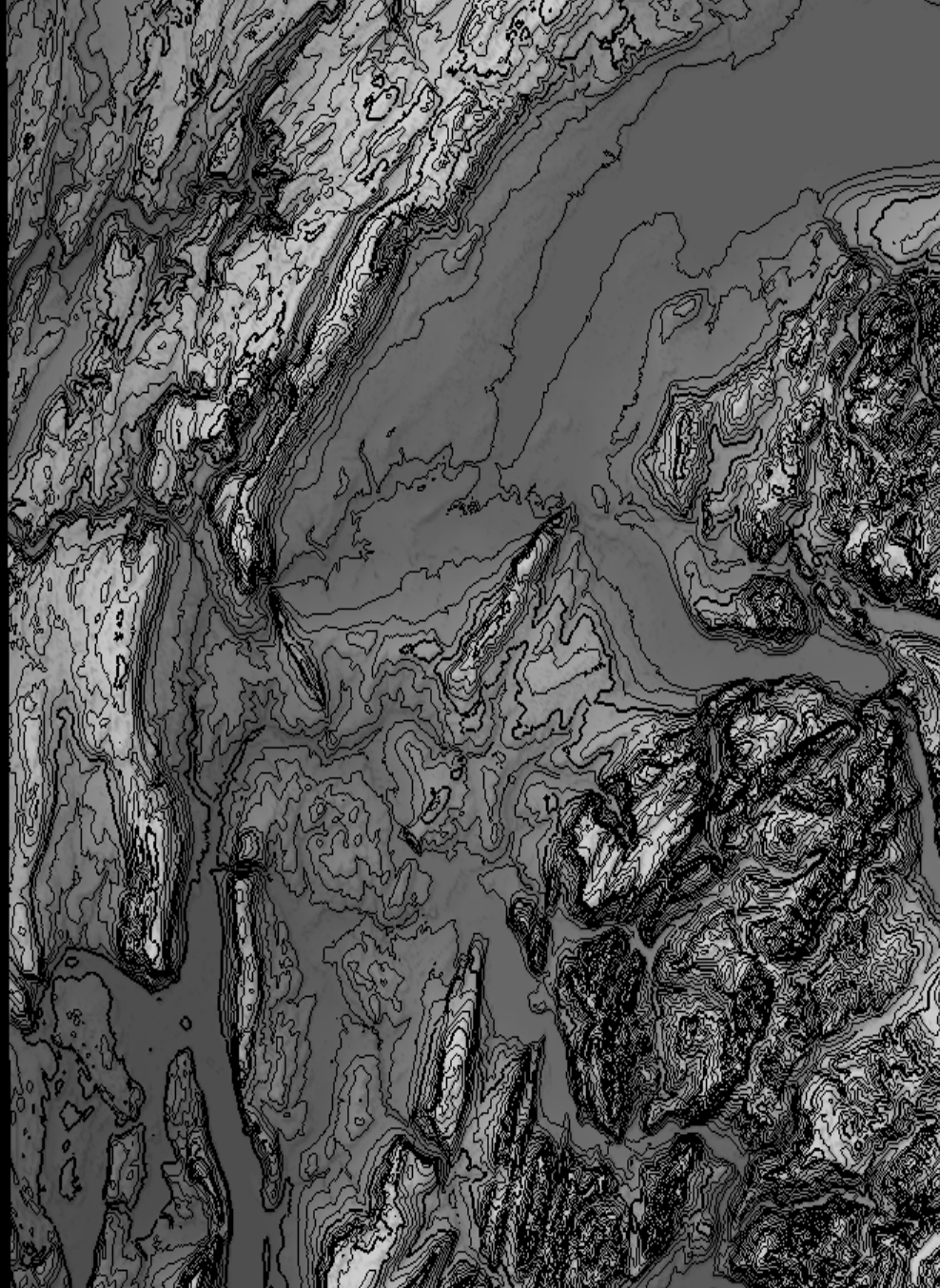
Average thermal gradient
(corrected BHT) of
25.4 ° C/km

Based on #26 deep boreholes from Western
Switzerland and Savoie (transect Aix-les-Bains –
Yverdon-les-Bains)

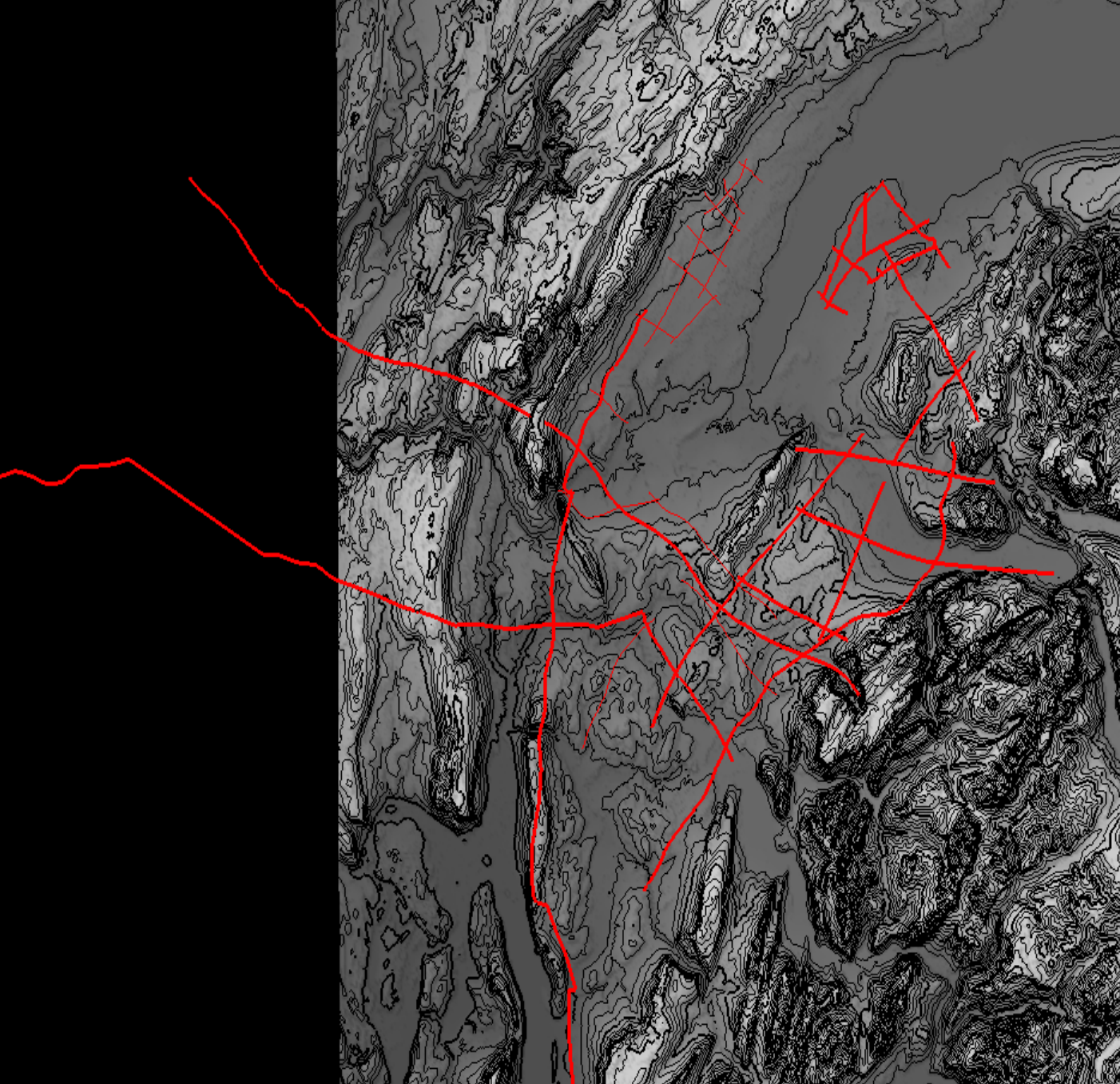


Chelle-Michou et al., in prep.

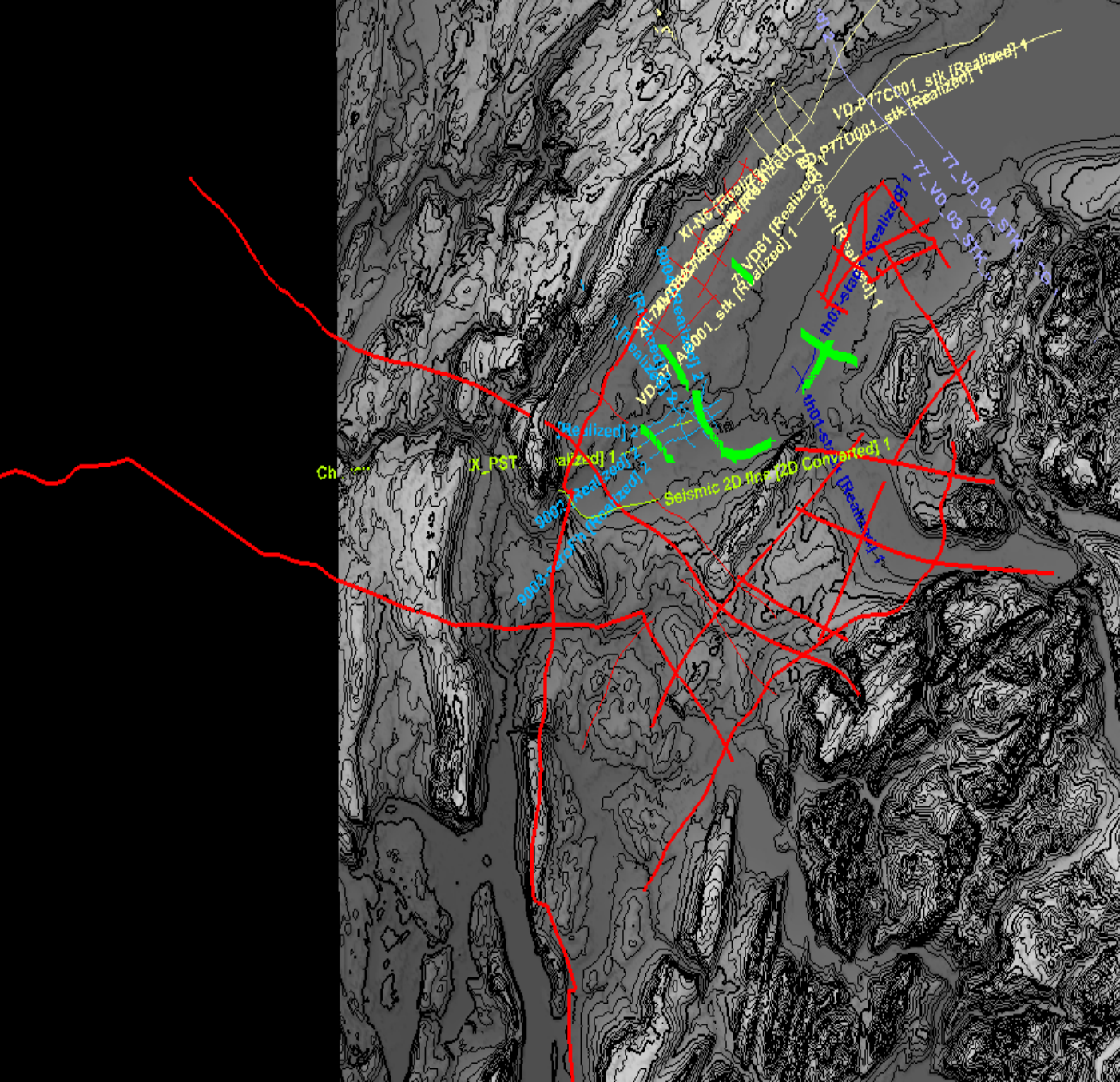
Seismic data base



GEOMOL
INTERREG
project

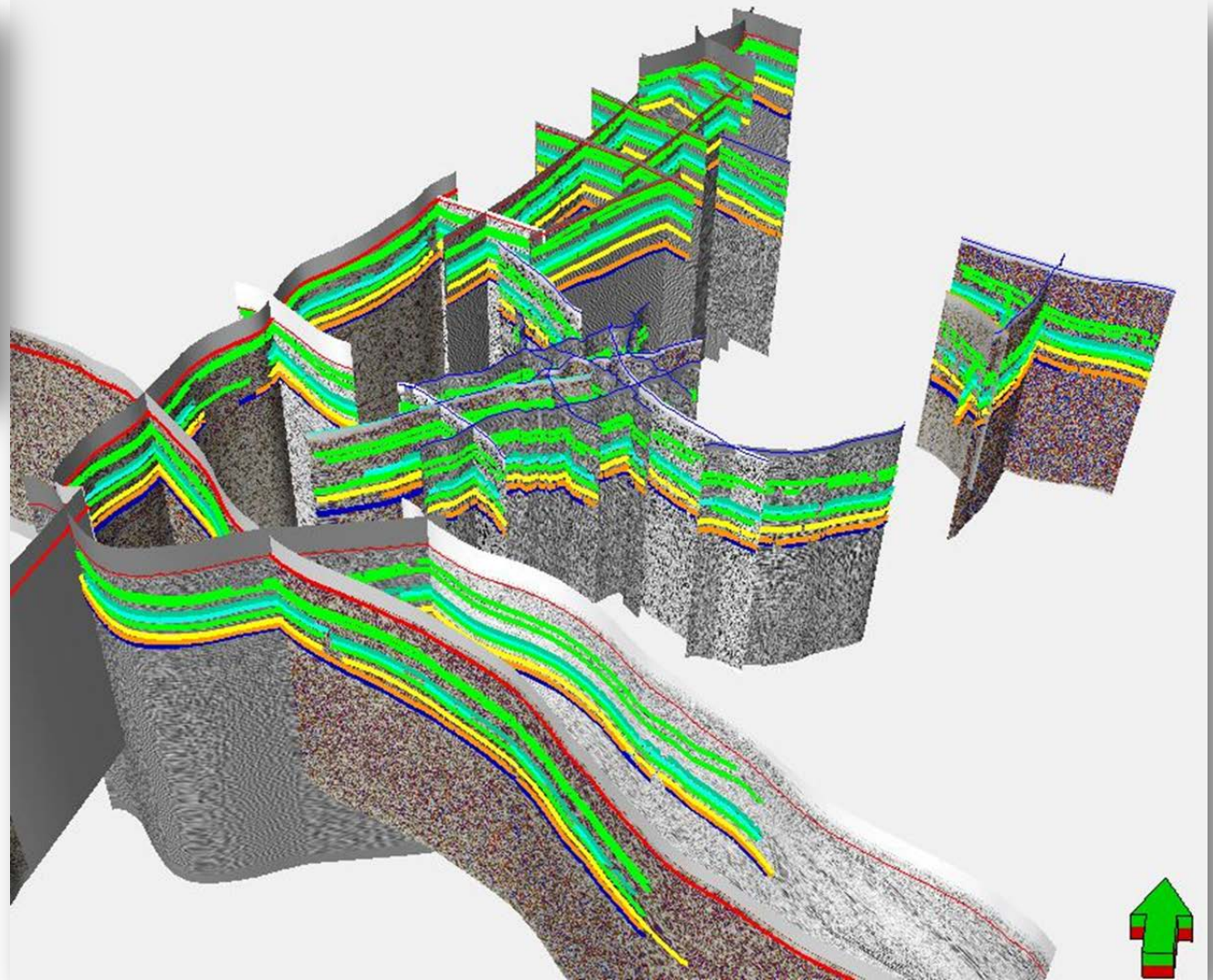


GEOMOL
INTERREG
project



GEOMOL
INTERREG
project

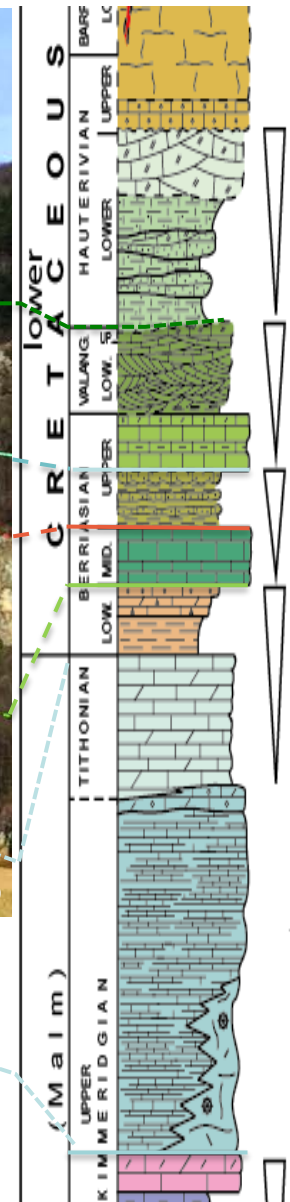
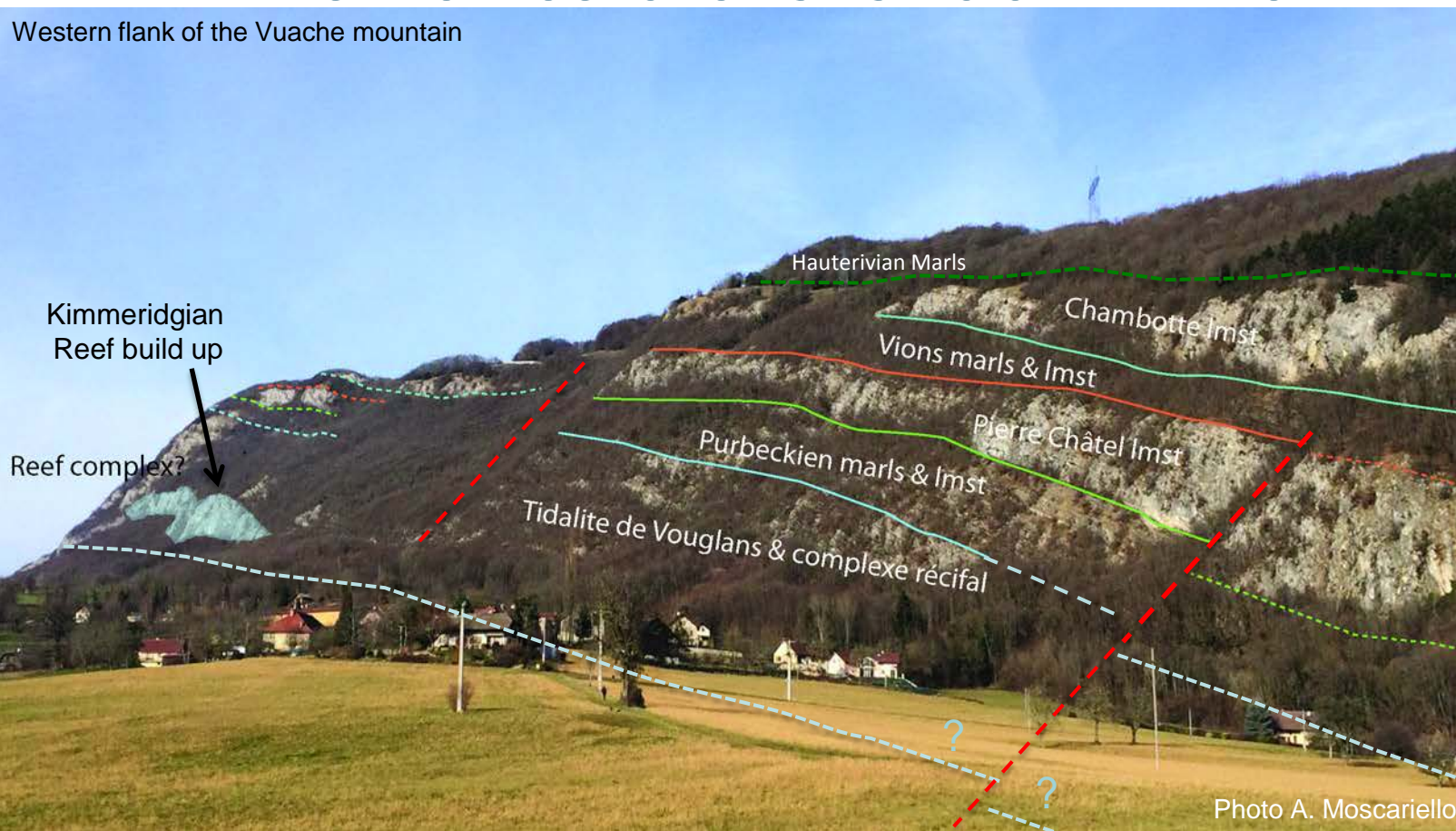
DATA EVALUATION: SEISMIC INTERPRETATION



Clerc N. et al., in prep.

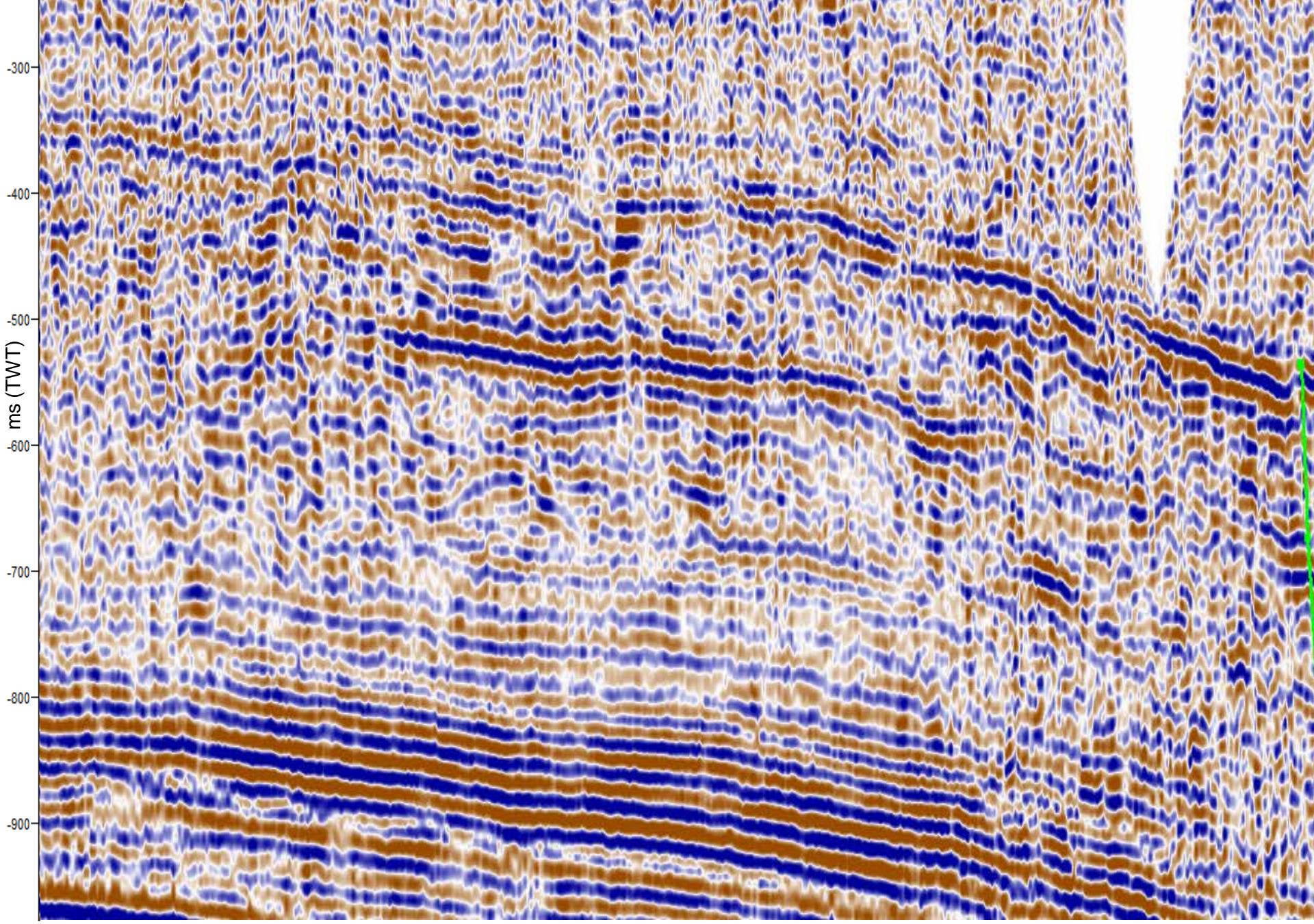
DATA EVALUATION: OUTCROP SEISMIC CALIBRATION

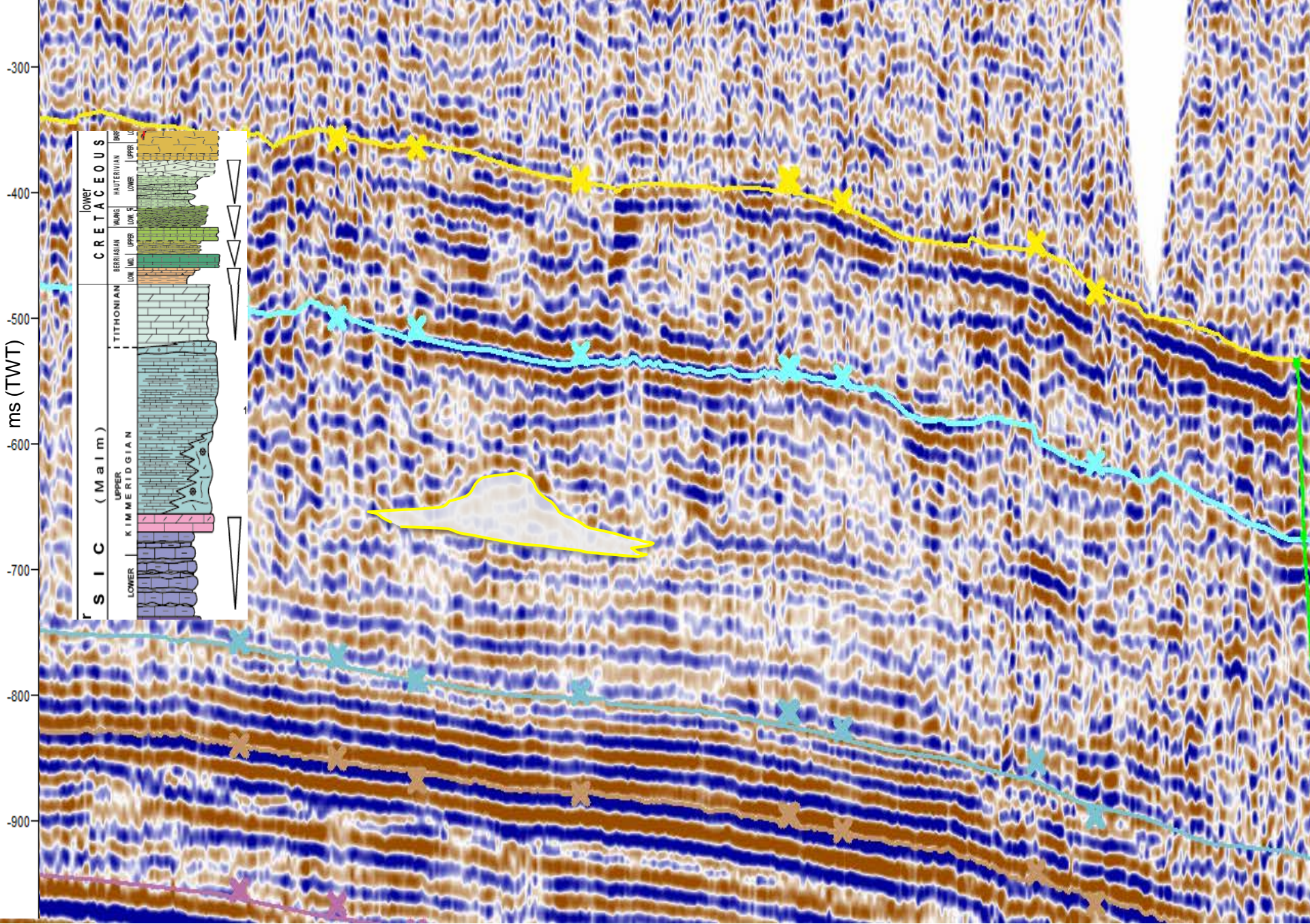
Western flank of the Vuache mountain



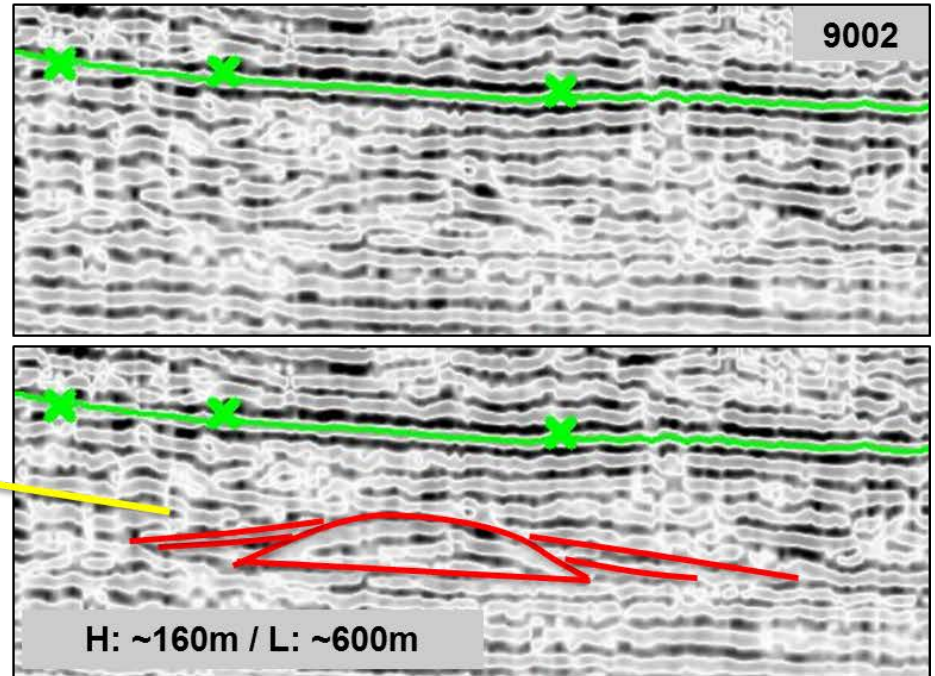
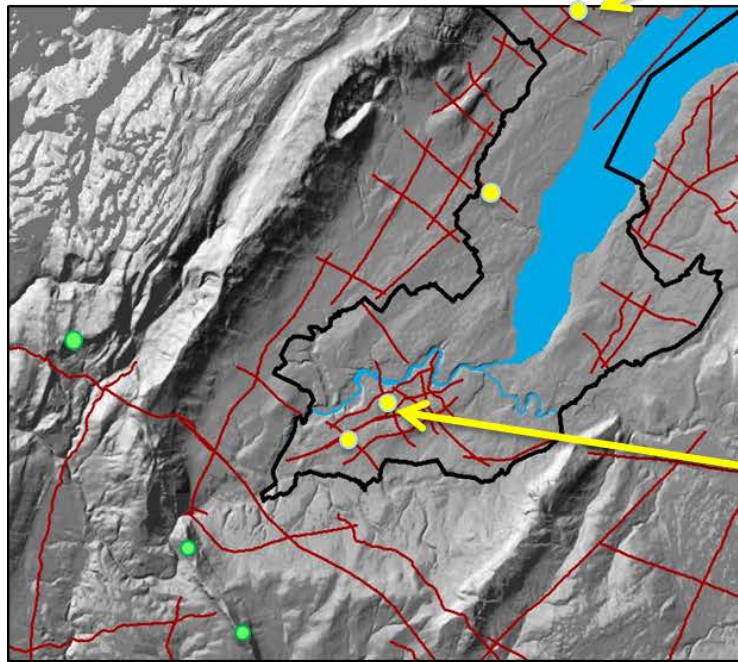
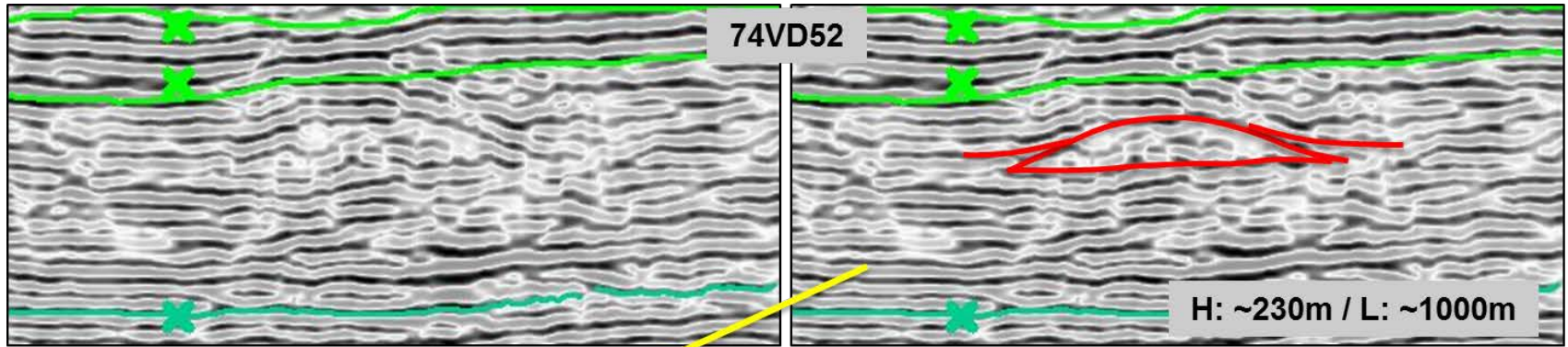
Reservoir stratigraphy and architecture:

- Sedimentary body geometry,
- Changes in vertical stacking pattern and lateral sediment composition (facies).
- Role of syn-sedimentary tectonic.



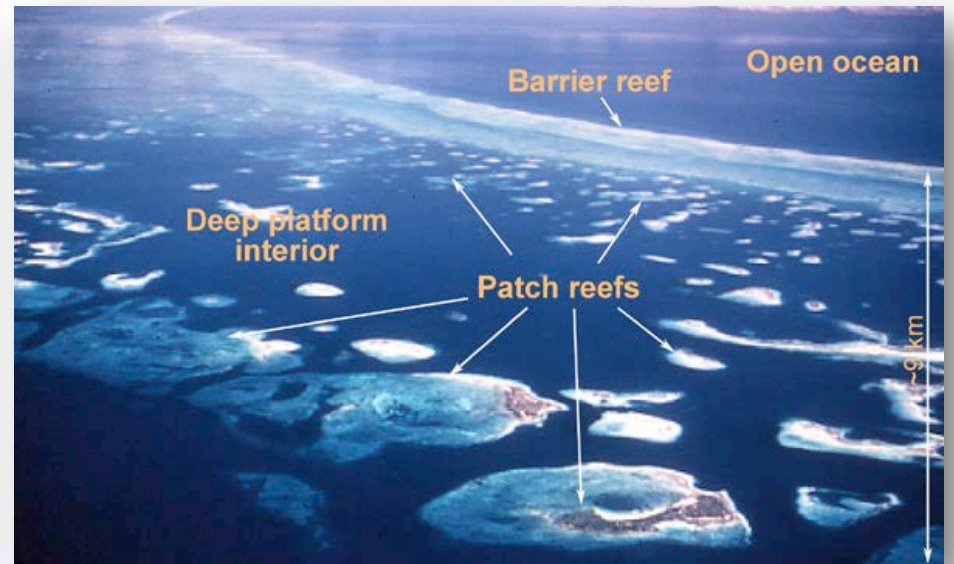
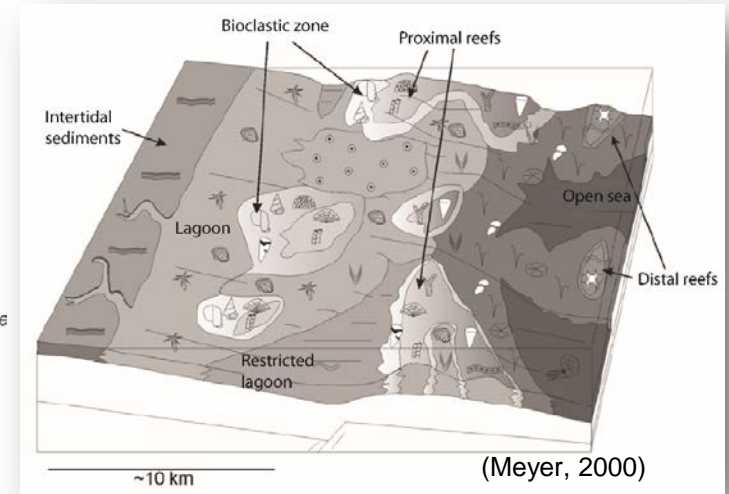
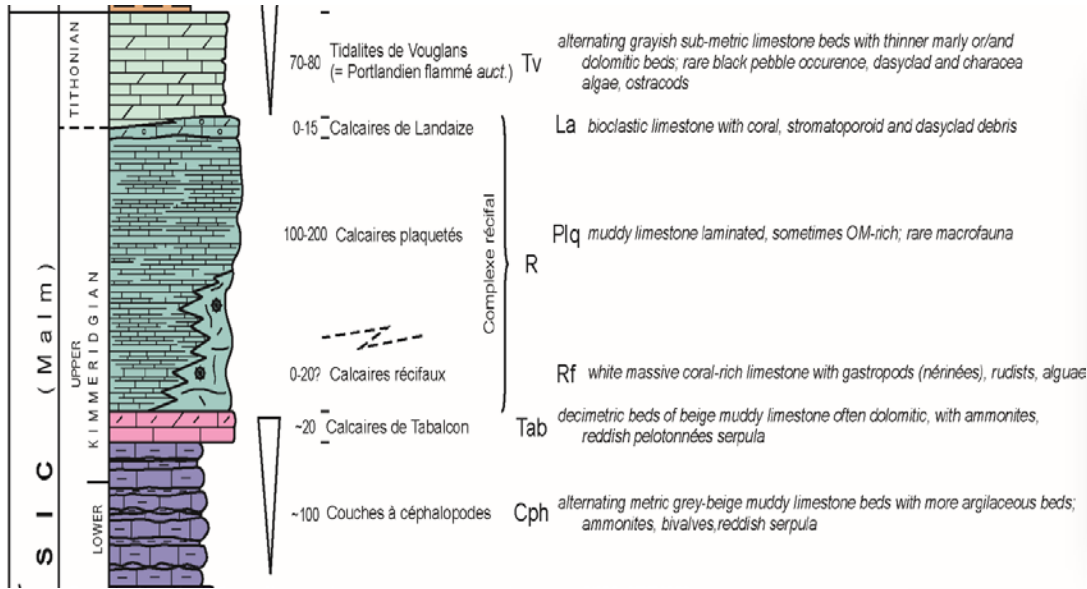


Kimmeridgian reef build-ups on 2D seismic?

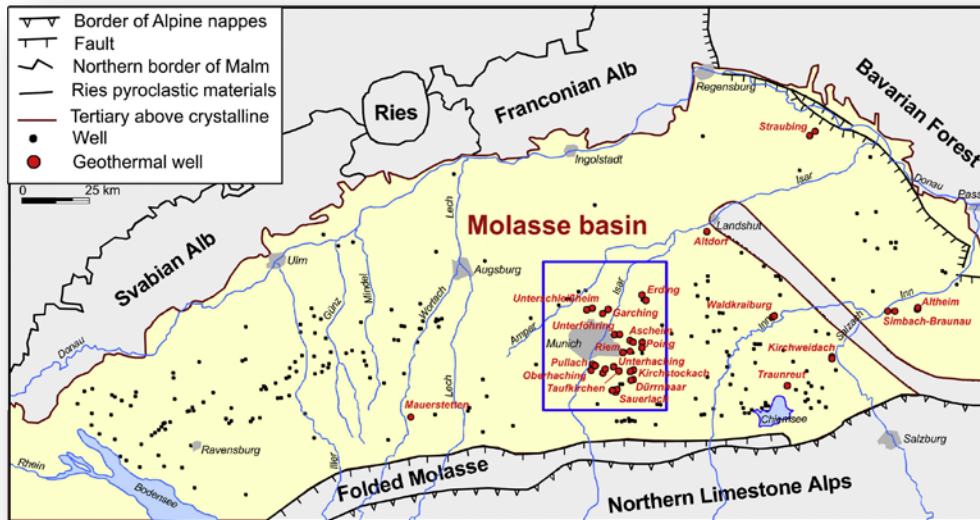


Clerc et al., in prep.

Geological setting: the Kimmeridgian Reef build ups

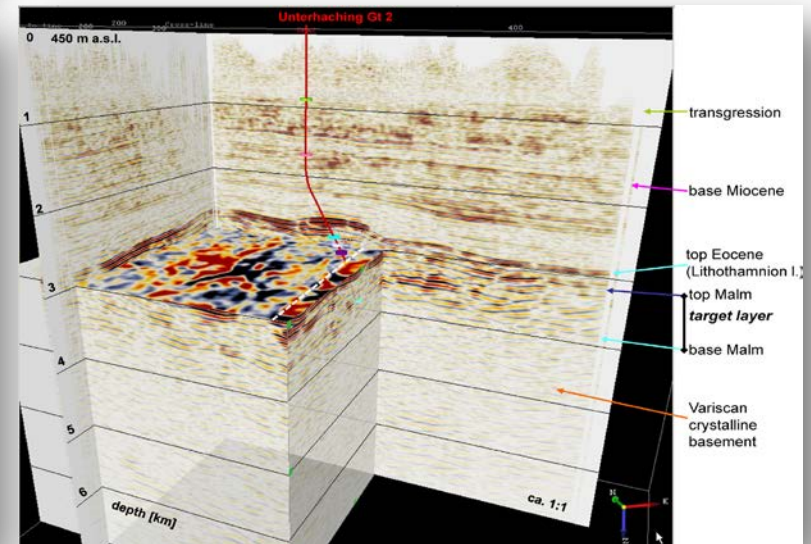
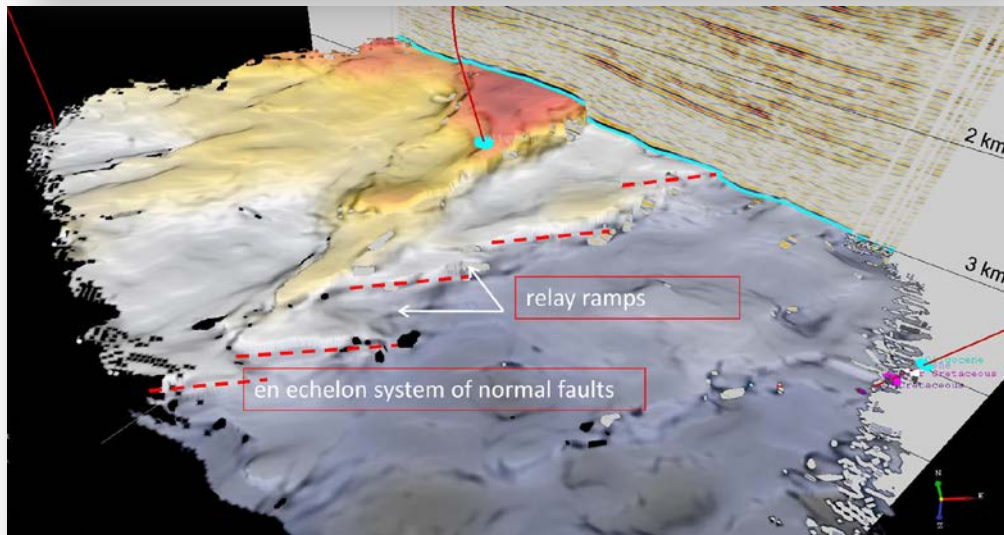


Could the Kimmeridgian reefs work as geothermal reservoir ?



Malm / Kimmeridgian Reef Complex: a possible good reservoir analogue from eastern Molasse Basin (Munich)

Lüschen et al., 2014

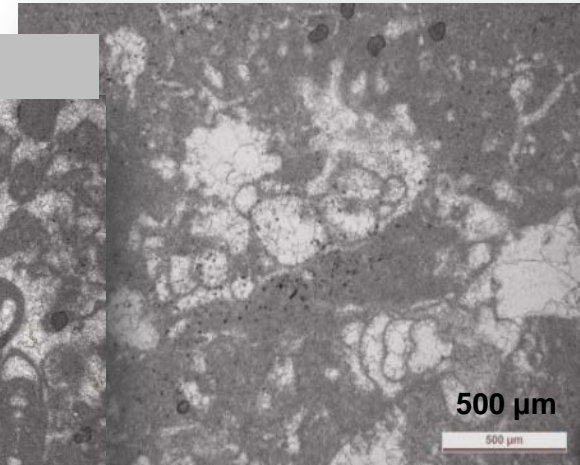
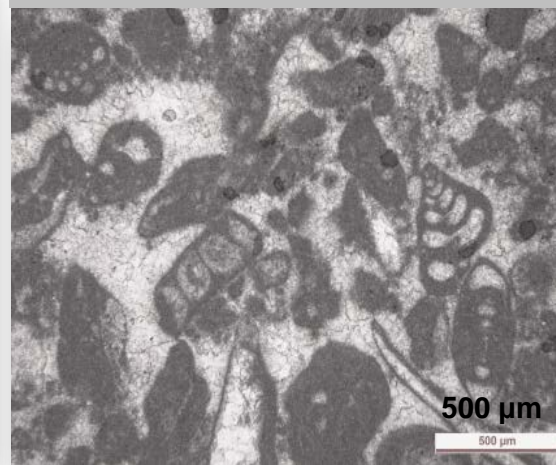


Carbonate Reservoir Characterization

Rudstone, Bioclastic peri-reefal zone



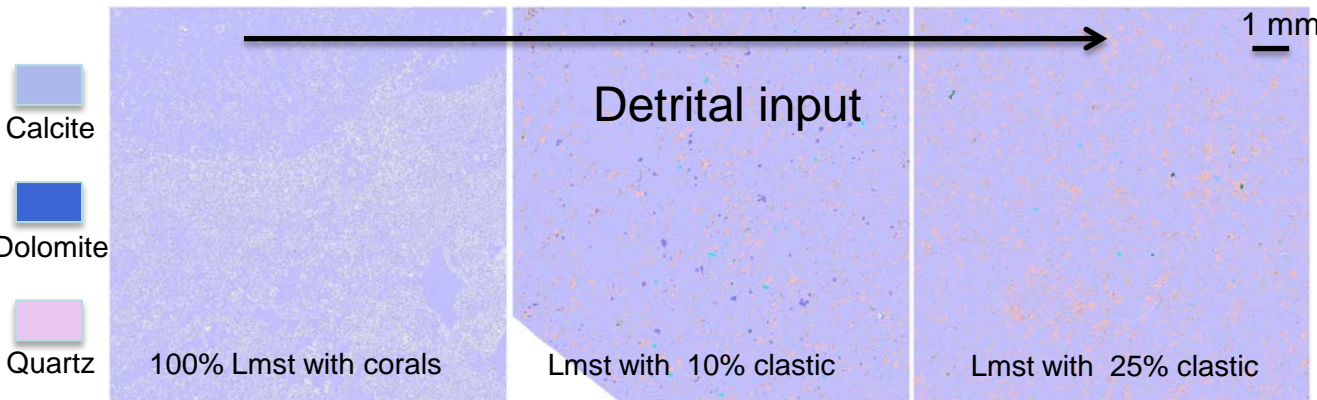
Boundstone, Proximal reef



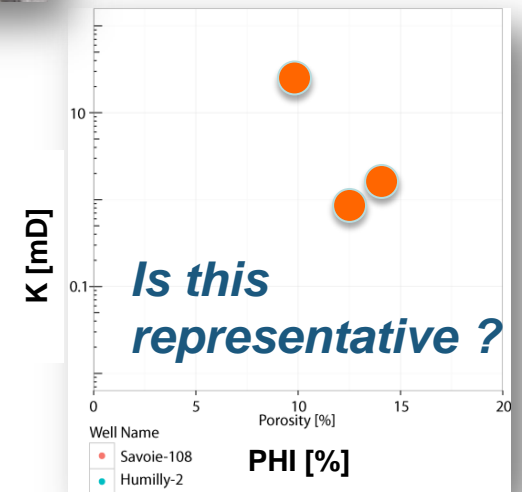
Well Savoie-108

3.5 cm

Well Humilly-2



QEMSCAN images



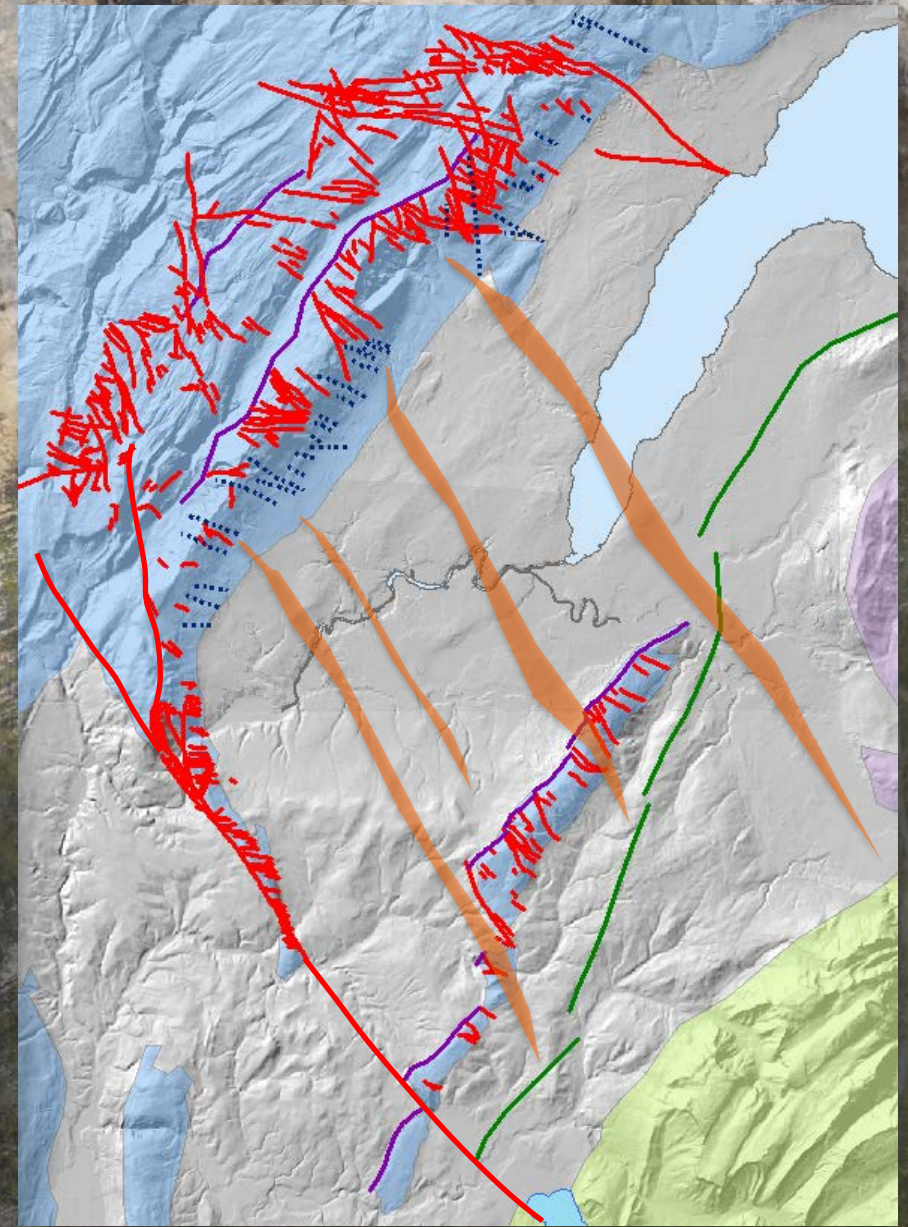
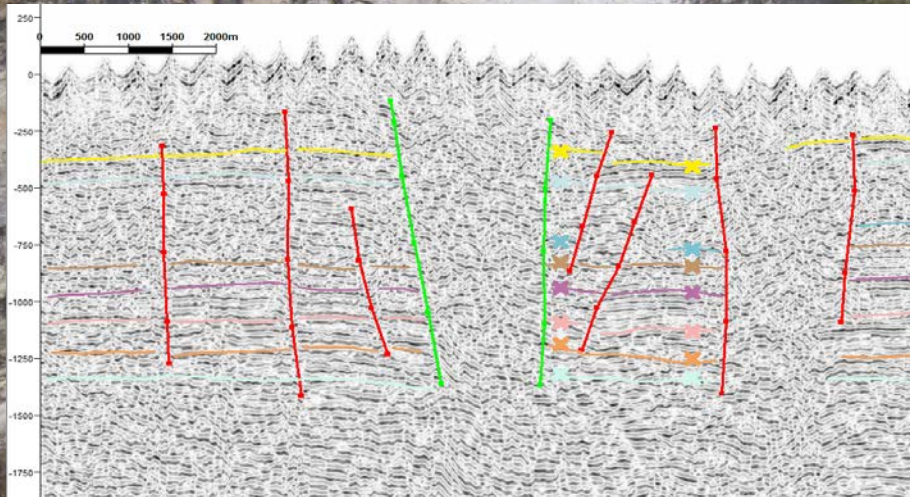
Rusillon et al., in prep.

FAULT & FRACTURE MODELLING

Structural model based on integration of observation from surface geology (outcrops), remote sensing and seismic interpretation.

Are there reservoir units more fractured than other ?

(geomechanical stratigraphy)



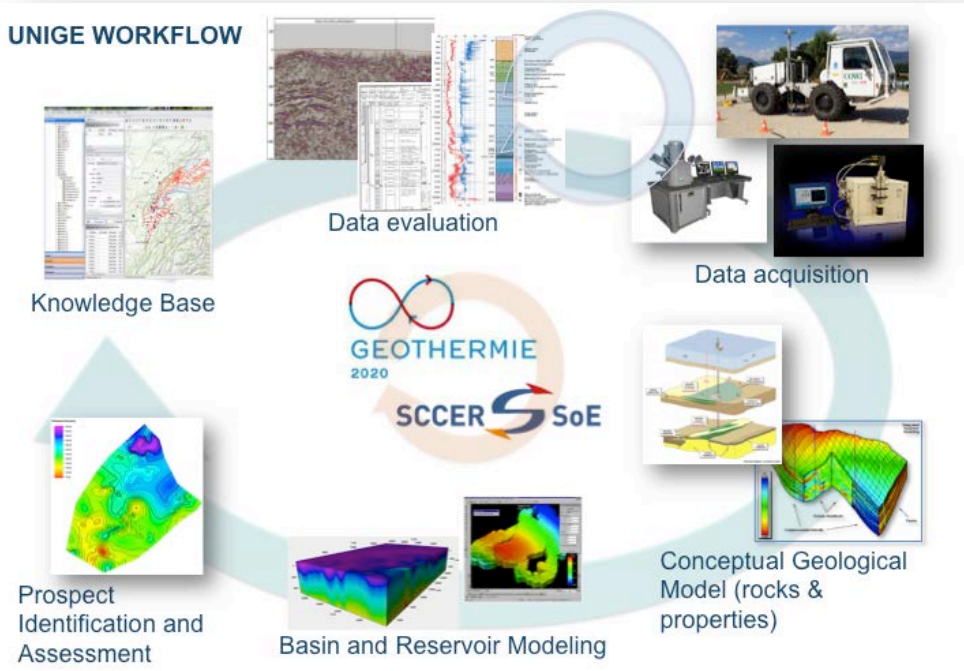
Vuache Fault Mandellaz Mountain

Photo A. Moscarillo 2015

UNIGE Tasks & Deliverables

- High-resolution mapping and 3D model of subsurface.
- Risked catalogue of geothermal systems and reservoir targets.
- Subsurface Uncertainty and Risk Register
 - (reservoir presence, distribution, properties, fracture and fault extension, occurrence of hydrocarbon, etc.).
- Identify knowledge gaps and provide recommendation for further data acquisition prior and/or during the exploration campaign.
- Implement innovative technology and knowledge generated by other SCCER-SoE programs
- and....

UNIGE WORKFLOW



SCIENTIFIC & TECHNICAL COMMITMENT



Et Neuchâtel

A contre-courant du reste de la Suisse, Genève mise sur la géothermie
 Les eaux du sous-sol pourraient couvrir deux tiers des besoins du canton, dès 2035.



Le canton de Genève pour l'étude de ses eaux souterraines
 Le canton de Genève a financé une étude scientifique pour évaluer le potentiel géothermique de son territoire. Cette étude, menée par l'Institut de géologie de l'Université de Genève, vise à déterminer la faisabilité de l'exploitation de la géothermie dans le canton. Les résultats de cette étude seront publiés prochainement.



COMMUNITY ENGAGEMENT



Gather full support and endorsement for geothermal exploration efforts (seismic acquisition campaign etc.)



Conclusion



- Comprehensive multi-scale approach from regional geophysical-scale to pore-scale
- **Large(st) applied research effort** in support of the **GEothermie 2020** program (Canton of Geneva) fully in line with **SCCER-SoE** objectives and deliverables.



SWISS COMPETENCE CENTER for ENERGY RESEARCH

SUPPLY of ENERGY 😊

THANK YOU !

Photo C. Chelle-Michou