UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Earth and Environmental Sciences

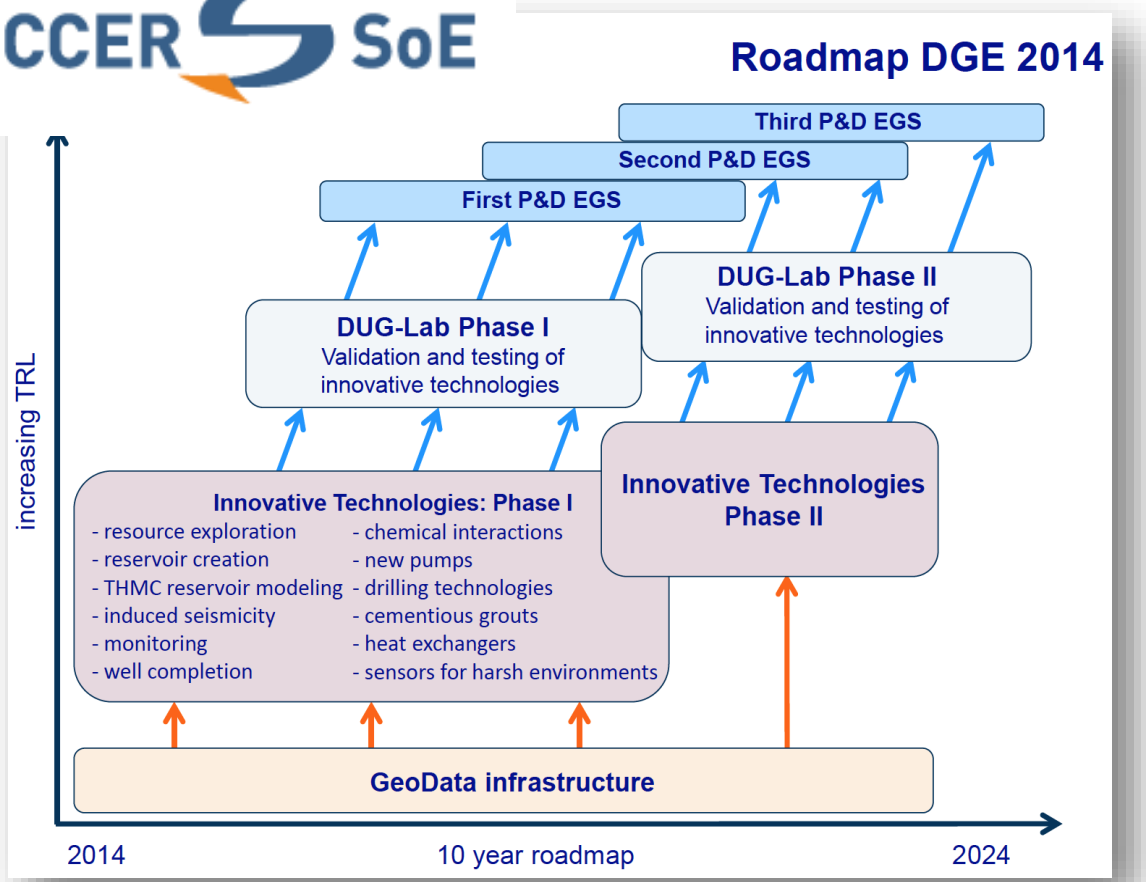
SCCER SoE

Demo: Geneva basin-scale hydrothermal play for heat exchange and storage

Prof. Dr. Andrea Moscariello
Geo-Energy / Reservoir Geology and Basin Analysis Group
Department of Earth Sciences, University of Geneva, 13 Rue de Maraîchers, CH-1205 Geneva

Swiss Geothermal Journey…

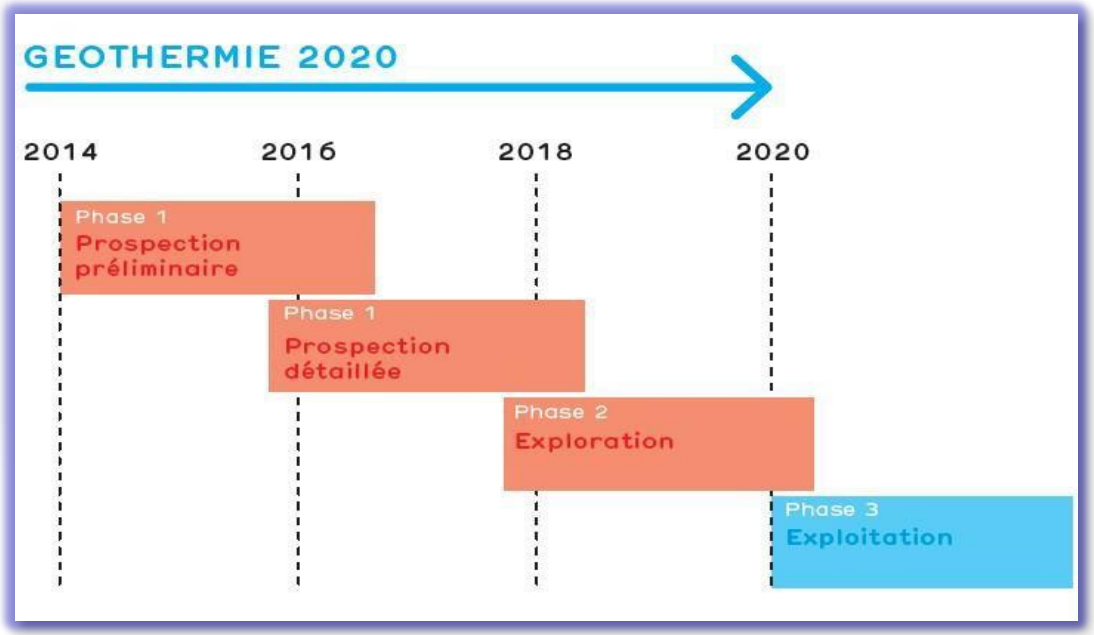
SCCER SoE



SIG

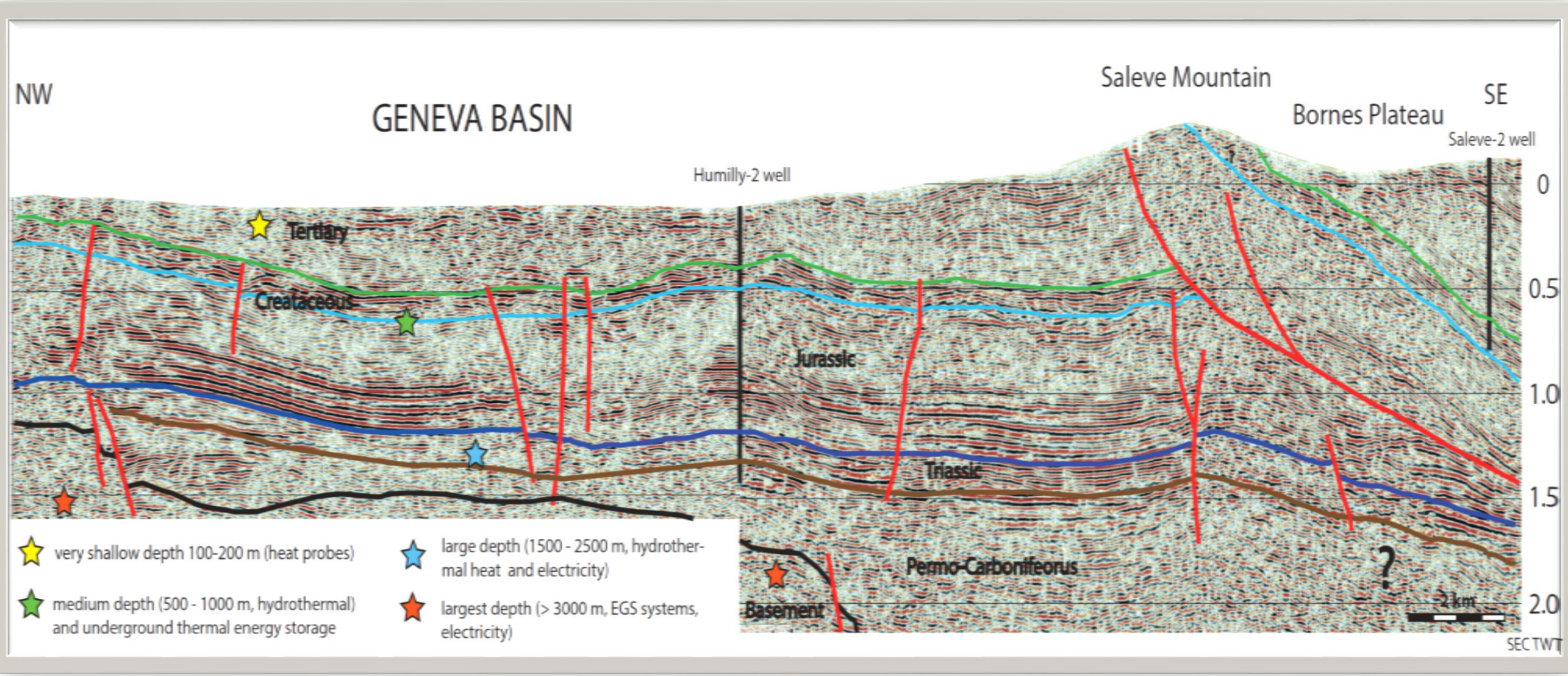
REPUBLIQUE ET CANTON DE GENEVE
POST TENEBRAS LUX

UNIVERSITÉ DE GENÈVE



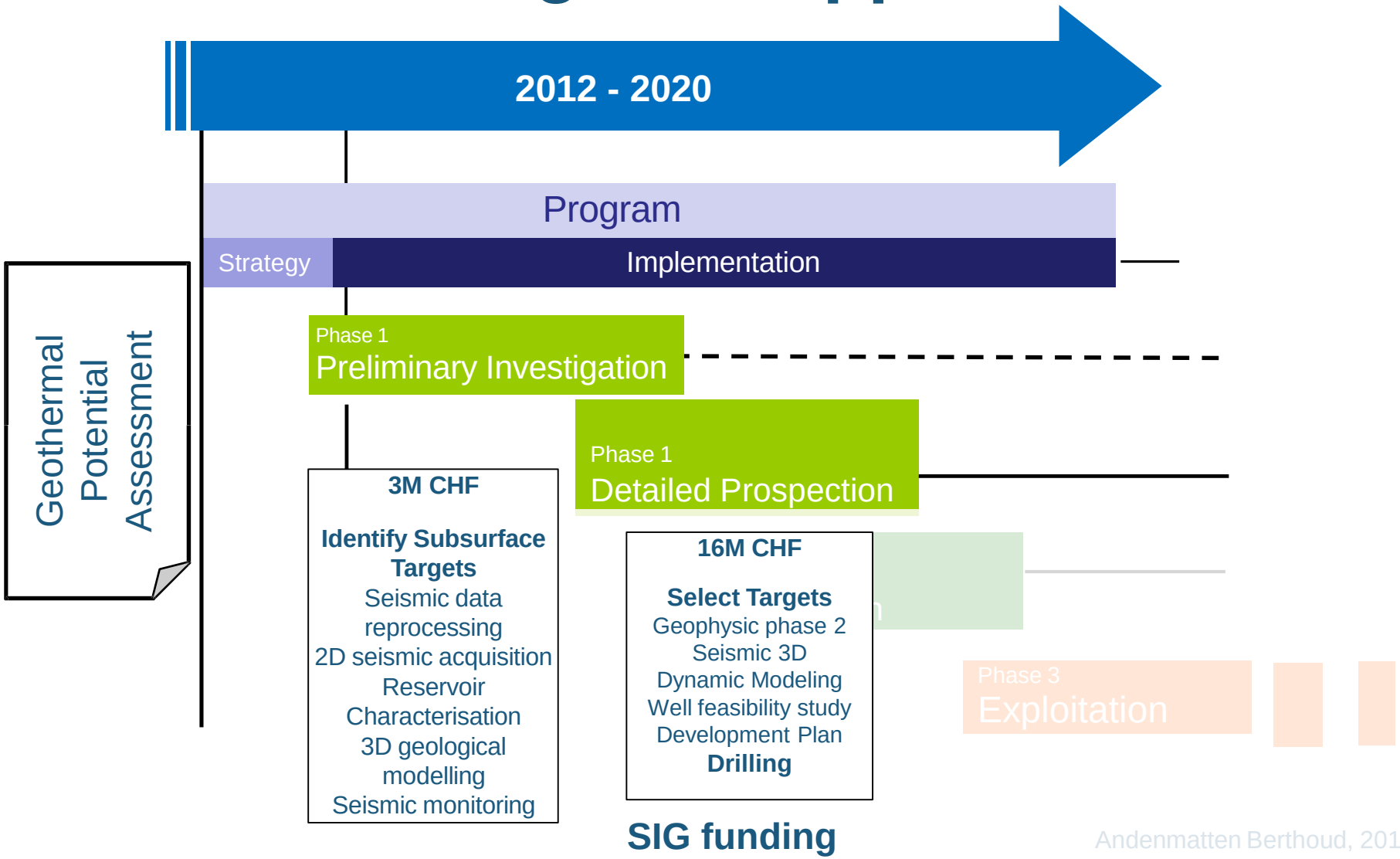

N
You are here
Greater Geneva Basin (GGB)
10 km

What are our options ?

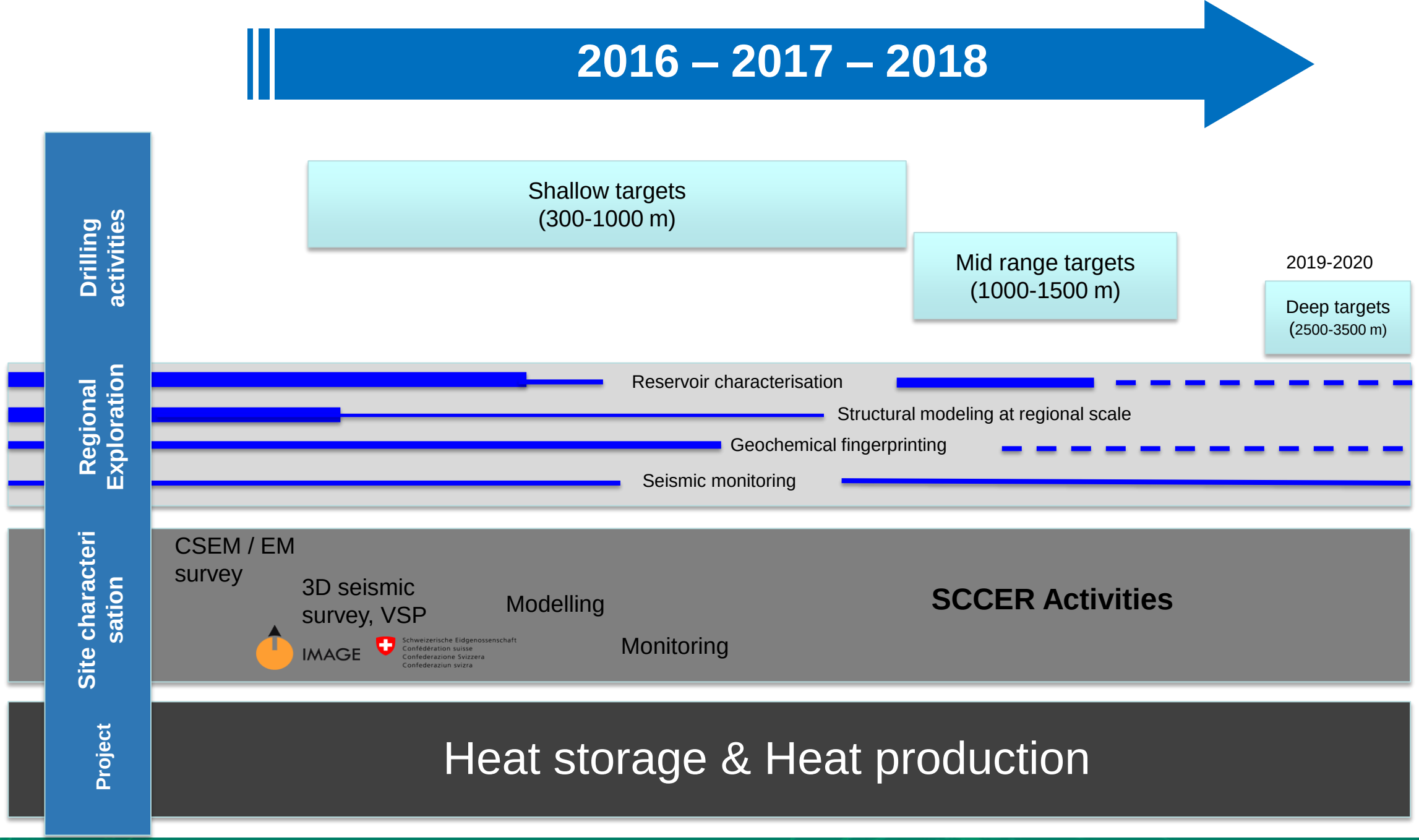


Moscariello, 2016, Proceedings EGC Strasbourg

“GEothermie 2020” program: an integrated approach



Andenmatten Berthoud, 2014


2016 – 2017 – 2018
Drilling activities
Regional Exploration
Site characterisation
Project
Shallow targets
(300-1000 m)
Mid range targets
(1000-1500 m)
2019-2020
Deep targets
(2500-3500 m)
Reservoir characterisation
Structural modeling at regional scale
Geochemical fingerprinting
Seismic monitoring
CSEM / EM survey
3D seismic survey, VSP
Modelling
Monitoring
IMAGE
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
SCCER Activities
Heat storage & Heat production

Purpose

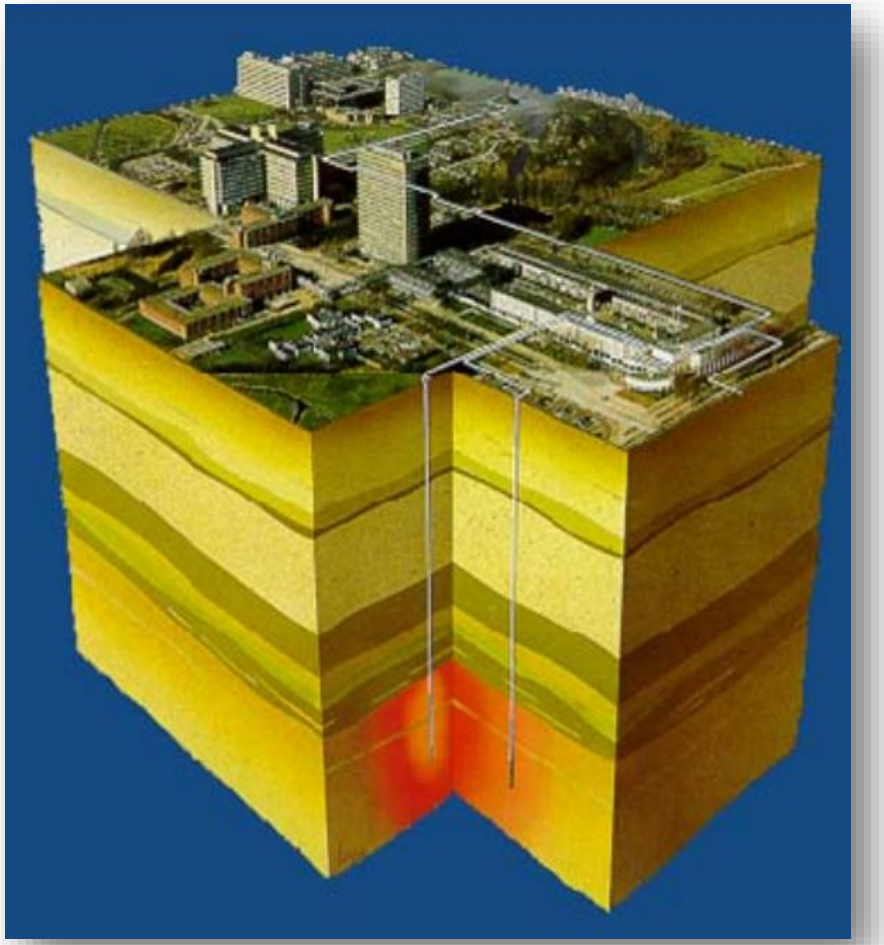
- storage and recovery of thermal energy (heat) in the subsurface - the most energy efficient geothermal technology available today for space heating and cooling.
- help achieve Geneva Canton goals of reducing heating and cooling energy costs and CO2 emissions, thereby moving toward energy independence.

Underground Thermal Energy Storage (UTES)

In most climates there is a time difference between supply and demand of renewable energy.
This mismatch can be solved by energy storage.

Thermal energy storage systems can be classified according to:

- Storage Purpose - Heating, cooling or combined heating or cooling
- Storage Temperature - Low < 40-50˚ C and High >50 ˚ C
- Storage Time – Short term (hours- weeks) or Long term (months - seasons)
- Storage Technology - ATES, BTES, CTES, DTES, Pit/Tank Storage, PCMES
- Storage Application - Residential, Commercial or Industrial

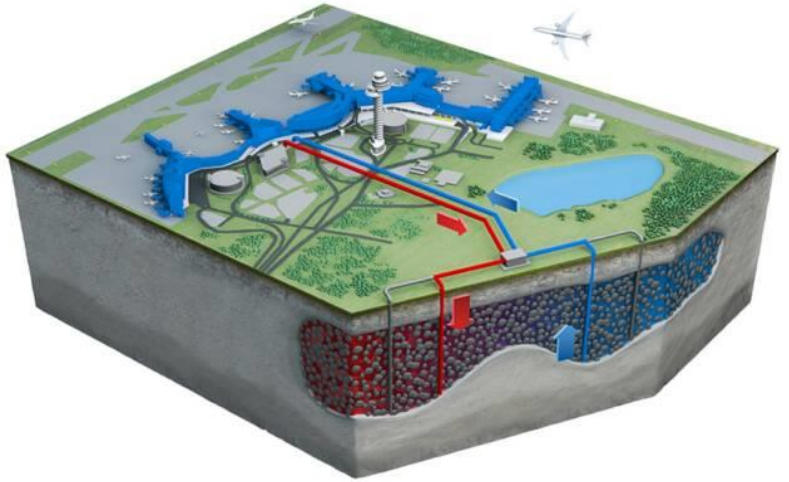


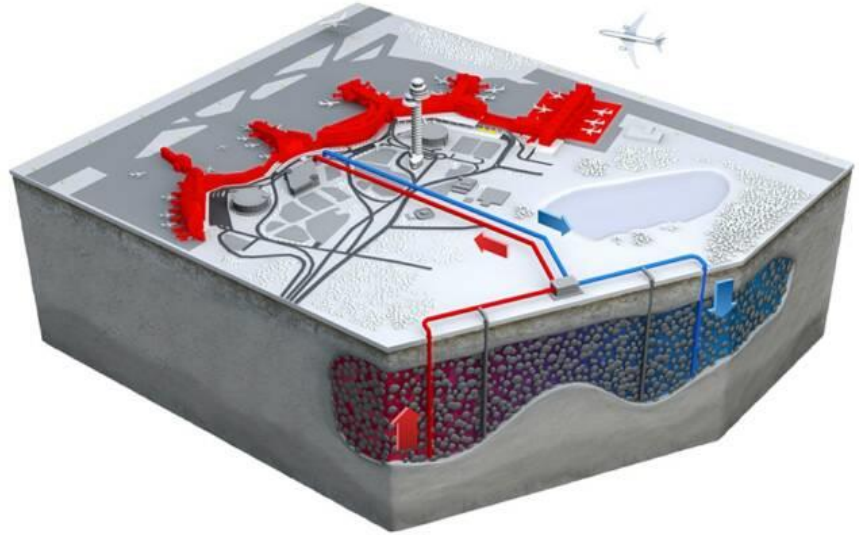
ATES in Utrecht, The Netherlands

ATES Aquifer Thermal Energy Storage, **BTES** Borehole Thermal Energy Storage, **CTES** Cavern Or Mine Thermal Energy Storage, **DTES** Duct Thermal Energy Storage, **Pit/Tank Storage**, **PCMES** Phase Change Material Energy Storage

What are the underground options in the Geneva Area ?

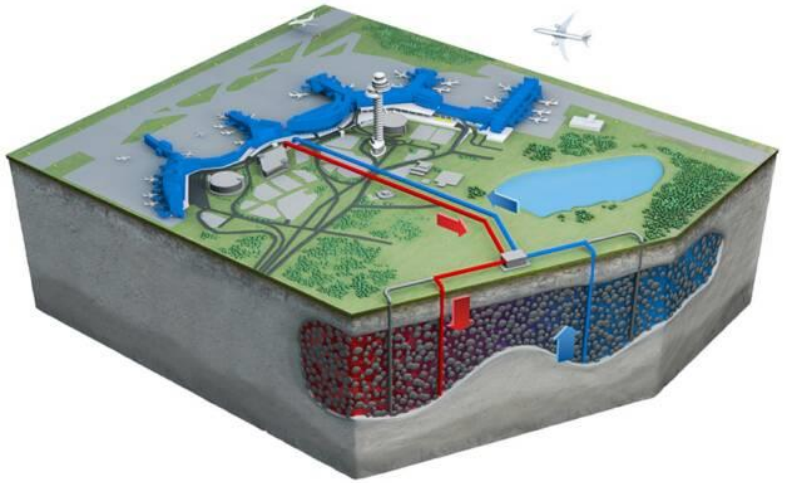
- **ATES - Aquifer Thermal Energy Storage**
  - Technology that is composed by **one or more wells drilled for injection and extraction of groundwater**.
  - **Thermal energy is stored in the groundwater and the porous matrix** through which the groundwater flows.
  - Heat is transferred to the ground by the groundwater, which is pump from/to a number of extraction and injection wells.

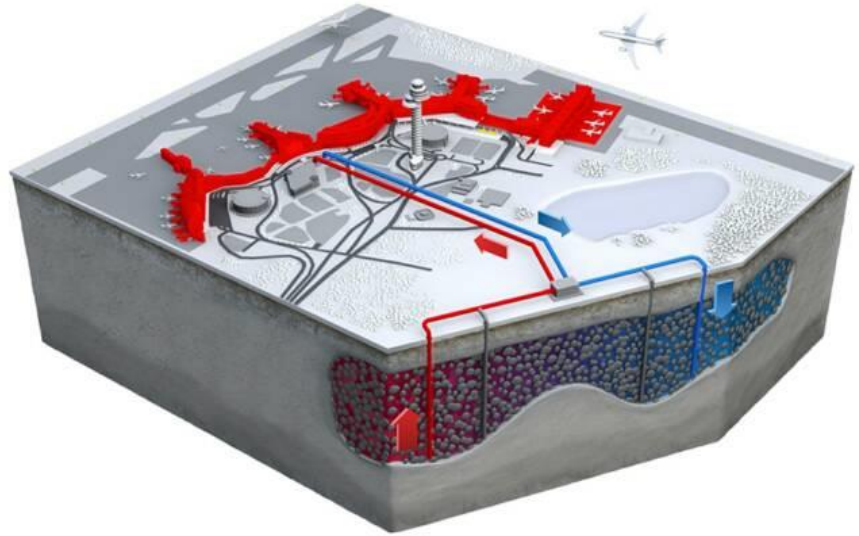




What are the underground options in the Geneva Area ?

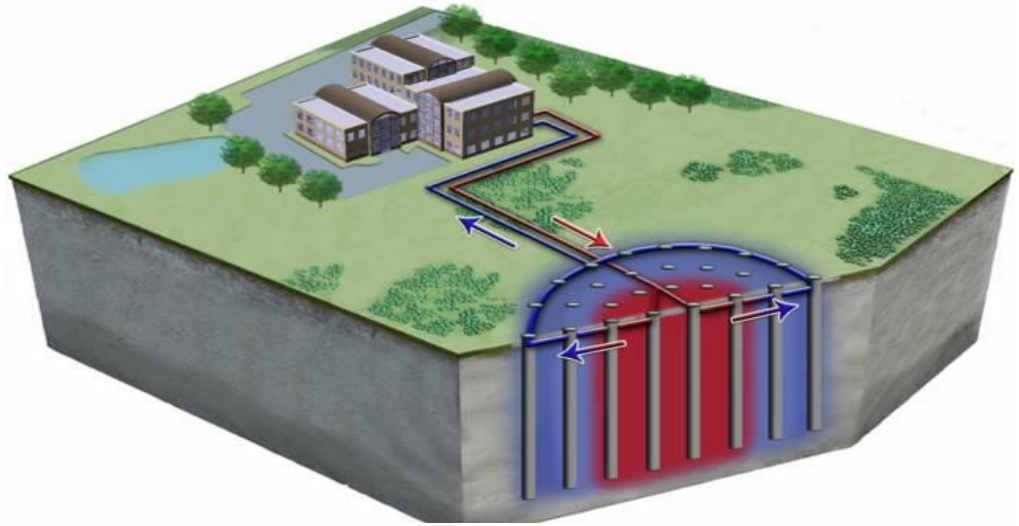
- **ATES - Aquifer Thermal Energy Storage**
  - used for energy conservation, not energy production
  - at least two thermal wells are installed.
  - heat exchangers, conveyance piping, and mechanical systems and controls necessary to integrate an ATES system with a heating, ventilating and air conditioning (HVAC) system.

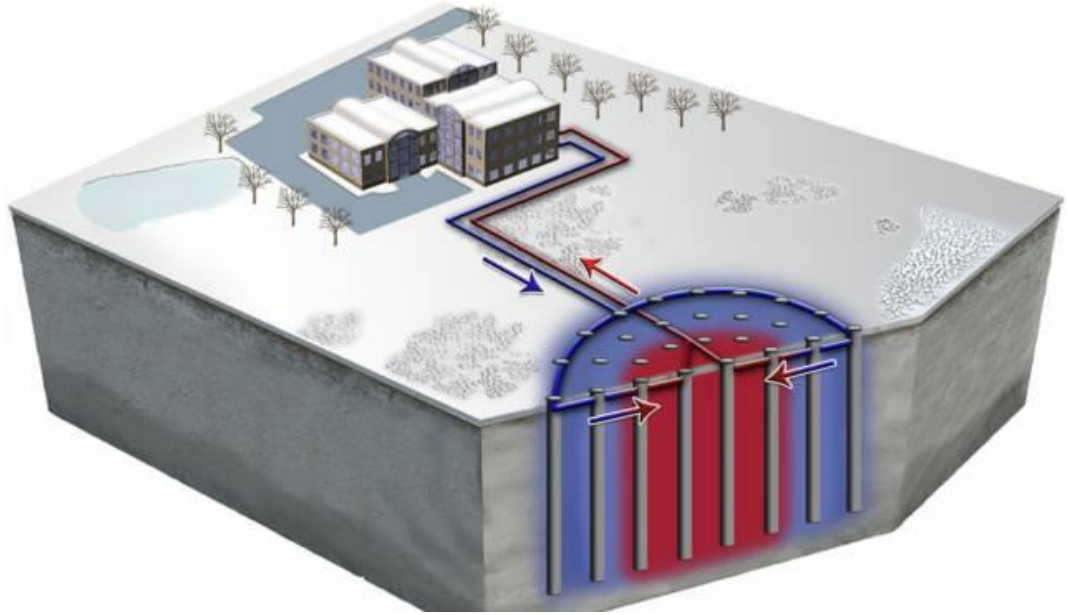




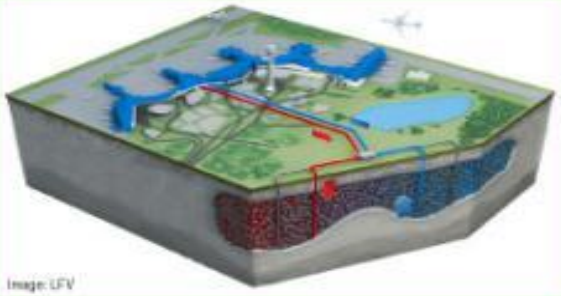
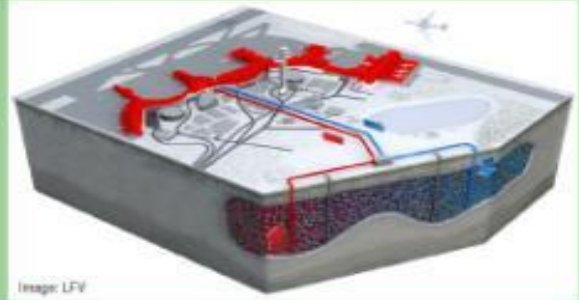
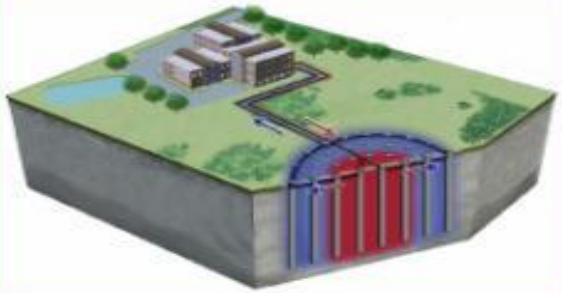
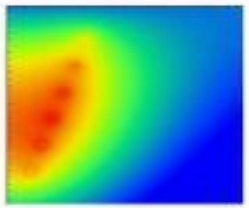
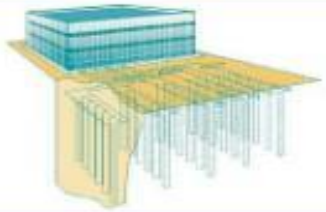
What are the underground options in the Geneva Area ?

- **BTES - Borehole Thermal Energy Storage**
  - BTES typically involves design and operation of a ground heat exchanger (GHX) in a manner such that heat is sequentially built up in, or abstracted from, a cylindrical volume of soil or rock.
  - This is accomplished by configuring the GHX array in a radial fashion, and reversing the flow direction seasonally.





Geothermal Energy Storage - The Future of Efficient Buildings

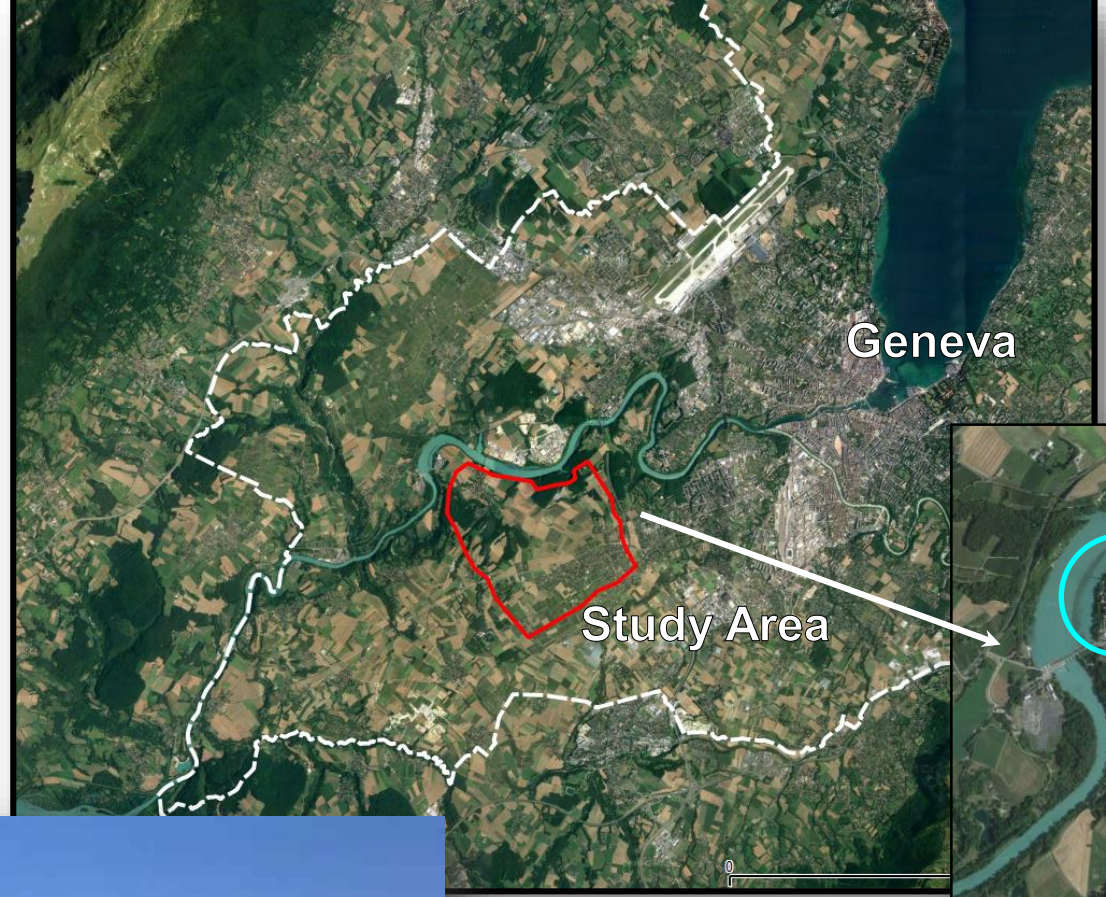
		Summer Cooling	Winter Heating	COP	Capital Cost	Life Cycle Cost
Thermal Energy Storage	ATES (Aquifer Thermal Energy Storage)			8-20	$$$	$$
Thermal Energy Storage	BTES (Borehole Thermal Energy Storage)			4-7	$$$$$	$$$
Existing Applications	Geothermal GSHP Dissipative GHX Design			3-4	$$	$$$$
Existing Applications	Fossil Fuel Heating & Conventional Air Conditioning		 	1-3	$	$$$$$$

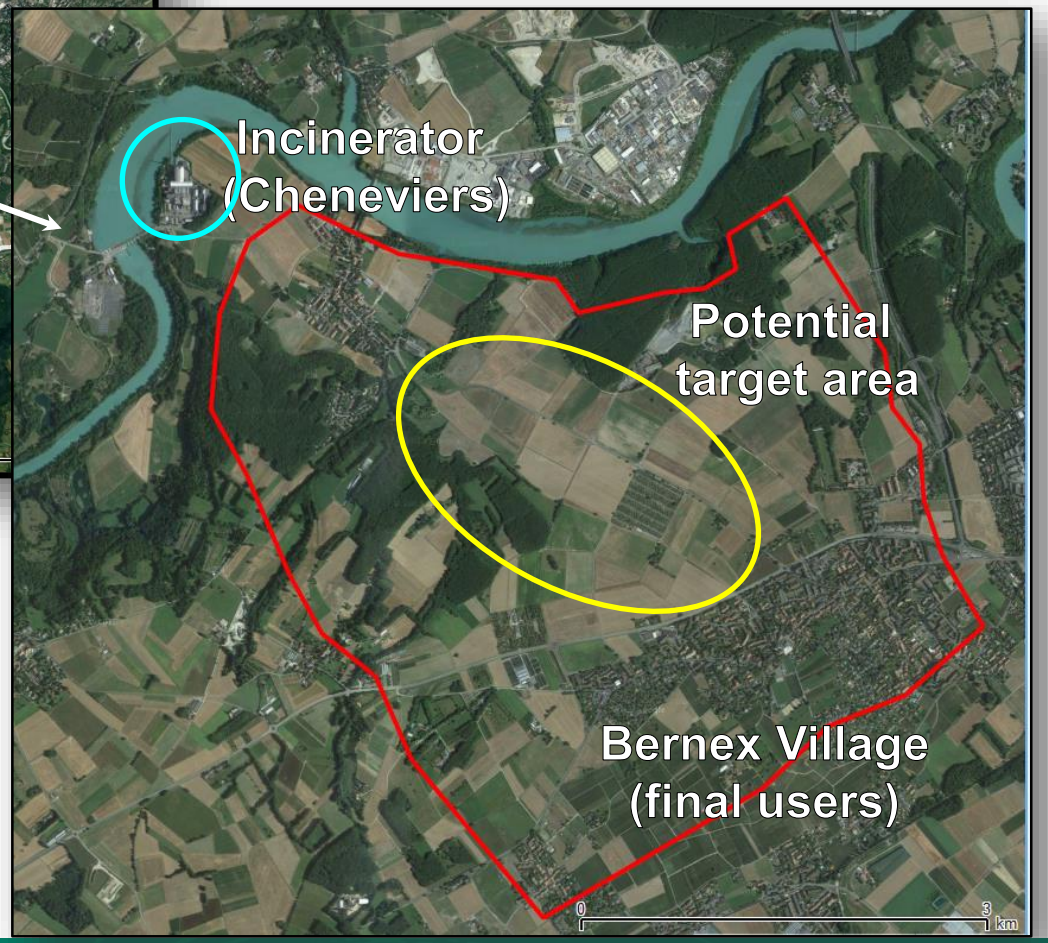
Coefficient of performance

Underground ENERGY

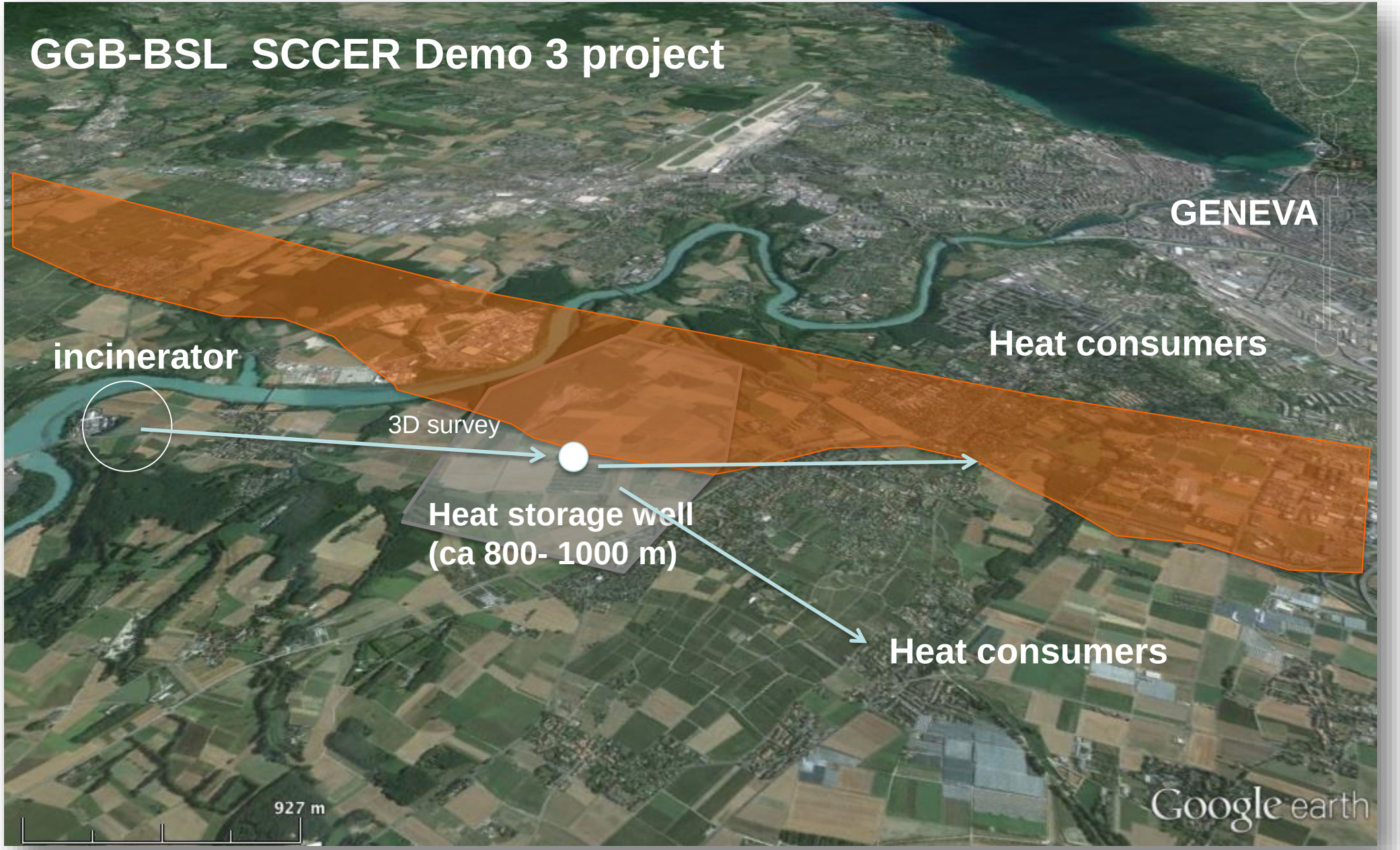
UTES Project Area

Geneva basin-scale hydrothermal play for heat exchange and storage

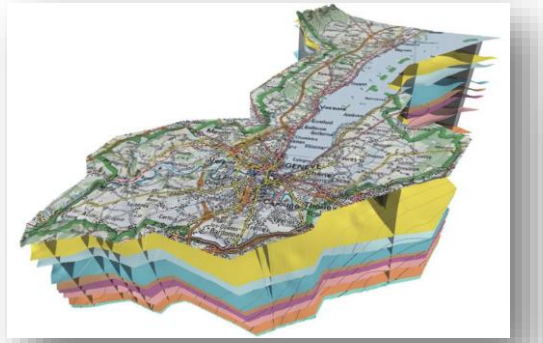


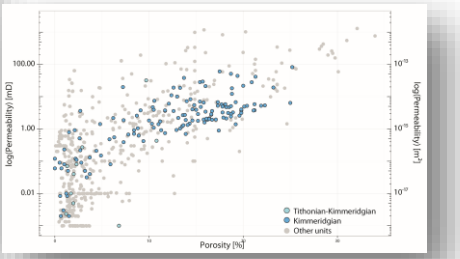


Heat production:
50-150 GWh /year
depending on
recovery
temperature
(> 100 ℃ or > 30 ℃)

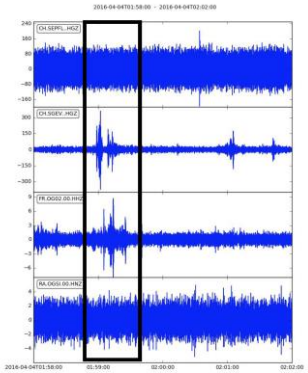

GGB-BSL SCCER Demo 3 project
GENEVA
Heat consumers
incinerator
3D survey
Heat storage well
(ca 800- 1000 m)
Heat consumers
927 m
Google earth

Heat Storage Project





- Ongoing Preparatory phase
  - Finalise 1st pass geological modelling
  - Refine velocity model
  - Passive Seismic monitoring
  - Geochemical fingerprinting
  - Assessment of hydrocarbon occurrence
- Following phase
  - Integrated geophysical acquisition and inversion; drilling



OGS

IMAGE

Bundesamt für Energie BFE

swisstopo

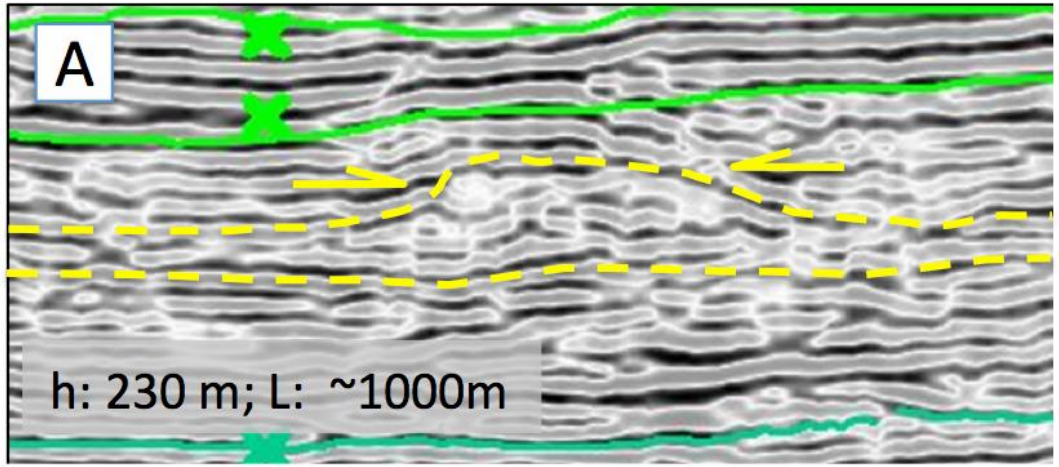
Geo2X Geophysics for Geology

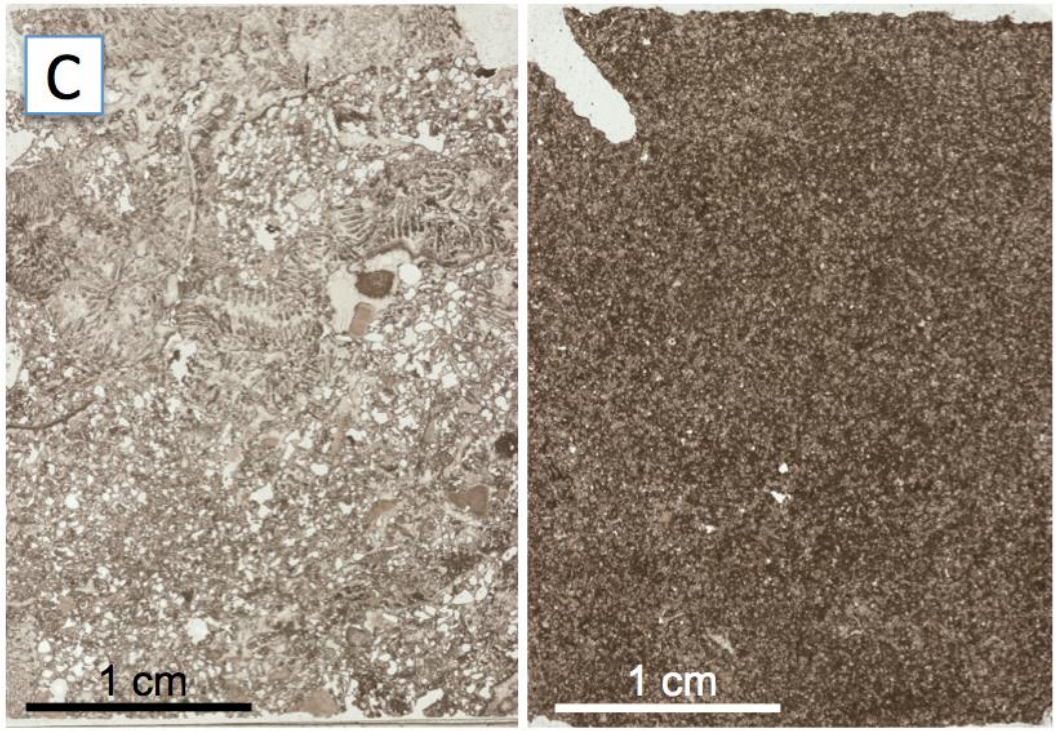
SIG

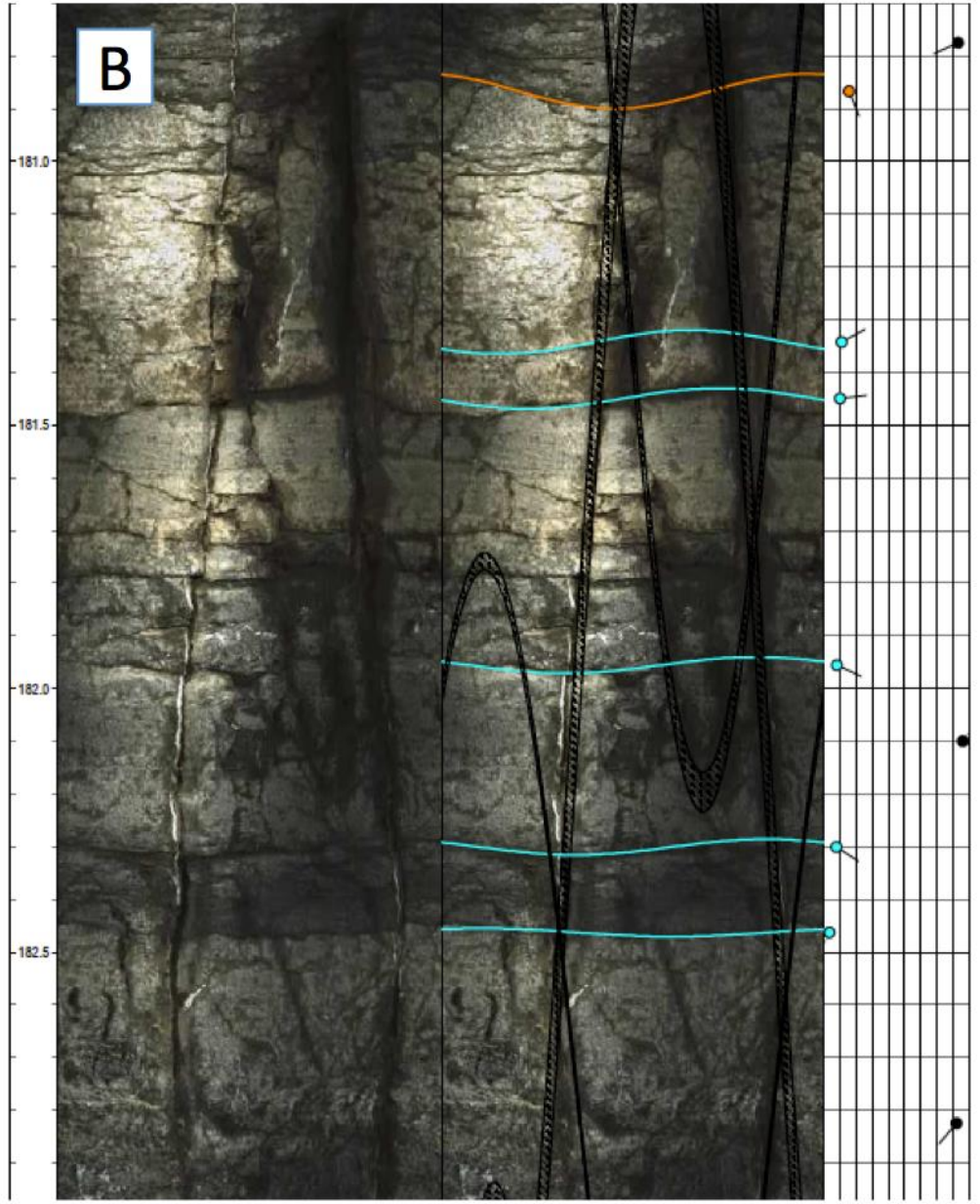
ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

REDUCE UNCERTAINITIES and MITIGATE PROEJCT RISKS

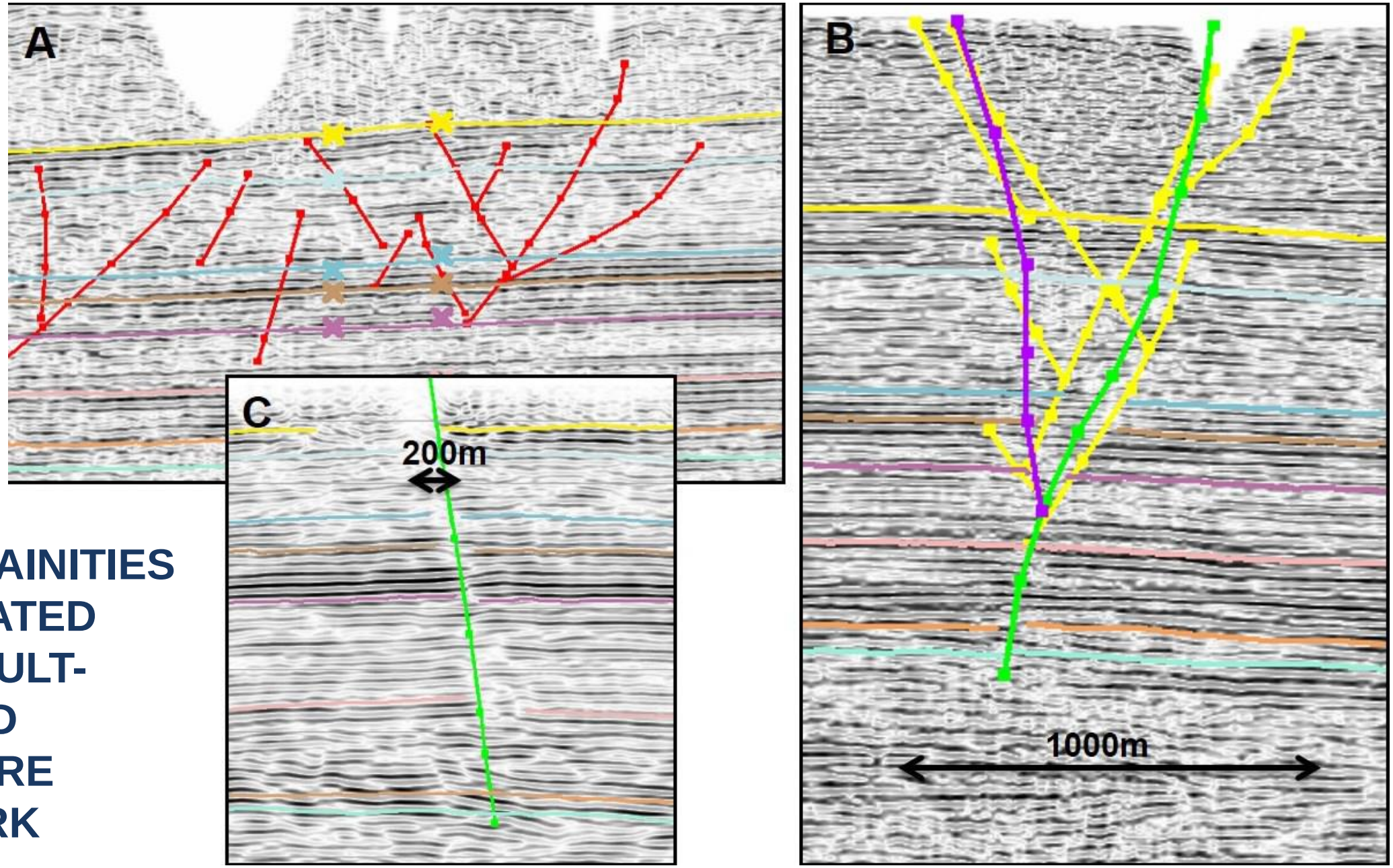


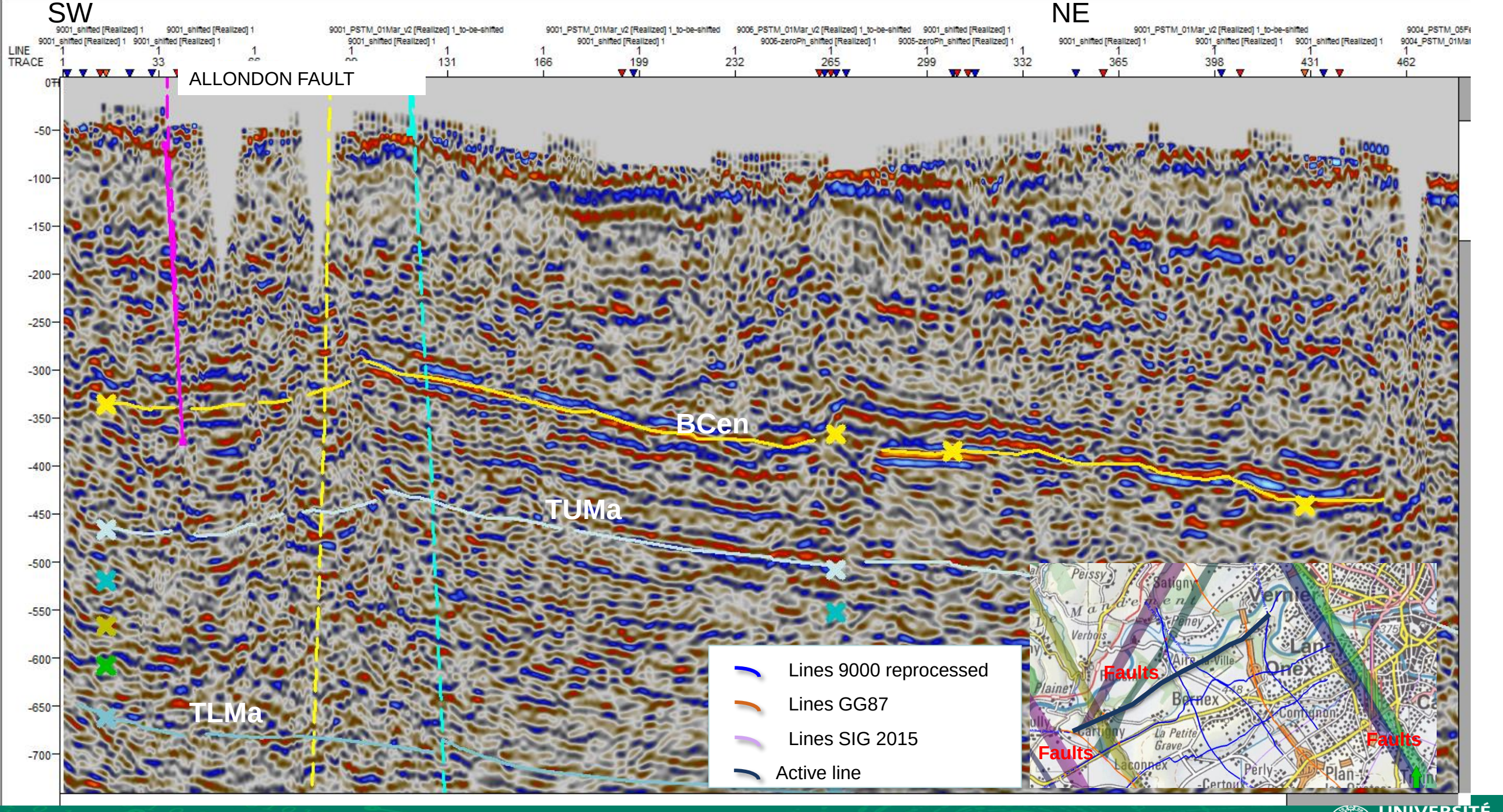


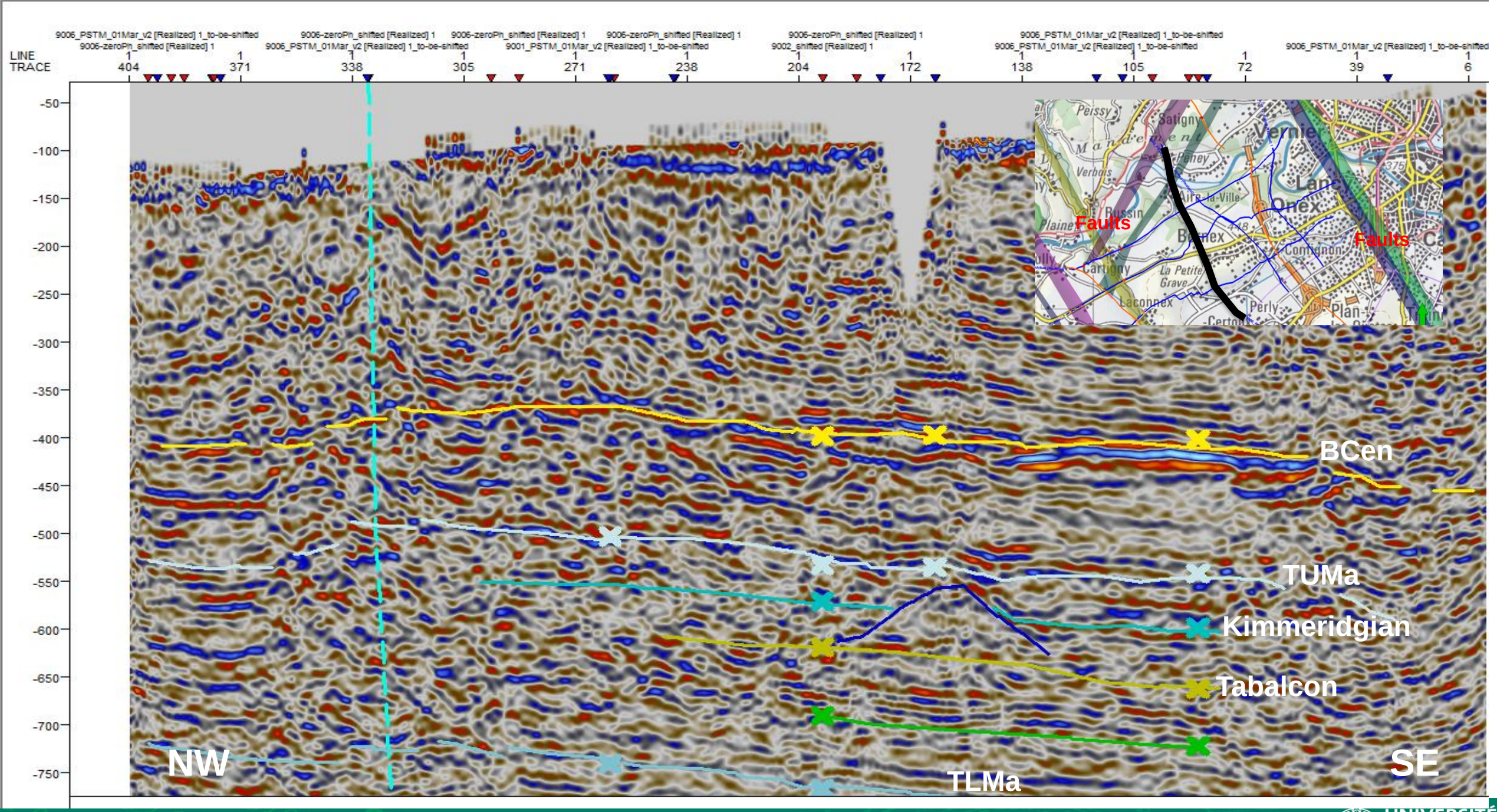


Moscariello, 2016, Proceedings EGC Strasbourg

UNCERTAINITIES ASSOCIATED WITH FAULT-RELATED FRACTURE NETWORK

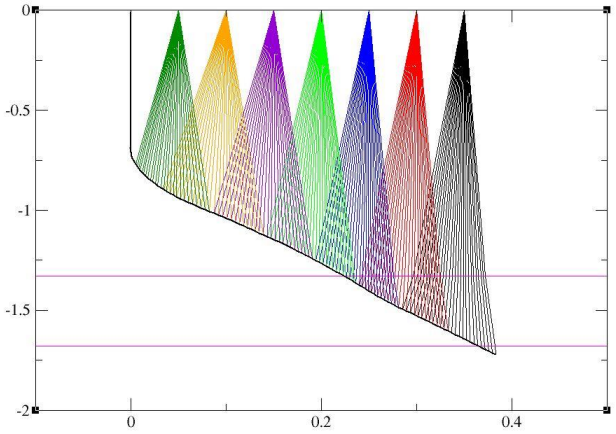


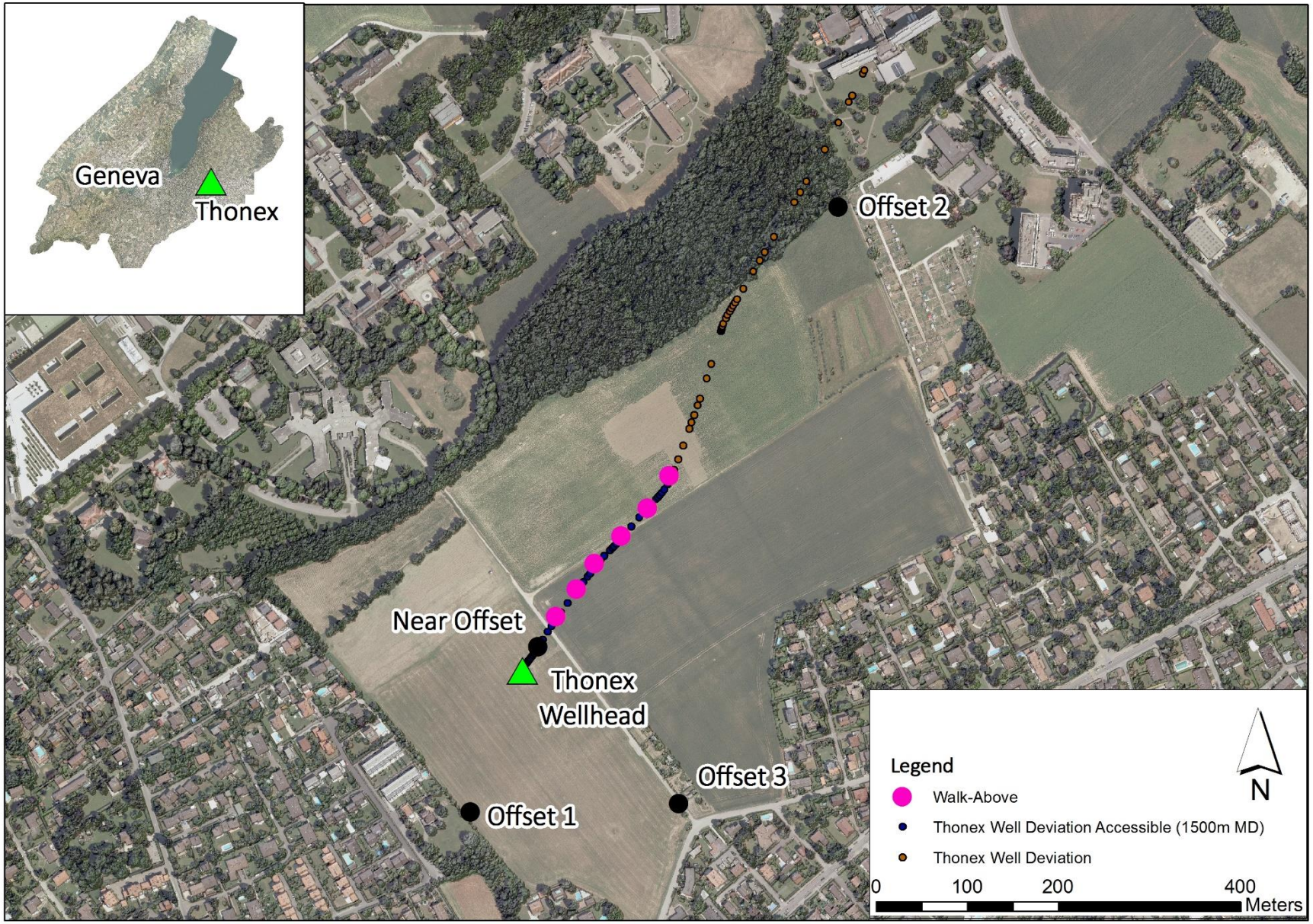

SW
NE
LINE
TRACE
ALLONDON FAULT
BCen
TUMa
TLMa
Lines 9000 reprocessed
Lines GG87
Lines SIG 2015
Active line
Faults
Faults
Faults


LINE
TRACE
9006_PSTM_01Mar_v2 [Realized] 1_to-be-shifted
9006-zeroPh_shifted [Realized] 1
9001_PSTM_01Mar_v2 [Realized] 1_to-be-shifted
9002_shifted [Realized] 1
404
371
338
305
271
238
204
172
138
105
72
39
6
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
-600
-650
-700
-750
Faults
Faults
BCen
TUMa
Kimmeridgian
Tabalcon
TLMa
NW
SE

1. One near-offset VSP
2. Three offsets VSPs
3. One walk-above VSP

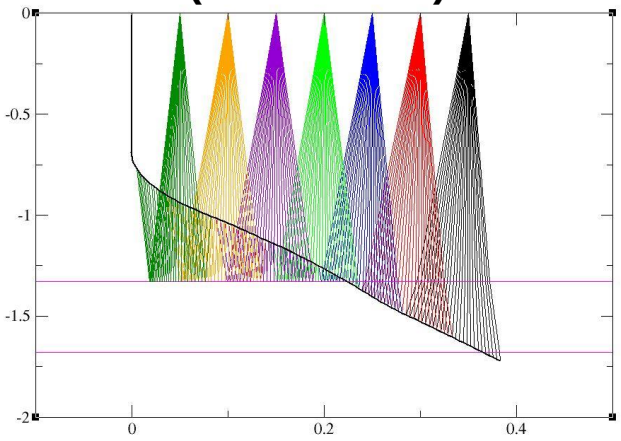
WAB illumination map (direct)

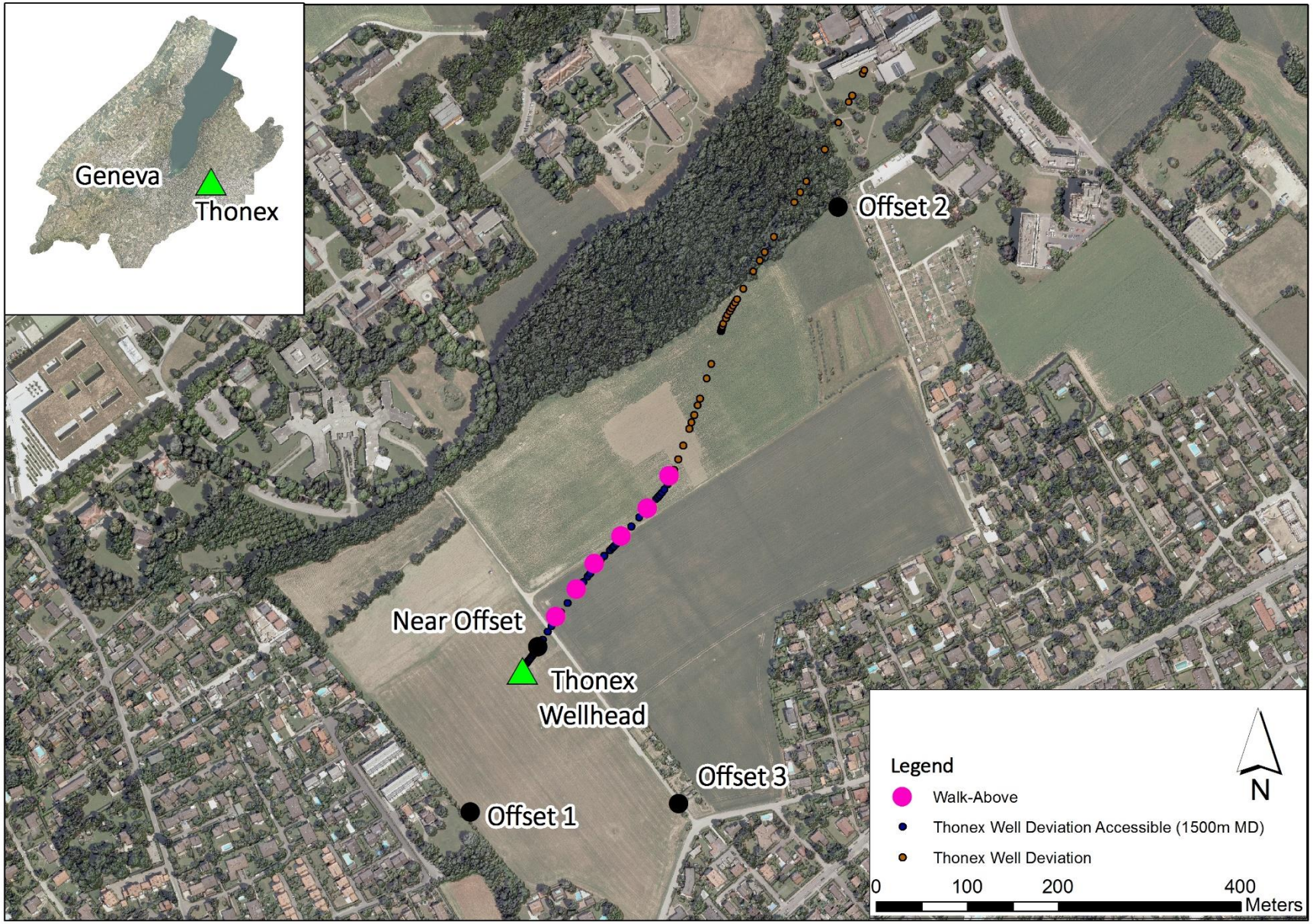




1. One near-offset VSP
2. Three offsets VSPs
3. One walk-above VSP

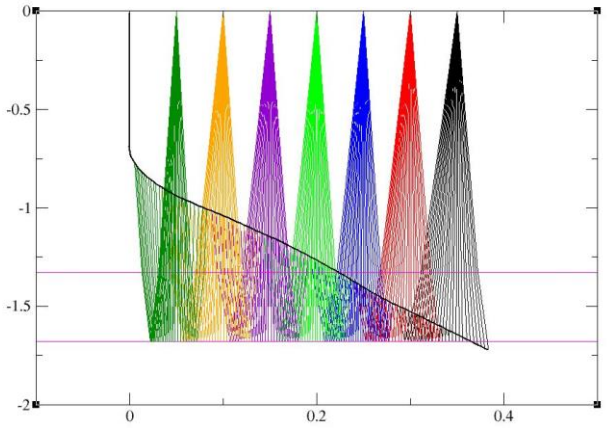
WAB illumination map (1st reflector)

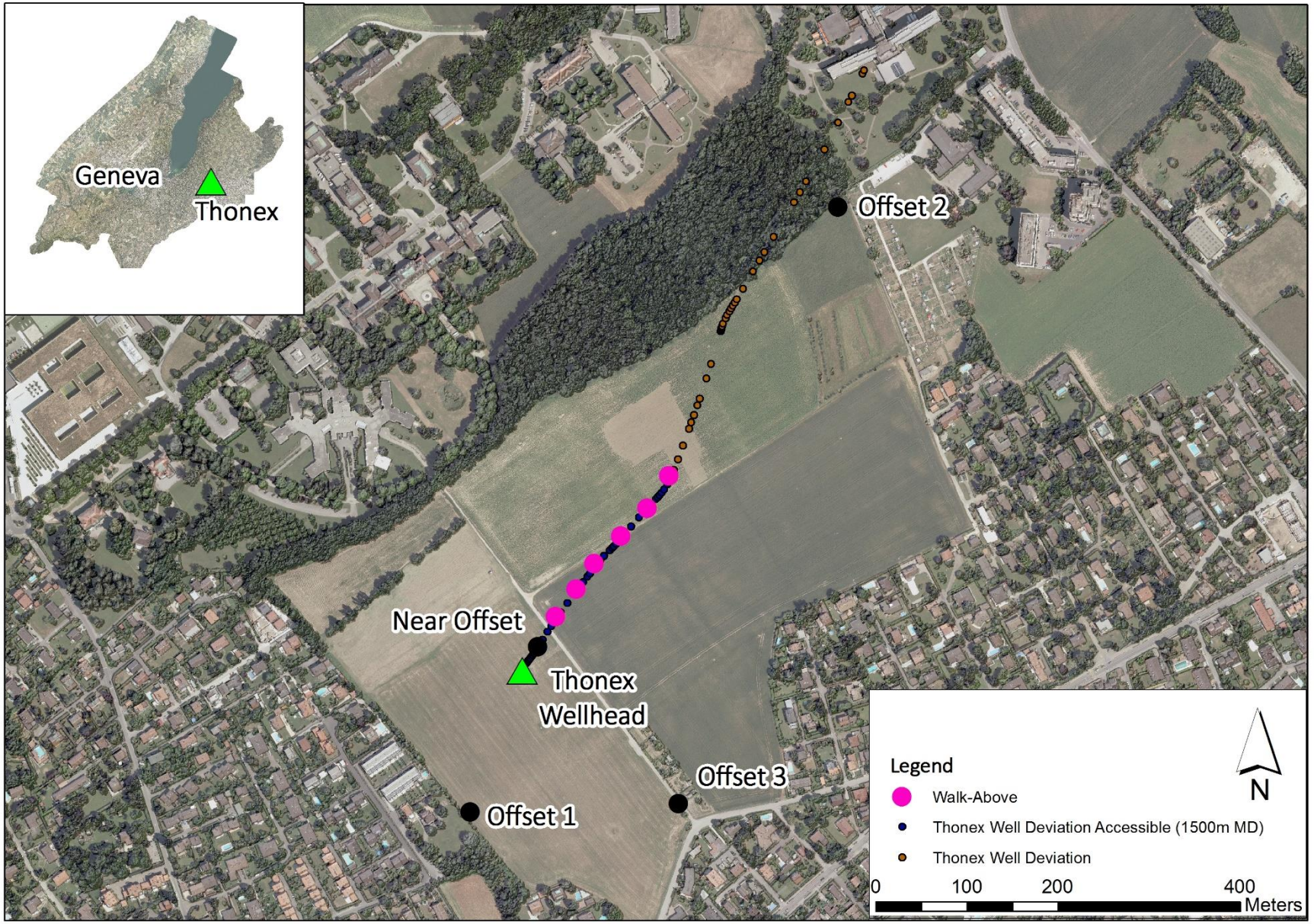




1. One near-offset VSP
2. Three offsets VSPs
3. One walk-above VSP

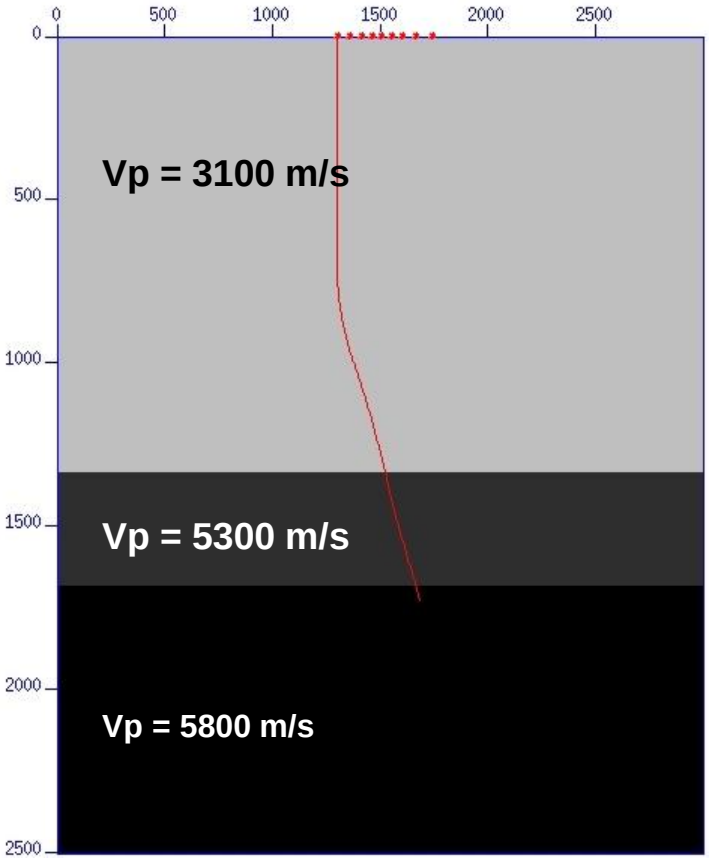
WAB illumination map (2nd reflector)

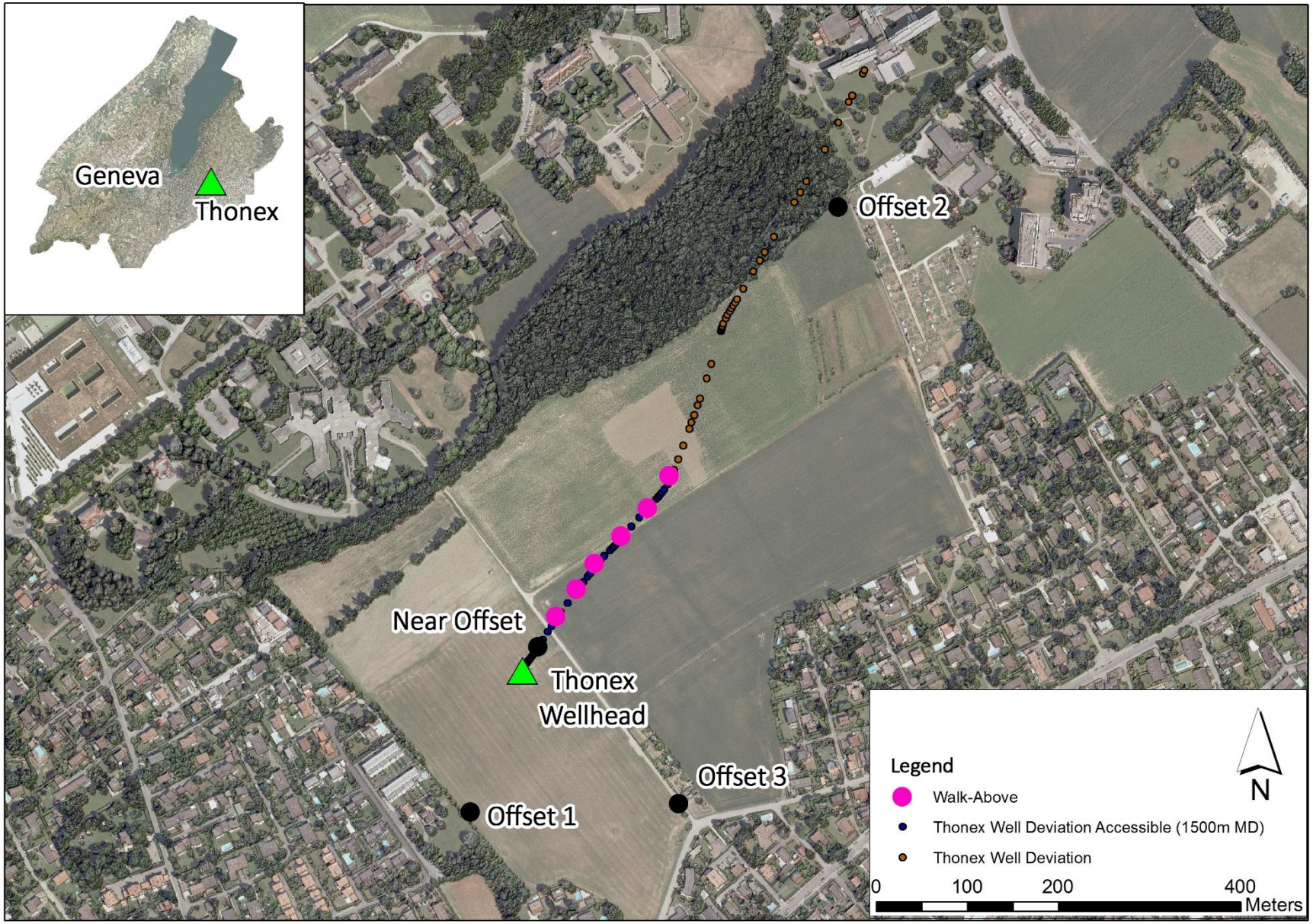




1. One near-offset VSP
2. Three offsets VSPs
3. One walk-above VSP

Well provisional velocity model

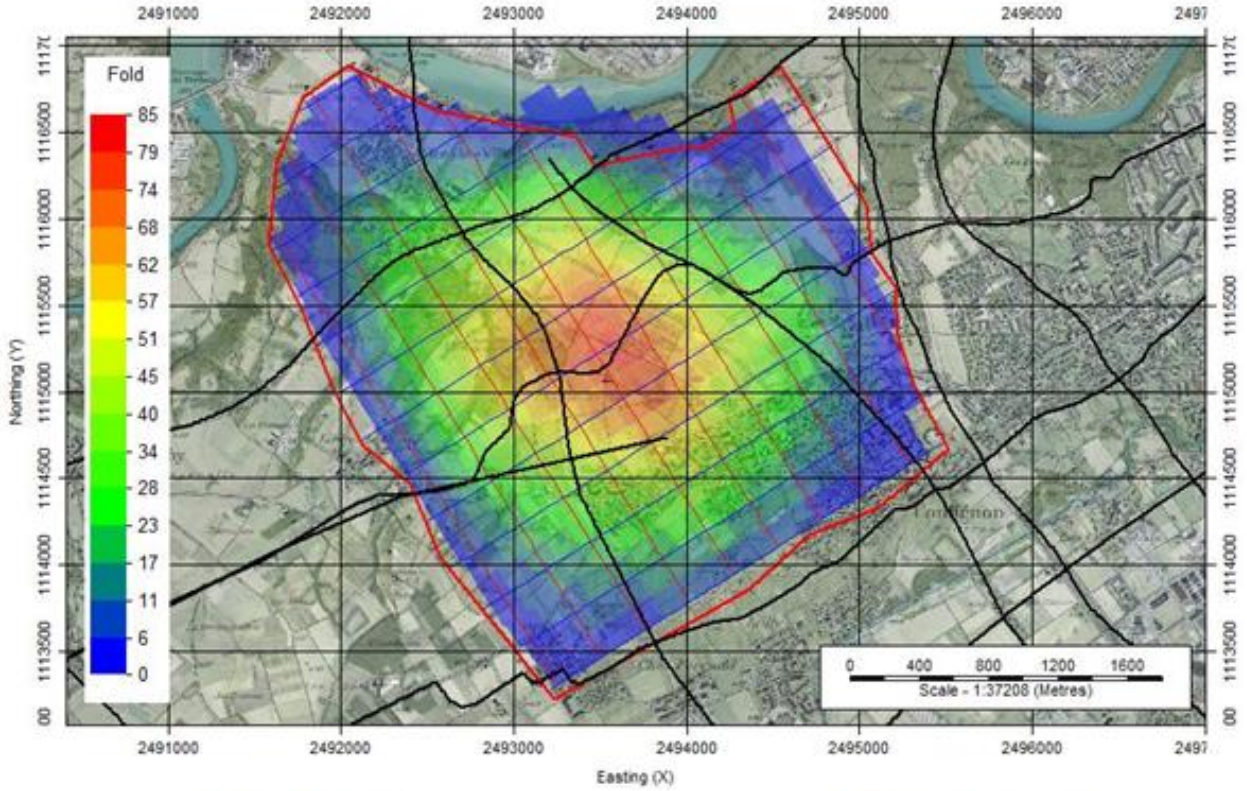




3D SEISMIC AQUISITION DESIGN

Geophysics for Geology

Geneva - 3D Seismic Design



Survey Layout

- Survey limits from scouting
- 10 shot lines, 300m line spacing, 30m shot spac.
- 13 receiver lines, 300m line spac., 30m trace spac.
- 956 shot stations
- 1019 receivers stations

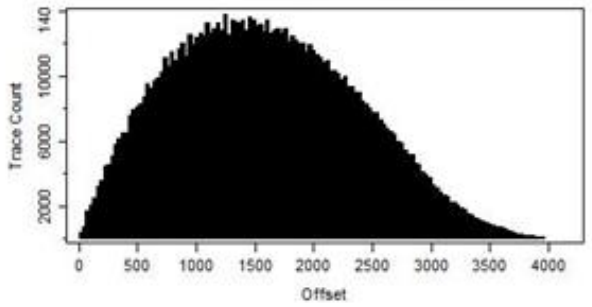
Pattern

- All live stations

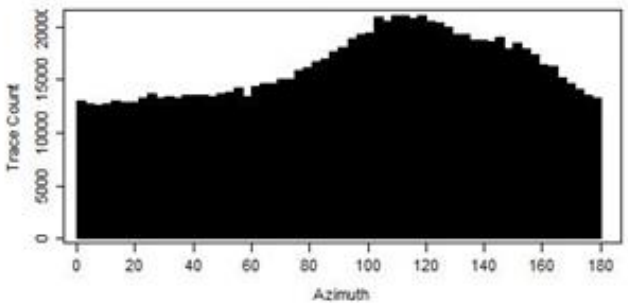
Acquisition Statistics

- Maximum active traces: 1019
- Total Shots: 956

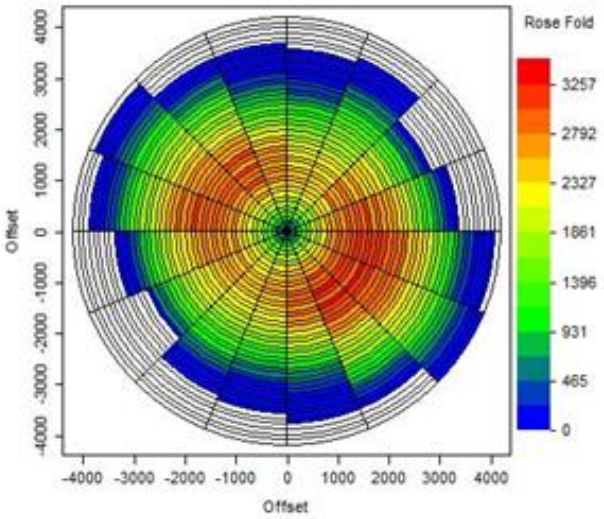
Histogram of "Offset".



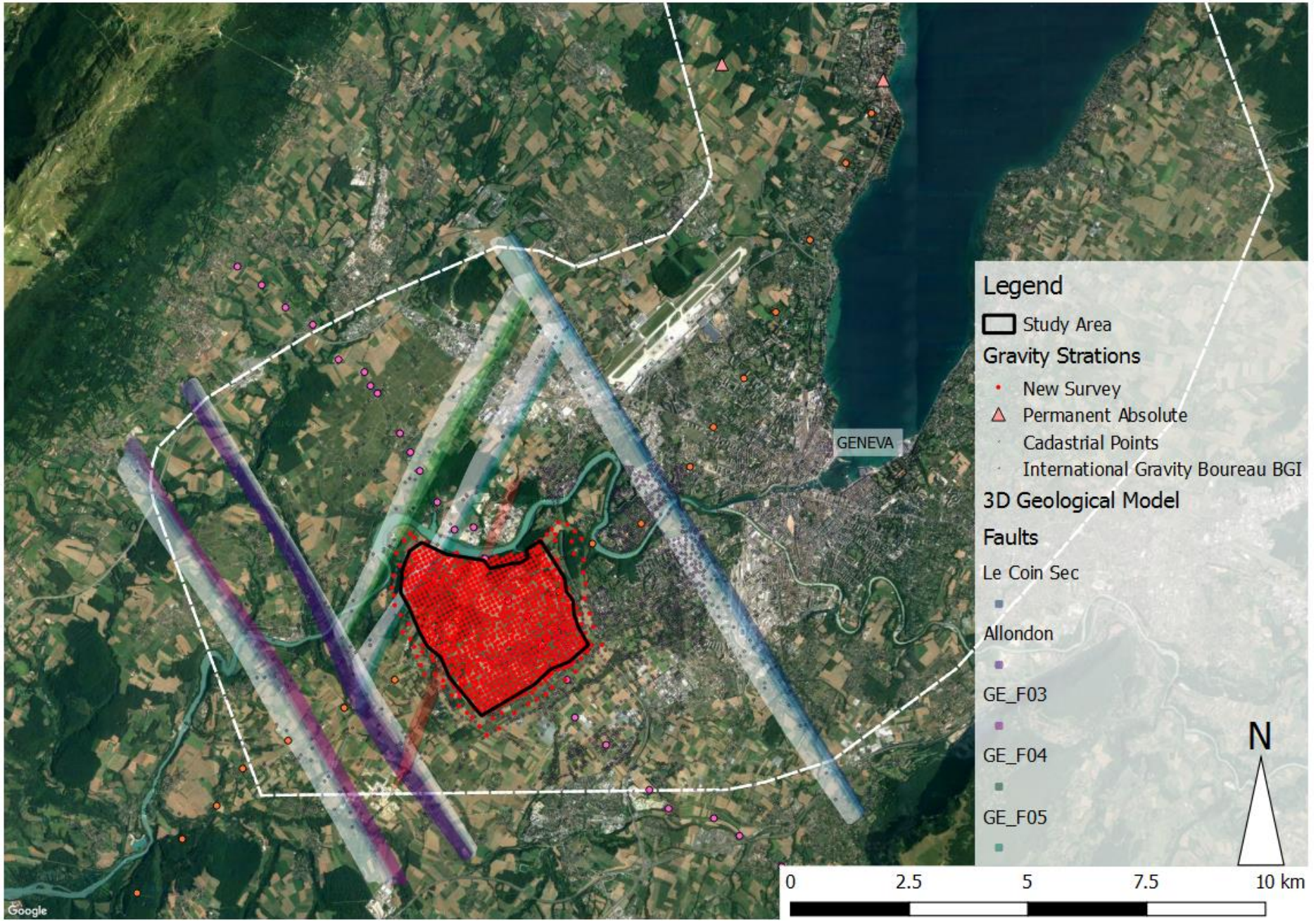
Histogram of "Azimuth".

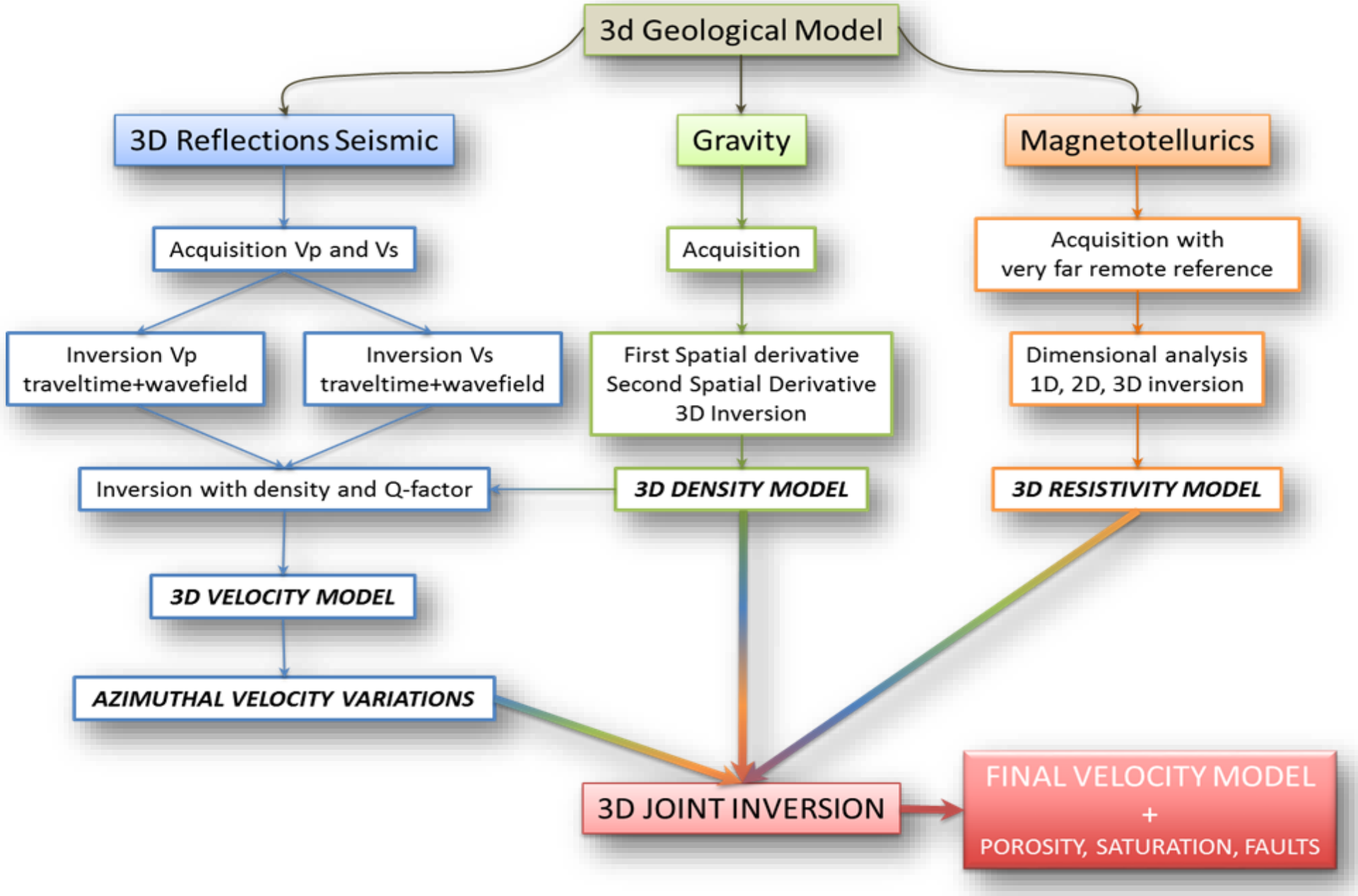


Rose Diagram of "Offset" vs. "Azimuth".



GRAVITY AND MAGNETIC AQUISTION





Developing and implementing innovative exploration project workflows

SIG

geo2X
Geophysics for Geology

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

- Greater Geneva Basin - Basin Scale Laboratory (GGB-BSL) and Geothermal Energy (Heat Production & Storage)
  - Firm geophysical acquisition program and drilling plan at progressively increasing depths
  - Step wise approach (success based acceptance)
  - Borehole(s) and subsurface data available to applied science experience open to SCCER community (i.e. test and validate of new concepts, models)
- International Research Program Partnerships

IMAGE

European Commission

ITN FRICFAULT

GGB-BSL & SCCER

- **Crucial Opportunity for Phase 2 SCCER programme and SCCER Community**

SCCER SoE

THANK YOU

Photo C. Chelle-Michou

“GEothermie 2020” & SCCER-SoE task force

Dr. Michel Meyer, Carole Nawratil De Bono

REPUBLIQUE ET CANTON DE GENEVE

POST TENEBRAS LUX

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

UNIVERSITÉ DE GENÈVE

Aurélie Angéloz, Veronica Antunes, Maud Brentini, Nicolas Clerc, Stephanie Favre, Elme Rusillon,

Dr. Luca Cardello, Dr. Aurore Carrier, Dr. Cyril Chelle-Michou, Dr. Damien Do Couto, Dr. Branimir Segvic, Dr. Luca Guglielmetti,, Dr. Yasin Makhloufi

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