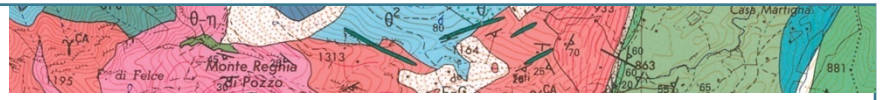

Local geological 3D model, two examples in the Rhine Graben:
•the geothermal potential of the Strasbourg-Obernai area
•the deep geothermal site of Soultz-sous-Forêts

C. Dezayes[1], P. Baillieux[2], G. Heilbronn[1], I. Thinon[1], G. Courrioux[1], P. Calcagno[1]

[1] Geothermal Energy Department of BRGM (French Geological Survey), Orléans (France)

[2] Swiss Laboratory of Geothermal Energy, Neuchâtel University (Switzerland)

Workshop GeORG - Freiburg
November 18, 2010

Department Geothermal Energy

Outline

- Presentation of 2 models in the Rhine Graben
- Focus on data available and used
- Method to construct the fracture network, essential in the framework of the graben tectonic

Editeur géologique E3D GeoModeller software

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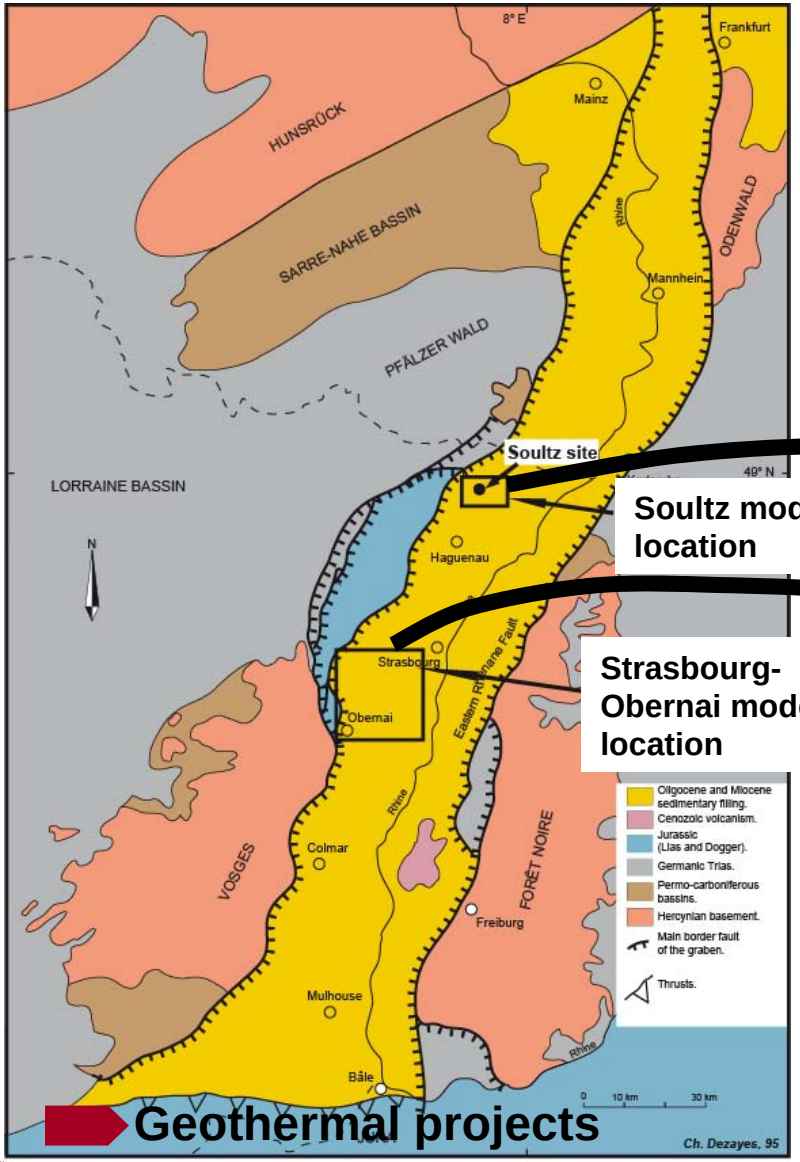
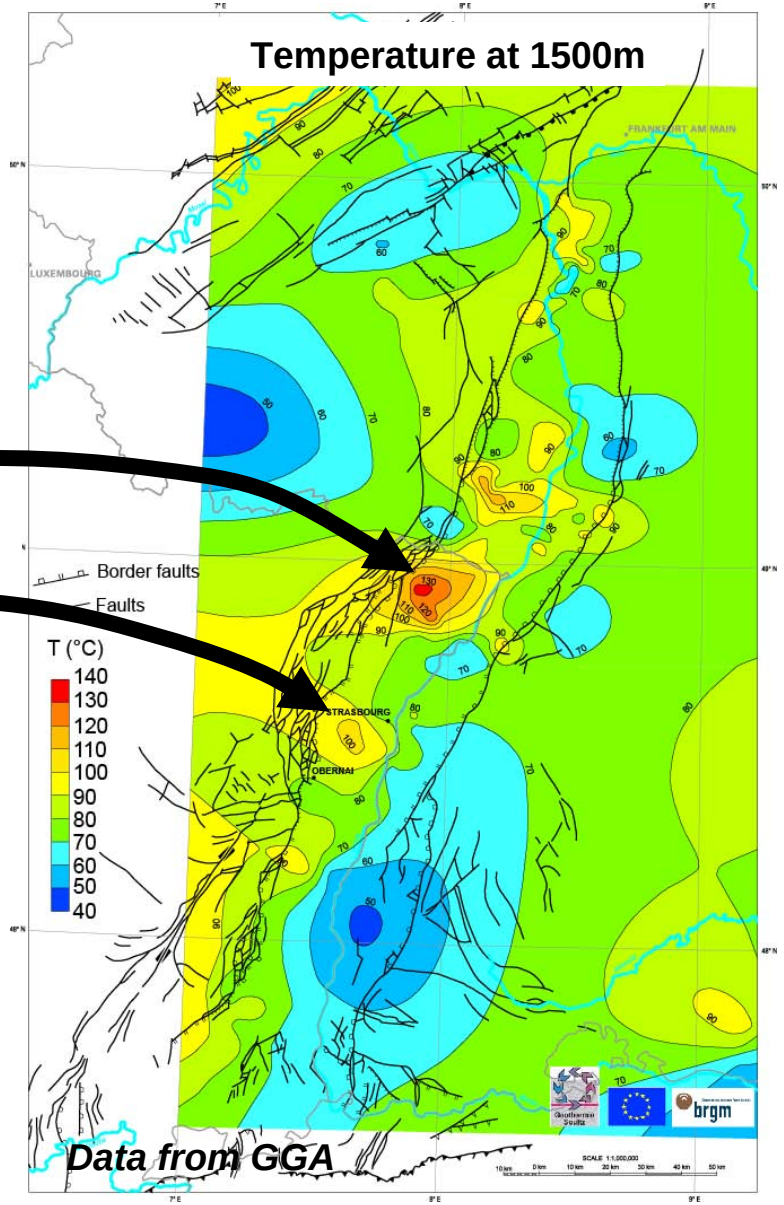
Location of 3D model



Soultz model location

Strasbourg-Obernai model location



Geothermal projects

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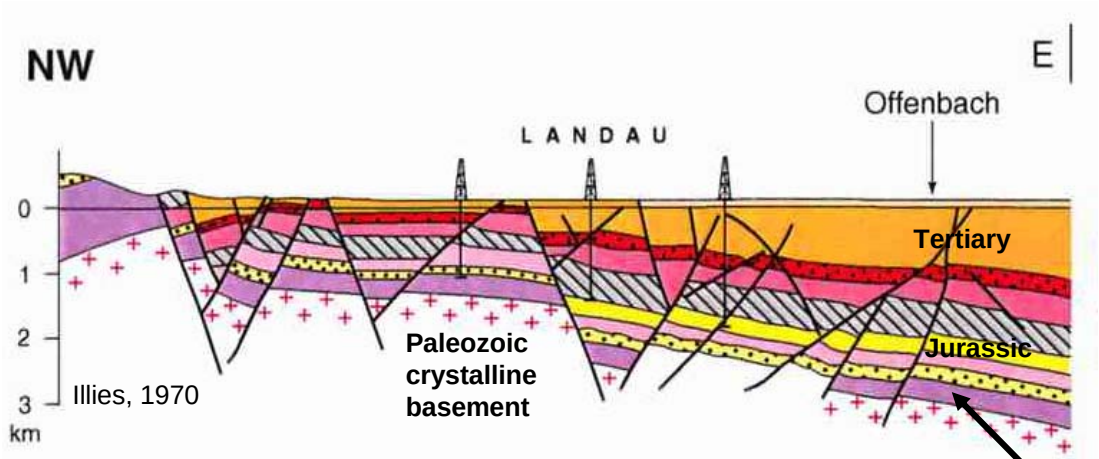
Strasbourg – Obernai

➢**Assessment of the geothermal potential of the Buntsandstein to develop renewable energy in promising area.**



Buntsandstein (lower Trias): argillaceous sandstones.

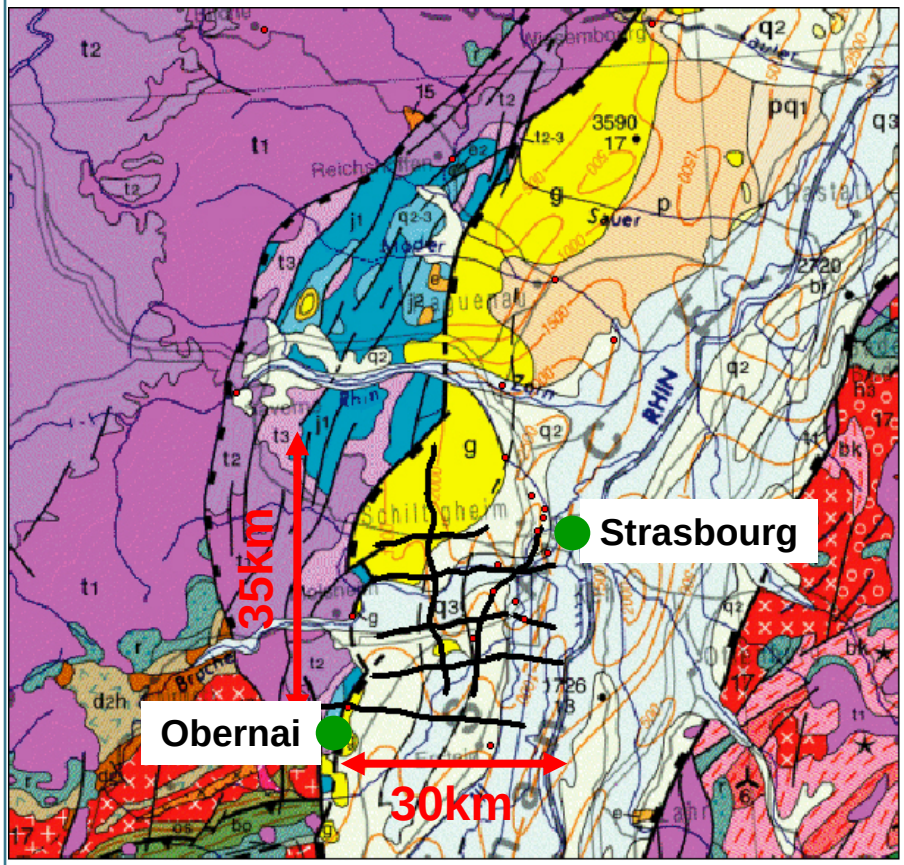
T°=140-150°C

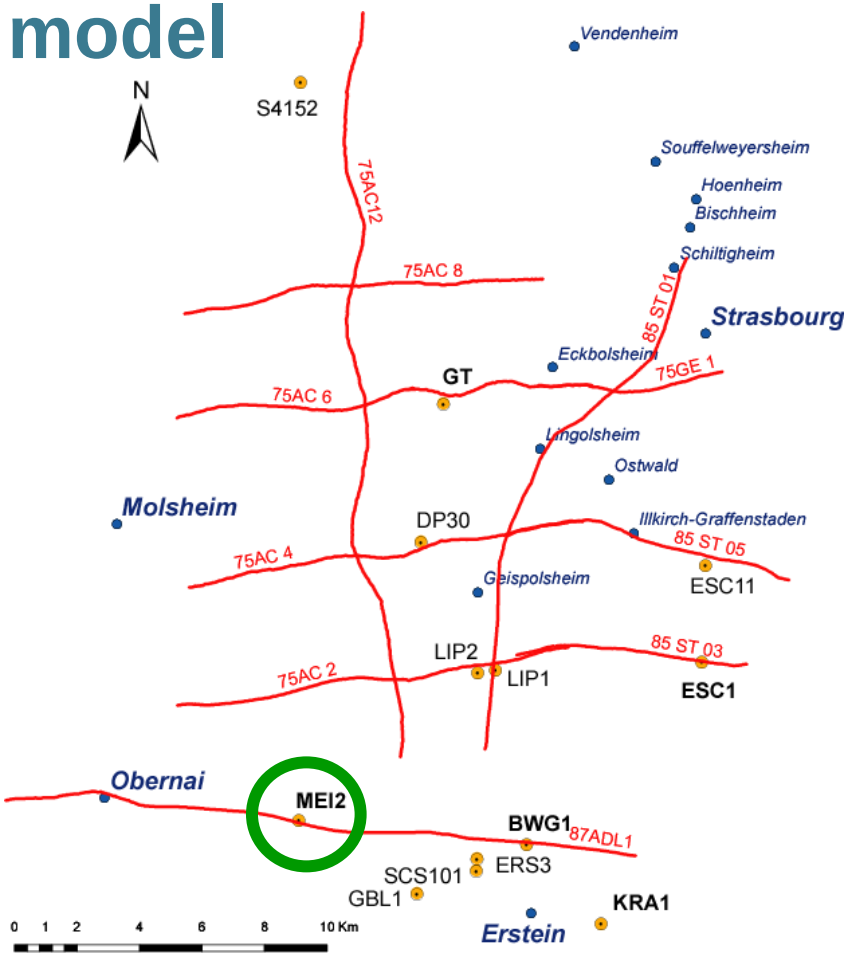
Heat in place : $Q = \rho \cdot C_v \cdot V \cdot (T_i - T_f)$ From Muffler & Cataldi, 1978

Volume of the reservoir

► Building a 3D model to estimate the volume of the Bunsandstein

Data available for the 3D model





- **143 km of seismic profiles acquired in 70-80's and reprocessed**
  - **5 transverse to the main structures of the graben**
  - **2 parallel to the main structures of the graben**
- **13 boreholes to identify the reflectors and constrain the model**
  - **not homogeneously distributed**
  - **only 5 boreholes reach the Buntsandstein and 1 reach the basement**

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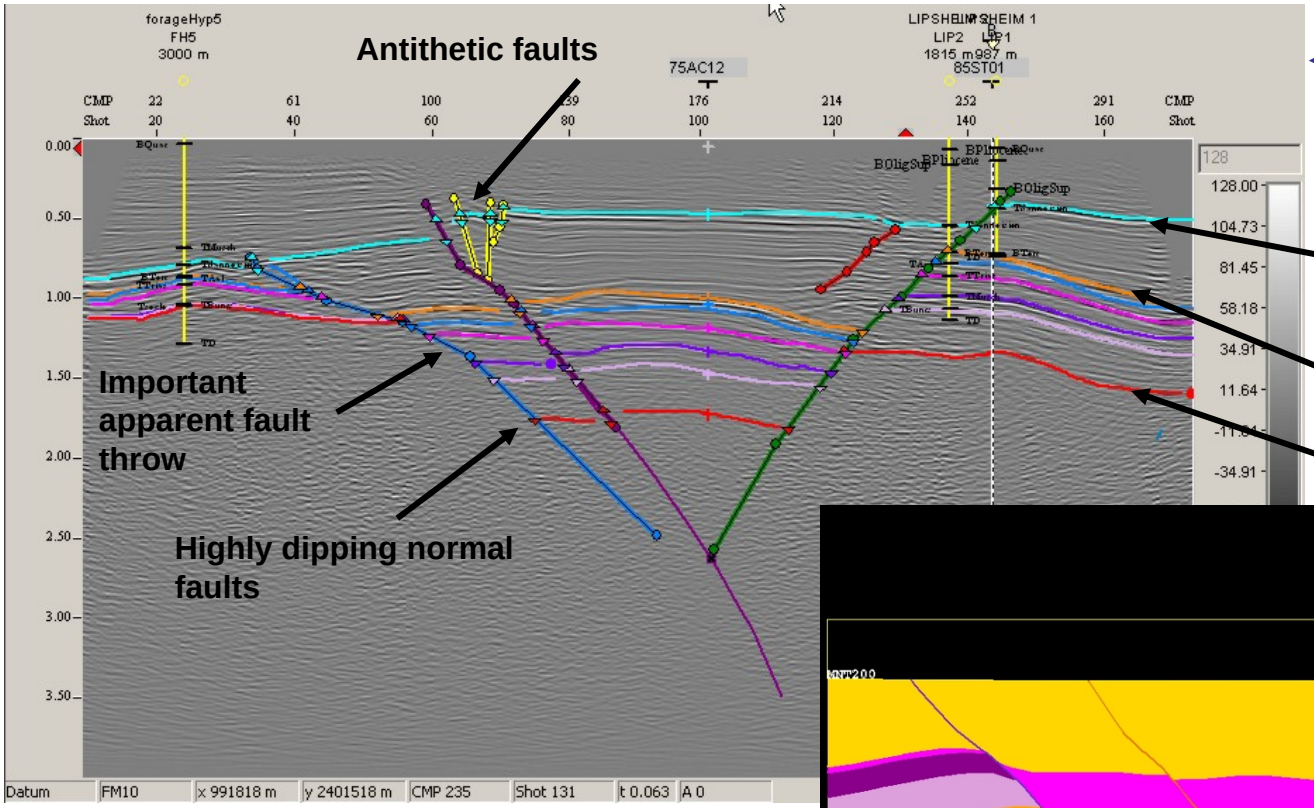
Interpretation of seismic data

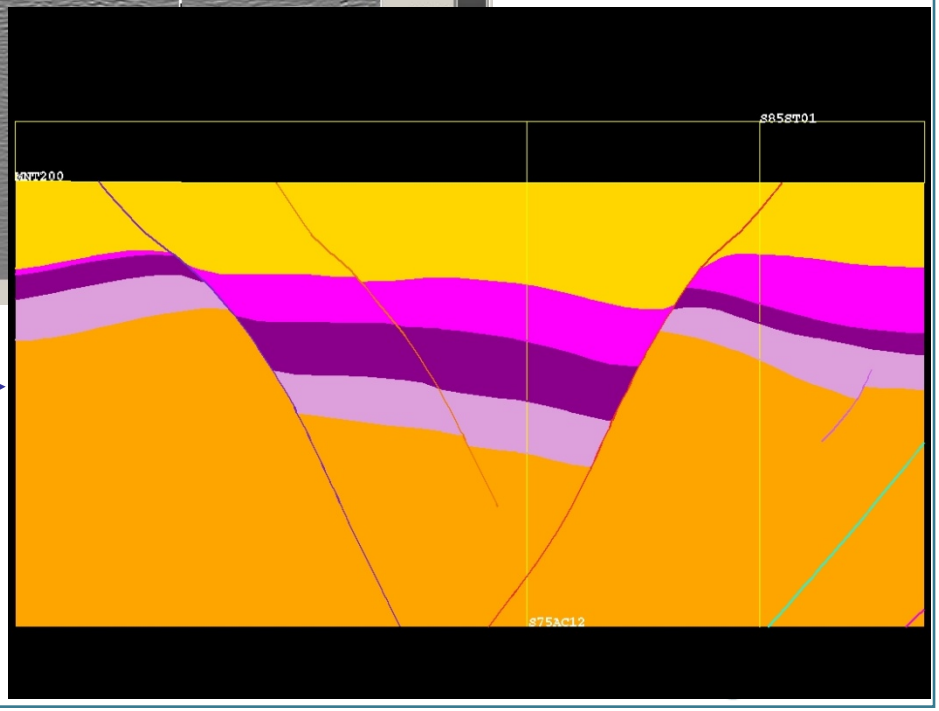


Cross-section in time

Base of Foraminifera Marls [bff]

Base Tertiary [bt]

Top basement [tkr]



Cross-section converted in depth

►Each seimic profile = cross-section in the model

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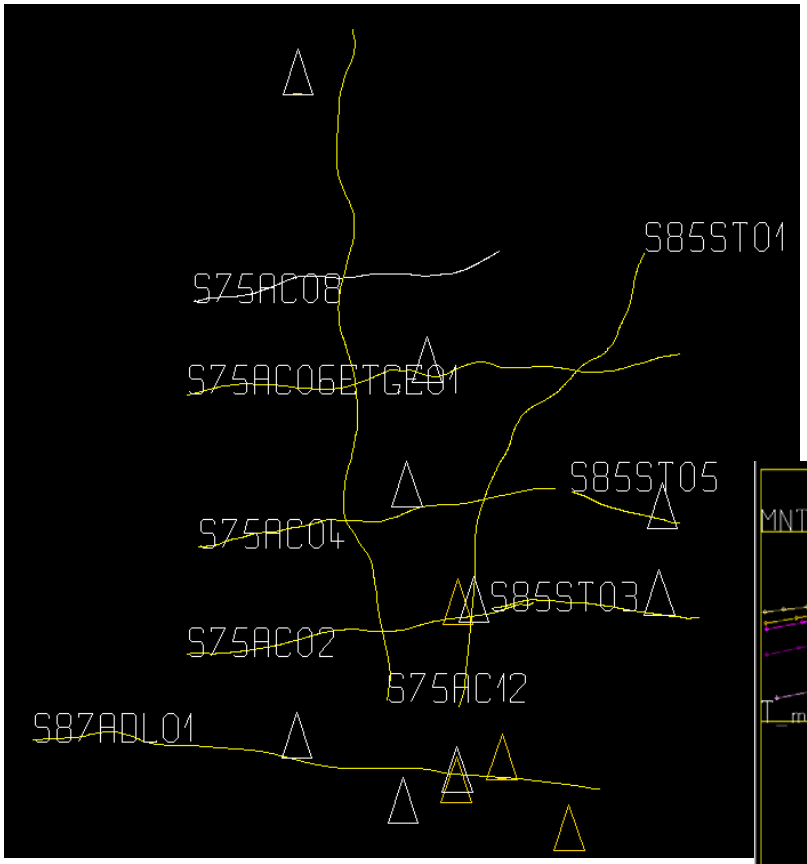
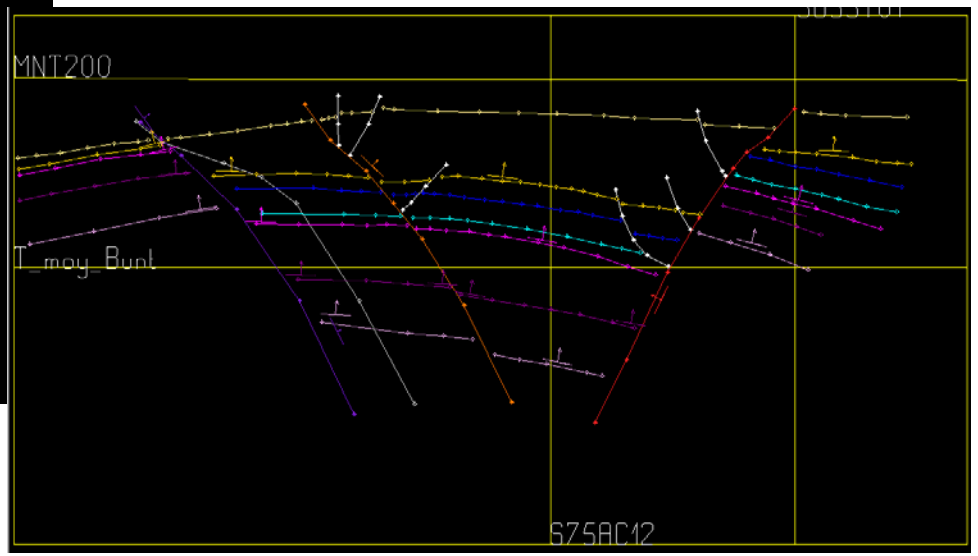
Data in the modeller



Topographic map



Seismic interpretation

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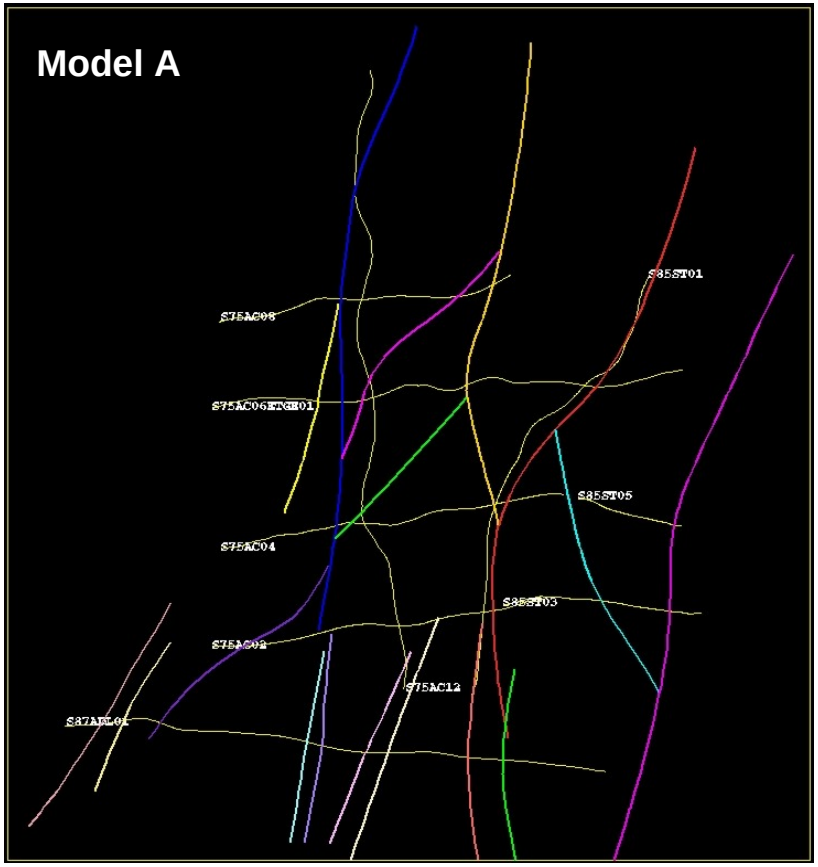
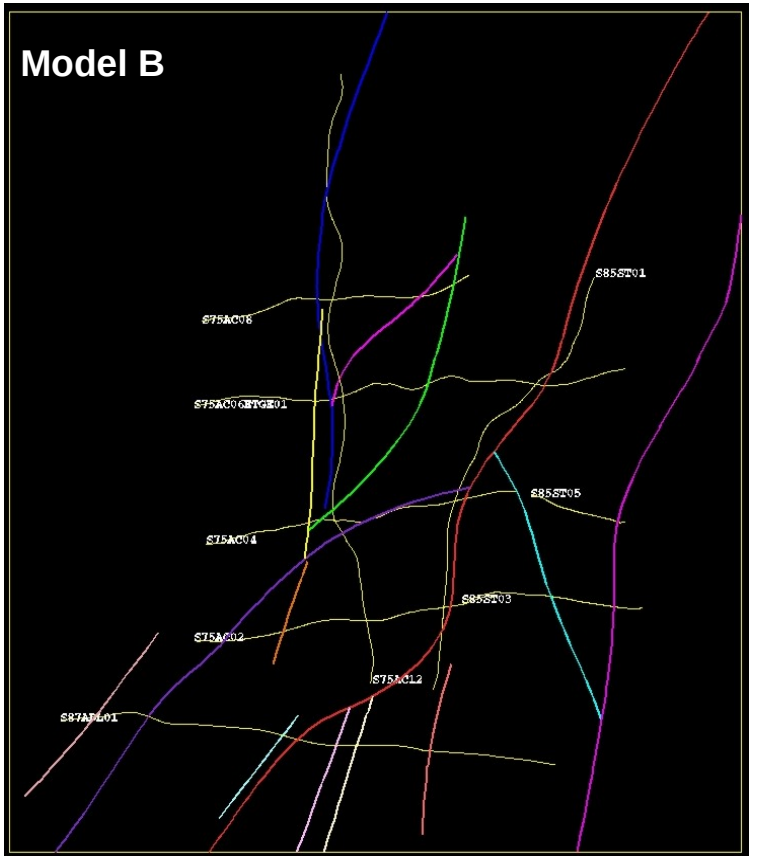
Fault correlation

Fault traces on map





Correlation of faults between the different cross-sections takes into account vertical extension of fault, their throw and dip dir.

► 2 different structural pattern based on different hypothesis

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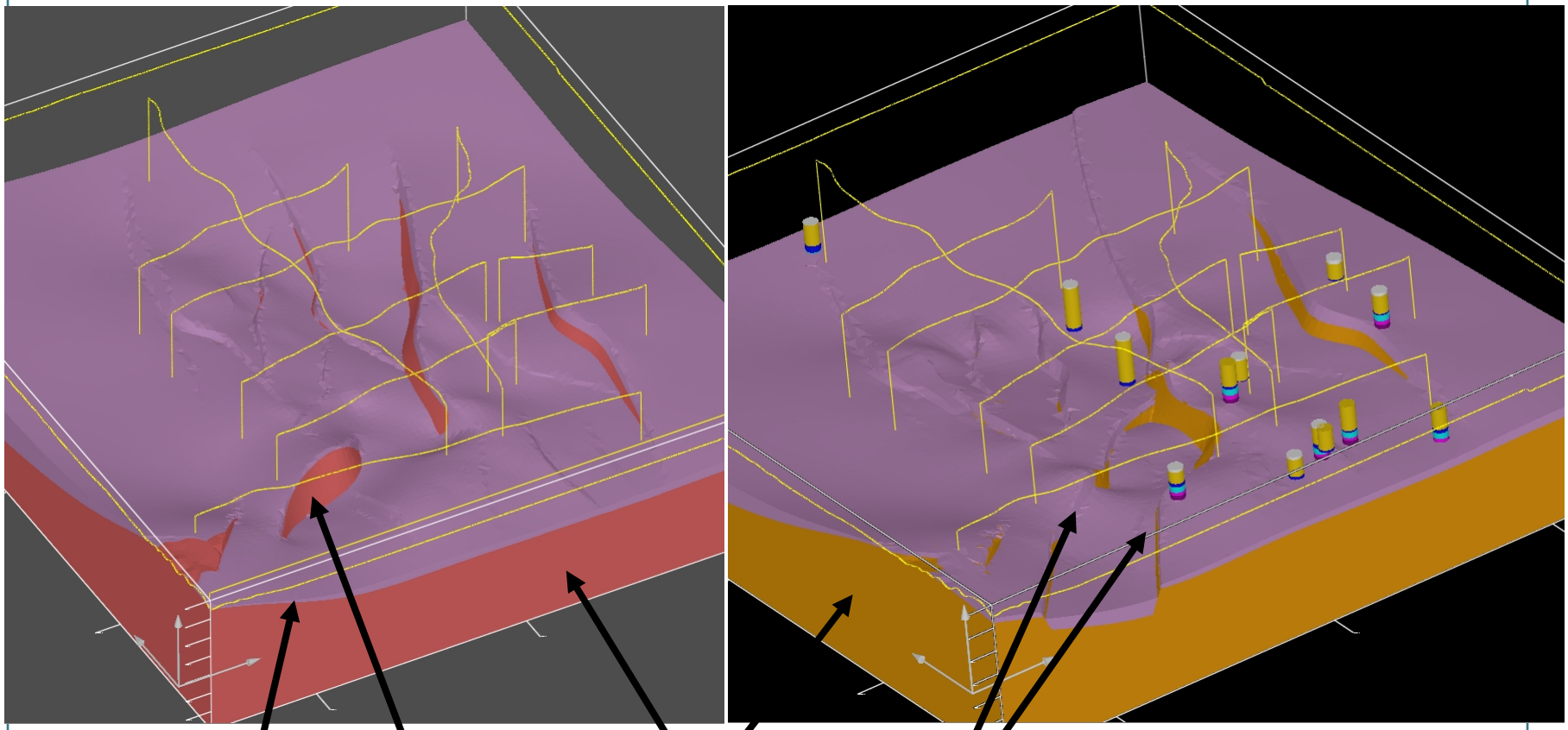
3D model

Model A **Model B** **View to the NE**



For the following computation of the geothermal potential, we take into account the both models.

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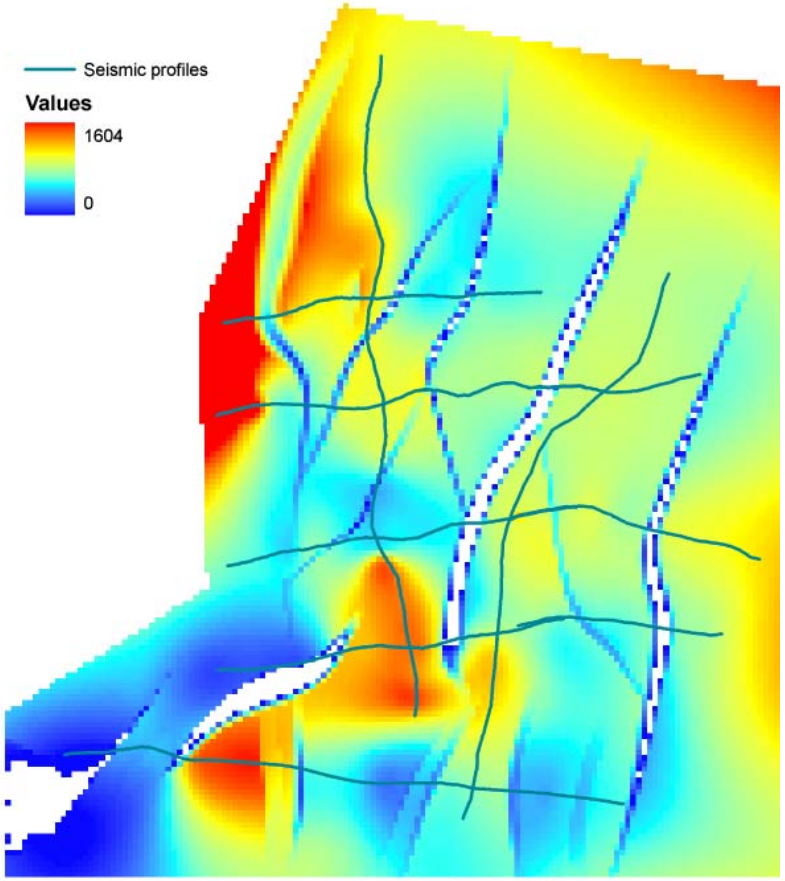
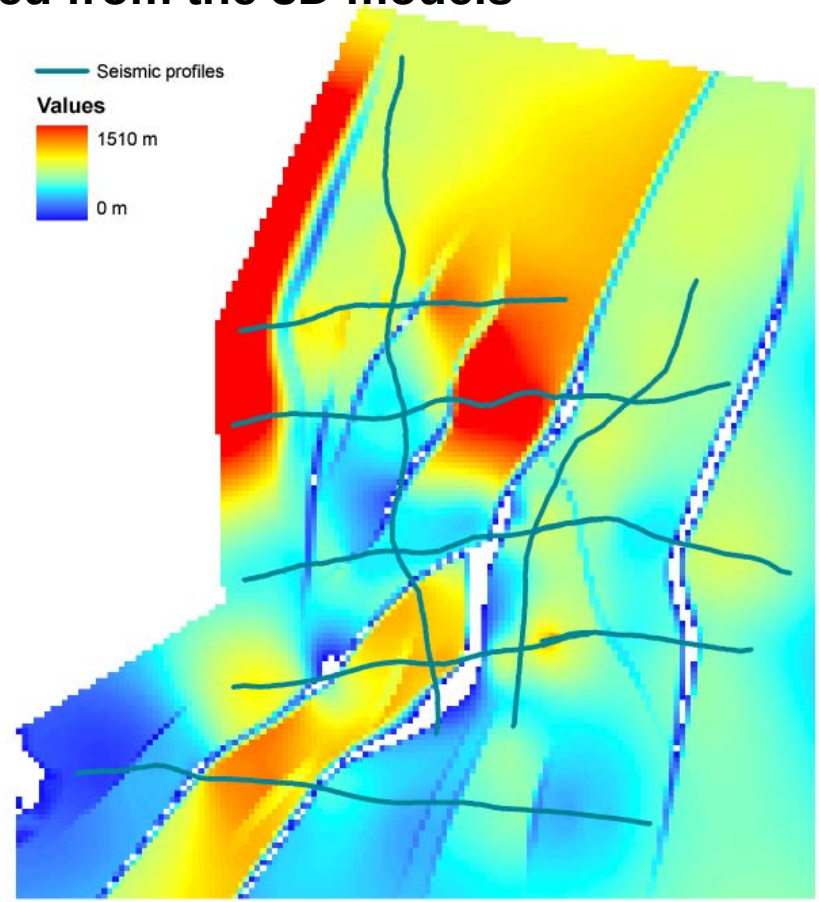
Buntsandstein thickness

► **Thickness maps deduced from the 3D models**





Model A

Volume = 275 km³

Model B

Volume = 302 km³

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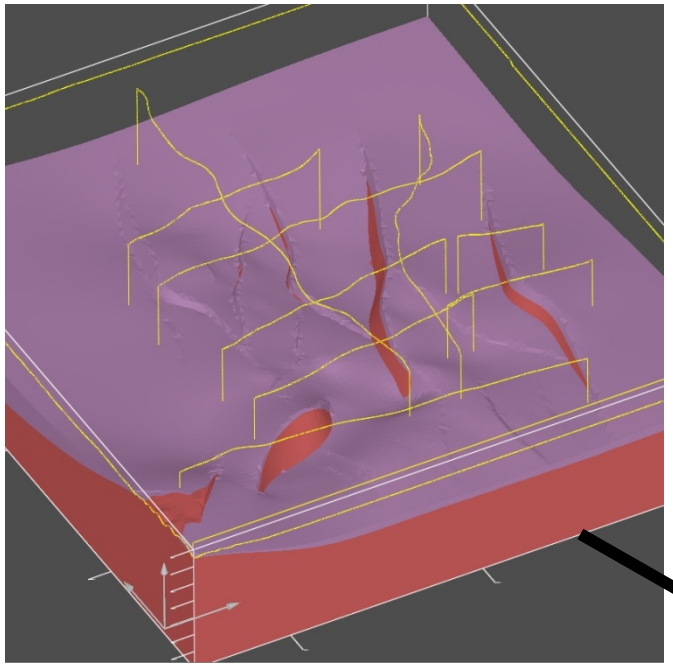
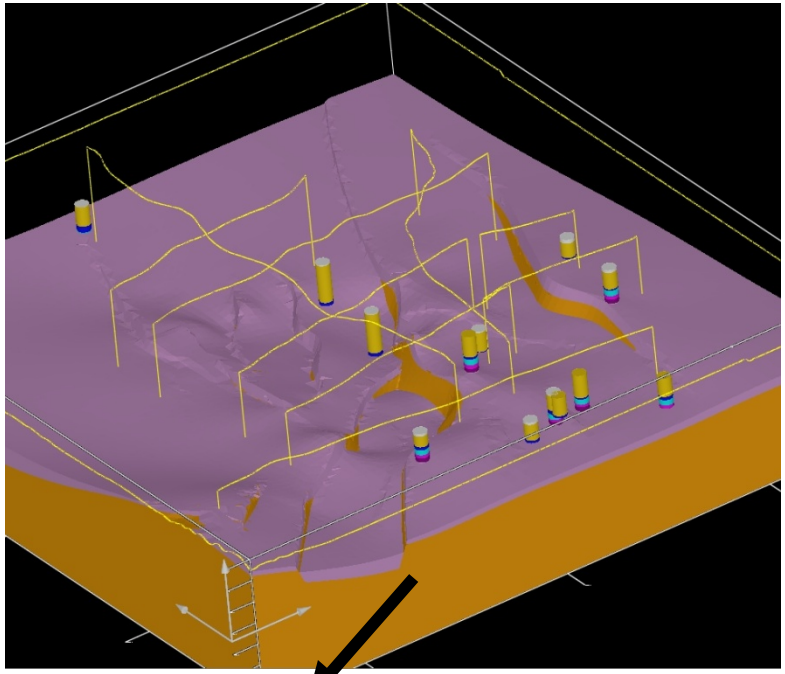
Geothermal potential





	Model A	Model B
Volume	275 km^3	302 km^3
Q	1224 $GW_{th}.yr$	1346 $GW_{th}.yr$
Qexpl	337 $GW_{th}.yr$	370 $GW_{th}.yr$

T° = 100°C

R_T . R_G = 27%

Difference = 10%

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Conclusions

- Reservoir geometry determined by 3D modelling
- Geothermal potential depends of geological conditions
  - **Geometry of reservoir**
  - **Type of reservoir (fractured or not)**

Good knowledge of the reservoir geometry = best assessment of geothermal potential

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Soultz EGS site

GeORG team at Soultz, september 2010

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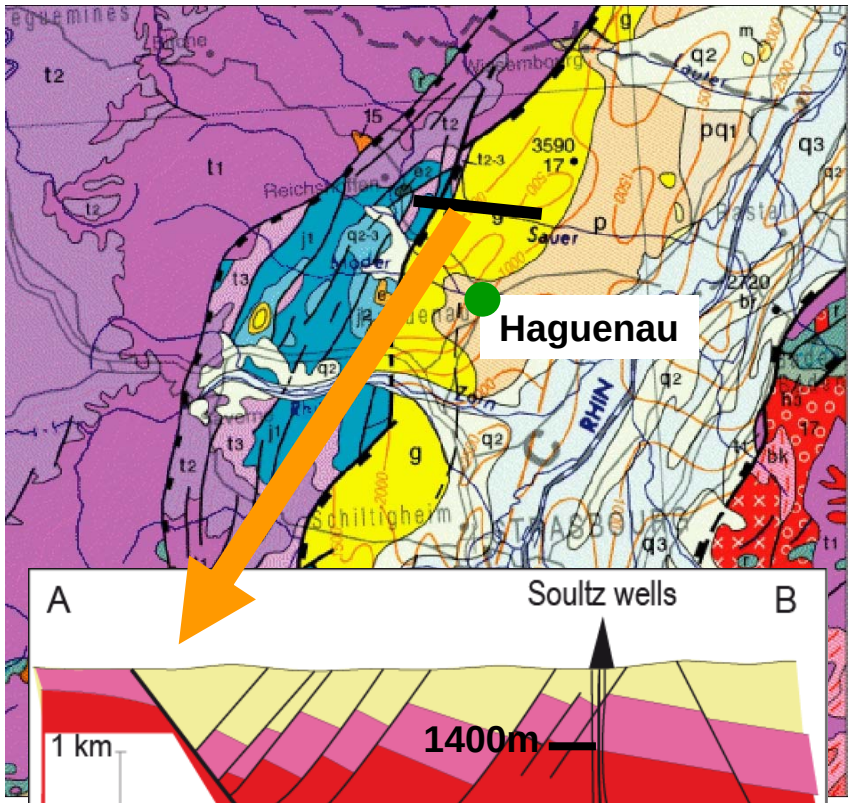
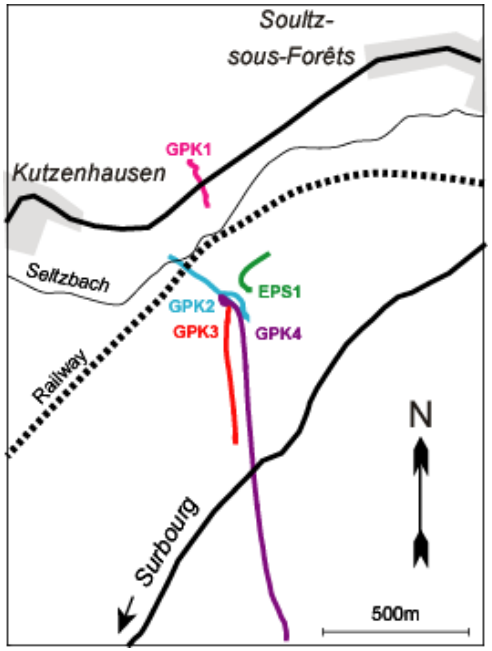
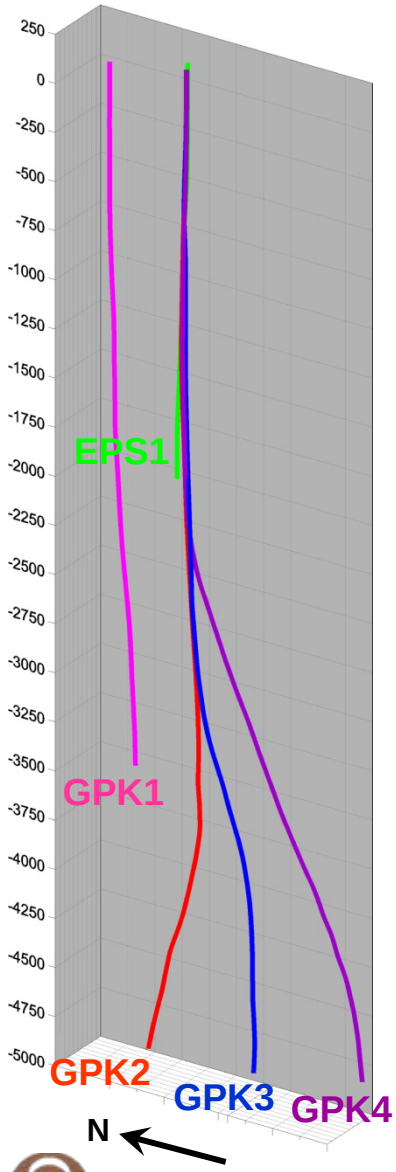
Setting of the EGS Soultz site





Since 1987:

- EPS1 fully cored ➔ exploration
- GPK1 ➔ preliminary injection tests
- GPK3 ➔ reinjection well
- GPK2 and GPK4 ➔ production wells



►Explotation of the heat of the deep granite basement

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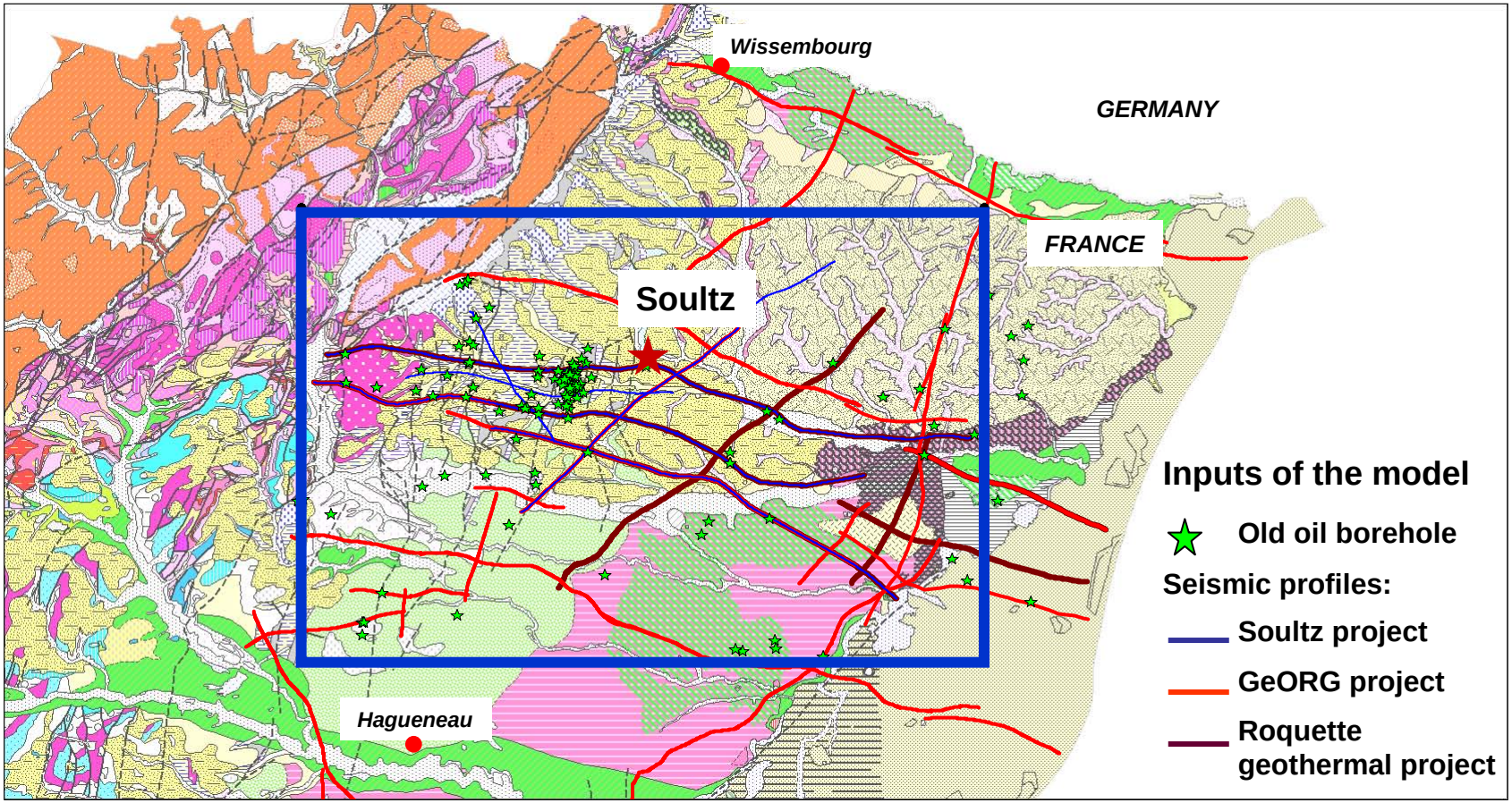
Setting of the 3D model



Model dimension: 30 x 20 x 6 km

- **Oil exploitation stopped in the 70's**
- **Exploration campaign done in the 80's**

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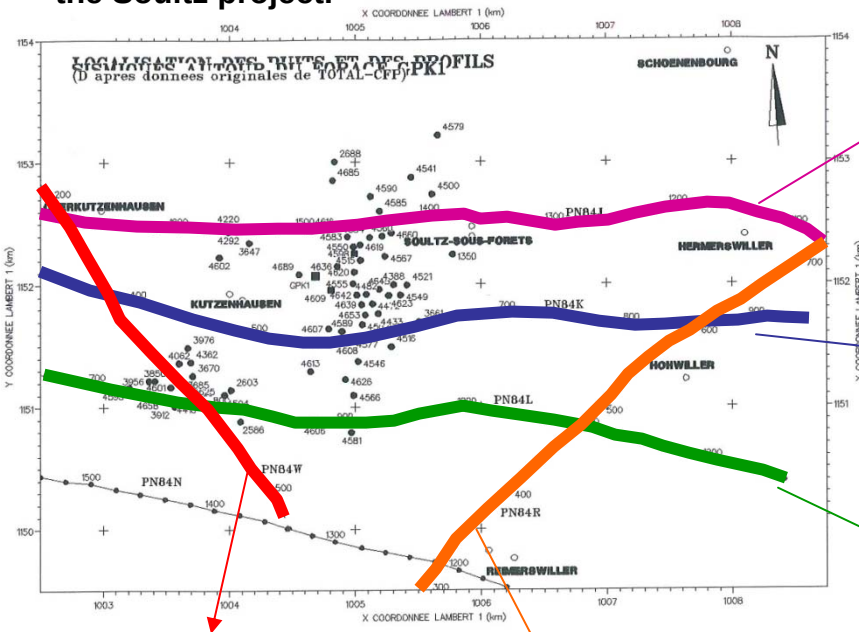
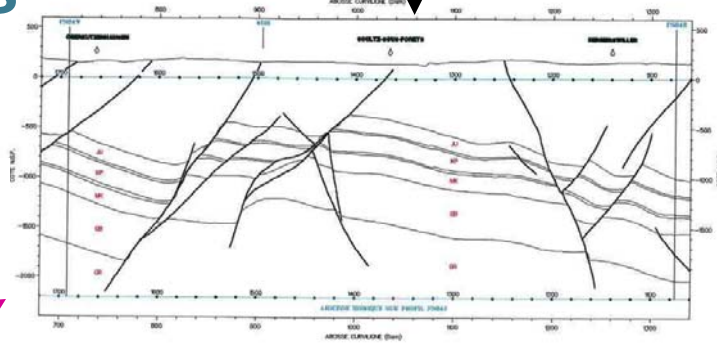
Geological cross-sections

Previous geological cross-sections (Cautru, 1985) done in the framework of the exploration phase of the Soultz project.

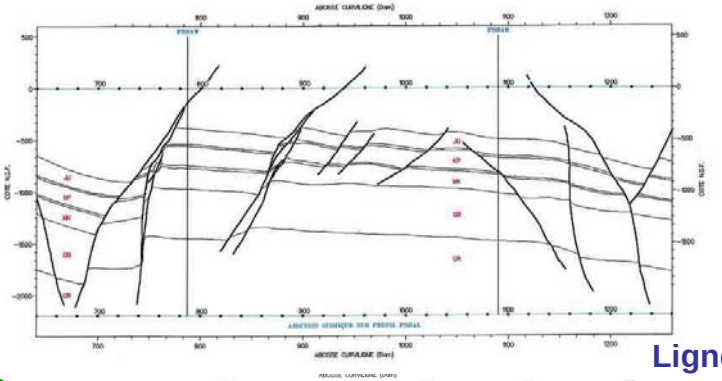


Horst of SOULTZ

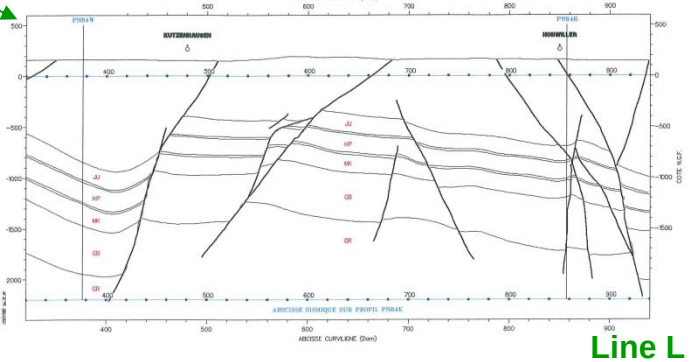
W E



Line J



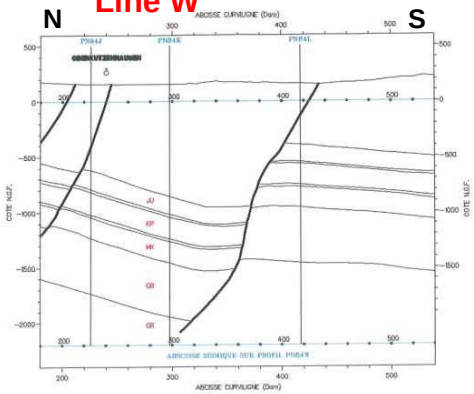
Ligne K



Line L

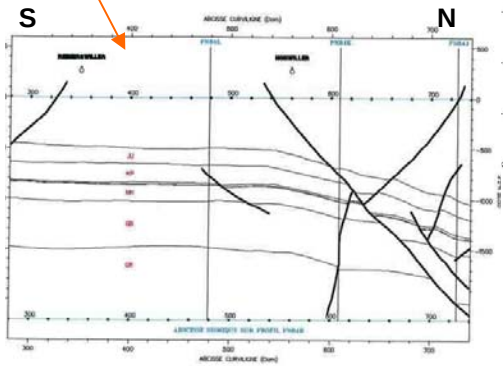
Line W

N S



Line R

S N



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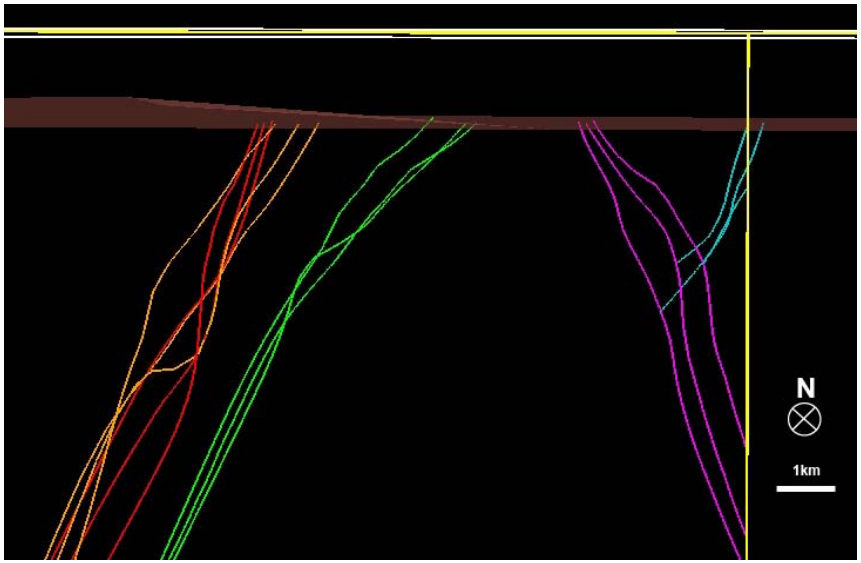
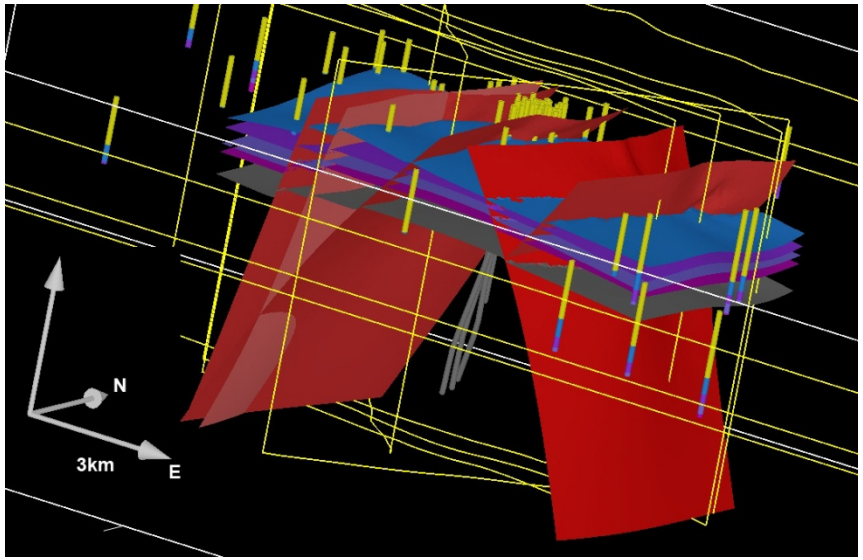
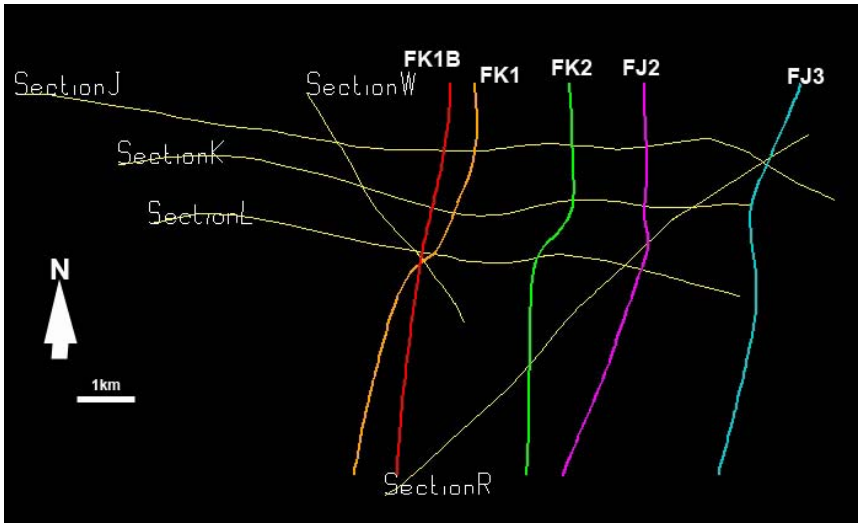
Large scale faults in the sedimentary cover





FAULT CORRELATION

Vertical view to the north.
Superposition of faults on 3 profiles



Map view to the faults correlated between the seismic profiles

Interpolation of the geological layers
Taking into account the borehole data

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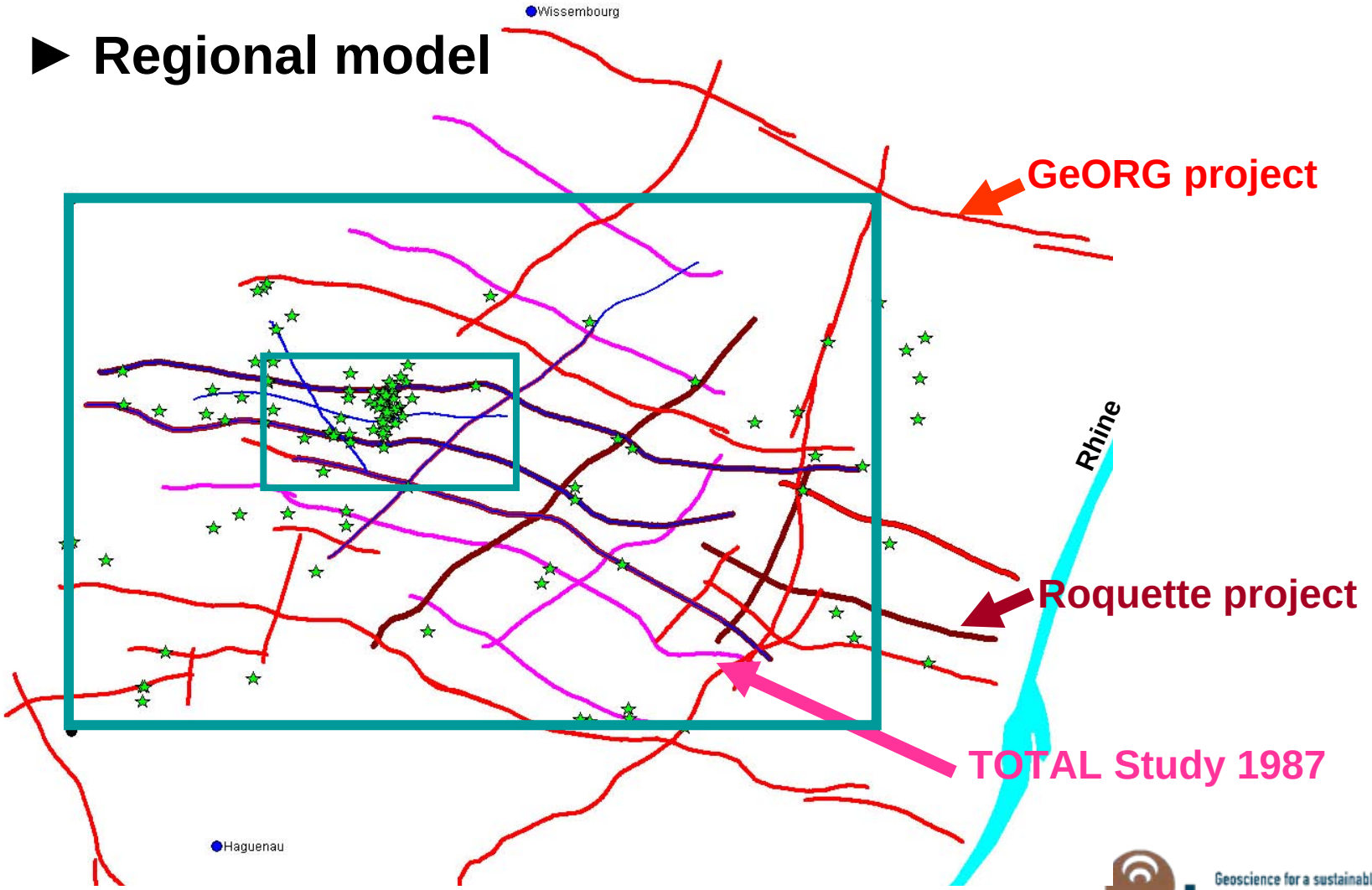
Extension of the model

- **Regional model**



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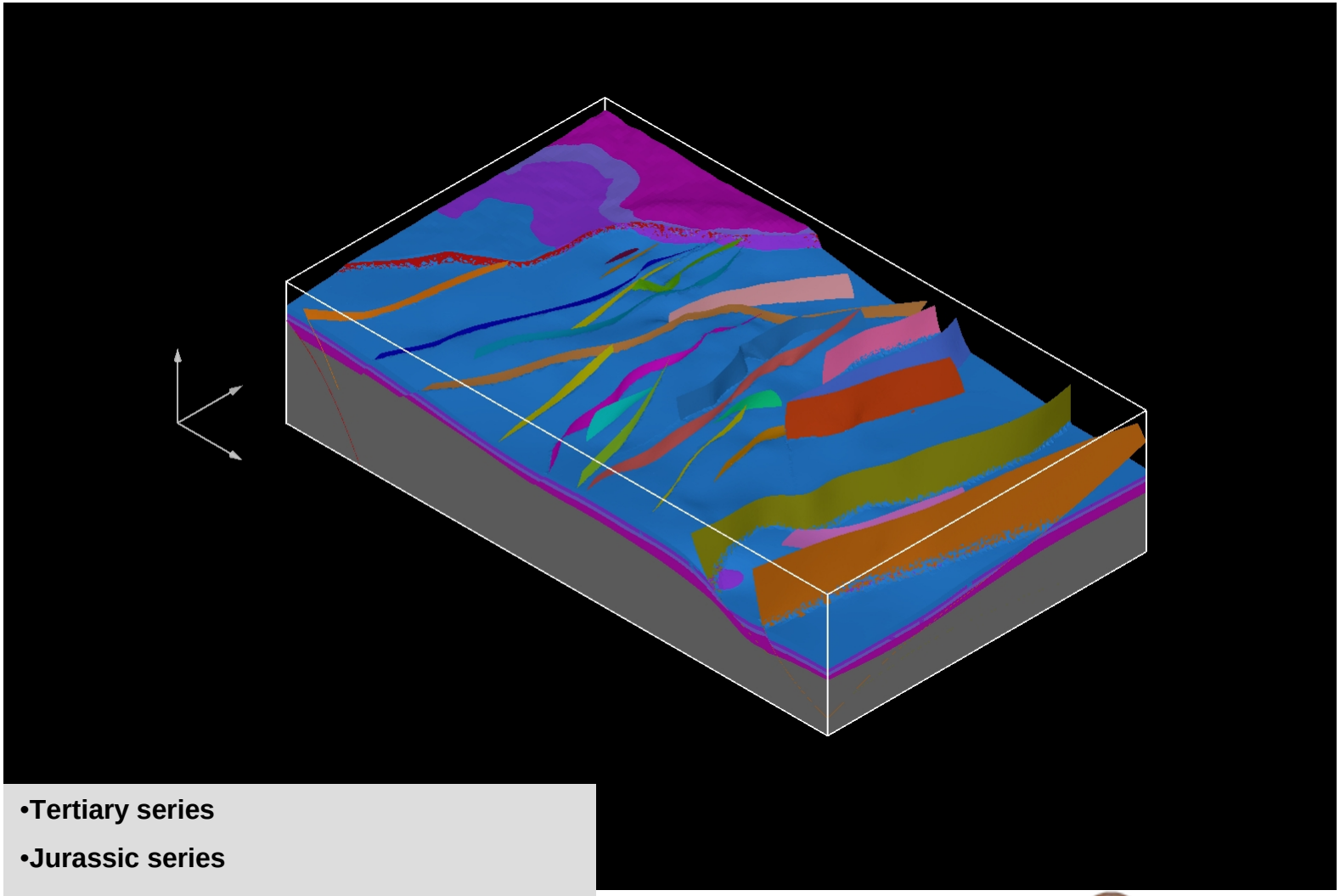
Complete model for the sedimentary cover



- **Tertiary series**
- **Jurassic series**
- **Triassic series, including surfaces of Keuper, Muschelkalk and Buntsandstein**
- **Basement**

- **Fault network: NNE-SSW**
- **Major fault dipping eastward**

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Conclusions

- We provide the first 3D geological model at the regional scale for the Soultz area.
- This model could be used to investigate other geothermal reservoir in this area.
- This model could be the basis for other modelling.

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Many thanks to

- ES Géothermie ;
- ADEME (French Agency for Environnement and Energy) ;
- Students: Gloria Heilbronn, Typhaine Duval, Julien Castera.

Thank you for your attention