Prospective for Geothermal Electricity in Europe

6th Regional Workshop
Germany, Poland, Czech Rep., Slovakia, Hungary, Austria, Switzerland

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INTELLIGENT ENERGY EUROPE

GEOELEC - Towards an assessment of the resource and the potential of geothermal power

Goal of the project:

- Prospective study to forecast geothermal resource for producing electricity to attract potential investors based on
  - Geological surveys
  - Oil & Gas company public reports
  - Direct contacts with underground 'explorators'
  - 7 regional workshops to complete data compilation

and a common methodology to assess the potential of geothermal electric power

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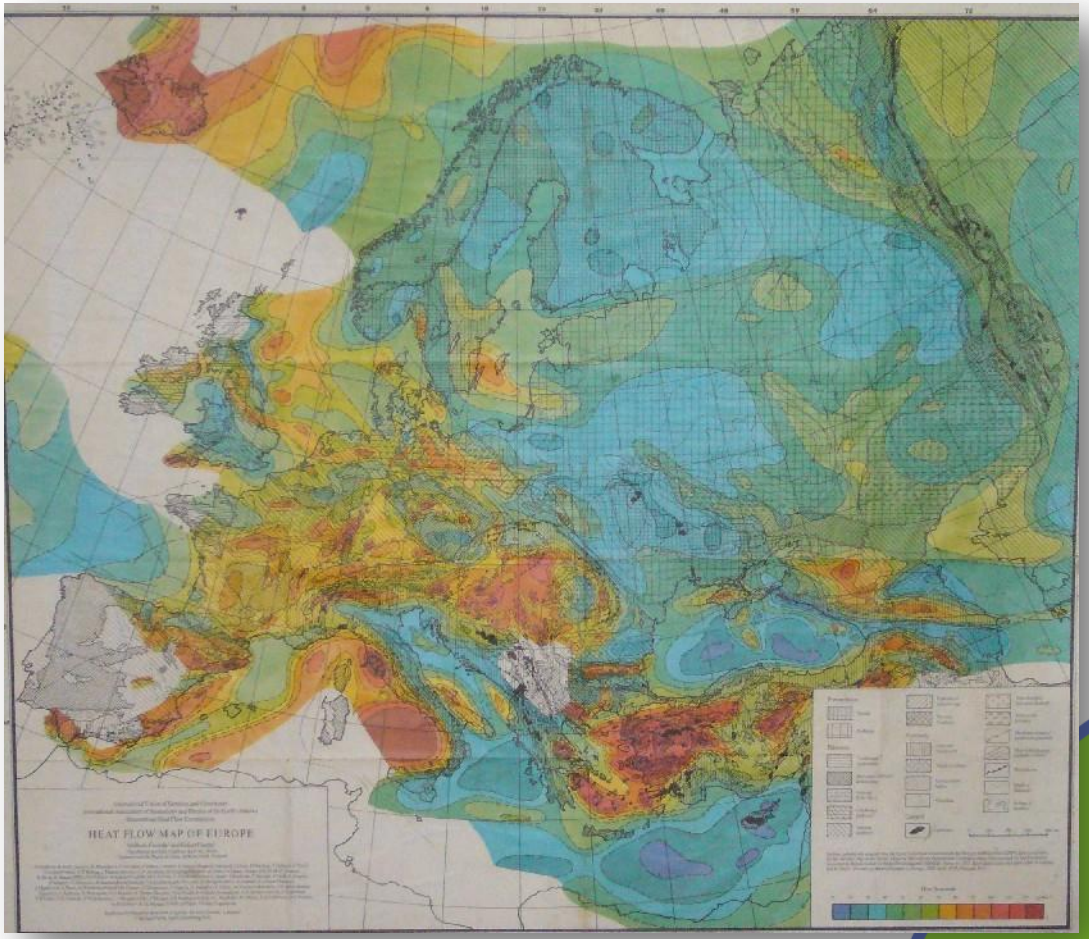
Early geothermal data compilations

CERMAK, V. & RYBACH, L. (eds.) (1979): Terrestrial Heat Flow in Europe

Book with different papers from a Workshop

A map of heat flow density was included in that book

Similar book:
CERMAK, V. & HÄNEL, R. (eds.) (1980): Geothermics and Geothermal Energy, Symposium EGS/ESC Budapest



(Map by Cermak & Hurtig, 1979)

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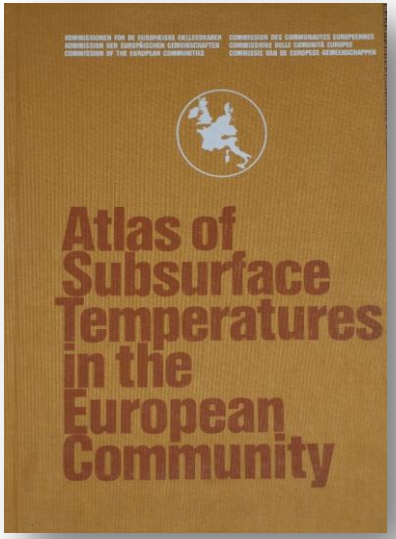
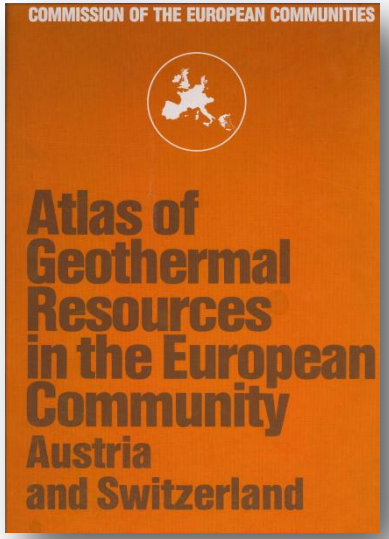
Atlas of geothermal resources in Europe

Coordinated by BGR

1980

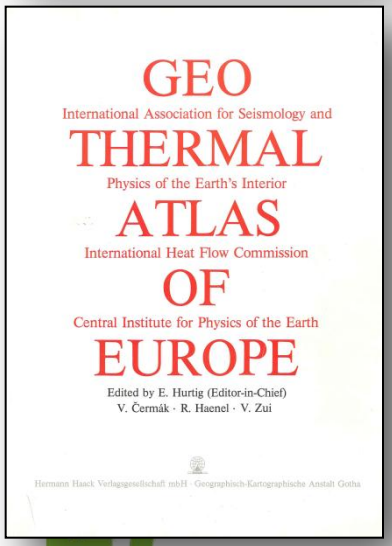
Only heat flow and temperatures at depths between 500 and 5000, for countries and regions (e.g. Soultz-Landau)

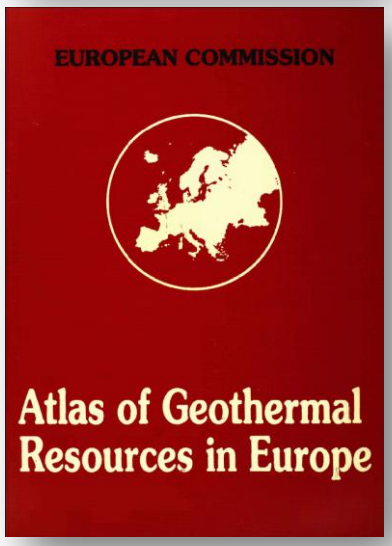




1988

1992



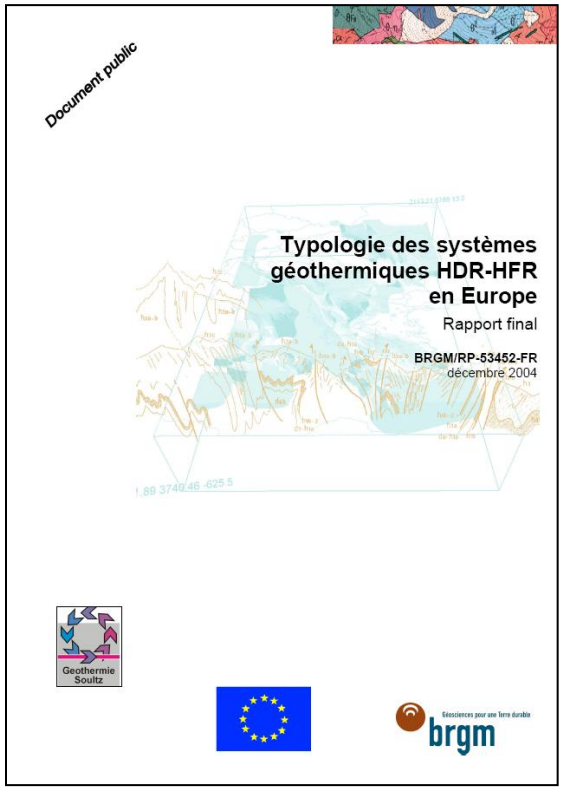


2002

Overview:
Heat Flow
Temperature at 1 Km and 2 Km depth
European Geothermal resources

Typology of continental hot fractured systems in Europe

(Contribution of the European Hot Dry Rock Energy Project, 2001-2004)



Report available on BRGM website

http://www.brgm.fr

Yielded by BRGM

Genter A. et al. (2003) – Typology of potential Hot Fractured Rock resources in Europe. Geothermics 23, p. 701-710.

Genter A. et al. (2004) - Typologie des systèmes géothermiques HDR/HFR en Europe. Open file report. BRGM/RP-53452-FR, 165 p., 75 fig., 10 tabl.

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Geothermie Soultz

Objective and results

- Objective
  - Demonstrate the reproducibility of the Soultz concept to other deep fractured areas in Europe

- Results
  - Analysis of extrapolated temperature at 5000 m depth
  - Location of interesting area
  - Focus on promising zones for producing electricity from deep geothermal energy
  - Computation of geothermal deep potential in Europe

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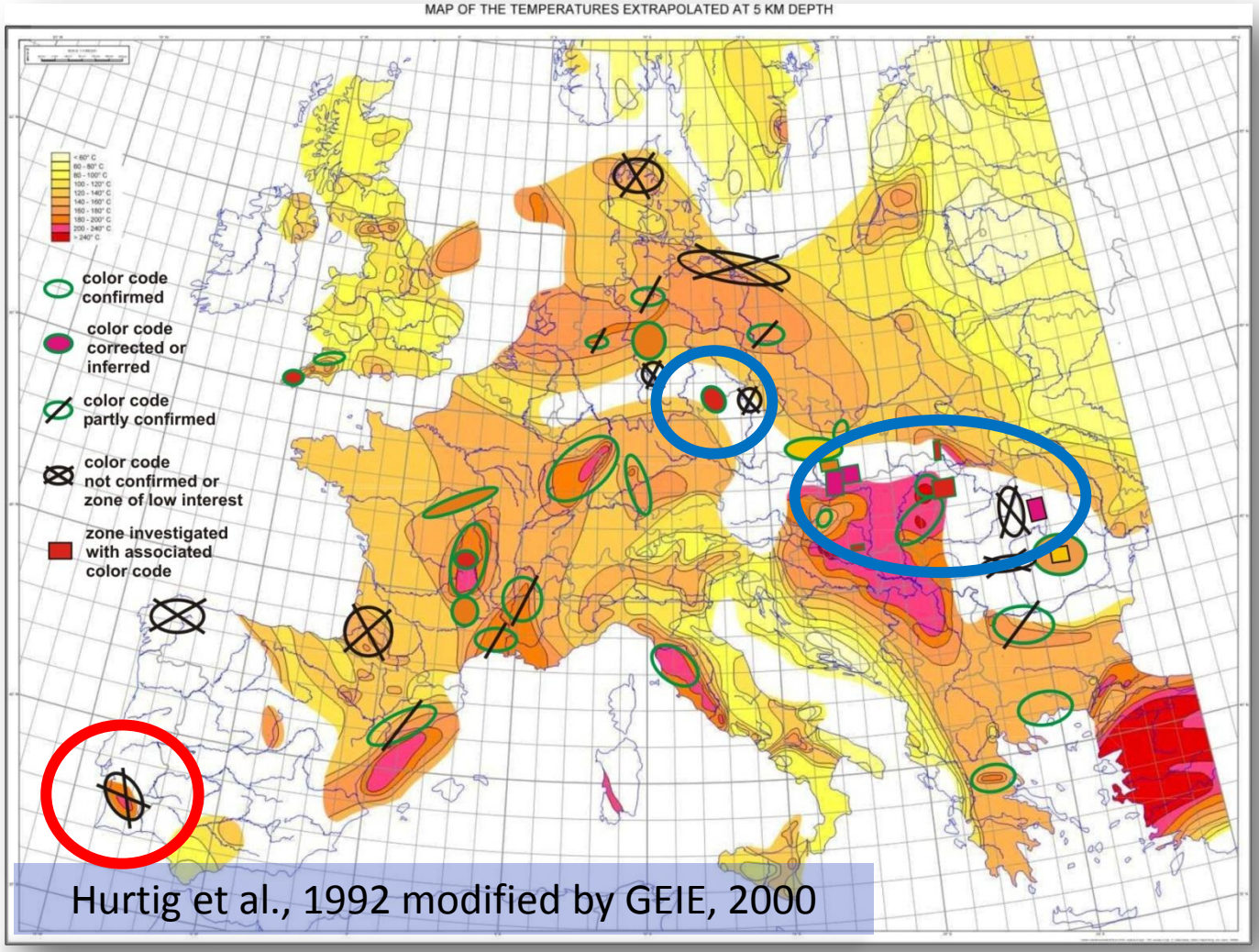
Analysis of the map of the temperature extrapolated at 5 km depth



Hurtig et al., 1992 modified by GEIE, 2000

-> only 5% of measured sites reach a depth >3500m

->70% <1000m

Comparison with data in literature, database (IHFC)….
-> elimination of high temperature areas
- > include areas not documented

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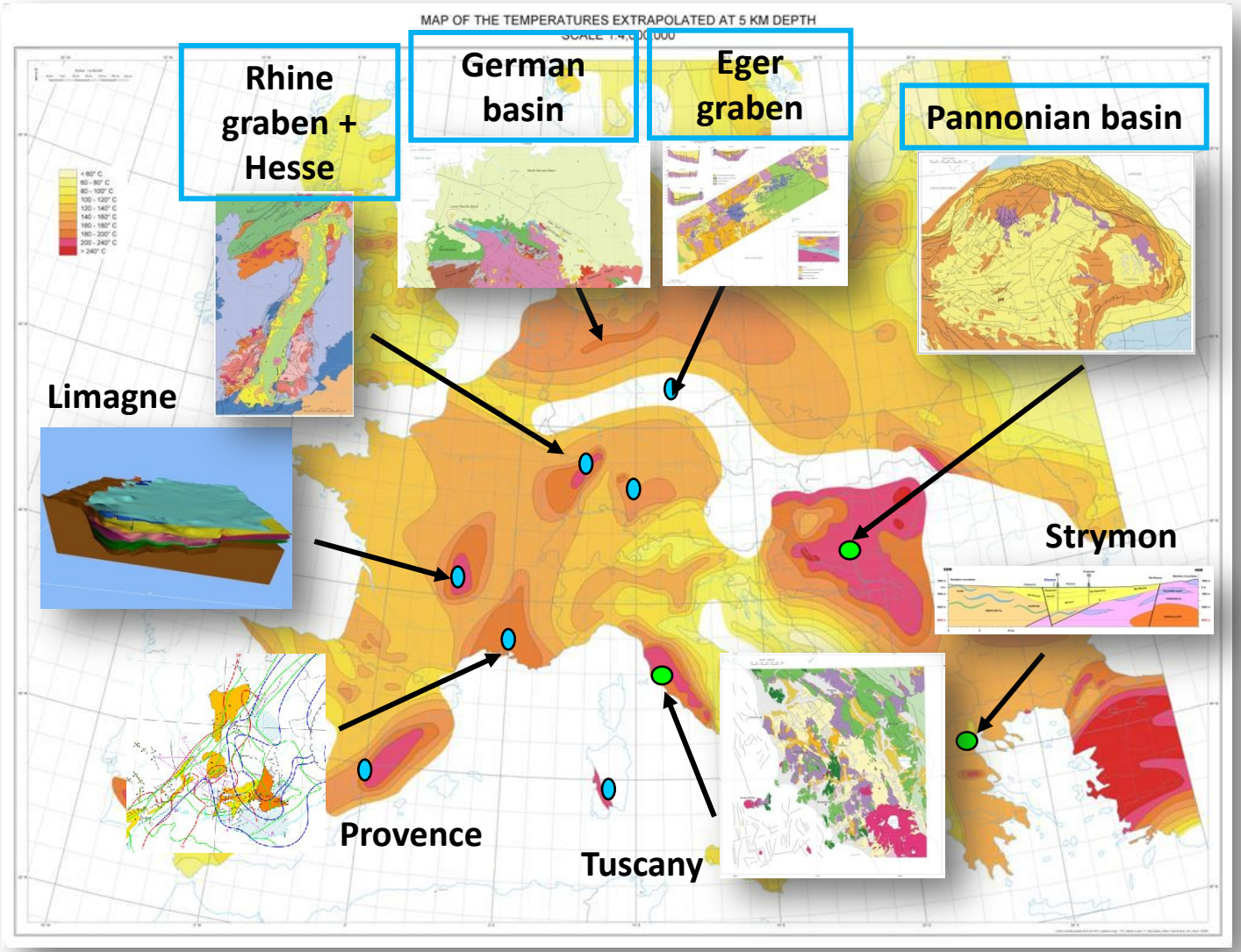
Focus on promising zones

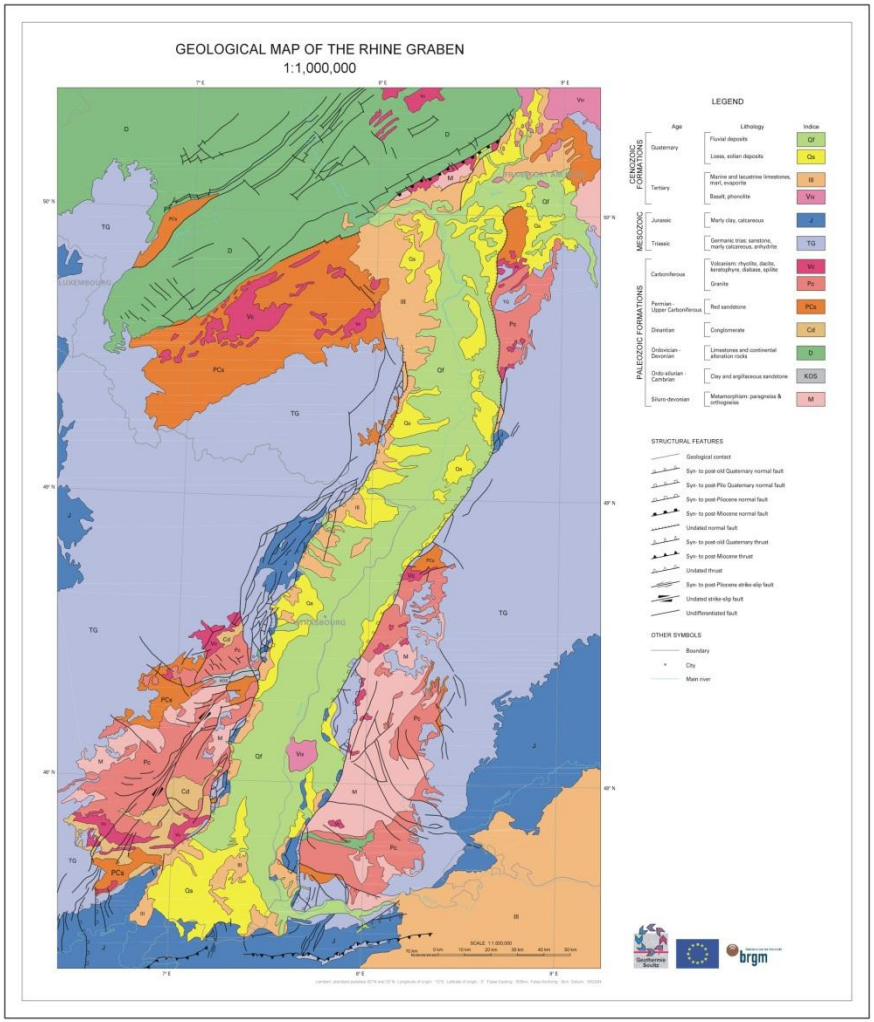


Promising areas studies

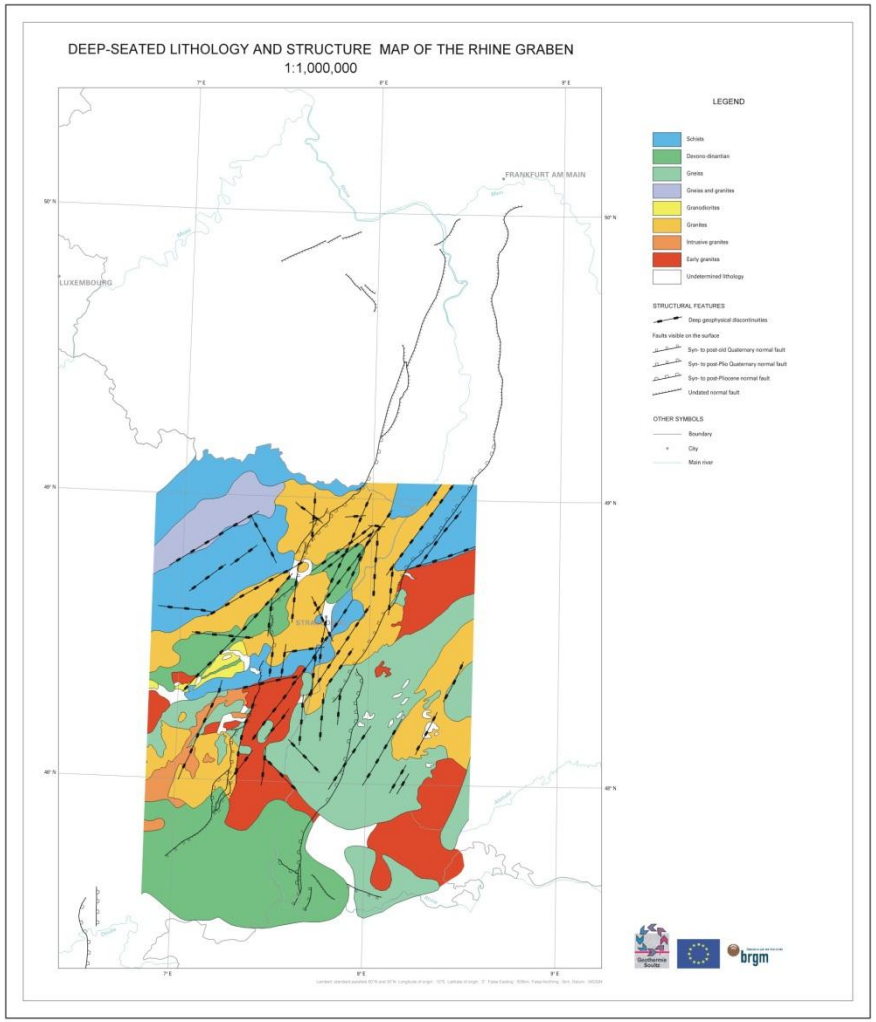
- Geographical and geological setting
- Origin of the geological structure
- Serie of maps:
  - Depth of basement
  - Thickness of sediments
  - Volcanism
  - Structures (faults, fractures…)
  - Stress field and seismic events
  - Hot springs
  - Temperature and heat flux
  - Geothermal potential

Rhine Graben

Synthetic geological map



Deep-seated lithological map



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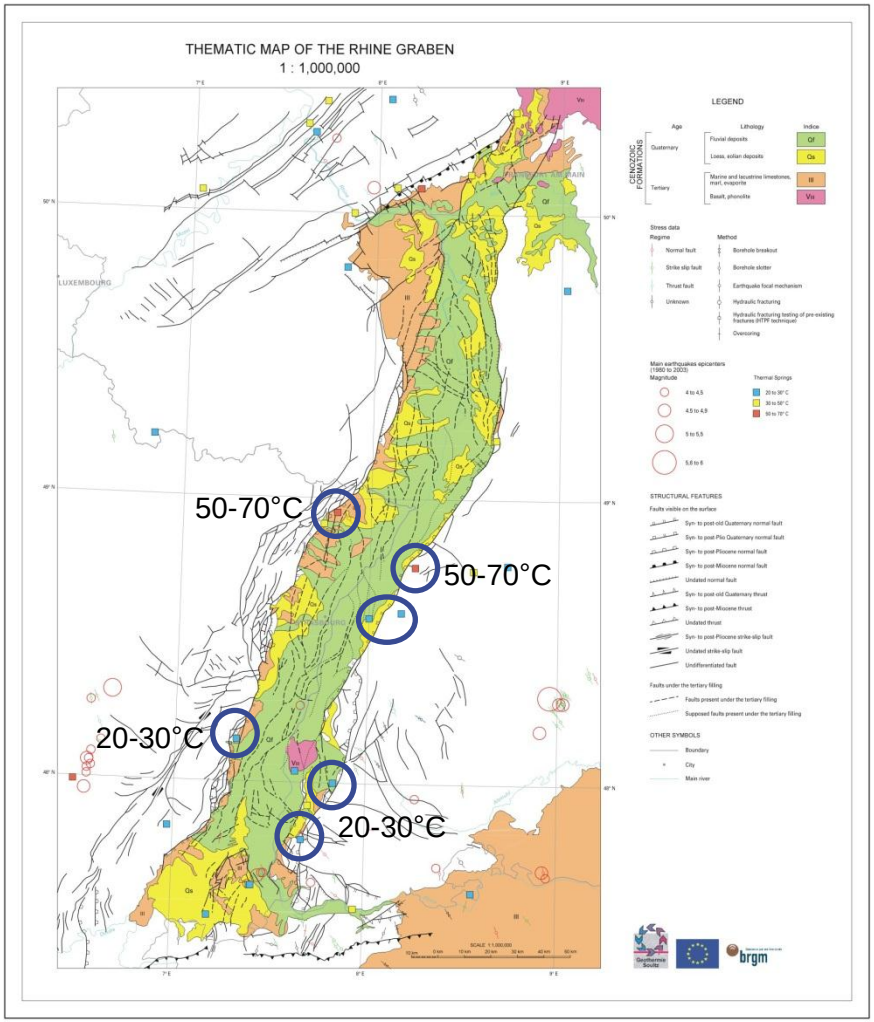
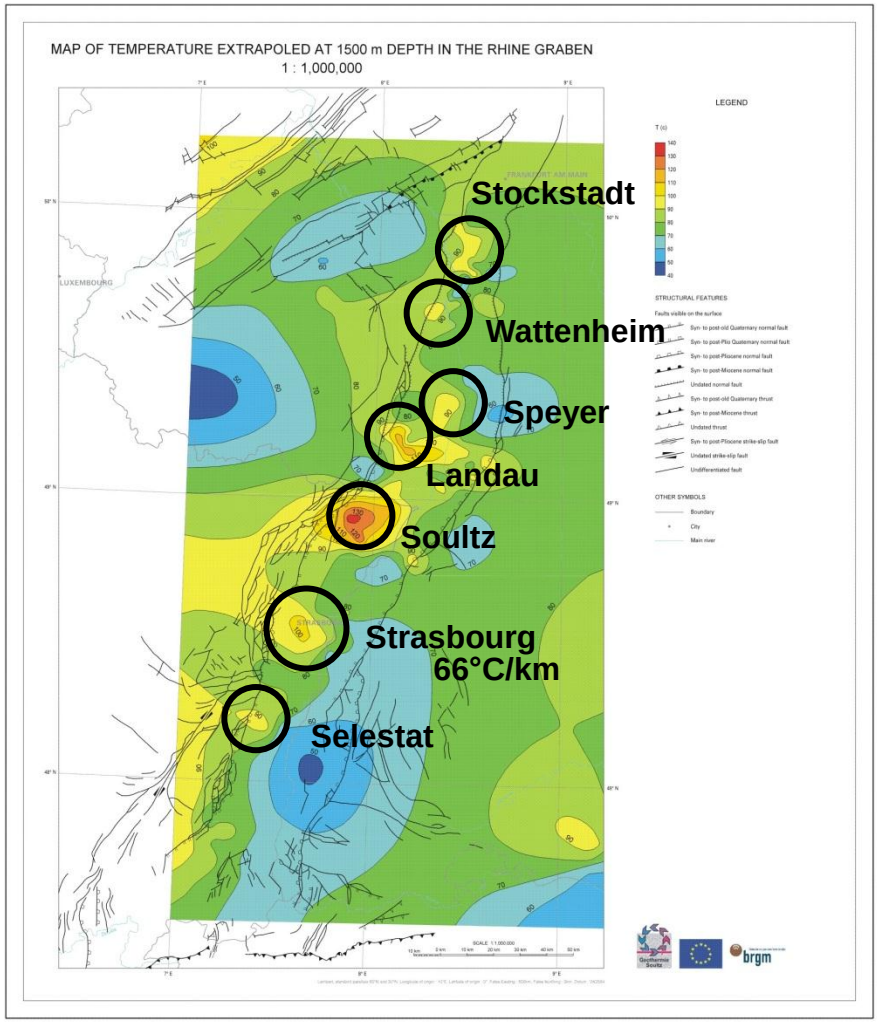
Rhine Graben

Thematic map

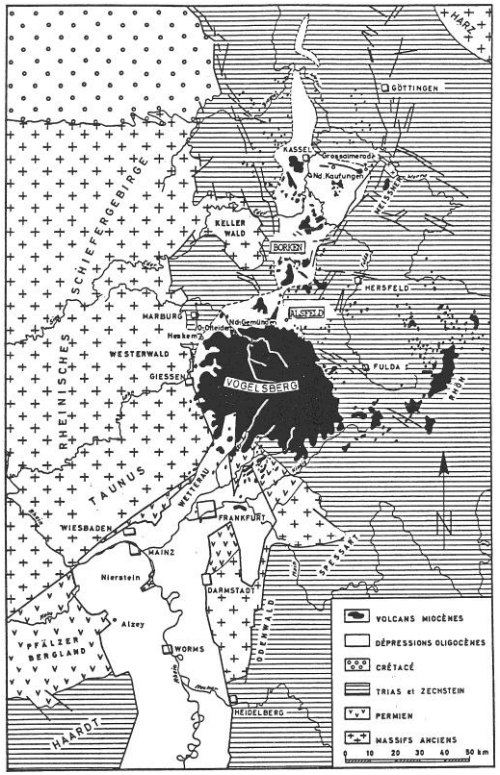


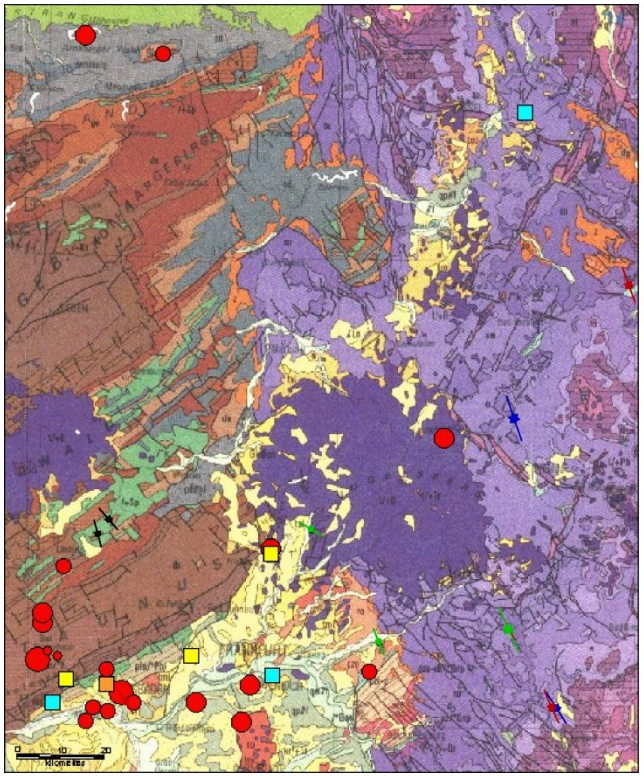
Map of temperature extropolated at 1500m

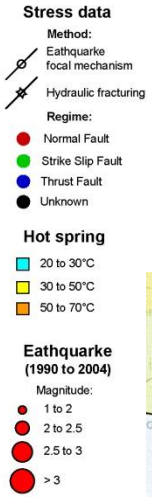


Hesse valley

Following structure of the Rhine Graben
Scattered faults

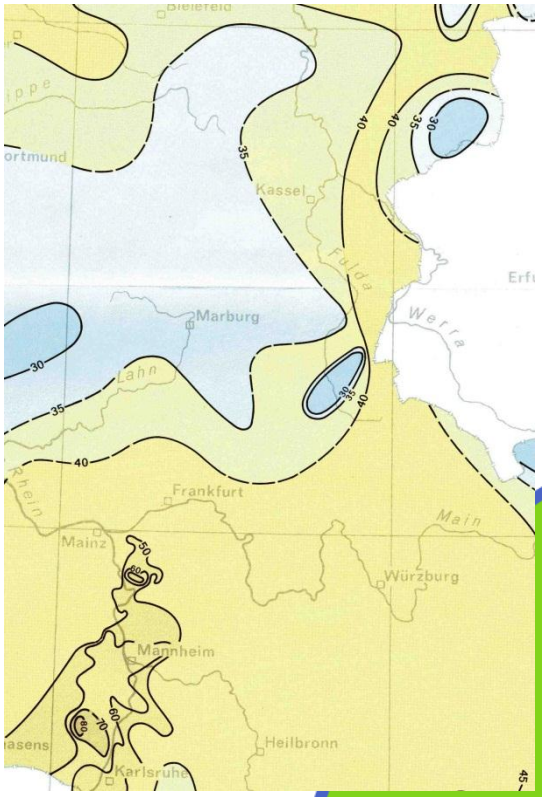






Earthquarke in the south M<3
Thermal springs 30-40°C

About 30°C @1000m depth



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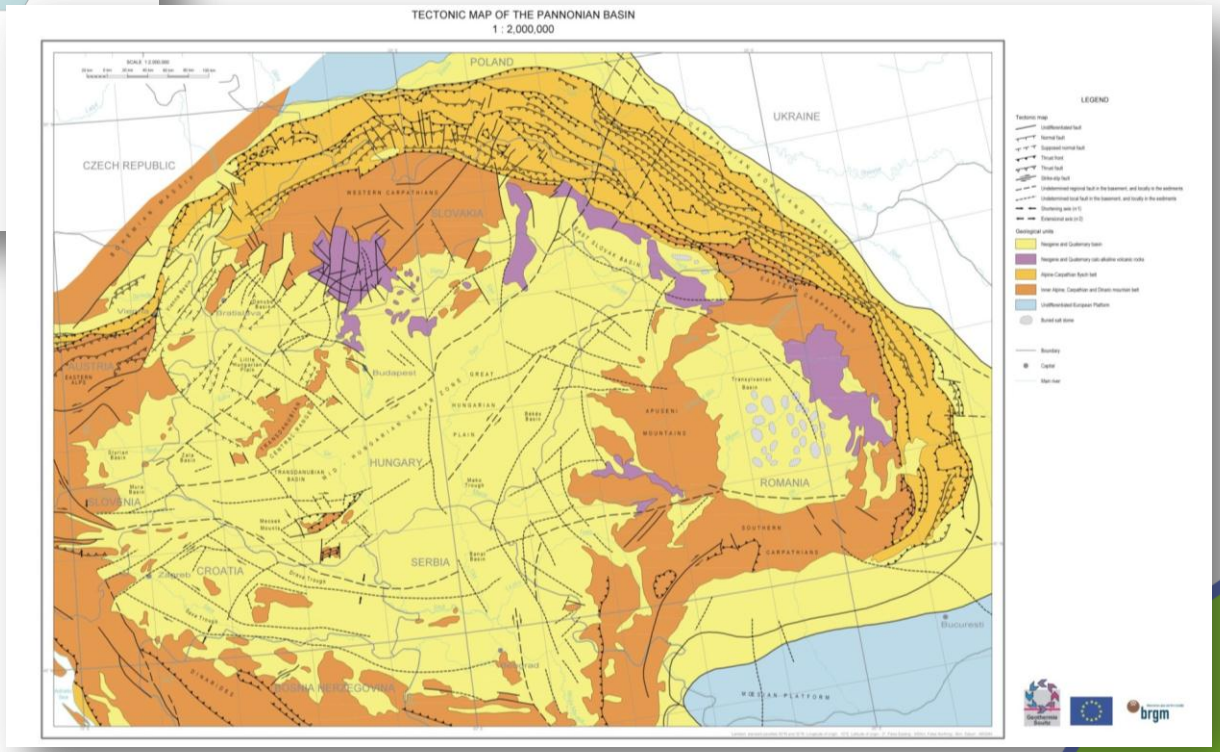
Panonnian basin

Tectonic map



Complex back-arc basins with horst and graben

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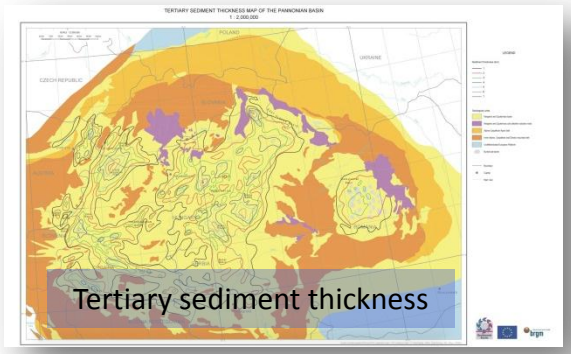
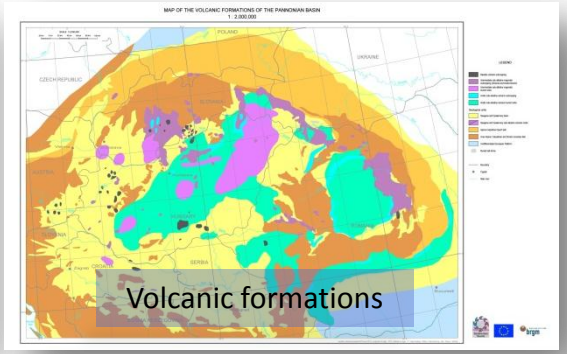
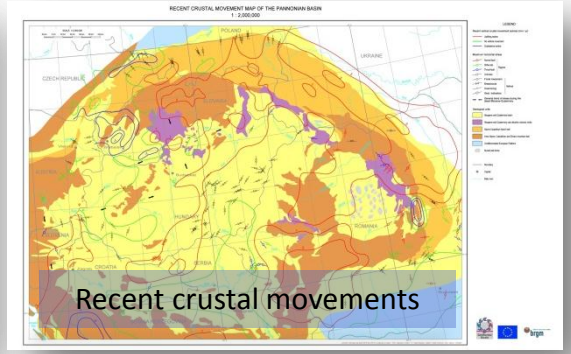
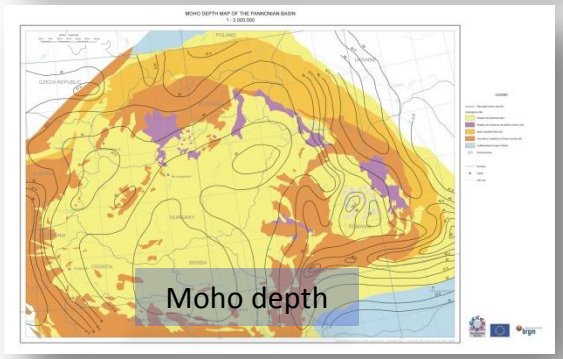
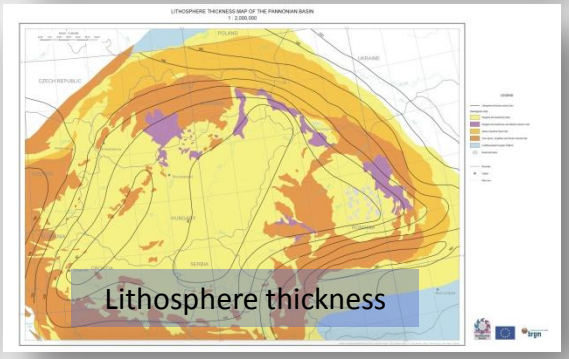
Other maps

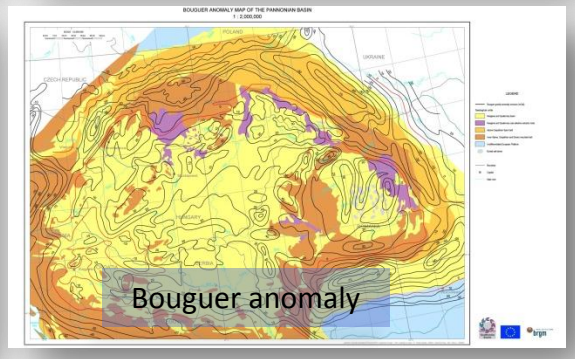


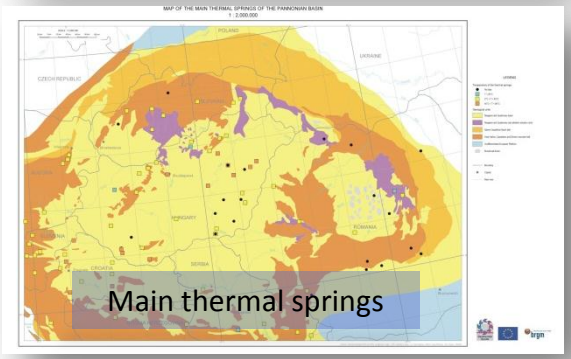


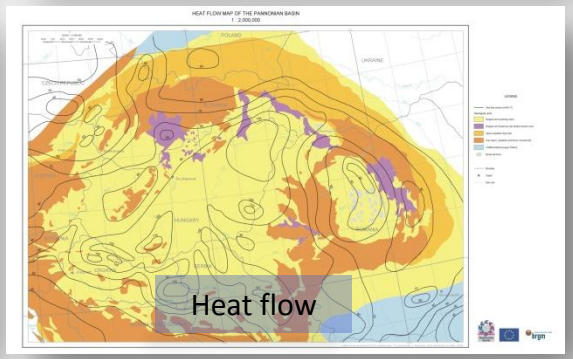












High heat flow :
reduced thickness of the crust
50°C-100°C @ 1000m

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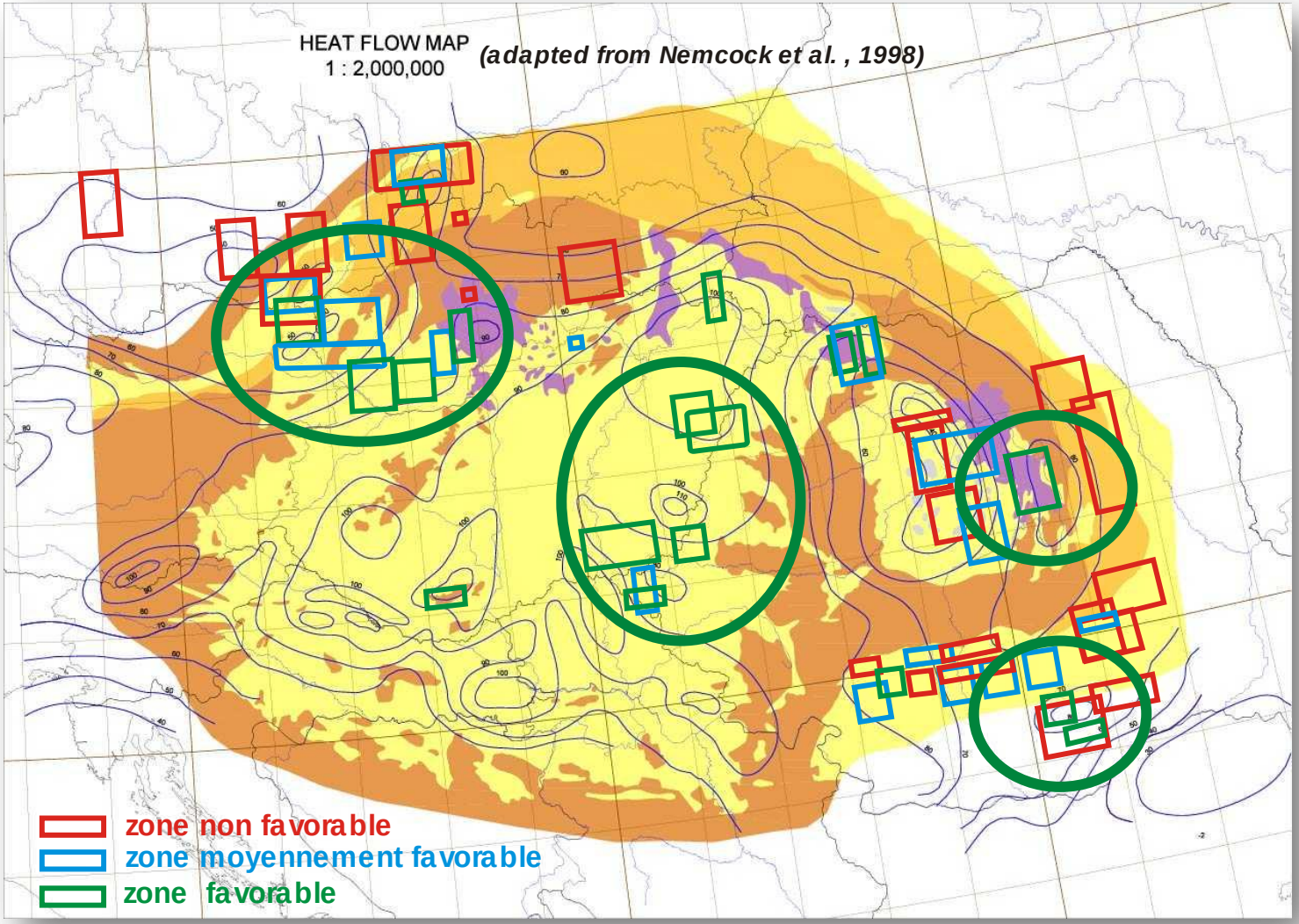
Different geothermal reservoirs identified and exploited

Crossing all maps for promising areas



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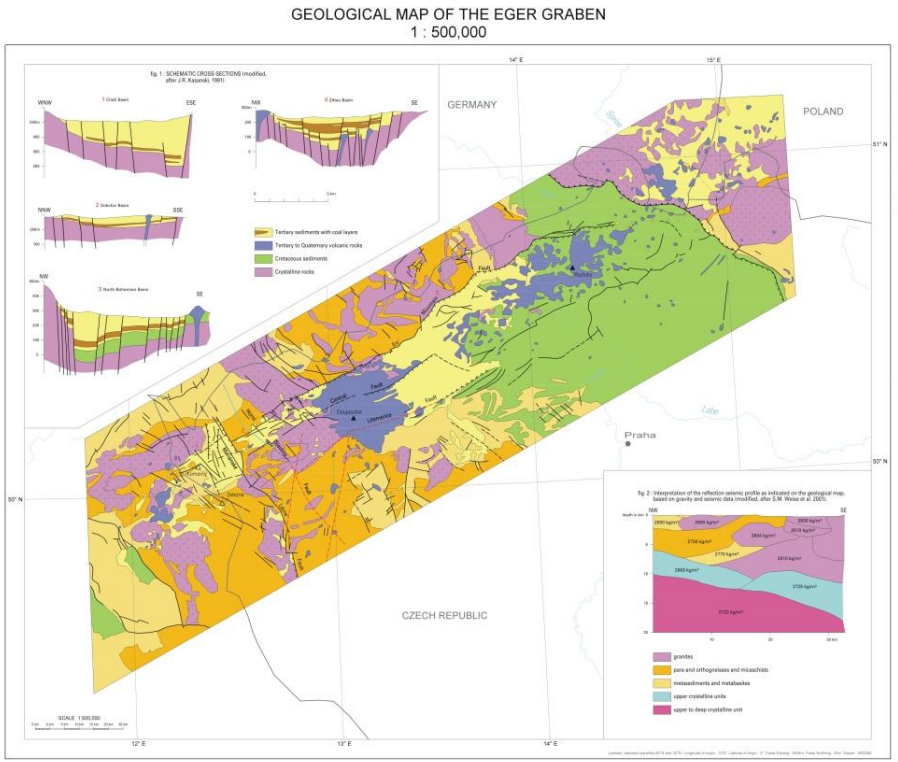
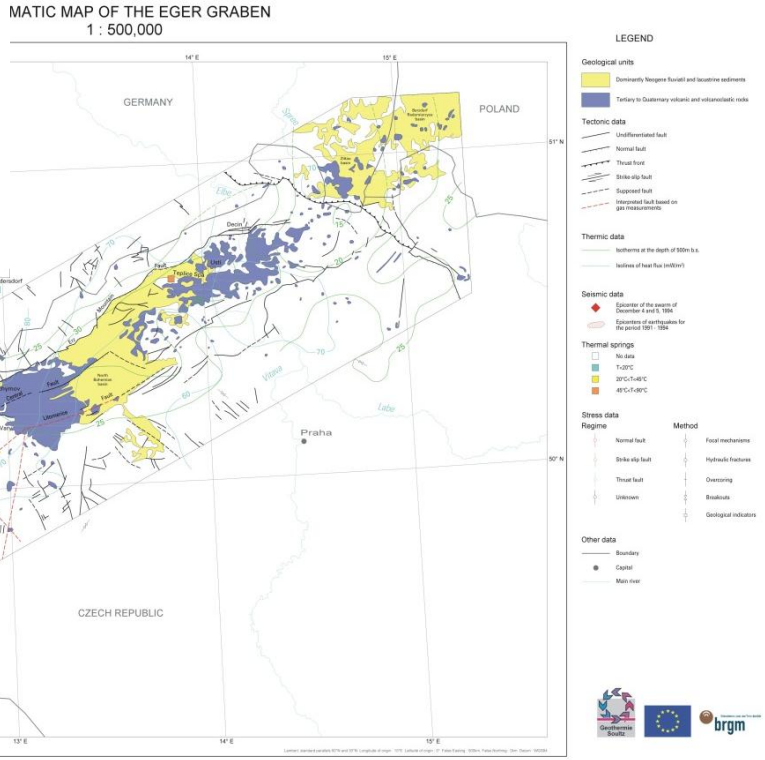
Eger (Ohre) graben



Czech Rep., Germany and Poland
Tertiary graben
4 shallow sub-basins (100-400m)
Crustal faults



Active faults (M>4)
Hot springs 70°C
Thermal gradient 40°C/km

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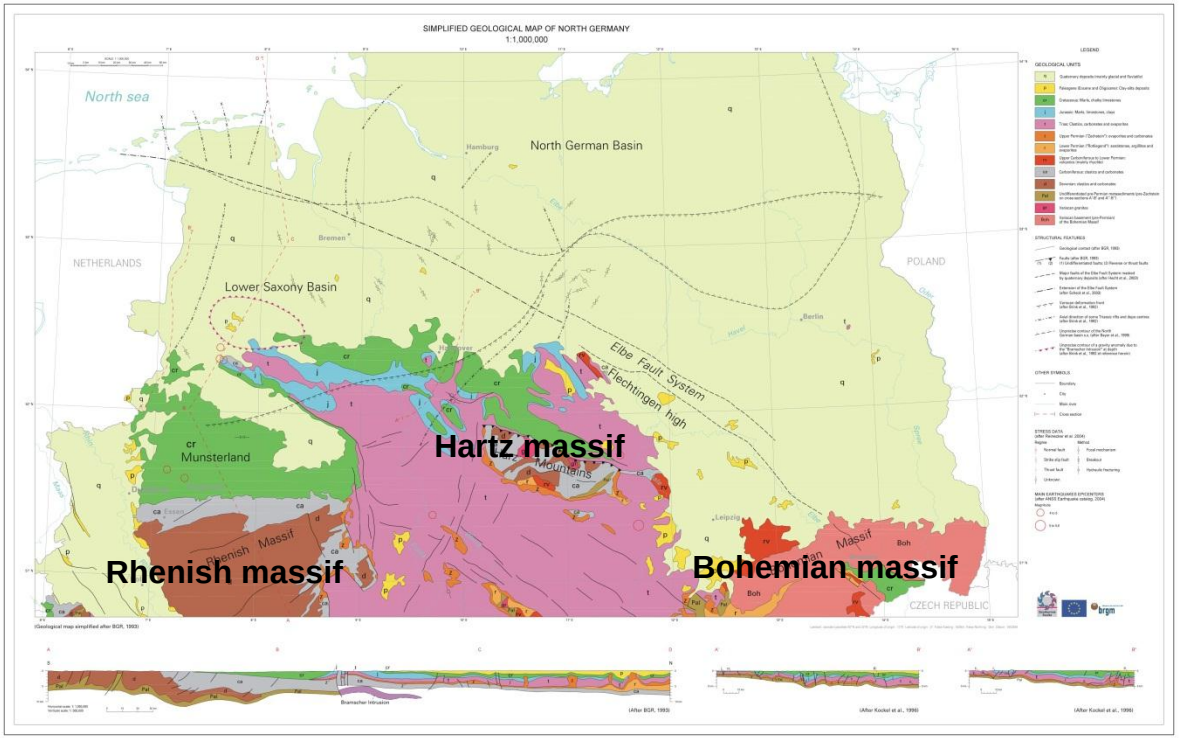
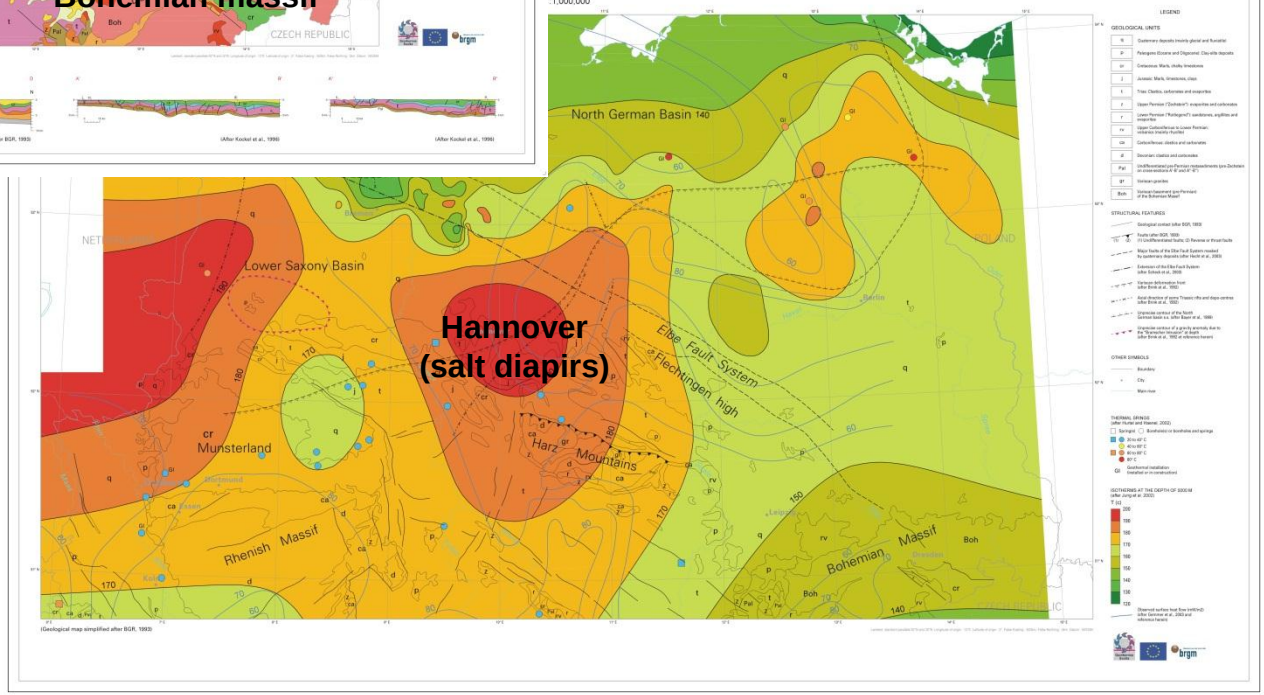
North German Basin



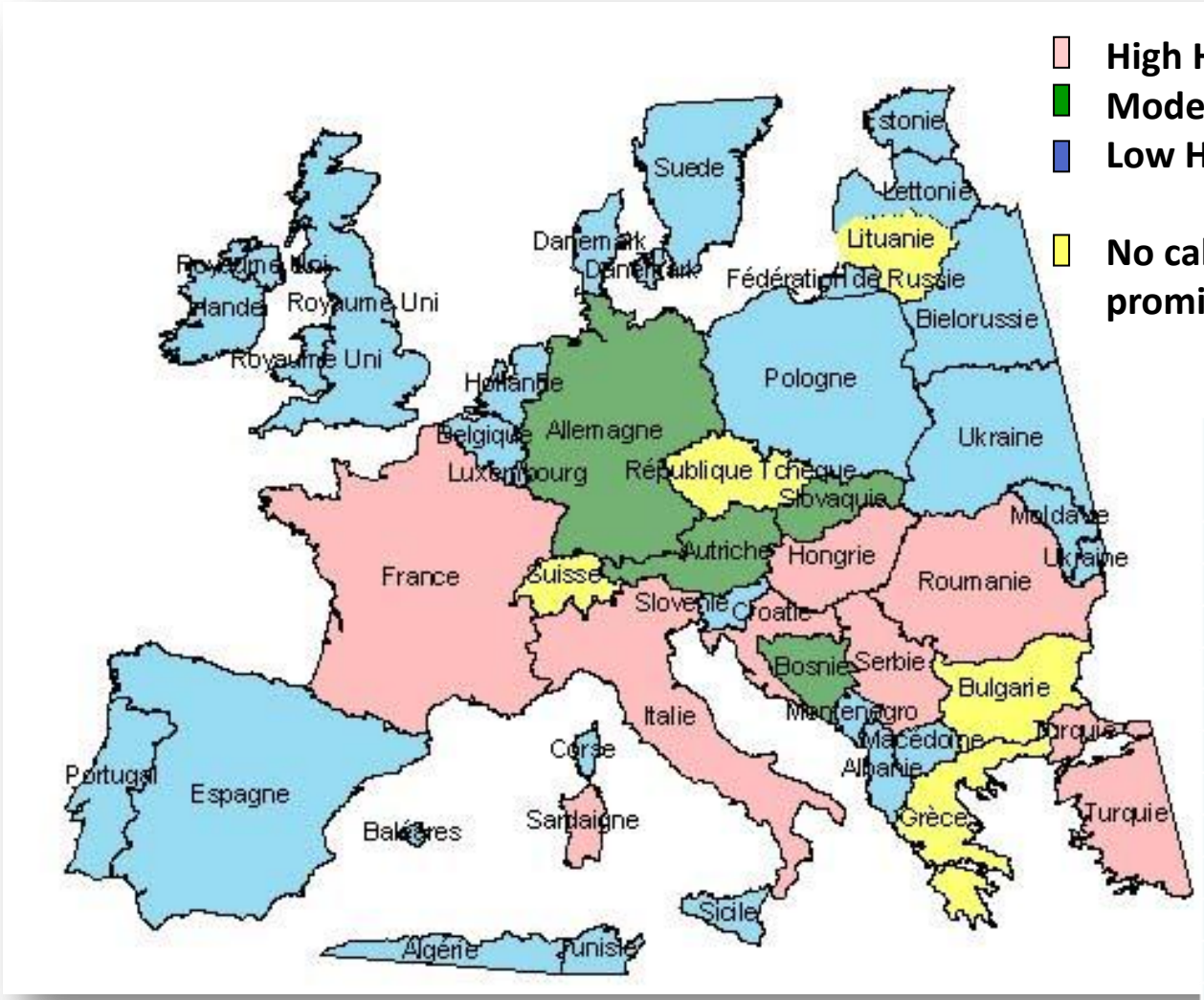
Thickness of sedimentary cover : 10km
Permian to Tertiary
Rifting, inversion alpine tectonics, salt diapir

Temperature at 5km depth



Hot springs : 60°C-100°C

Geothermal potential for the European countries



- **High HFR potential**
- **Moderate HFR potential**
- **Low HFR potential**

- **No calculations but promising HFR potential**

Pays	Potentiel estimé (GWh)	% de surface T > 180 °C @ 5000 m
Austria	660	9,90
Bosnia	230	5,90
Bulgaria	30	0,40
Croatia	1 300	29,00
England	60	0,35
France	4 700	12,00
Germany	670	2,60
Greece	100	1,25
Hungary	6 270	76,00
Italy	1 900	8,20
Romania	1 220	6,70
Serbia	3 960	52,00
Slovakia	300	6,80
Slovenia	70	4,50
Spain	60	0,50
Turkey	11 560	80,00

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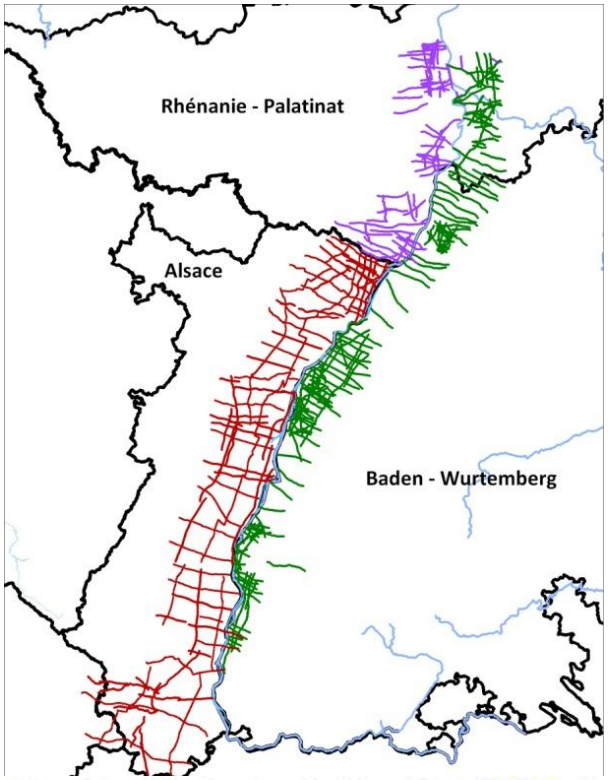
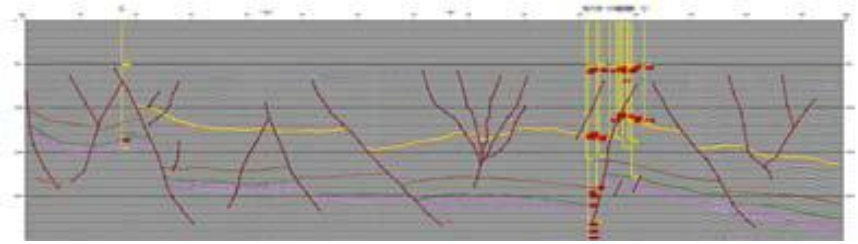
12%of surface with temperature > 180°C at 5000km

Interreg project IV : GeORG





Reproceesed and reinterpretation of previous seismic profiles (from oil exploration)

- European project during 4 years (Oct 2008-Dec 2012) collaboration between Germany, Switzerland and France
- Objective: building a 3D geological model of the Rhine Graben to give some answers to deep resource users and improve the geological structure knowledge.
- Data
  - 1600 kms of seismic profiles in the French part
  - 4000 kms of seismic profiles in the German part
  - 50 kms of seismic profiles in the Basel area
  - 1800 boreholes
- Partners: LGRB (Freiburg), LGR (Mainz), Uni Basel, BRGM, town of Basel, Canton of Basel, CR Alsace, CG Haut-Rhin, CG Bas-Rhin, ADEME

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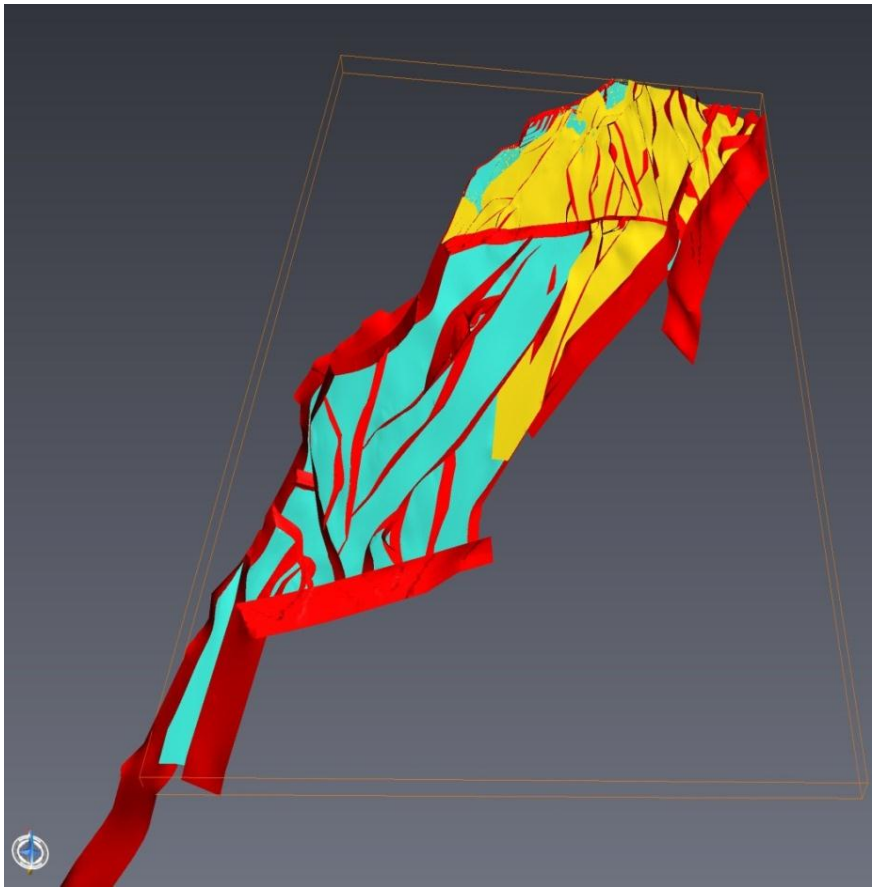
GeORG project

3D geological model



Geopotential : CCS (CO_2 sequestration), deep water and geothermal energy

Goals for geothermal potential:
Temperature maps and heat in place computation for:

- Malm
- Hauptrogenstein (Grande Oolithe)
- Muschelkalk
- Buntsandstein
- Top of the basement

GeORG stand at

GeoTHERM

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http://www.geopotenziale.org

Thank You!

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