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The Limagne geothermal reservoir (France): from 3D geological model to potential assessment

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ADEME Agence de l'Environnement et de la Maîtrise de l'Energie

engine

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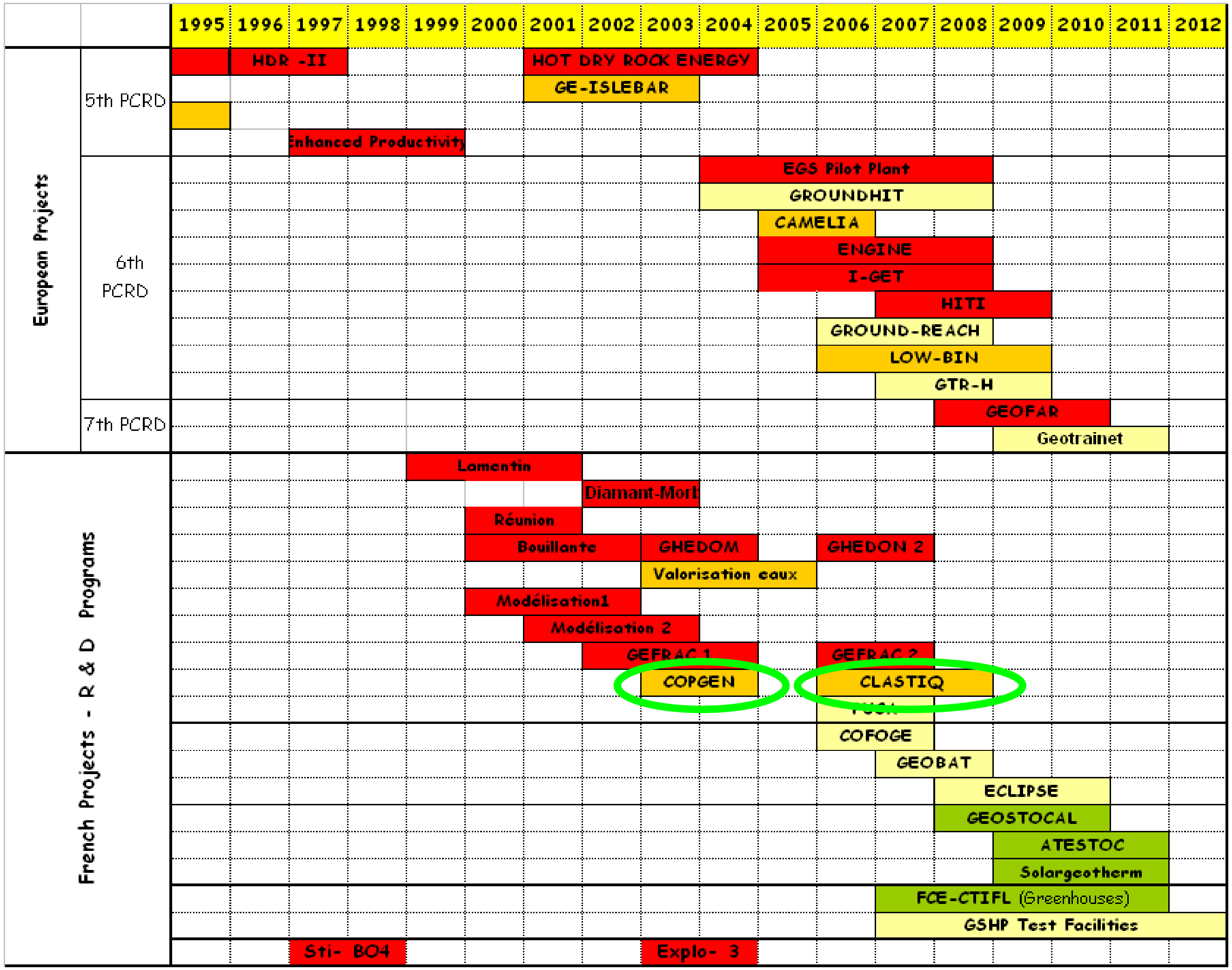
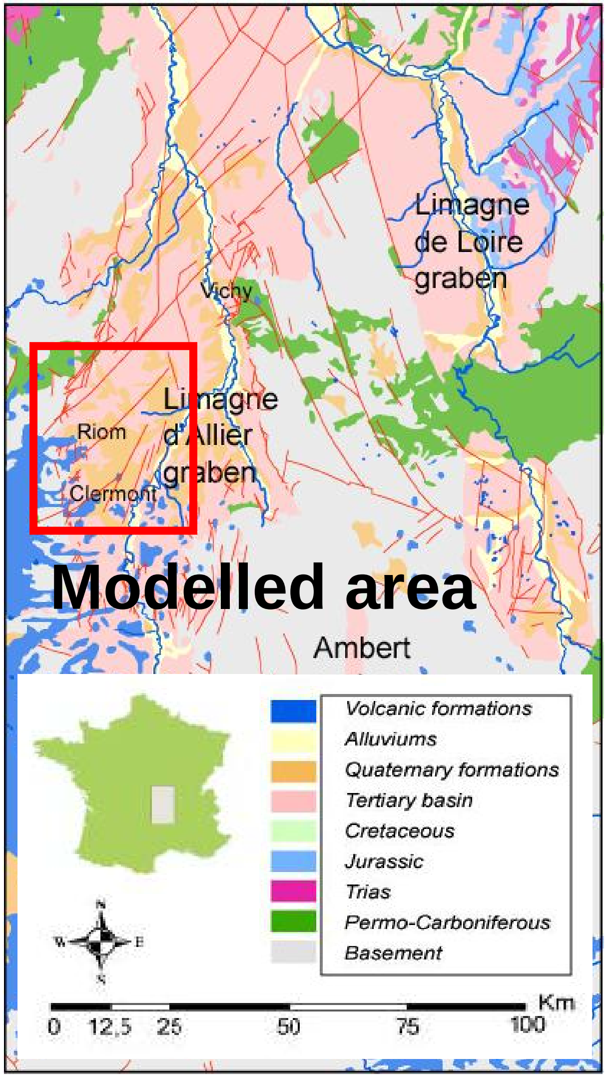
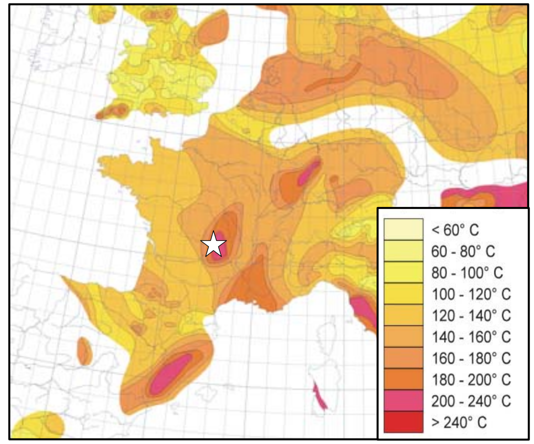
BRGM R&D Geothermal programs



Geological setting





> **European map of the temperatures extrapolated at 5 km depth from Hurtig et al., 1991.**

Marl and limestone — Marl and sand — Sand and conglomerate

Epoch	Age	Lithology	Formation Name
Oligocene	Chattian		**S4_Top**
			S4_Intermediate
			S4_Reservoir
	Rupelian		**S3_Top**
			S3_Intermediate
			S3_Reservoir
Eocene	Priabonian Bartonian		**S2_Top**
			S2_Intermediate
			S2_Reservoir
	Lutetian		**S1_Top**
			S1_Intermediate
			S1_Reservoir
< Cenozoic		**MTER (Basement)**	

Evaporites — Erosion event

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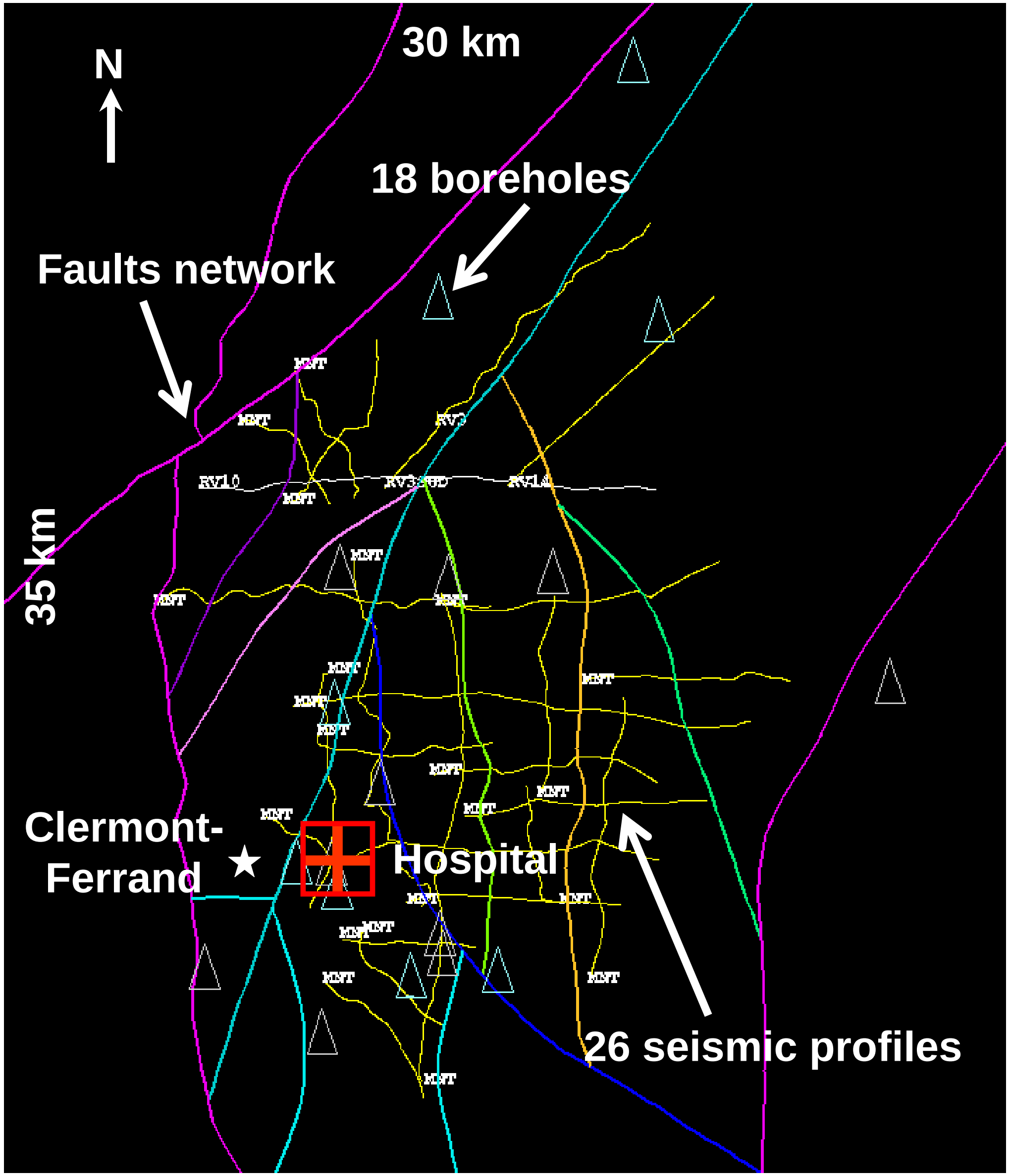
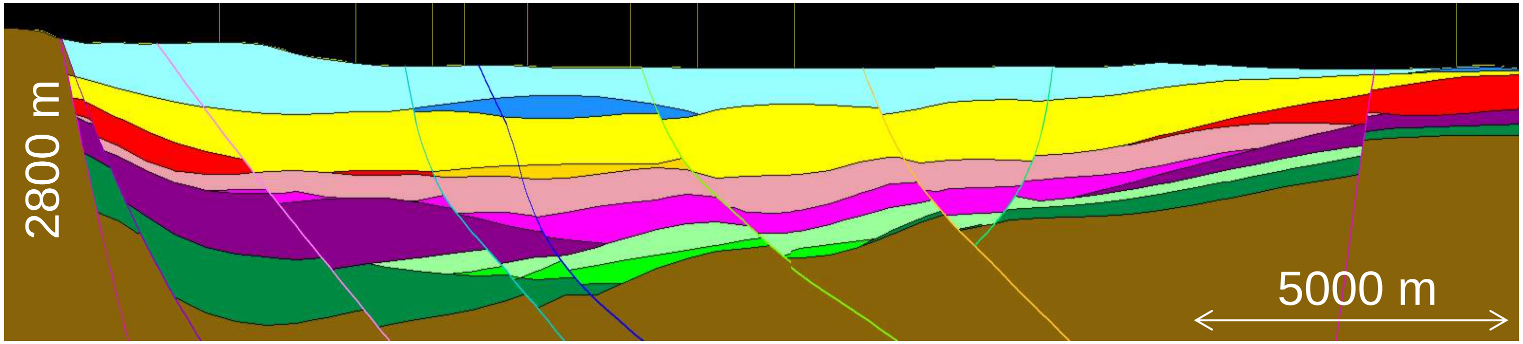
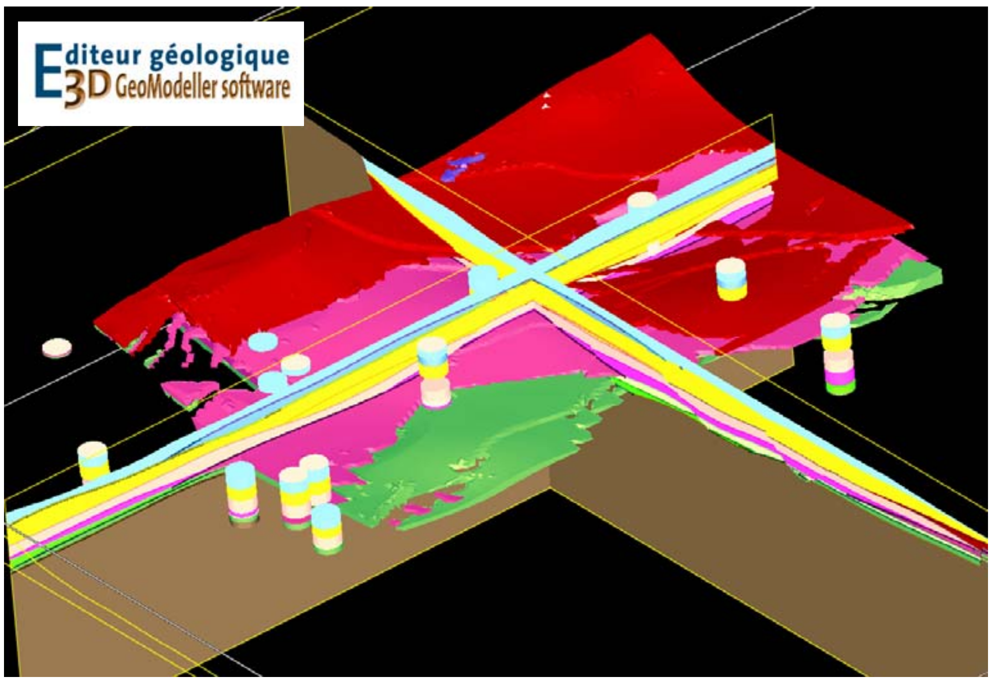
Geological modelling - Data

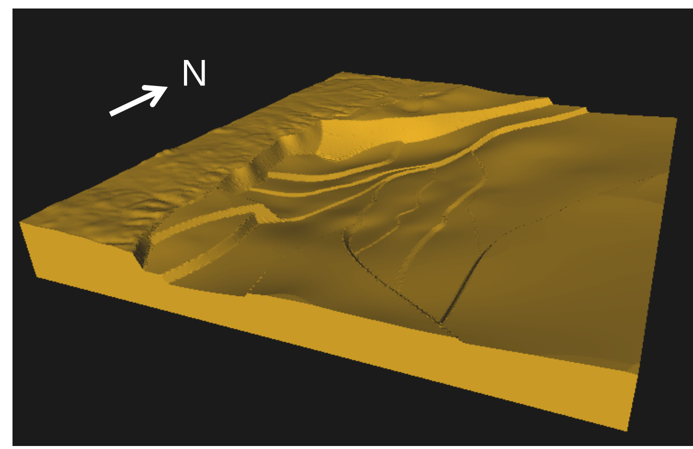


Geological modelling - Results





> **Geometry of the basement is built using the relative displacements of the fault blocks, given by the seismic sections and the boreholes.**



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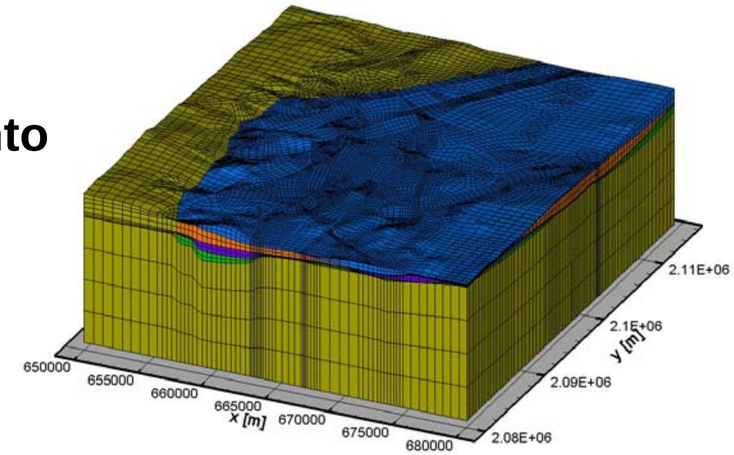
Thermal modelling - Method

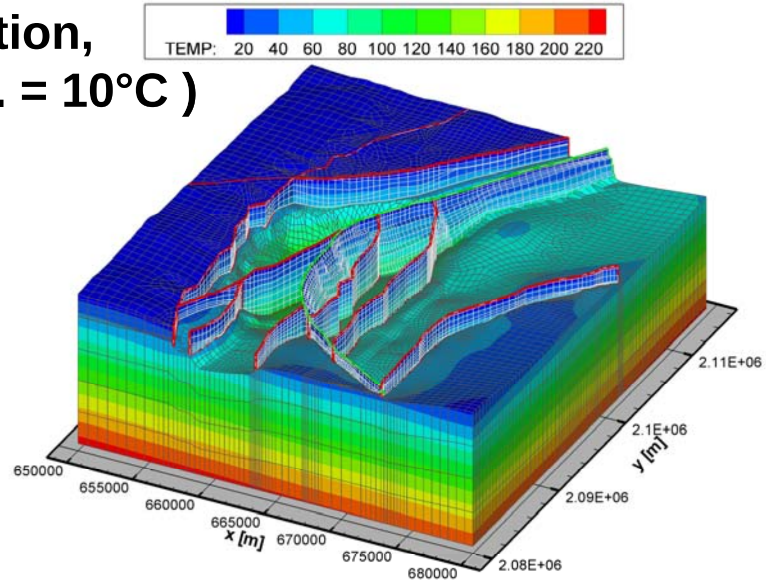


1. **Meshing of the 3D geological model into a Finite Element Mesh.**
   - **5 Layers (3D elements) and**
   - **9 faults (2D elements)**

   are considered on the domain.

2. **Estimation of the main thermal parameters (thermal conductivities, heat production, basal heat flow = 105 mW/m², surf. T. = 10°C)**

Layer	Thermal conductivity [W m^{-1} K^{-1}]	Heat production [W m^{-3}]
MTER	3.00	3.0 10^{-6}
S1	2.25	0.5 10^{-6}
S2	2.40	0.5 10^{-6}
S3	2.30	0.5 10^{-6}
S4	2.20	0.5 10^{-6}
Faults	3.00	-



3. **Calculation of temperature code FRACTure, diffusive model**

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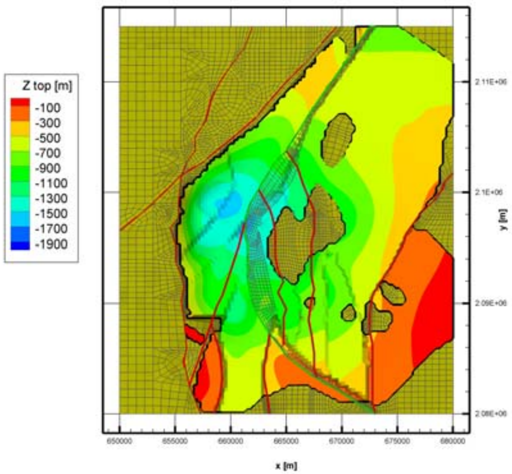
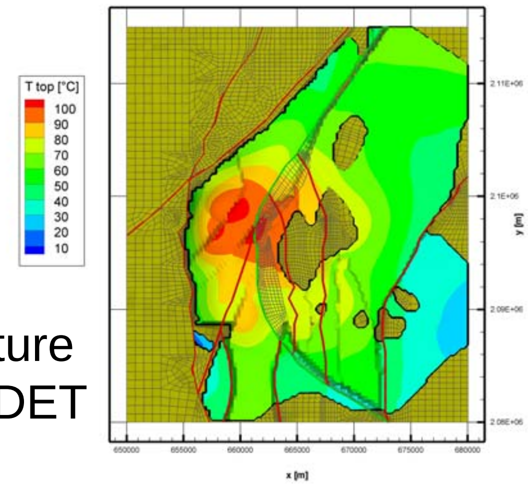
Geothermal potential - Method

1. **Extract temperature from 3D model at depth of assumed aquifers**

Example



Depth of aquifer S1DET



Computed temperature at the top of aquifer S1DET

2. **Extract thickness of the aquifer from the 3D geological model**

3. **Compute the total amount of energy available Heat In Place (HIP)**

$$E_{HIP} = \rho c_P \cdot V \cdot (T_{prod} - T_{reinj})$$

For S1DET, E_{HIP}=11’300 PJ

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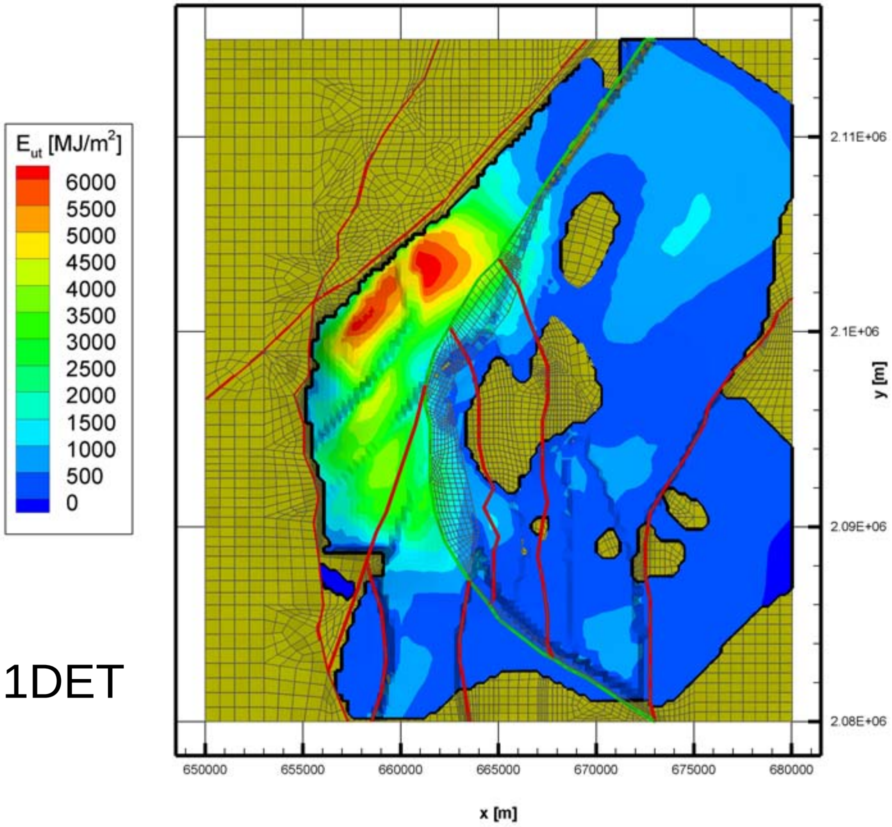
Geothermal potential - Results

1. **Total E_{HIP} in the aquifers:**

Layer	Heat in Place [PJ]
S1det	11'300
S2det	4'700
S3det	600

2. **Mapping of the geothermal potential**

   Recoverable energy
   = 5% of total Heat In Place



Example of aquifer S1DET

Conclusion

- **Integrated study from geology interpretation to geothermal potential estimation.**
- **Valorisation of old data used for a new 3D geological interpretation.**
- **3D thermal modelling constrained by the geometry of the geological formations.**
- **Computation of the recoverable geothermal energy from temperature modelling.**
- **Deepest aquifer seems to be the most interesting geothermal target.**

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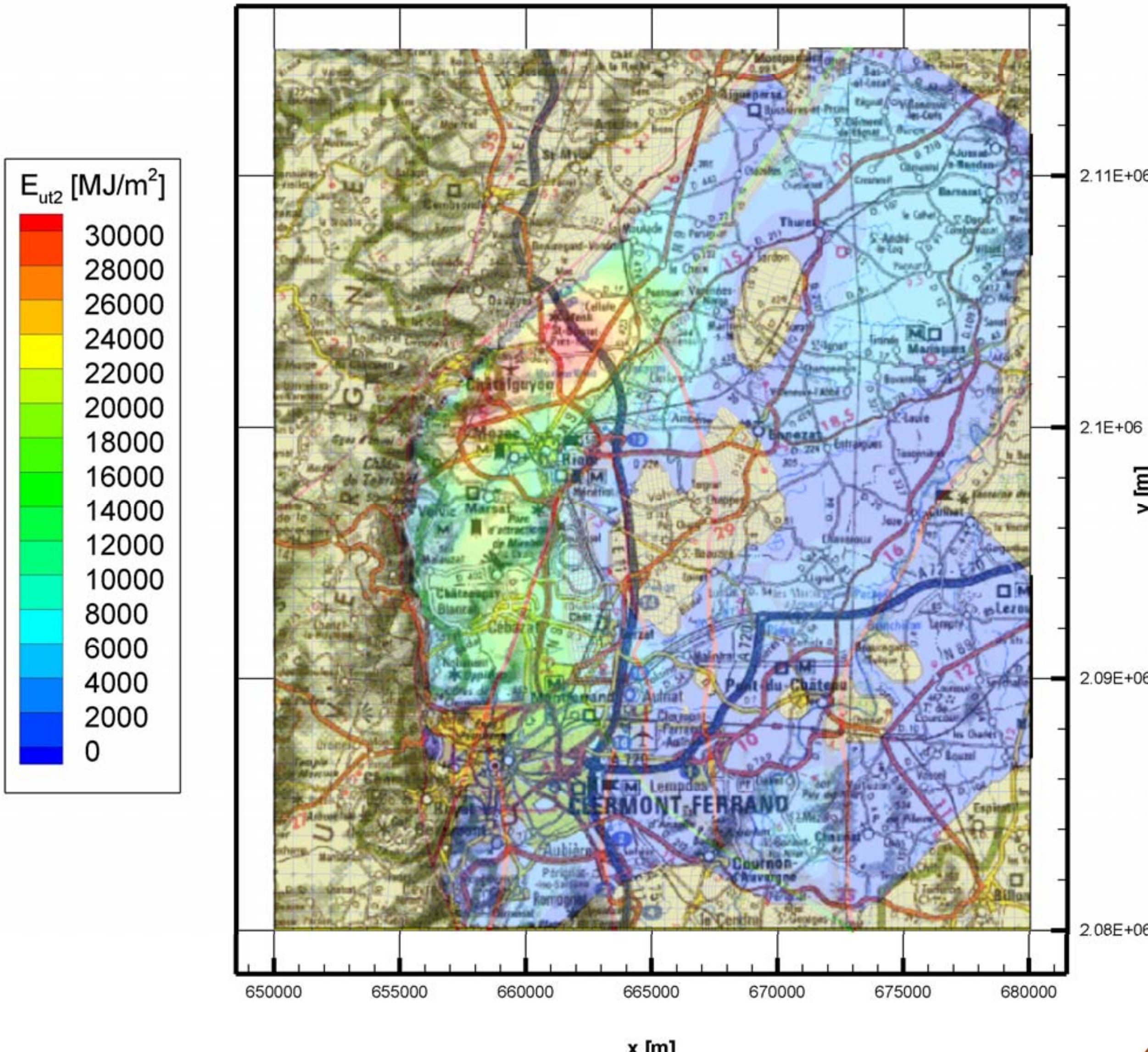
Perspectives

> **Improve 3D geological model accuracy: new geological data, gravimetric and/or magnetic data for forward or inverse modelling.**

> **Better temperature data on the domain for better temperature modelling.**

> **Study to take into account the hydraulic conductivity of the aquifers for temperature modelling and recovery factor improvement.**

> **Geothermal exploration of the area…**



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