Hydrodynamic and Thermal Modeling in a Deep Geothermal Aquifer, Faulted Sedimentary Basin, France.

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Introduction

Within projects of geothermal energy, hydrodynamic and thermal modeling is used to forecast the impacts of geothermal deep wells, in case of pumping and reinjection of geothermal fluid in a deep faulted groundwater reservoir.

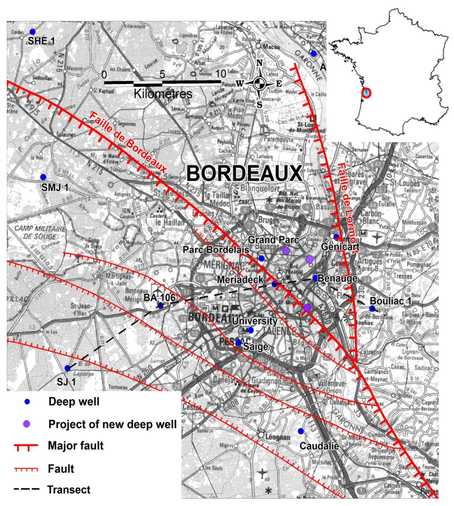


Figure 1. Model extension, faults in Bordeaux and deep wells

Objectives

- to understand the behaviour of multilayer aquifer system
- to determine the geothermal potential of the aquifer

Study site: Bordeaux, Aquitaine basin, SW France.

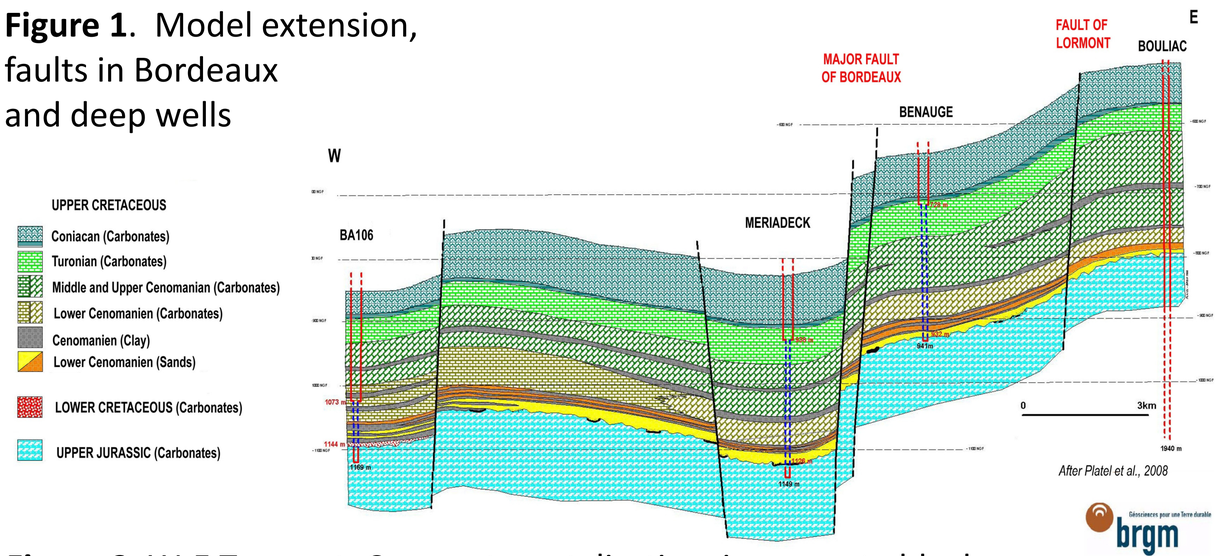
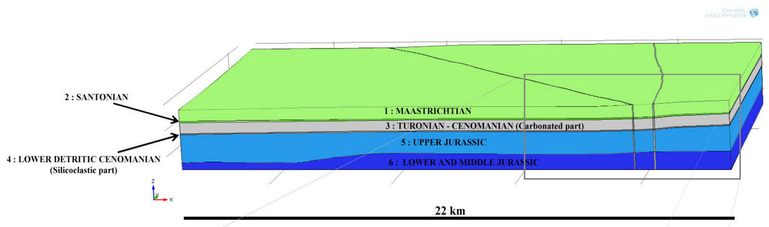


Figure 2. W-E Transect. Compartmentalization in separate blocks

Methodology

Several steps to reproduce and understand the target reservoir behaviour for the geothermal project.

1. Construction of 3D geological model
2. Reconstitution of aquifer layers hydrodynamic (1983-2013)
3. Reconstitution (1983-2013) and simulation (2014-2044) of the thermal evolution



2 major faults represented vertically, with a 50 m thickness.

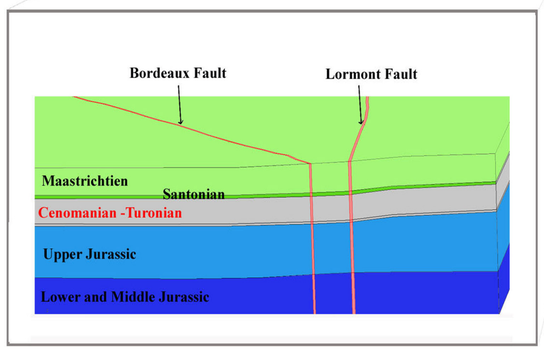


Figure 3. 3D geometry of the model

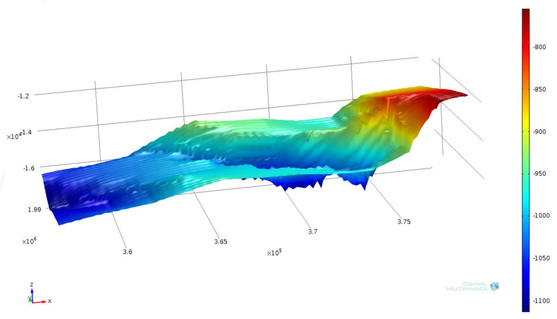


Figure 4. Top wall of the geothermal reservoir

Other faults directly included in the 3D geometry and in the kriged cards of hydrodynamic and thermal parameters.

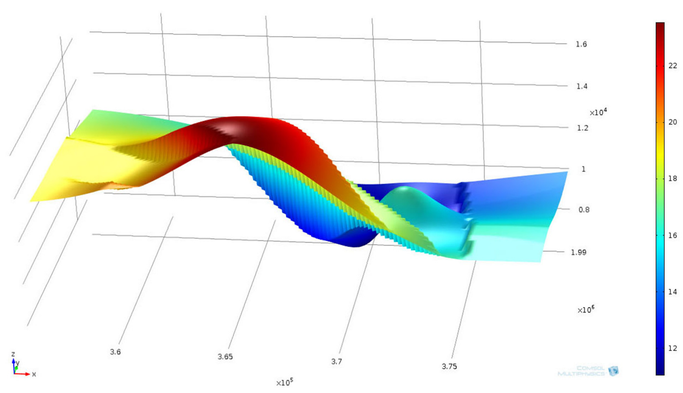


Figure 5. Thickness variations of the aquifer detrical layer

The detrical layer of the aquifer produces 75 to 80% of the water.

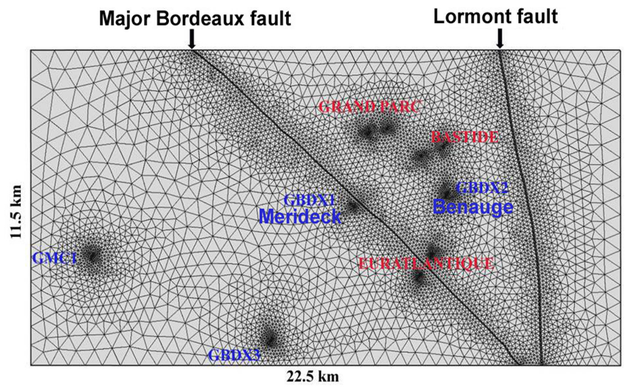
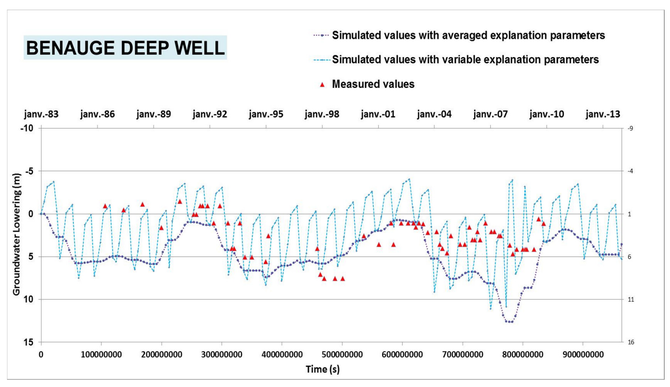


Figure 6. Model mesh, existing deep wells (in blue), and new geothermal doublets (in red)

Results

- Good agreement with hydrodynamic observations
  - The model reproduces the measured groundwater lowering of two deep wells,
  - Using variable exploitation parameters allows understanding punctual measured values.



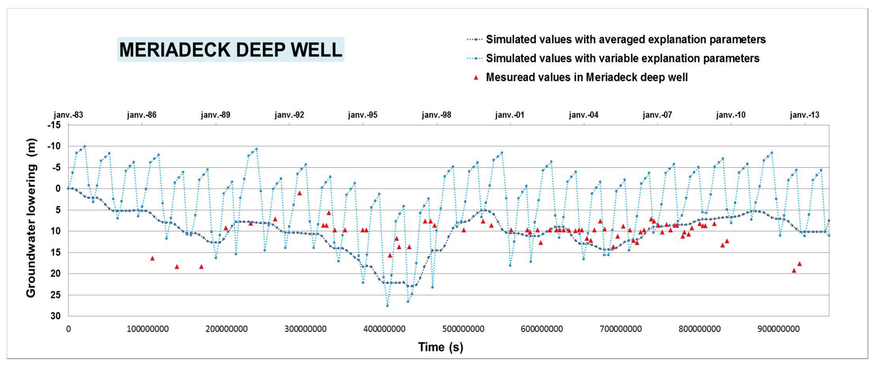
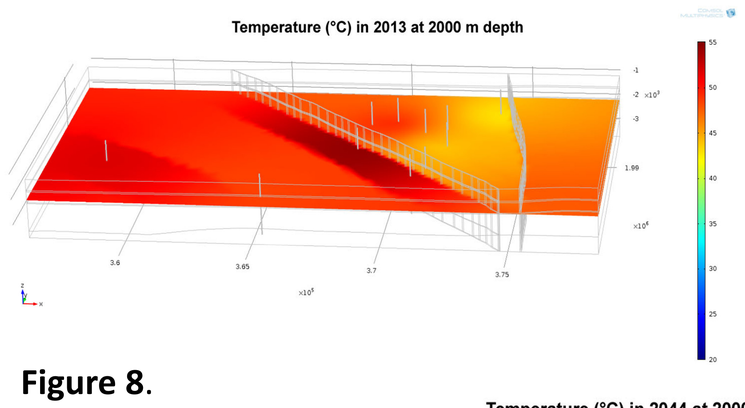


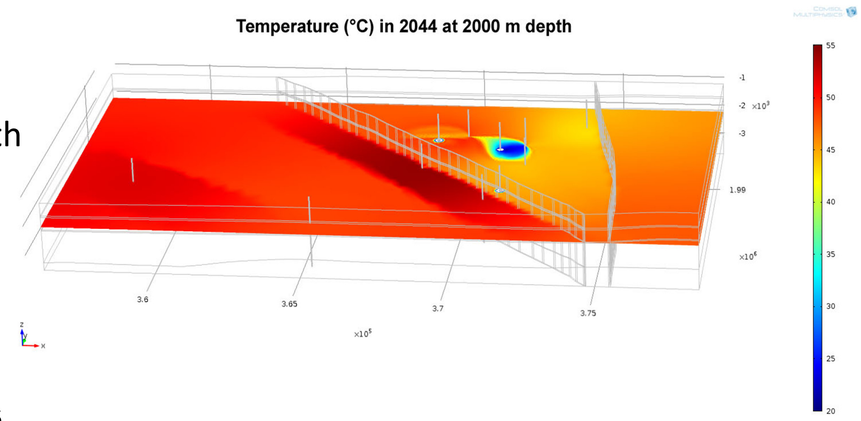
Figure 7 Groundwater lowering in the 2 deep wells : model results and measured values

- Impacts of geothermal fluid flow exploitation over 60 years, and evolution of cold fluid bubbles due to injection deep wells.



Impact of the new pumping and reinjection deep wells between 2013 and 2044.

Figure 8. Temperature distribution, at 2000 m depth



Conclusions

Using COMSOL Multiphysic with especially the hydrodynamic module (Fluid flow with Darcy's Law) and heat transfer module has allowed building a 3D hydrogeological and thermal model to predict successfully the behaviour of 6 new deep wells in a faulted sedimentary basin, already in use for the geothermal energy needs of a city.

References:

MALCUIT et al., 2012. Report CFG Services 13 CFG 29.

PLATEL et al., 2008. Etude sur les possibilités de valorisation et de réinjection des eaux de rejet des forages géothermiques de Mériadeck et de la Benauge, commune de Bordeaux (Gironde). Rapport BRGM/RP-56120-FR, 106 p.

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