A NEW GEOTHERMAL EXPLORATION WORKFLOW FOR DEEP SEDIMENTARY BASINS AND BASEMENT

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In order to expand the geothermal energy exploitation, we need to explore various geological contexts, particularly the sedimentary basins, which concentrate many customers. Nowadays, with the improvement of the binary power plant productivities and the need of industrial heat, the deep layers of sedimentary basins and the upper part of the basement are attractive to tap fluid with temperature between 120°C and 150°C. In a normal geothermal gradient (around 30°C/km) context, this temperature range is reached between 3 and 5 km depth and corresponds to the deep layers of sedimentary basins (aquifers more or less permeable, namely HSA) and the upper part of the basement, more or less fractured and altered, having potentially used EGS technologies.

In such complex and diverse geological setting, we propose to set up and validate an integrated and scale-dependent exploration workflow that consists in building, step by step, more and more refined subsurface models based on larger scale models To achieve this, three questions arise:

- What are we looking for? What are the key parameters and the key situations favorable for geothermal heat/fluid extraction?

In order to optimize the exploitation, the three essential parameters to know are obviously temperature (the highest at the shallowest depth), the natural permeability (both from porosity and fractures), and the presence of brines and recharge waters. These key parameters are related to the geological patterns and subsurface phenomena, which are called key situations and constrain spatially the favorable areas.

- Which methods are able to identify these key situations at the different scales?

Standard exploration methods (e.g. active/passive seismics, electromagnetics, geothermometry and geology) have been tested on the specific case of basement and deep sedimentary layers to validate which techniques are relevant to identify key situations. Whereas some of these can be very capital-intensive (e.g. active seismics), the economic benefit to the project through its geological risk reduction can easily compensate for the upfront investment.

- How used these methods to find the best drilling place and reduce the financial risk of drilling?

First, a geological and structural model is built based on geophysical data and geological analysis. Thermal, hydraulic and mechanical models, independent or partially coupled, are then built based on this geological model and other data like temperature, fluid geochemistry and stress data. Finally, the definition of success criteria based on the key situations allows to analyze these models together and determine the best area(s) to investigate at a finer scale.

Three scales have been considered in the pre-drill exploration workflow:

- the continental scale considers temperature and stress field that constrain regional scale;

- the regional scale covers a geological region considered as relevant and can be considered as the first exploration scale where temperature, stress field and groundwater flow are to be taken into account;

- the local scale corresponds to the last scale before a license drawing is actually considered and takes into account mainly the stress field and groundwater flow models.

At the end of the workflow, the chance of success of the first exploration well(s) at the most promising areas can be assessed.