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Kongress 1 - Tiefe Geothermie / *congress 1 - Deep Geothermal Energy*
14.30 - 14.55

Geothermal Geosolutions for resource exploration and characterization

Lösungen für die Exploration und Charakterisierung von geothermischen Ressourcen

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Identifying and confirming the resource is a crucial aspect for the success of a geothermal project. Reducing the uncertainties associated with the structural setting, the lithology and properties of the potential reservoirs, and the expected temperature of the geothermal fluid allow de-risking the subsequent activities, and in particular increasing the chances of success of the first well drilled in a prospect, which is the costliest item in the project lifecycle.

Geophysics-centered, data-driven solutions are the keystone of this effort, aiming at integrating the information available prior to drilling to quantify the relevant properties of the subsurface and setting the stage for further geological, fluid and heat flow, and geomechanical modeling. These solutions can be delivered in a consolidated digital platform to perform the workflow in the most consistent fashion across different disciplines.

The analysis of the geothermal potential based on acquired geophysical data is the first step. Magnetotelluric and gravity data provide a cost-effective source of 3D data to delineate the structural lineaments and fault network, defining the geological framework at the basin scale or at smaller scales. Multi-physics measurements and interpretation allow to map the lateral changes in lithology, supported by rock-physics characterization of the reservoir properties.

Highly automated solutions utilizing advanced litho-petro-elastic engines are used for accurate modeling of subsurface properties and temperature in 3D (Figure 1). Thermal properties such as thermal conductivities can be derived from temperature distributions by means of inverse geothermal modeling, integrated with geophysical observations with data assimilation techniques, to identify potential geothermal "sweet spots" and deviations from the background model (Figure 2).

Basin modelling techniques can be used to compute pre-drill distributions of pore pressure, temperature, porosity and permeability, thus de-risking the placement of the first well; overpressured hydrocarbon accumulations such as shallow gas pocket can also be detected, further reducing the risks in the drilling operations (Figure 3).

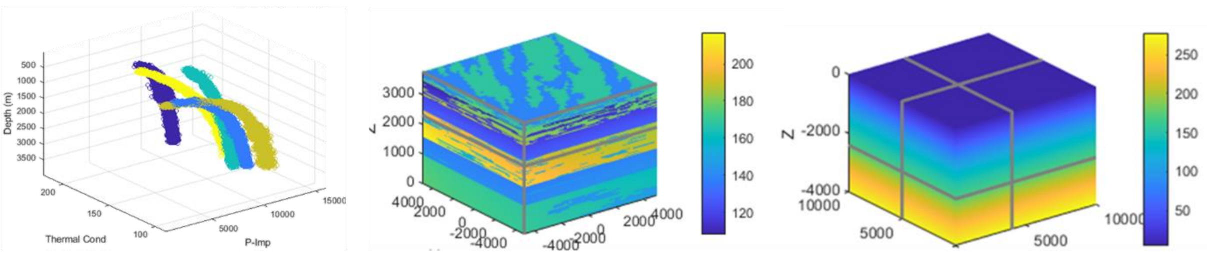

Figure 1: utilization of advanced litho-petro-elastic models (left) to estimate thermal conductivity (center) and temperature distribution (right).

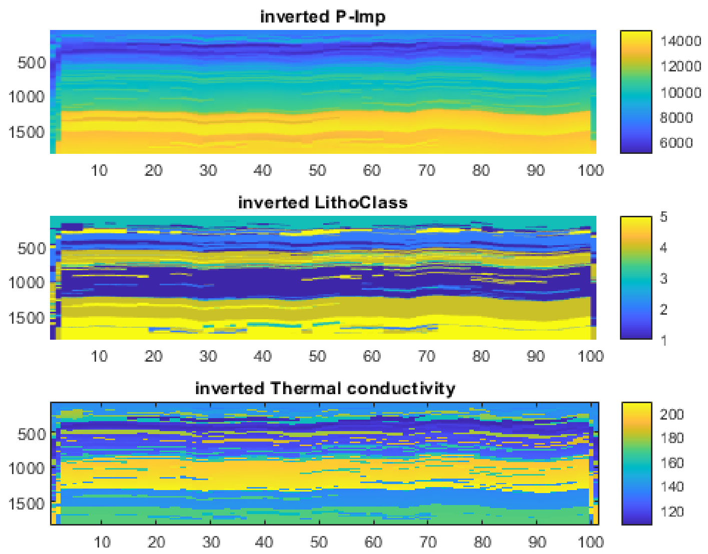

Figure 2: inverse geothermal modeling used to derive impedance, lithology and thermal conductivity.

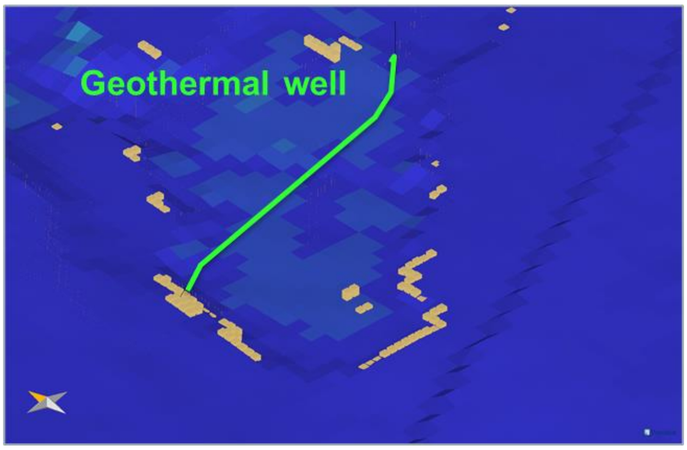

Figure 3: overpressured gas accumulations in the vicinity of a geothermal well (adapted from Omodeo Salè et al. 2020)

Finally, natural fractures can be modeled in 3D based on different geological processes (tectonic paleo-stress, association to fault, fault damage zones, thermal cooling, mechanical effects) and from different sources of information, improving the success rates in localizing "sweet spots" for resource targeting.

The resulting model can be enriched with offset well data to further characterize the expected heat and fluid flow behavior, as well as the geomechanical stability of the target formations, of the fault network, and of the planned wellbores.

Case studies from different context in Europe will be presented to provide examples of the application of these techniques.

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