A simplified operational strategy combining well architecture and hydraulic stimulation for EGS

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Enhanced/Engineered Geothermal Systems (EGS) are key installations for the short or medium term development of deep geothermal reservoirs. In Europe, a large part of the EGS potential is represented by deep reservoirs in the top of crystalline basement in rift context and in carbonates in flexural basins. At such depths, uncertainties exist both on reservoir permeability and on available resources. Different solutions are proposed to achieve a technical and economic viability for the reservoir exploitation, depending on the geological setting: deviated drilling in sedimentary basins while hydraulic or/and chemical stimulations in crystalline basements.

The work presented aims at giving a first, simplified operational strategy based on well architecture (position and orientation) and hydraulic stimulation of the reservoir. The strategy depends on the geological setting and on the hydraulic network of the reservoir, but must ensure in any case as less mechanical risk as possible during drilling (wellbore stability). To do that, 3D models for the hydraulic stimulation of faulted/fractured reservoirs are proposed for both geological settings (crystalline basement and sedimentary basin), and enable simulation of several wellbore trajectories. Prior to any numerical modeling, conceptual models are required for the reservoir's geometry. Such models are built using geological descriptions and in situ data found in the literature. For both tested geological settings, a wellbore trajectory optimized regarding the hydraulic stimulation can be identified. The wellbore mechanical stability during drilling is checked for under the in situ stress state using particles-based numerical models that take into account the rock texture.

Based on the 3D numerical simulations of hydraulic stimulations, an optimized well trajectory favoring irreversible increases of hydraulic apertures within the reservoir was identified for each tested geological setting: inclined wellbore dipping with a direction related to those of the hydraulic structures for the crystalline basement model (extensional tectonic regime), and vertical wellbore for the sedimentary basin model (strike-slip tectonic regime). No mechanical risk for the wellbore stability was highlighted for the crystalline basement model. However, the particle-based model resulted in an ovalization of the vertical wellbore in the sedimentary basement configuration.