Initiation of discontinuities by thermal and hydraulic stimulation in the near-well area in well RN-15-IDDP2 (Reykjanes, Iceland): A numerical investigation.

Mariane Peter-Borie, Annick Loschetter

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M. Peter-Borie[1], A. Loschetter[1]
[1] BRGM, 3 av. C. Guillemin BP36009, F-45060 Orléans Cedex 2, France.

The DEEPEGS project aims at demonstrating the feasibility of enhanced geothermal systems (EGS) for delivering energy from renewable resources in Europe. The first demonstrator currently being deployed is located in Reykjanes (Iceland). The drilling of RN-15/IDDP-2 has been successfully completed on January 2017. The final measured depth of the well is 4659 m. The temperature measured at depth under disturbed conditions was 426°C, which gives an order of magnitude of the high temperature reached. Short time injectivity index was estimated to be around 1.7 $L.s^{-1}.bar^{-1}$ at the end of the drilling operation. This confirms the necessity of stimulation methods to enhance the injectivity, as expected. Numerical simulations were carried out to investigate the possible initiation of discontinuities by thermal and hydraulic stimulation in the near-well area in the context of well RN-15/ IDDP2.

In order to model the initiation of stimulation cracks in the near-well area, it is proposed to use the Discrete Element Method (DEM), and more specifically bonded-particles model. Indeed, simulations at the granular phase level (micro scale) with DEM seem adapted to capture the thermo-mechanical processes induced by rock cooling in the near-well area and to understand the impact on the mechanical behaviour at metric scale. The code PFC2D (© Itasca Consulting Group) was used for the implementation of the DEM.

The objective is to build a realistic model, corresponding to the beginning of thermal stimulation at Reykanes in well RN-15 (IDDP-2). We assume that a cold fluid (30°C) is injected in the well in a diabase of the Reykjanes field. The injection takes place at a depth of 4600 m, where the rock temperature is around 430°C and the pressure in the well is 34 MPa. Since the rock mass is considered impermeable (except for fractures), the main heat transfer process considered is conduction. We study the initiation of the failure in the rock mass in the near-well area in a 2D plan perpendicular to the well. Considering the high level of uncertainties and the limited number of possible simulations (linked to the high computation time), it was decided to focus the parametric study on a limited number of parameters, considered as ill-known: 1/the stress state, 2/the hydraulic pressure, 3/the heat transfer coefficient.

Figure **1** figure (1) illustrates the kind of results that will be further analysed during the presentation: cracks and possible associated fractures are recorded depending on time, as well as the temperature field. Simulations highlight fracture initiation or well breakout, if any.As expected, thermal stimulation drives to initiation of discontinuities. The cracks propagation speed and the cracks repartition are strongly influenced by the cooling rate: a slow cooling drives to slower propagation of fractures, and allows the focusing of the crack within a single fracture, while very fast cooling creates several tortuous fractures. The stress state has also a direct impact on the intensity, kinetics and shape of damages.

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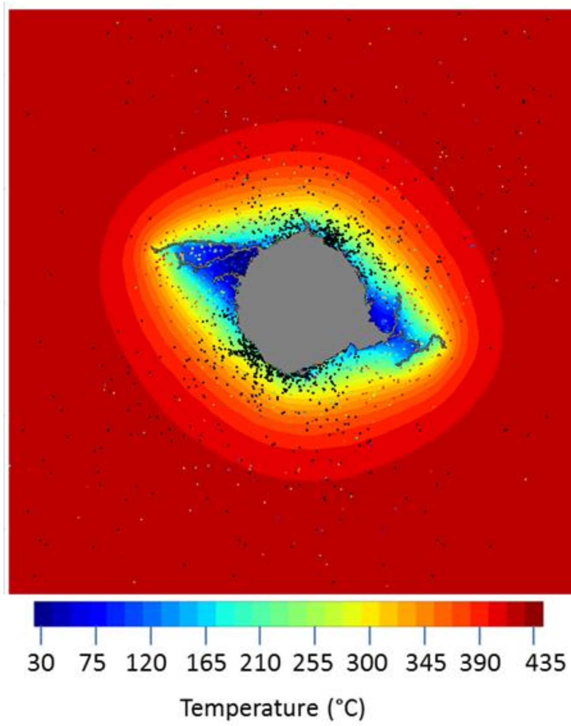

Figure 1 – Overview of a simulation result: view of temperature field with cracks represented by points (for the strike-slip stress state, with a well pressure of 34 MPa and a slow cooling rate, after 2 hours of thermal stimulation). A fracture propagates in the direction of maximal stress. Cracks accumulation in the direction of the minimum stress reveal slight break-out.