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Evaluation and improvement of methods to quantify the exploration risk of geothermal projects

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The quantification of exploration risks is of major importance for geothermal project planning. The exploration risk is defined as the risk of not successfully achieving a geothermal reservoir with minimum levels of thermal water production and reservoir temperatures (UNEP 2004). A simple method to quantify the probability of success (POS) for geothermal wells is to determine the single risks for temperature and flow rate and calculate the overall probability by multiplying the individual probabilities (SCHULZ et al. 2010). Since 2002, over 50 expert studies to evaluate the exploration risk of geothermal projects in Germany were carried out based on this method. The studies are requested as a basis for insurance contracts covering the risk of not achieving the necessary parameters. The estimated probabilities for temperature and flow rate in the expert reports were now compared with the parameters actually reached in meanwhile realised projects. The results are used for an improvement of the method.

The probability of success for a given temperature was calculated using local temperature information in the vicinity of the planned well location. The greater significance of nearby temperature data was considered by inverse distance weighting. In highly productive deep aquifers, which are of major interest for geothermal projects, temperature gradients often strongly decrease due to an intense vertical mixing of the thermal water. Thus, the top of the considered aquifer was used as the reference point of the temperature assessment. As still some positive gradient can be expected within the aquifer, this is a conservative estimation. The evaluation of the reports should therefore especially answer the question, whether this approach has led to a systematic underestimation of the temperature.

To calculate the probability of success for hydraulic parameters, the theoretical drawdown at a given flow rate was calculated for existing wells from hydraulic test data. The probability of success was then calculated as the proportion of wells theoretically reaching the given flow rate at a maximum drawdown of the water table. Geothermal wells and regional geologic aspects were considered with weight factors in the equation.

The evaluation of has shown that the expert studies provided a solid valuation basis for the risk insurance of the temperature. The comparison with data from meanwhile realised projects did not indicate a systematic under- or overestimation of the temperature. Considering the hydraulic parameters, two wells did not yield the expected productivities, which was in the range of the given probabilities, however. The results of the evaluation are used for an improvement of methods to quantify the exploration risk of geothermal wells. In more recent studies, more weight has been put on the assessment of the seismic interpretations. Together with project partners it is investigated, whether seismic results and further geologic information can be included in a quantitative way. Furthermore, other weight factors and geostatistical approaches are tested for their applicability.