Englische Kurzfassung – Abstract

The joint research project EWS-tech conducted by the project partners Solites, the European Institute for Energy Research (EIFER), the Institute of Applied Geosciences (AGW) as well the Materials Testing and Research Institute (MPA Karlsruhe) from the Karlsruhe Institute of Technology (KIT) aims at the solution of basic questions concerning the grouting quality of borehole heat exchangers. For this, a three-stage approach of laboratory, small-scale and real-scale experiments was chosen. On the laboratory scale, detailed characterizations of 15 borehole grouting materials regarding their chemo-physical parameters (water/solid ratio, viscosity, sedimentation behavior, compressive strength etc.) and studies concerning grout permeability and permeability of the system as well as the long term durability of grouting material in sulfate aggressive or CO_2-containing environments were conducted. The robustness towards lower temperature conditions and towards changes in the water/solid ratio was analyzed in two additional testing scenarios for four selected borehole grout materials. Based on the laboratory characterization 36 small-scale experiments were performed to visualize the grouting process of borehole heat exchangers with the goal to understand the grouting process and the origin of discontinuities within the grouting. In a 6 m high test station above ground the influence of different parameters (type of grouting material, water/solid ratio of grouting material, mixing intensity, mixing time, injection rate, type of borehole heat exchanger, surface roughness of borehole etc.) towards the grouting quality were determined. To verify the results from laboratory and small-scale experiments 8 real scale experiments were conducted. For this a testing ground with two 30 m deep experiment boreholes was build. The multiple usable experiment boreholes enable a nondestructive removal of the borehole heat exchanger and the analyses of the effective condition of the grouting quality. By correlating the results and findings from the laboratory, small-scale and real-scale tests laboratory test criteria for grouting material and test criteria for on-site use as well as guidance for a high-quality grouting of borehole heat exchangers can be developed. These criteria and recommendations can be included in official guidelines or regulations etc. The determined criteria can also serve as a basis for an internal and external quality control. The insights gained on the long-term stability of grouting material can serve as a basis for an assessment of the damage potential of potentially hazardous borehole heat exchangers. In summary, the research project EWS-tech contributes to a significant improvement in borehole heat exchanger quality.