Challenges on measuring and monitoring techniques for shallow geothermal energy

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Abstract

Understanding and quantifying effects that result from the use of shallow geothermal energy is an important prerequisite for developing sustainable management strategies for the near-surface geothermal potential. Until now, relevant literature studies have generally investigated temperature changes and resultant effects based on single point sources, with oversimplification of the (hydro-) geological regime often occurring. A quantitative assessment of potential effects, especially considering the extensive use of shallow geothermal energy, cannot be made based on these approaches. In addition, high resolution information about small scale groundwater flow fields, geology, soil matrix properties, and temperature regime are required. Therefore, exploration and monitoring techniques are necessary for: a) geothermal site characterization under special consideration of site-specific conditions; and b) monitoring and optimized use of near surface geothermal reservoirs.

Geothermal site characterization poses several challenges to measurement techniques, as insufficient site characterization can have a strong impact upon efficient use of geothermal heat systems. Until now, physical sediment characteristics, e.g. thermal conductivity, have been measured as integral values over the installation depths of ground source heat pumps (usually up to depths of 100m). The local hydrogeological regime is often not considered. Thereby, a detailed analysis of sedimentary and hydrogeological site properties could significantly contribute towards planning reliability and towards reducing uncertainties in dimensioning ground source heat pumps.

Once in operation, the use of shallow geothermal reservoirs has direct effects and impacts upon the groundwater. Distinct requirements related to reservoir characteristics, the hydrogeological regime and geology arise based on the intended use. As such, effective and continuous monitoring is required to ensure that an efficient operation of shallow geothermal applications is maintained.

Based on these differentiated requirements, measuring and monitoring techniques must be developed and adapted which are capable of capturing relevant processes and parameters at sufficient spatial and temporal resolutions and increase the reliability, efficiency and sustainability of using shallow geothermal energy.