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Long-term predictions of minewater geothermal systems heat resources

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Abandoned underground mines usually flood due to the natural rise of the water table. In most cases the process is relatively slow giving the mine water time to equilibrate thermally with the the surrounding rock massif. Typical mine water temperature is too low to be used for direct heating, but is well suited to be combined with heat pumps. For example, heat extracted from the mine can be used during winter for space heating, while the process could be reversed during summer to provide space cooling. Altough not yet widely spread, the use of low temperature geothermal energy from abandoned mines has already been implemented in the Netherlands, Spain, USA, Germany and the UK.

Reliable reservoir modelling is crucial to predict how geothermal minewater systems will react to predefined exploitation schemes and to define the energy potential and development strategy of a large-scale geothermal – cold/heat storage mine water systems. However, most numerical reservoir modelling software are developed for typical environments, such as porous media (a.o. many codes developed for petroleum reservoirs or groundwater formations) and cannot be applied to mine systems. Indeed, mines are atypical environments that encompass different types of flow, namely porous media flow, fracture flow and open pipe flow usually described with different modelling codes. Ideally, 3D models accounting for the subsurface geometry, geology, hydrogeology, thermal aspects and flooding history of the mine as well as long-term effects of heat extraction should be used.

A new modelling approach is proposed here to predict the long-term behaviour of Minewater geothermal systems in a reactive and reliable manner. The simulation method integrates concepts for heat and mass transport through various media (e.g., back-filled areas, fractured rock, fault zones). As a base, the standard software EPANET2 (Rossman 1999; 2000) was used. Additional equations for describing heat flow through the mine (both through open pipes and from the rock massif) have been implemented. Among others, parametric methods are used to bypass some shortcomings in the physical models used for the subsurface. The advantage is that the complete geometry of the mine workings can be integrated and that computing is fast enough to allow implementing and testing several scenarios (e.g. contributions from fault zones, different assumptions about the actual status of shafts, drifts and mined out areas) in an efficient way (Ferket et al., 2011). EPANET allows to incorporate the full complexity of the subsurface mine structure. As a result, the flooded mine is considered as a network of pipes, each with a custom-defined diameter, length and roughness.