Investigating mineral reactions during high-temperature aquifer thermal energy storage (HT-ATES)

DANIELA B. VAN DEN HEUVEL, PETER ALT-EPPING, CHRISTOPH WANNER, URS MÄDER, LARRYN W. DIAMOND

Institute of Geological Sciences, University of Bern, Baltzerstrasse 3, 3012 Bern, Switzerland (daniela.vandenheuvel@geo.unibe.ch, peter.alt-epping@geo.unibe.ch, christoph.wanner@geo.unibe.ch, urs.maeder@geo.unibe.ch, diamond@geo.unibe.ch)

As part of the Swiss Energy Strategy 2050, Switzerland aims to increase the use of surplus heat from industry (e.g. municipal waste incinerators) for district heating. While heat generation from these industrial sources is more or less constant, the heating demand is characterised by seasonal fluctuations. In order to overcome this mismatch of demand and supply, excess thermal energy can be stored in sandstone- and carbonate-aquifers during summer and recovered and fed into the district heating network during winter. In order to increase the potential of aquifer thermal energy storage (ATES), new pilot projects planned within the framework of the GEOTHERMICA-Heatstore project aim for higher injection temperatures (60 to 110 °C). As the reservoir fluids are in equilibrium with calcite and/or dolomite, heating them up will result in carbonate mineral precipitation, potentially clogging surface installations and reservoir porosity.

In order to quantitatively investigate the mineral reactions expected during ATES, we are performing laboratory experiments on drill core samples from the target formations under the conditions planned for the HT-ATES system. By measuring changes in the fluid composition as a function of time, we can infer the stoichiometry and kinetics of mineral dissolution and precipitation reactions. In addition, we are investigating different conditions (variations in temperature and fluid composition) in order to generate data transferrable to other reservoir formations. We are also investigating the effectiveness of potential mitigation strategies such as conditioning of fluids by CO_2 addition or the usage of carbonate inhibitors.

All of our experimental data is fed into 3D THC models representing the two pilot sites planned in Switzerland (in Geneva and Bern). The models will be used to guide development of the sites as well as help to predict the long-term behaviour of the reservoir formation. In addition, the models can be used as a planning tool to develop more HT-ATES systems inside and outside of Switzerland in the future.