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Hydrogeochemical impact assessment of pumped hydro power storage in open-pit lignite mines

Tobias Schnepper[1,2], Michael Kühn[1,2], and Thomas Kempka[1,2]
[1]GFZ German Research Centre for Geosciences, Fluid Systems Modelling, Telegrafenberg, 14473 Potsdam, Germany
[2]University of Potsdam, Institute of Geosciences, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany

As recent developments regarding the increasing demand of renewable energy sources in the European energy sector demonstrate, the need for large-scale energy storage technologies intensifies. Since the availability of wind and photovoltaic energy are undergoing high fluctuations, excess energy has to be stored to be available at times of high energy demand. Implementation of pumped hydro power storage (PHS) plants in abandoned underground reservoirs are intensively studied as potential storage solution (e.g. Pickard, 2012), whereby open-pit lignite mines are also expected to contribute to this issue (Thema and Thema, 2019), but are hardly investigated, yet. PHS follows the concept of pumping and releasing water between two reservoirs located at different elevations.

The success of energy storage by PHS in abandoned mines highly depends on the geo- and hydrochemical processes in the reservoirs and the surrounding porous media (Pujades et al., 2018). Oxidation of sulphur bearing minerals, especially of pyrite, might trigger the generation of Acid Mine Drainage (AMD; Akcil and Koldas, 2006), which can impact groundwater chemistry as well as slope stability, and further induce corrosion at critical technical infrastructure (Pujades et al., 2018).

In the scope of the present study, we have investigated the major chemical reaction paths by numerical modelling to conceptualise comprehensive reactive transport simulations for environmental risk assessments. For that purpose, we considered available research findings from studies on the Lusatian and Rhenish lignite mining areas, and applied these to other European mining sites. Calcite buffering, mineral dissolution-precipitation balances, heavy metal contamination as well as mixing processes between the potential reservoirs and groundwater have been taken into account. In summary, geochemical impacts potentially occurring with PHS operation under hydrochemical boundary conditions representative for European open-pit lignite mines were investigated and quantified.

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