Hydrochemical changes induced by Underground Pumped Storage Hydropower: influence of aquifer parameters in coal mine environments

Estanislao Pujades[1] , Anna Jurado[2], Philippe Orban[3], Alain Dassargues[3]

[1] Department of Computational Hydrosystems, UFZ – Helmholtz Centre for Environmental Research, Permoserstraße 15, 04318 Leipzig, Germany

[2] Department of Hydrosciences, Technische Universität Dresden, 01062 Dresden, Germany

[3] Hydrogeology and Environmental Geology, Geo3, Dpt ArGEnCo, University of Liege, 4000 Liege, Belgium

estanislao.pujades-garnes@ufz.de / estanislao.pujades@gmail.com

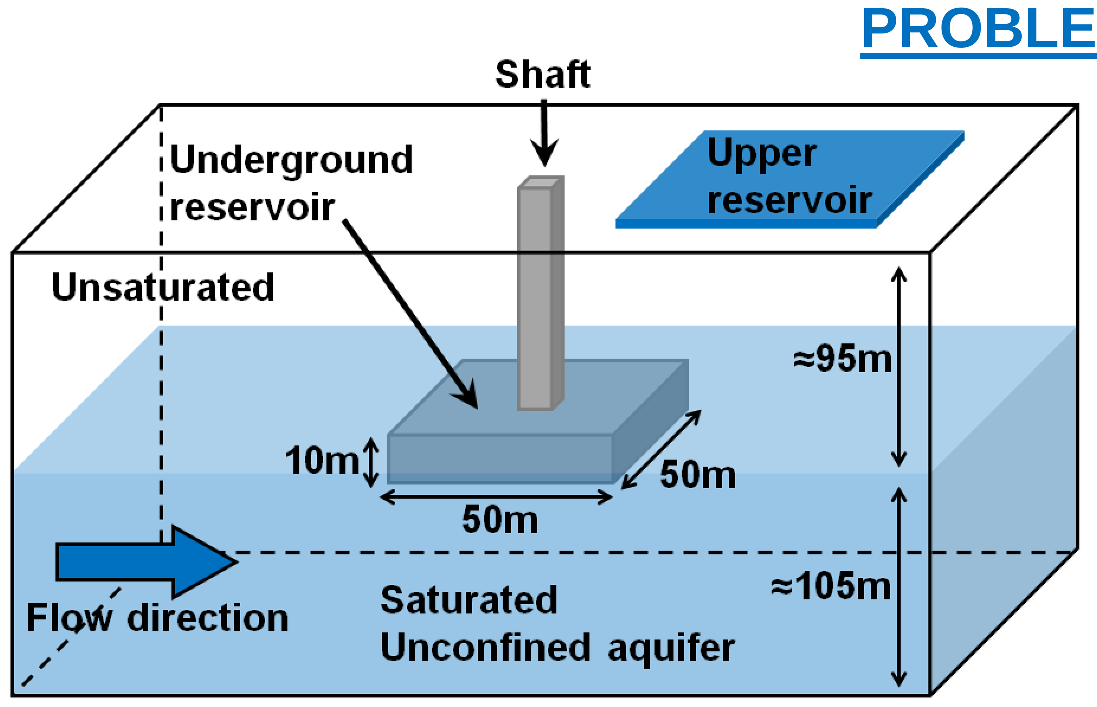
Introduction

Underground pumped storage hydropower (UPSH) induces hydrochemical changes when pumped and discharged water evolves to reach equilibrium with the atmosphere (in the surface reservoir) and with the surrounding medium (in the underground reservoir). These hydrochemical changes may impact the environment and the efficiency, especially in coal mine environments were the presence of sulfide minerals is common. For this reason, it is of paramount importance to ascertain the variables that control the behavior of the system in order to establish criteria for the selection of abandoned mines to be used as underground reservoirs in future UPSH plants.

Coupled hydro-chemical numerical models are used for investigating the influence of hydraulic parameters on the hydrochemical changes when pyrite is present in the surrounding medium. Results allow understanding how the hydraulic conductivity and the porosity affect the hydrochemical changes and their associated consequences.

Materials and methods

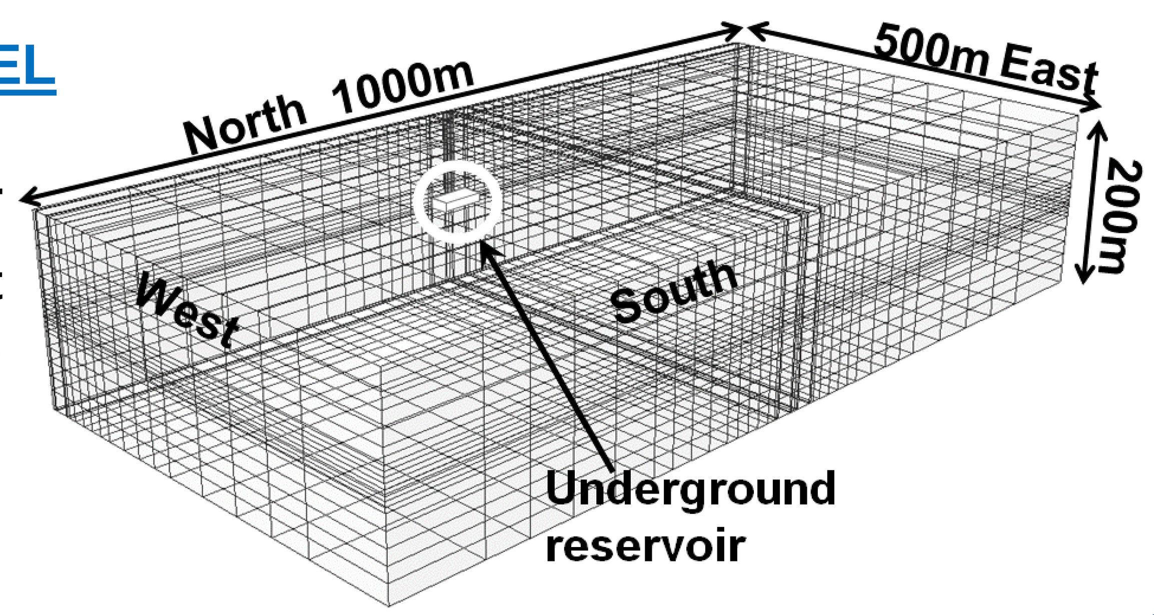
PROBLEM STATEMENT



- The porous medium contains 1% of Pyrite.
- 21500 m^3/d are pumped and injected consecutively in phases of 12 hours
- Scenario 1: K = 0.01 m/d and θ = 0.05
- Scenario 2: K = 0.1 m/d and θ = 0.05
- Scenario 3: K = 0.01 m/d and θ = 0.25

NUMERICAL MODEL

The problem is simulated using the code PHAST (Parkhurst et al., 1995; Parkhurst and Kipp, 2002) that solves multicomponent, reactive solute transport in three-dimensional saturated groundwater flow.

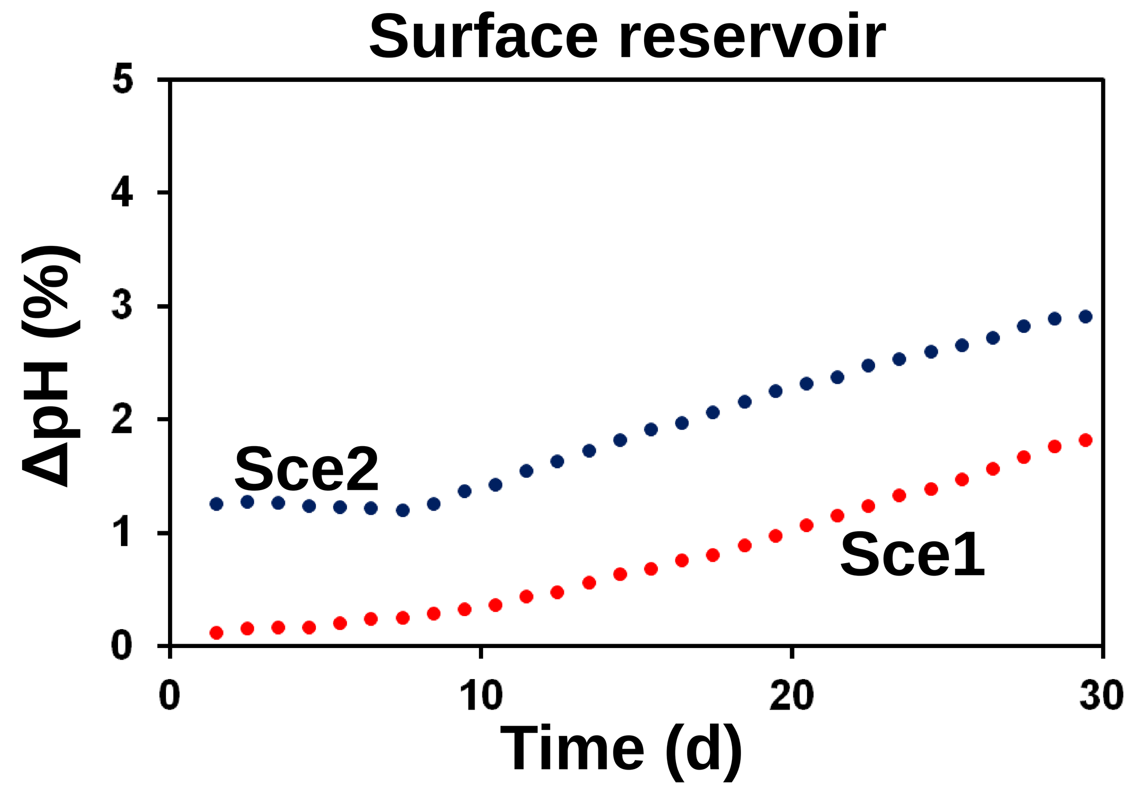


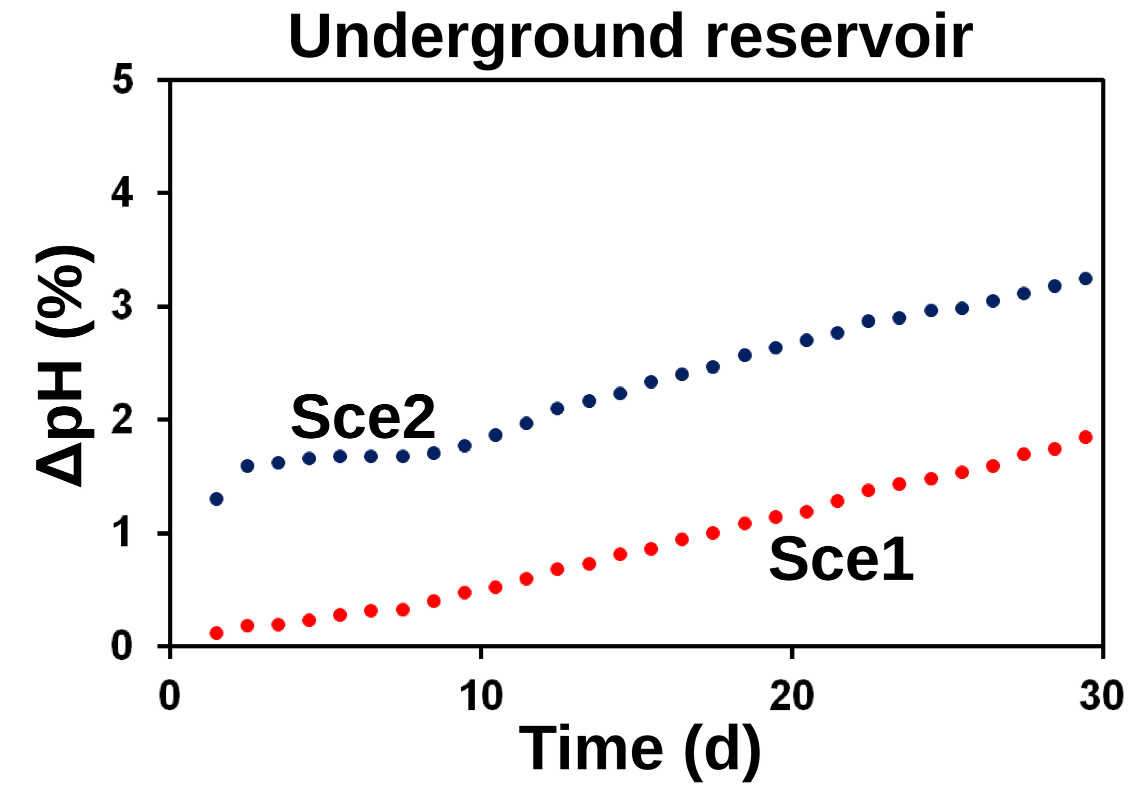
Conclusions

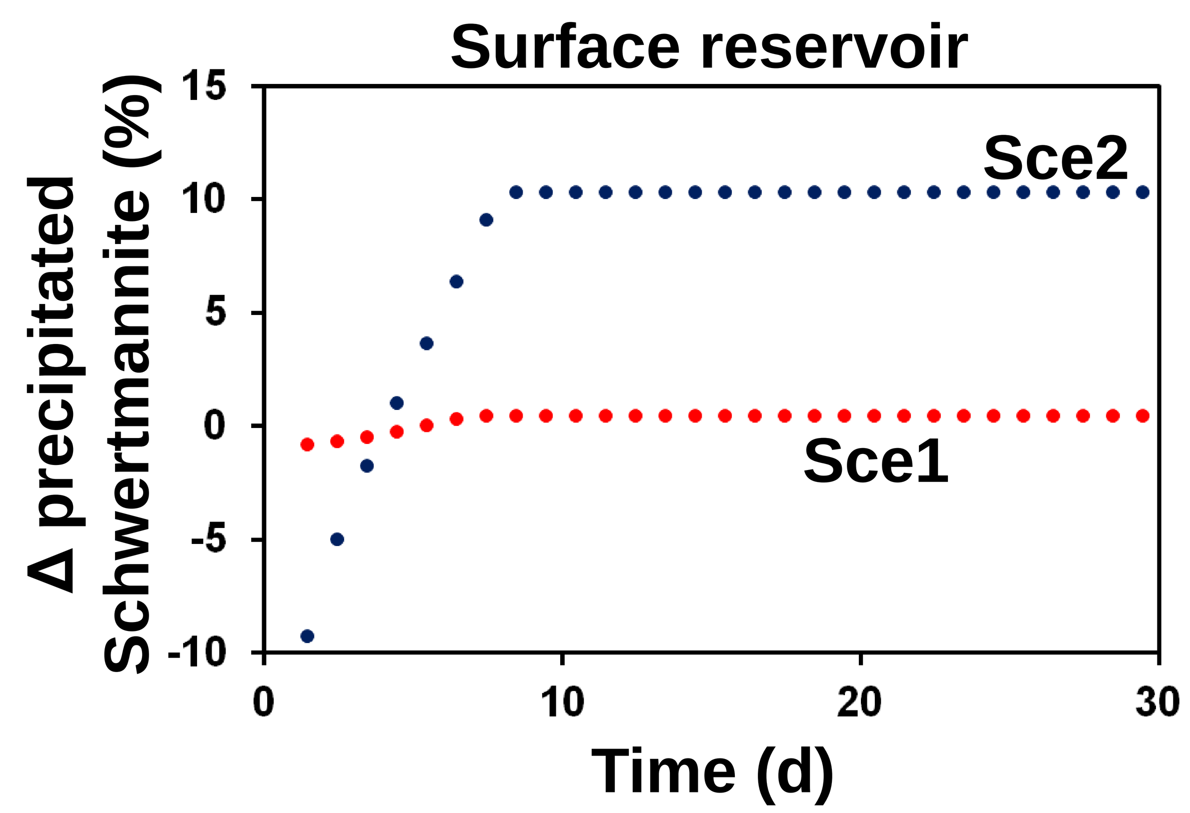
- Hydraulic parameters modify the hydrochemical changes produced by UPSH.
- Environmental impacts and efficiency would vary depending on the hydraulic conductivity and the porosity of the porous medium.
- pH increases in the reservoirs for high values of K or θ because more water from the upgradient side (not altered by UPSH) reaches the reservoirs. For the same reason precipitation of schwertmannite increases for scenarios Sce2 and Sce3.
- In the porous medium (downgradient side), pH decreases and more pyrite is oxidized when K is increased while pH decreases and less pyrite is oxidized when θ is increased.

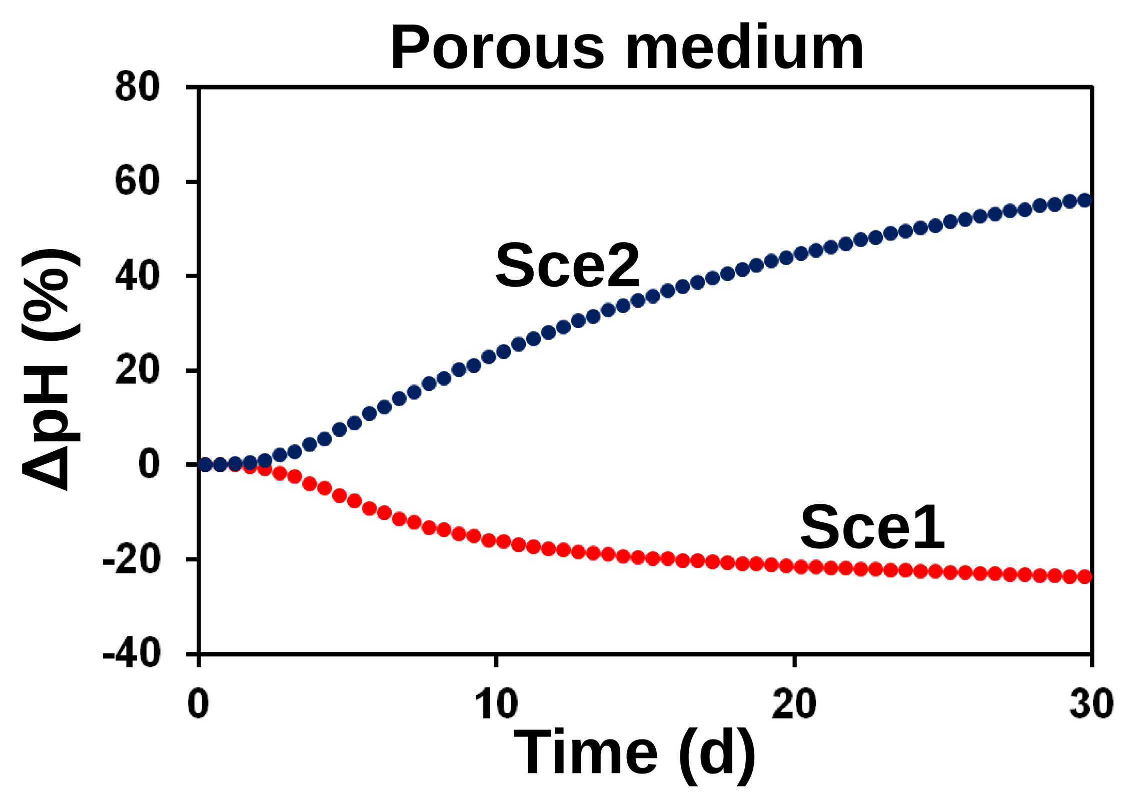
Results

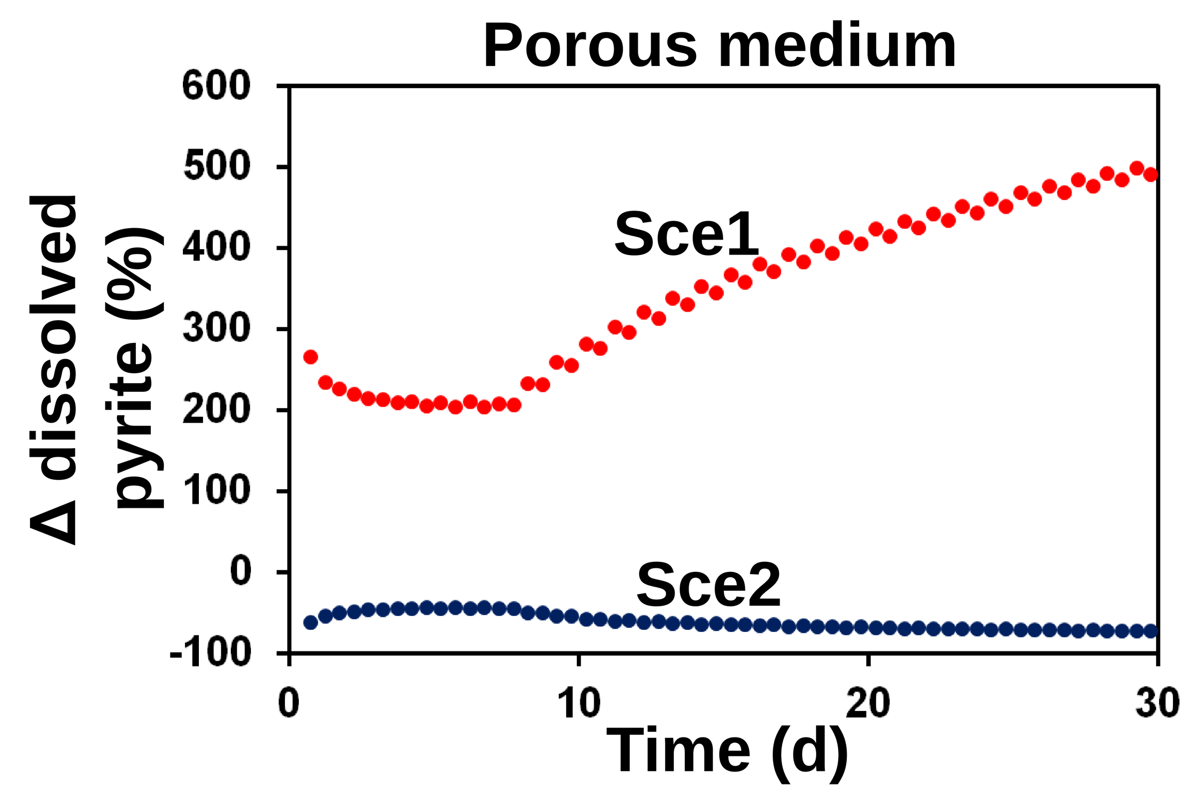
Results show the variation in percentage with respect the reference scenario











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