Karlsruhe Institute of Technology

Machine Learning for Enhancing Geothermal Energy

Institute of Applied Geosciences (AGW)
Department of Geothermal Energy & Reservoir Technology

MALEG - Machine Learning for Enhancing Geothermal Energy Production

Michael Trumpp[1], Lars Ystrøm[1], Florian Eichinger[2], Johannes Amtmann[3], Daniel Winter[4], Joachim Koschikowski[4], Thomas Kohl[1], Fabian Nitschke[1]

[1] Karlsruhe Institute für Technology (KIT),[2] Hydroisotop GmbH,
[3] Geosaic GmbH, [4] Fraunhofer Institute for Solar Energy Systems (ISE)

✉ Michael.Trumpp@kit.edu ✉ Lars.Ystroem@kit.edu

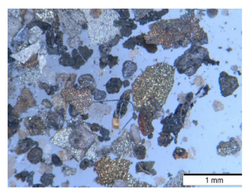
Motivation

The objective is to enhance the efficiency of geothermal power plants through an artificial intelligence called MALEG via emulation of site-specific geochemical processes occurring within geothermal power plants. Mineral precipitation and degassing are controlled by pH, temperature, pressure and salinity and are the most common processes. The aim is to derive concrete action requirements for operators, such as an increased heat extraction, reduction of pressure maintenance or prevention of fouling.

Geochemical Sampling & Monitoring

Sampling at geothermal power plants to quantify the geothermal brine chemistry using fluid and solids analyses. Determination of precipitation and degassing potential.

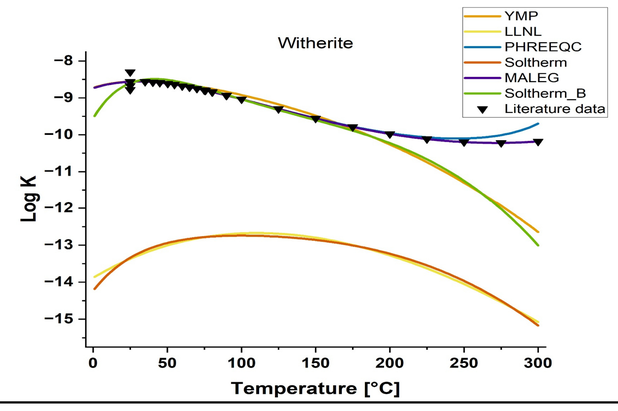
Sampling of the brine and solids analyses of filter residues from a production well

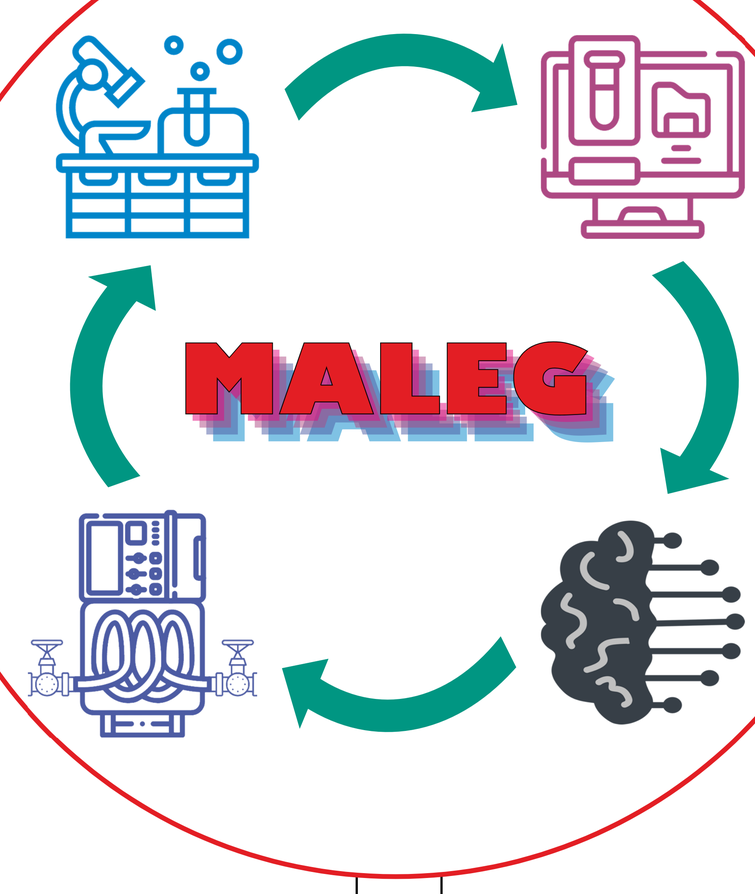


Optimization of deterministic modeling

Evaluation, comparison and validation of thermodynamic data sets using experimentally determined equilibrium constants in order to create a new PHREEQC database for deterministic modeling.

Comparison of the thermodynamic equilibrium constants K over the temperature from various PHREEQC databases



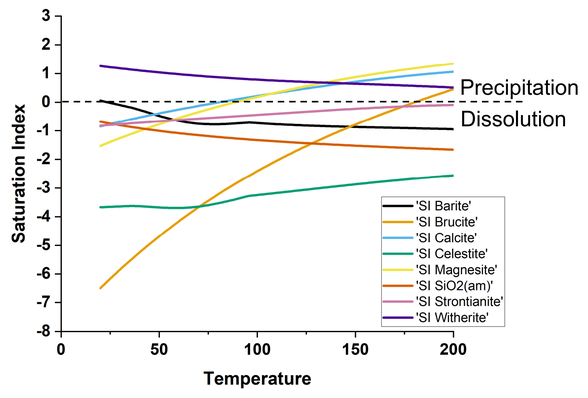


Hardware-Twin

In-situ demonstrator connected to the power plant as a bypass. Experimental adjustment of power plant parameters (temperature, pH value, pressure) under constant geochemical monitoring and sampling.

Digital-Twin

Scaling Potential over the temperature



Deterministic geochemical models based on an initial fluid characterization are compared with machine learning models to create an physical informed artificial intelligence which can interact with the Hardware-Twin to adjust operation parameters.