

European Fluid Atlas

In the REFLECT project, the formerly existing and newly measured data of geothermal fluids will be visualised through the European Fluid Atlas. Fluid data are collected from 21 European countries (Figure 3). In the Atlas, the layers will provide point feature information presented on a base map, including geography, geology and depth range, as well as physical, chemical and microbial properties of fluids. Data of wells, rocks and reservoirs will be also available. The focus is on fluids used for electricity generation ($> 100\text{ }^{\circ}\text{C}$), but there is a potential to include data from heat projects.

For the Atlas, a free and open-source cross-platform is used, in which the geographic information system provides the environment to view, edit and analyse geospatial data. The interface will include query and filtering tools to explore the database with a map based visualisation.

With the Atlas, operators can rapidly assess what kind of fluids might be expected at a certain location, and thus have an improved view of the associated risks when installing a geothermal power plant. The compositional maps will be developed into risk maps for the different operational issues by combination with numerical modelling. The Fluid Atlas can be later integrated into other databases, thus it can be an addition to already existing initiatives of geological data collection.

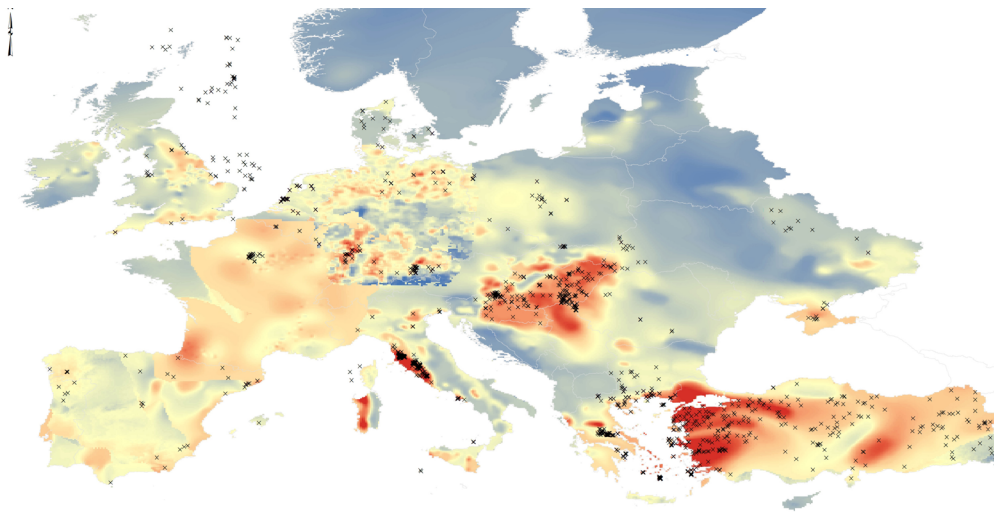


Figure 3: Basemap 'Temperature at 1000m depth' layer of the 3D Subsurface Temperature Model of Europe for Geothermal Exploration, J. Limberguer (Utrecht University) & J.D. van Wees (TNO Utrecht and Utrecht University). Small crosses indicate the locality of the data collected for the Fluid Atlas.

Microbiology Research

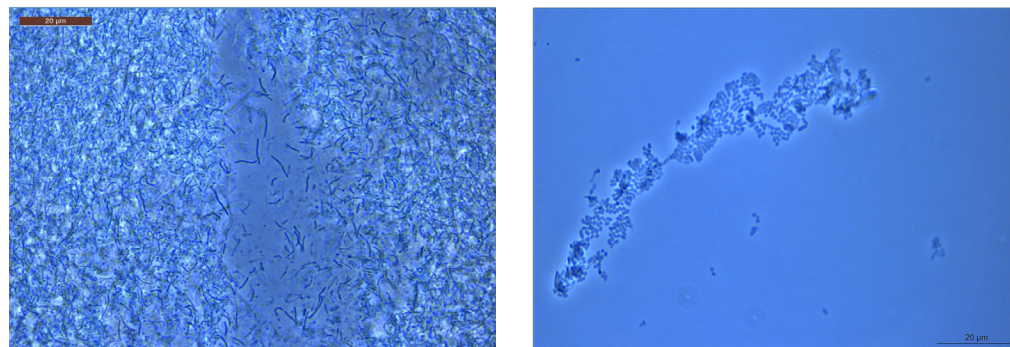


Figure 4: Left: cells of a new *Thermaerobacter* sp. strain (Firmicutes) isolated from the production site in Insheim (DE). Right: bacterial isolate from Krafla (IS) potentially related to the hgcl clade from Actinobacteria. Both organisms belong to bacteria groups known to produce survival structures with high tolerance to extreme environmental conditions.

Despite the known presence of microorganisms in some geothermal fluids [1,2,3], their diversity and their potential role in the functioning of geothermal power plant systems are often not taken into consideration. However, microbial activity can have a significant impact on the operation of power plants, for example by inducing mineral precipitation, like silica scaling, and thus decreasing the plant's efficacy [1]. Moreover, using the geothermal reservoir in a power plant will change the environmental conditions to which these microorganisms are exposed. Such changes may lead to new reactions or new metabolisms that can become problematic, such as the above mentioned induced mineral precipitation [1]. As the knowledge on microorganisms in deep geothermal fluids is still scarce, the aim of this subtask is to increase our knowledge on the diversity of archaea, bacteria and fungi present in different deep geothermal fluids used for electricity production in Europe. In order to do so, two different approaches are used in parallel: a molecular approach, looking at the microbial DNA present in the fluids as a marker of microbial life; and a cultural approach, to investigate which microorganisms present in the fluids are culturable under laboratory conditions (Figure 4).

REFERENCES

- [1] Inagaki, F., Motomura, Y. and Ogata, S. (2003), doi: 10.1007/s00253-002-1100-y.
- [2] Filippidou, S. et al. (2016), doi: 10.1099/ijsem.0.001125.
- [3] Westphal, A. et al. (2019), doi: 10.1007/s00792-019-01080-0.

REFLECT

Improving the efficiency
of geothermal utilisation



From React to Reflect

The efficiency of geothermal utilisation largely depends on the behaviour of fluids that transfer heat between the geosphere and the engineered components of a power plant. The Horizon 2020 funded project REFLECT aims to avoid problems related to fluid chemistry rather than treat them. Fluid physical and chemical properties are often poorly defined, as in situ sampling and measurements at extreme conditions have proved difficult to date. Therefore, large uncertainties in current model predictions prevail, which are being tackled in REFLECT by collecting new, high-quality data in critical areas. The data is being implemented in a European geothermal fluid atlas and in predictive models to allow recommendations on how to best operate geothermal sites sustainably and to enhance geothermal technology development. REFLECT's research is also focusing on the microbial activity in some geothermal fluids to better understand how this influences the operation of a power plant.



Predictive Modelling

The REFLECT team has developed porousMedia4Foam, an open-source, multi-scale and multiphase package, where OpenFOAM® is coupled with PHREEQC to investigate hydro-geochemical interactions. The flow, transport of species, evolution of porous media properties and temperature are handled by solving equations implemented in OpenFOAM®, whereas the chemistry is exclusively handled by PHREEQC code. The code has extensively been validated for single phase flows at different scales with a specific emphasis on analysing the nature of fluid flow in geothermal production wells.

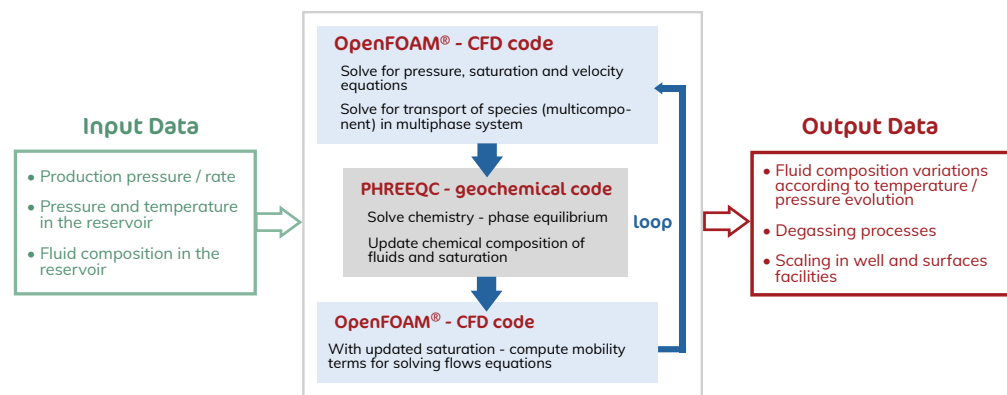


Figure 1: Calculations with porousMedia4Foam. CFD = Computational Fluid Dynamics.

A workflow for uncertainty quantification in the fluid composition and its impact on scaling has been developed and tested. A full coupling between the PHREEQC code and hydraulic model was made and the model is currently being tested for two example conditions (flow in the pipes and wells and flow in heat exchangers), considering fluid composition uncertainties.

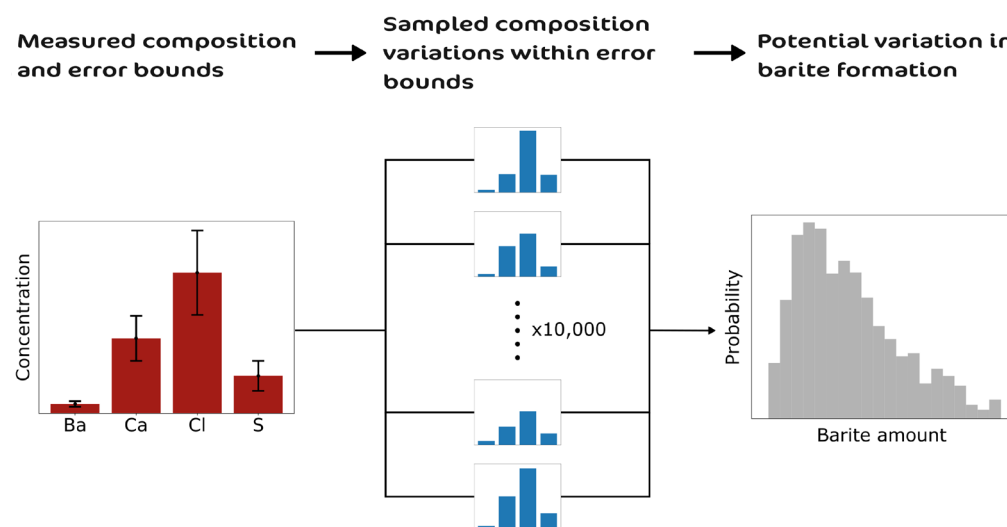


Figure 2: Distribution of barite precipitated layer thickness in the heat exchanger of a geothermal plant considering geothermal brine composition uncertainties.

PROJECT COORDINATOR

Helmholtz Zentrum Potsdam Deutsches GeoForschungsZentrum (GFZ)

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- Institut for Energiteknikk, Norway
- Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO, The Netherlands
- British Geological Survey, United Kingdom Research and Innovation, UK
- Islenskar Orkurannsoknir, Iceland
- Miskolci Egyetem, Hungary
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Cover photo and scales' picture: Simona Regenspurg



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