Tackling some geochemical challenges raised by enhanced geothermal systems (EGS): The example of Soultz-sous-Forêts, France

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The Soultz-sous-Forêts EGS is located in the Upper Rhine Graben, 50 km north of Strasbourg, France. The subsurface at this site is a natural deep hydrothermal system with a geothermal gradient noticeably higher than normal in the first 1 km of the sedimentary cover (~100 °C/ km) and natural brine circulation in the underlying fractured granite, which is responsible for a reduced geothermal gradient (10 °C/km) between 1 and 3.5 km. These exceptional features have fostered research projects for over 30 years on EGS, most of recent ones being currently carried out in the framework of the Laboratoire d'Excellence (LabEx) "G-Eau-Thermie Profonde" operated since 2012 by the Strasbourg University in partnership with CNRS, Electicité de Strasbourg and GEIE EMC, Soultz-sous-Forêts.

From a geochemical standpoint, the pumping of hot water and the re-injection of cooled water at depth favor the dissolution of some rock-forming minerals of the deep reservoir (e.g. feldspars), while promoting the precipitation of secondary phases. The relative intensities of primary mineral leaching and secondary phase formation may affect porosity and permeability of the reservoir, thereby influencing its hydraulic performance. Therefore, predicting the kinetics of fluid/rock interactions represents a critical issue for evaluating the efficiency of the EGS. This task is complicated by the fluid chemisty, which is such that most chemical reactions take place in a Gibbs free energy (ΔG) range where the dissolution rate-ΔG relations are undetectable by means of classical laboratory dissolution experiments.

Here we will describe how our most recent developments for measuring mineral dissolution rates in conditions relevant for the Soultz-sous-Forêts EGS by the use of profilometry techniques applied to dissolved minerals (e.g. atomic force microscopy, vertical scanning interferometry) challenge the conventional treatment of mineral reactivty and pave the way for a paradigm shift for modeling mineral dissolution kinetics