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Lithium resources in geothermal brines of the Upper Rhine Graben and possible extraction technologies

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Lithium is one of the most important raw materials for the mobility transition and energy storage, as it is irreplaceable for battery technology at least for the next decade. Europe is dependent on imports of lithium-ion batteries and has only very few lithium deposits in production that supply this raw material for domestic battery production. In addition to conventional lithium ore deposit types in granitic rocks, unconventional resources in geothermal basin brines have received exploration interest globally.
The Upper Rhine Graben in southwestern Germany and northeastern France hosts numerous warm springs. Geothermal waters in porous rock at depths of 2000-5000 metres have been used in geothermal power plants since the early 2000s. Although lithium contents of 150-600 mg/l are lower than in the salt lakes of South America, high flow rates and energy or balneological co-utilisation make the resource economically interesting. Four geothermal power plants in the Upper Rhine Graben alone could produce more than 1000 tonnes of lithium per year, which would correspond to a global share (2021) of 1% and would put Germany in 5th-6th place among global lithium producers.
However, technologically lithium extraction from the brine in a running geothermal power plant or bath is challenging. The following requirements for process stability have to be met in a fully industrial implementation: (1) temperatures of up to 150°C and pressures between 20 and 40 bars; (2) flow-rates of 20-100 L/s; (3) complex solute concentration of 100-200 g/L; pH of 4-5; (4) locally gas saturation of the liquid; and (5) lithium concentrations between 70 and 250 mg/L. Sorption on solid crystalline material is one of the most promising extraction technologies, as it is very selective for lithium, relatively robust, simple and fast, and already widely used in water treatment. Geologists have the necessary understanding of crystallography and fluid mineral interaction under the conditions given above and thus, play an important role in technology development. Currently, different Al-, Ti-, Mn-based minerals are tested. We developed Mn-based sorbents and tested zeolite and lithium-iron phosphate successfully in a pilot plant. The industry and research on the extraction technology, but also targeted exploration is ongoing and still in the pilot- or small demonstrator stage. The Upper Rhine Graben was amongst the first sites globally, but strong funding opportunities brings Canadian companies at the forefront of the technology.

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