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Biomining of critical raw materials using the oxalate-carbonate pathway

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Metals, such as copper, gold, lithium and rare earths (to name a few) are essential for the functioning of our modern societies. Indeed, information and communication tools, as well as low-carbon renewable energies require various metals for their effective functioning. For instance, a smartphone may contain up to 70 different metals! Yet metals are non-renewable natural resources and their mining in the environment is generally considered un-ecological and is often performed in a non-ethical manner. In addition, there is a strong geopolitical dependency for most metal resources, in particular for Europe. However, the overall need in metal resources is not expected to decrease due to a constant technological innovation, along with the traditional pattern of a consumer's society. For this reason, alternative sources for critical raw materials (CRM) are currently actively researched. The EU funded project '*CRM geothermal*' is focusing on deep geothermal environments exploited for the generation of electricity and heath as non-conventional sources of CRMs. Here, we are focusing on the microbially-mediated recovery of lithium from selected geothermal brines.

Microorganisms constantly interact with mineral materials in the environment, for example by altering their solubility and redox state. In addition to this, interactions between bacteria and fungi are known to be essential for the maintenance of biogeochemical cycles. For instance, in soils microbial interactions are central to promoting nutrients availability to plants or for the reduction of heavy metals' toxicity. These abilities can be harnessed for bio-inspired metal recovery processes. To do so, we centered our study on a biogeochemical process where metal solubility is under the control of microbial activity. Such a process is known as the oxalate-carbonate pathway. Briefly, in terrestrial environments, plants and fungi produce oxalic acid (oxalogenesis), which is then consumed by bacteria (oxalotrophy), eventually associated to a local pH increase. In the environment, the OCP is centered around the biogeochemical cycles of calcium and carbon and induces changes such as calcium complexation with oxalate and calcium precipitation as calcium carbonate ($CaCO_3$). In this project, we aim at assessing the feasibility of bio-recovering lithium from geothermal fluids as Li_2CO_3 by using a Li-based OCP process.