Towards green, widely applicable, and low-cost geothermal energy

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Reduction of H_2S and CO_2 emissions from geothermal power plants is an important environmental, economical, and social challenge that needs to be addressed. The geochemistry associated with H_2S and CO_2 injection and sequestration into geothermal reservoir was investigated. We have demonstrated with flow-through experiments how the injection of both gases back into reservoirs at 250˚C leads to the long-term underground storage of carbon and sulphur in a solid state. Aqueous analyses and SEM images confirm the rapid precipitation – in the order of days – of siderite [$FeCO_3$], solid solution of siderite and calcite [$(Fe,Ca)CO_3$] and pyrite [FeS_2] for several experimental rock types. Furthermore, the mineralization rates seem to be controlled by the Fe leaching of the host rocks during the initial stage of fluid-rock interactions.

These findings reject the general belief that basalt is the only host rock suitable for the mineral sequestration of CO_2 and H_2S, and provide examples of successful mineralization also in andesitic to acidic magmatic rocks, which are more commonly spread across the world geothermal fields. Despite no relation being observed between the levels of gaseous emissions and the associated specific lithology at a global scale, the host rock nature remains a key parameter in determining the required surface and volume to sequester CO_2 and H_2S. Based on experimental sequestration rates, the reservoir lithology with less CO_2 trapping capacity per cubic meter is rhyolite, whereas basalt and dacite show a similar potential. On the other hand, the H_2S uptake shows the opposite, favouring felsic rocks. The volume required to sequestrate 1 t of CO_2 and H_2S were 7-18 m^3 and 80-95 m^3, respectively.

The injection of gas mixtures also includes the economic advantages of not requiring expensive gas separation steps, large volumes of additional chemicals, or major modifications on the power plants, making it cheaper than conventional approaches but also suitable for a prompt worldwide application.