Towards zero emission geothermal plants in the framework of the H2020 GECO project: Insights on gas re-injection in geothermal reservoir and serpentininite carbonation from batch reactor experiments

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The EU H2020 GECO (Geothermal Emission Gas Control) project is aimed to produce new technologies to limit emissions from geothermal power generation by either gas re-injection or its use to produce commercial material through serpentininite carbonation. In this framework, the realization of a closed loop geothermal power plant has been planned in the Lardello geothermal area (Italy), where gas will be re-injected in a reservoir constituted by phyllites and micaschists.

A set of water-gas-rock interaction experiments was performed in order to: i) investigate the interaction between CO$_2$-H$_2$S gas mixture, representative of the geothermal fluids exploited at Larderello, and phyllites and micaschists of the reservoir ii) optimize the conditions for CO$_2$ mineral sequestration by reacting CO$_2$-H$_2$S gas mixture with different serpentinised ultramafic rocks buried in the nearby area. During the experiments, rock powder suspended in ultrapure ion-free MilliQ® water were reacted with a gas phase (CO$_2$-H$_2$S=98-2% or CO$_2$=100%) in a PARR 5500 HP stirred reactor at P-T conditions ranging from 20 to 60 bar and 90 to 250 °C, respectively. The liquid phase resulting from the experiments was analysed via ion chromatography and ICP-MS to determine ion contents, whilst rock and rock powder were examined with SEM-EDS and EPMA to identify mineral phases and determine mineral chemistry.

Preliminary results highlighted that H$_2$S plays a pivotal role in controlling the reaction pathways with phyllites and micaschists, allowing the formation of pyrite in a wide range of P-T conditions. This process induces a selective removal of Fe from the solution, while the exceeding SiO$_2$ deriving from mica and chlorite alteration re-precipitate as quartz. In this experiment, carbonate precipitation is prevented by the low Ca and Mg content of the samples and by the high water to rock ratio constrained by the experimental set-up. Experiments with ultramafic rocks were performed using serpentinised harzburgite and brucite-rich dunite in order to identify the most reactive lithology for mineral carbonation. Preliminary results show that CO$_2$ sequestration is strongly enhanced by the presence of brucite compared to serpentine but further experiments are
required to establish the most efficient reaction conditions.
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