Geo-electrical monitoring of H2S mineralization into pyrite, upon re-injection in basalts at Nesjavellir geothermal site, Iceland

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The hydrogen sulfur (H_2S) emitted from geothermal exploitation is an air pollutant: high concentrations of H_2S are corrosive and toxic. A solution to mitigate air pollution caused by geothermal exploitation is to re-inject geothermal gases (H_2S and CO_2) into basaltic rocks, where the gasses should mineralize into pyrite and calcite, respectively. Several re-injection projects are currently on-going in Iceland. The GEMGAS research project (Geo-Electrical Monitoring of H_2S Gas Sequestration) aims at developing a methodology for geophysical monitoring of H_2S sequestration by formation of pyrite (FeS_2), with focus on a re-injection project in the Nesjavellir geothermal reservoir, starting in September 2020 and with injections in the depth range 200-500 m.

With repeated measurements before and after injection, we aim at providing a dynamic view of electrical resistivity and polarization structure changes upon formation of pyrite in basalts. Five complementary methods are combined: surface Direct Current (DC) and Time-Domain Induced Polarization (IP), Self-potential (SP), Transient Electro-Magnetic (TEM), borehole logging, and finally DCIP using two metallic wellbore casings as current electrodes.

Preliminary results from the two "baseline" rounds of measurement carried out in 2019 and 2020 illustrate important issues related to the dense metallic and electrical infrastructure buried at the site. We present improvements made to the data quality by changing the acquisition strategy between 2019 and 2020. We also give an overview of the variability between the two baseline rounds before H_2S injection, in particular through time-lapse inversions.

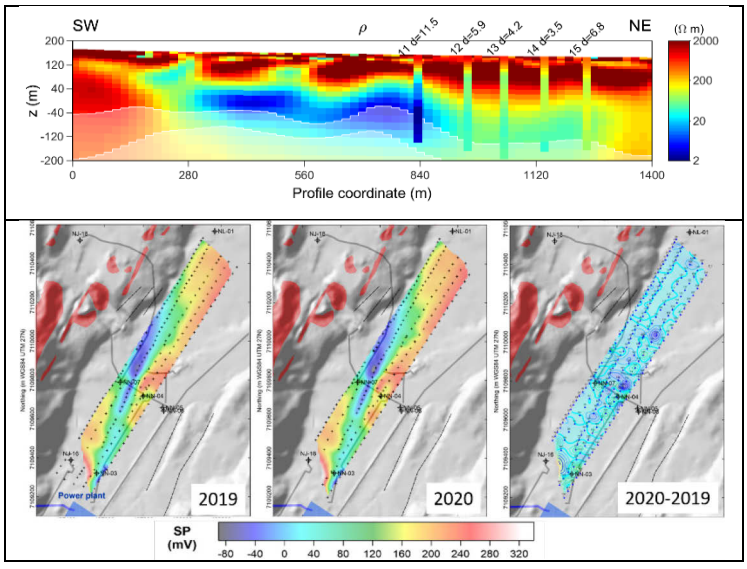

Figure caption: Top panel: superposition of DC (2D) and TEM (1D) resistivity models obtained from 2019 data along one of the DCIP profiles. Bottom panel: self-potential maps obtained in 2019 and 2020, as well as a map of the difference between the two years.