Imaging the resistivity structure of the Reykjanes high-enthalpy geothermal field with the Controlled-Source Electro-Magnetic method

Mathieu Darnet, Nicolas Coppo, Pierre Wawrzyniak, Eva Schill, Nadine Haaf, Steinthor Nielsson

Imaging the resistivity structure of the Reykjanes high-enthalpy geothermal field with the Controlled-Source Electro-Magnetic method

Mathieu Darnet[1], Nicolas Coppo[1], Pierre Wawrzyniak[1], Eva Schill[2], Nadine Haaf[2], Steinthor Nielsson[3]

[1]BRGM, France, [2]KIT, Germany and [3]ISOR, Iceland

The Reykjanes geothermal field is located at the tip of the Reykjanes Peninsula. It is part of the Reykjanes fissure swarm, which is the sub-aerial extension of the Reykjanes Ridge. The South-western tip of the Reykjanes Peninsula is mostly covered by sub-aerial basaltic lavas and to a lesser degree by hyaloclastites. Hot ground and surface alteration at the Reykjanes geothermal field extends over an area of about 1.5 km². In this zone, there are also numerous fumaroles and mud pots indicating a buried high temperature field. A geothermal plume reaches to about 900 m depth and below the reservoir expands to at least 4 km² at 2 km depth with borehole temperatures exceeding 300°C.

As part of the EU H2020-funded DEEPEGS project, the IDDP2 well has been drilled into the Reykjanes geothermal field and is currently being stimulated. In an attempt to monitor the massive and soft hydraulic stimulations, we undertook a 4D Controlled-Source Electromagnetic (CSEM) monitoring experiment to sense and map from surface EM measurements electrical resistivity changes occurring within the geothermal reservoir as a result of the stimulations.

In this paper, we will report out the results of the baseline 3D CSEM survey acquired in 2016 and covering the Reykjanes geothermal field. We will show that despite the presence of high industrial electromagnetic noise, we managed to recover a reliable 3D resistivity image of the geothermal field but also achieved a CSEM data quality sufficient to be able to measure resistivity changes occurring at reservoir depth during the stimulations, if any. These should ultimately help us mapping the areas of the subsurface where resistivity has changed due the stimulations of the reservoir and hence mapping the fluid flow pathway within the supercritical geothermal system.

The DEEPEGS project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 690771