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Is ERT suited for the continuous monitoring of volcanic systems? A case study during the 2023 unrest of the Reykjanes system.

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Geo-electric methods such as Electrical Resistivity Tomography (ERT) and Induced Polarization (IP) have become increasingly important in the characterization of volcanic and geothermal systems. The methods rely on the electrical properties of the subsurface. In volcanic settings, the main influences are temperature, gas content (i.e. saturation), mineralizations, and the presence of alteration clays.

The ERupT project aims to assess the suitability of ERT to visualize the dynamics in hydrothermal systems. With the long-term aim of improving hazard assessment associated with phreatic/hydrothermal eruptions. In that context, a semi-permanent ERT setup was installed at the Reykjanes geothermal area in Iceland. In October 2022, the monitoring system was installed on-site, automatically measuring one profile per day, with currently 15 months of uninterrupted data, except for 5 days due to technical issues. The profile is 355 meters long and has a depth of investigation of 30 to 50 meters.

The 2021 eruption at Fagradalsfjall has marked a new age of volcanism in the Reykjanes peninsula, 2023 was marked by two eruptions. The first eruption happened in the Fagradalsfjall system on July 10th. The second eruption started on 18 December, North of Grindavik, in the Svartsengi system. The eruption sites are located at respectively 30 and 10 km from the field site. Although the ERT system is located at a considerable distance from the eruption sites and the investigation depth is quite shallow, we observed signals possibly related to both eruptions and accompanying unrest, manifesting as a significant increase in resistance (figure1).

The first peak in resistance happened between 19 and 26 June with an increase of more than 100%, shortly after that, the Fagradalsfjall system erupted. A second peak is observed at the end of August, here the increase happens slowly, as opposed to the sudden peak in June, with a steady increase starting on August 8th, reaching a peak on August 30th. Contradictory to the first example, no immediate eruption occurred after this second peak.

In this context, an increase in resistance is likely caused by a drop in saturation due to high gas levels, which can be caused by magma degassing during the uprise. This raises the question of the time difference between the peaks and the subsequent eruptions, possible factors are the difference in morphological context (sill vs dyke intrusion) and preferential flowpaths relative to our monitoring site. It should also be noted that this behavior is not observed in all data points,

hence advanced processing is needed combined with interpretation using data from other methods. Tremor and soil temperature data are available along the ERT profile, together with one CO₂ sensor in the center of the profile.

To our knowledge, this is the first time that ERT has been used for daily monitoring of a volcanic system. With joint interpretation to deduce the signal origin, we believe that ERT can be a valuable addition to volcanic monitoring networks.

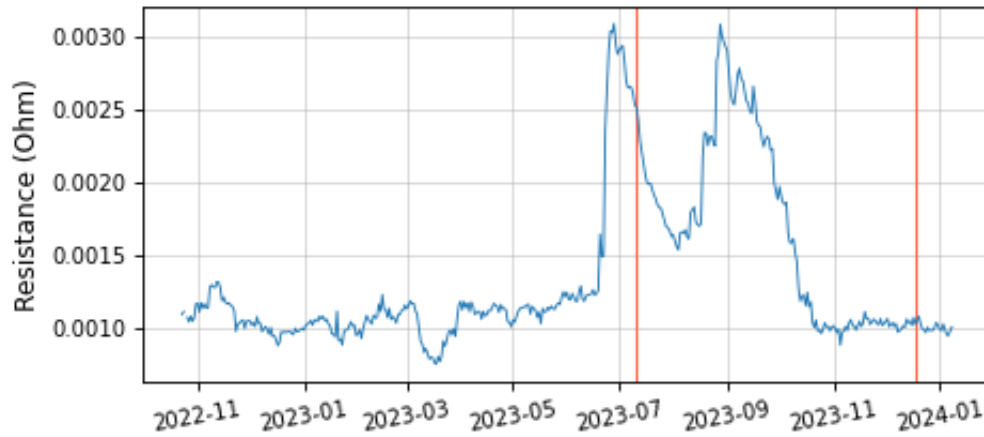


Figure 1: Resistance evolution in one measurement point, eruptions are indicated by the red lines.