Resistivity survey of Grímsvötn

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Overview

1. Introduction
2. Existing data
3. Resistivity
4. Method
5. Summary
The study area - Grímsvötn

- High temperature geothermal field
- The most active volcano in Iceland
- Located within Vatnajökull glacier
- Covered with 300 – 600 m thick ice
- Overlying ice acts as calorimeter
- Thermal output 2000 – 4000 MW
The study area - Grímsvötn
Main objectives of the project

- To map the spatial extend and depth span of resistivity anomalies within the Grímsvötn geothermal system
  - Calorimeter exists for Grímsvötn allowing comparison with other high-temperature geothermal systems

- To map the location and extent of magma bodies in the uppermost 3 – 5 km of the crust under the volcano

- To assess the thermal release from a pristine geothermal system for comparison with other geothermal systems under full exploitation
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Gravity and magnetic data
p-wave velocities
Alteration vs. resistivity

Resistivity Structure summarised

- **ALTERATION**
  - Saline water
  - Fresh water

- **RESISTIVITY**
  - 50-100°C
  - 230-250°C
  - 250-300°C

- **TEMPERATURE**
  - Boiling curve
  - Amb. temp

- **Method**
  - Pore fluid conduction
  - Mineral conduction
  - Surface and pore fluid conduction

- **Summary**
  - Rel. unaltered
  - Smectite-zeolite zone
  - Mixed layer clay zone
  - Chlorite zone
  - Chlorite-epidote zone
Example from Nesjavellir
Grímsvötn - Simple model
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Data collection

- Two 3 weeks long resistivity surveys using LOTEM-method
  - $2 \times 2$ km source loop
  - $10 - 15$ A square wave
  - TEM and MT equipment measures $H_x$, $H_y$ and $H_z$
- $\sim 300$ sounding sites
- $3 - 4$ source loop locations
3D inversion - Conceptual model

- Signal processing and inversion
  - 3D resistivity model

Joint interpretation of resulting 3D resistivity model with other existing geophysical data
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Motivation
- Grímsvötn is amongst the most powerful high temperature geothermal areas in the world
- Resistivity structure of geothermal systems are very distinctive
- Resistivity survey has not been carried out in Grímsvötn

Expected outcome
- Deep insight into the Grímsvötn geothermal system
- Better understanding of geothermal systems in general
  - Study the interplay of volcanism and geothermal systems
  - How do volcanoes transfer heat, and how much, to the surface
- Initiate the use of LOTEM in Iceland
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