

Annual Repeat Magnetotelluric Measurements for Monitoring The Geysers Geothermal Field, Northern California (2021-2023)

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SUMMARY

Understanding temporal changes in a geothermal system is important for monitoring system efficiency and optimizing production. The Geysers, in northern California, is the world's largest electricity generating steam field and has been operating since the 1960's. ReInjection of municipal wastewater over the last three decades has stabilized production, however understanding injected fluids flow paths and how they influence the field could help optimize production. Magnetotellurics (MT) is sensitive to fluids and is an ideal method for monitoring fluid injections. Between 2021 and 2023, three annual repeat MT surveys of between 50-55 sites each were collected and modeled in various ways to image temporal subsurface changes related to the geothermal steam field. An initial survey from 2017 was used as the baseline model to which other surveys were compared to. Residual phase tensor ellipses computed for the various combinations of comparisons indicate that changes in the steam field are compartmentalized and fault controlled, where the largest changes occur near the injection wells. Inverting each survey using various starting models, prior models, and other constraints generally shows the steam field became more resistive over time (~10%), suggesting an increase in steam. Models from 2022 and 2023 image areas that became more conductive over time and these spatially correlate with injection wells suggesting either a higher fluid content or increase in salinity. The resistivity models are in good agreement with passive seismic tomography models where areas of resistive changes correlate with a decrease in Vp/Vs and conductive changes correlate with an increase in Vp/Vs. This study demonstrates MT data can be collected in a noisy environment and provide valuable results for monitoring temporal subsurface resistivity changes.

Keywords: Magnetotellurics, monitoring, The Geysers

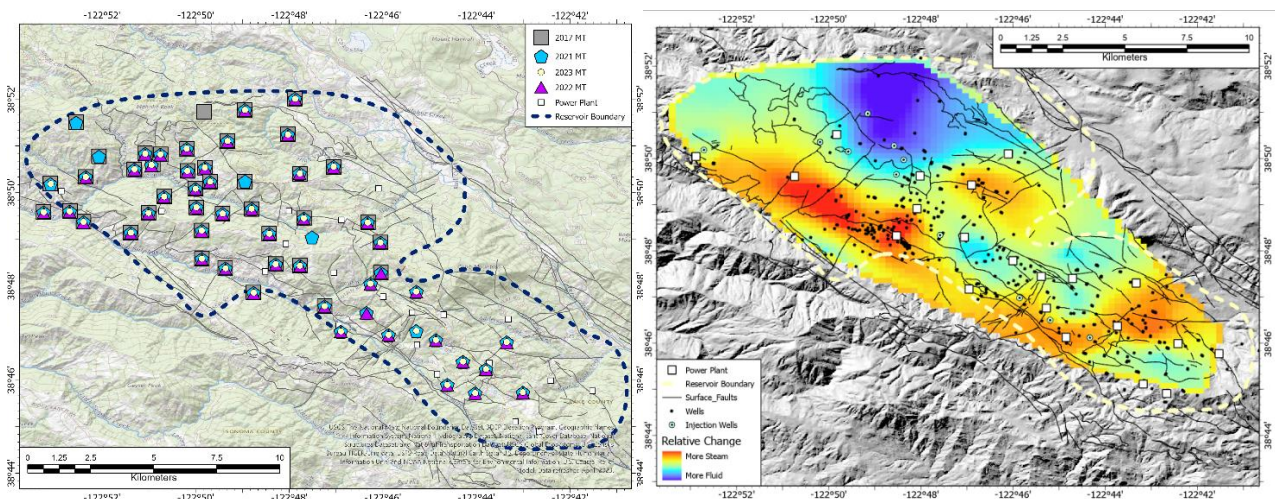


Figure 1. Left: repeated MT station locations by year. Right: Estimated subsurface resistivity changes between 2021 and 2023 with injection wells. Topographic base map is from the U.S. Geological Survey National Map.

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