Deconvolution well test analysis applied to the Waiwera geothermal reservoir (New Zealand)

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Exploration, utilization and monitoring of conventional and unconventional geothermal resources

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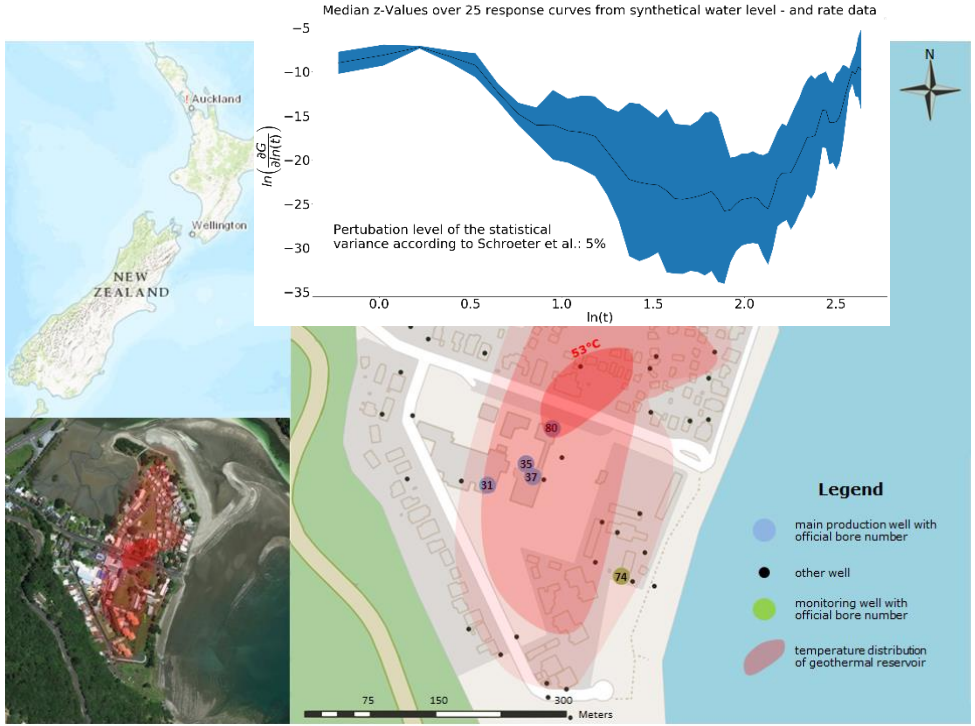
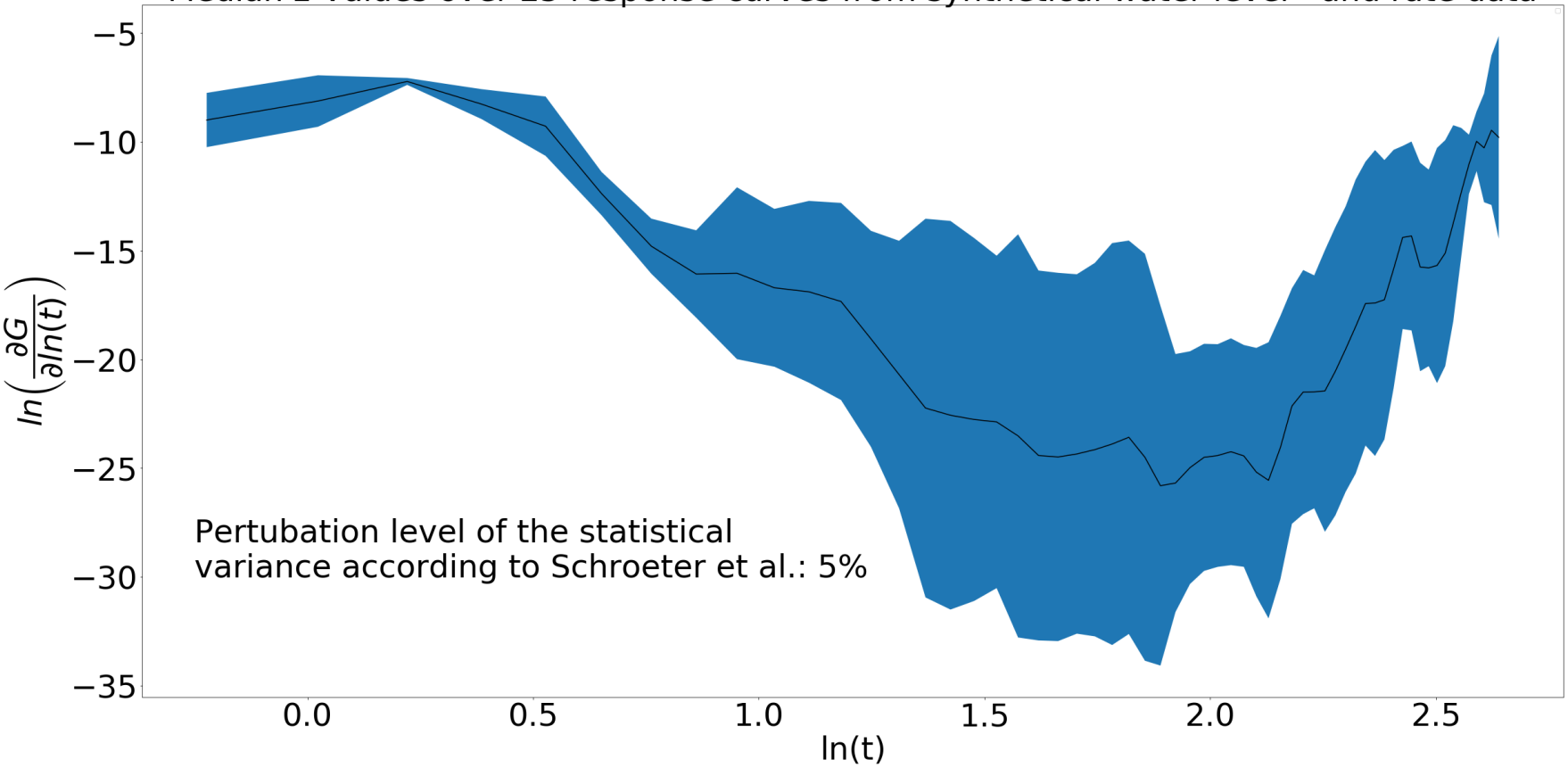
Motivation: Sustainable use of resource in accordance to water management plan. Determine physical relation between abstraction rates and water level change.

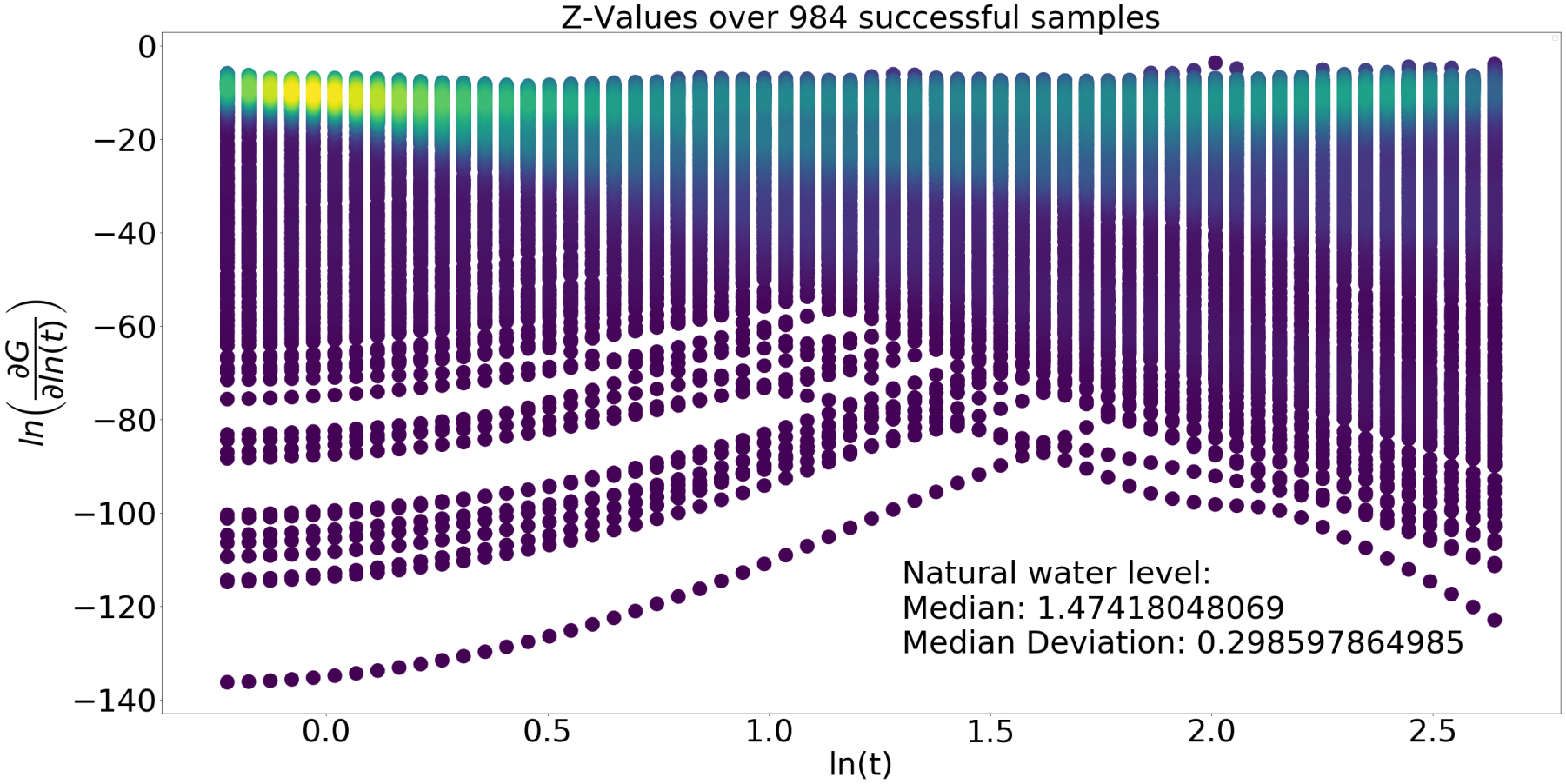
Methods: Modified deconvolution algorithm for a variable-rate well test analysis applied to production history and treated like a pumping test.

Results: System is characterised by radial flow and shows a leaky flow boundary. Findings agree with former pumping test. Double-porosity flow which was expected could not be determined.



Median z-Values over 25 response curves from synthetical water level - and rate data




Z-Values over 984 successful samples
0
−20
−40
−60
−80
−100
−120
−140
$ln\left(\frac{\partial G}{\partial ln(t)}\right)$
0.0
0.5
1.0
1.5
2.0
2.5
ln(t)
Natural water level:
Median: 1.47418048069
Median Deviation: 0.298597864985

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Thermal UAS survey of reactivated hot spring activity in Waiwera, New Zealand

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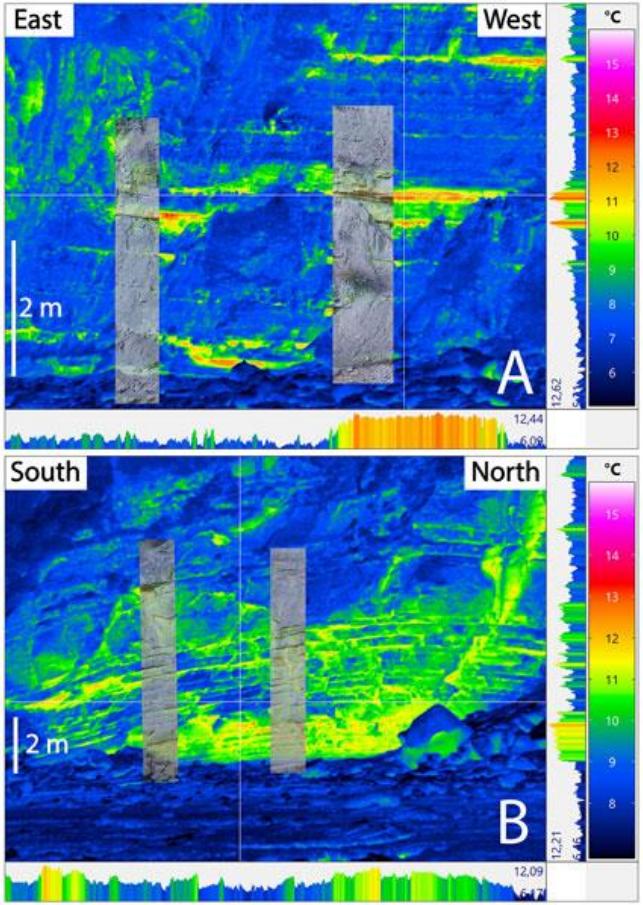
Abstract. The utilization of geothermal reservoirs as alternative energy source is becoming increasingly important worldwide. Through close-range aerial photogrammetry realized by unmanned aircraft systems (UAS), this study investigates the surface expression of a leaking warm water reservoir in Waiwera, New Zealand, that has been known for many centuries but remained little explored. Due to overproduction during the 1960s and 1970s the reservoir has suffered significant pressure reduction, which resulted in the loss of artesian conditions and led to the desiccation of the hot springs in close succession. However, shortly after the recent shutdown of the primary user (Waiwera Thermal Resort & Spa) renewed artesian activity was reported by locals but no hot spring activity has been observed so far. Therefore, this study was carried out in October 2019 to assess the actual conditions of thermal activity in the area of the former hot springs. UAS with coupled thermal infrared cameras were used for thermal mapping and the obtained data show renewed activity of the hot springs on the beachfront of Waiwera. Faults and fractures were identified as important fluid pathways, as well as individual fluid conducting lithologies.



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Investigation of the influence of earthquakes on the water level in the geothermal reservoir of Waiwera (New Zealand)

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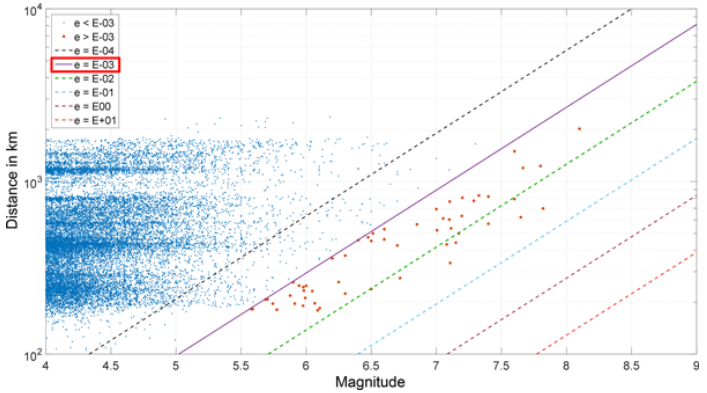
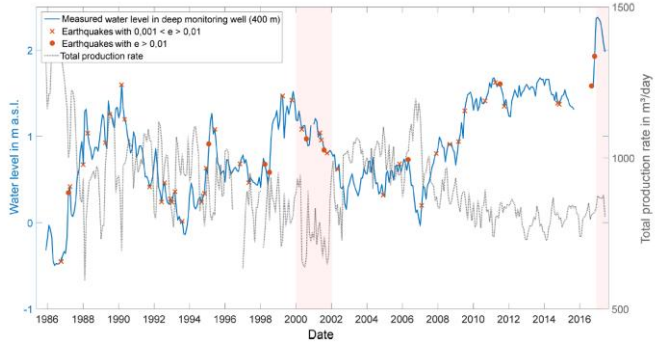


Abstract. The water level of the Waiwera geothermal reservoir is mainly governed by the production operations due to a commonly strong pumping signal. However, in the hours and days after the Kaikoura earthquake on 14 November 2016, it increased by more than 0.5 m, indicating that seismic events can have an influence as well. In a continuous time series consisting of monthly means of water level data and pumping rates starting in 1986, we tried to determine if events above a certain strength alter groundwater dynamics at Waiwera in general. We applied an empirical equation and calculated the on-site seismic energy density from earthquake magnitudes and distances. All recorded earthquakes with a magnitude above 4 within a radius of about 1500 km around New Zealand have been taken into account. A clear correlation cannot be proven but none of the recorded earthquakes led to such a high energy density in Waiwera as the Kaikoura event did. For the future, it is recommended to increase the resolution of the metred water production rates to daily averages to improve the detectability of water level changes following earthquakes.



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Multivariate regression model from water level and production rate time series for the geothermal reservoir Waiwera (New Zealand)

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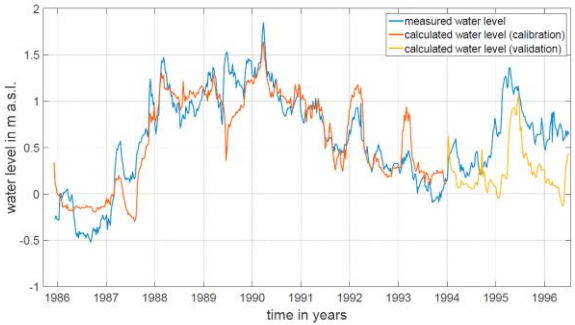
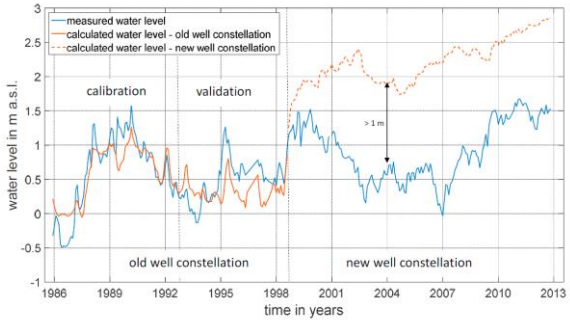
[b]*University of Potsdam, Earth and Environmental Science, Potsdam, Germany*
[c]*Free University Berlin, Department of Earth Sciences, Berlin, Germany*





Abstract. Water management tools are necessary to guarantee the preservation of natural resources while ensuring optimum utilization. Linear regression models are a simple and quick solution for creating prognostic capabilities. Multivariate models show higher precision than univariate models. In the case of Waiwera, implementation of individual production rates is more accurate than applying just the total production rate. A maximum of approximately 1,075 m3/day can be pumped to ensure a water level of at least 0.5 m a.s.l. in the monitoring well. The model should be renewed annually to implement new data and current water level trends to keep the quality.

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Assessment of data driven and process based water management tools for the geothermal reservoir Waiwera (New Zealand)

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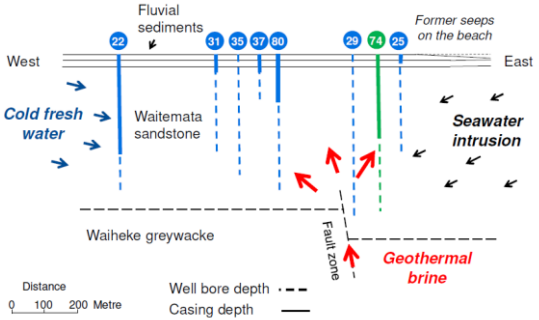
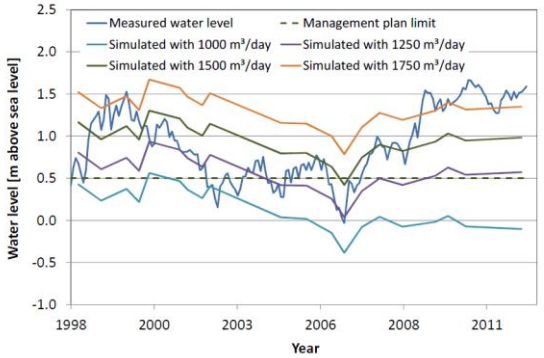
Abstract. The reservoir below the village is commercially used since 1863. Due to overproduction in the 1960s and 1970s the water level declined critically. Therefore, abstraction rates were limited, monitoring deployed and models set up to manage the site sustainably. It is shown here that data driven models based on experience and observations are of higher accuracy and provide better prognoses. Process based simulations are more flexible and the foundation for system understanding of the geothermal area. The earlier are "black box" and need regular revision and the latter are the only way for future and prospective scenarios.





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