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

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The geothermal reservoir in Waiwera has been subject to active exploitation for a long time. It is located below the village on the Northern Island of New Zealand and was used commercially since 1863. The continuous production of geothermal water, to supply hotels and spas, had a negative impact on the reservoir. Until the year 1969 from all wells drilled the warm water flow was artesian. Due to overproduction the water had to be pumped from the 1970s on. Further, within the years 1975 to 1976 the warm water seeps on the beach of Waiwera ran dry. In order to protect the reservoir and the historical and tourist site in the early 1980s a water management plan was deployed. The "Auckland Council" established guidelines to enable sustainable management of the resource [1]. However, shortly after the recent shutdown of the primary user (Waiwera Thermal Resort & Spa) renewed artesian activity was reported by locals and newly obtained observation data indicate revived activity of the hot springs on the beachfront of Waiwera [2].

So far, the physical relation between abstraction rates and water level change of the hydrogeological system is only fairly understood [3]. The aim of this work was to link the influence of rates to actual reservoir properties and measured water level data. For this purpose, the daily abstraction history was investigated by means of a variable-rate well test analysis. For the analysis, a modified deconvolution algorithm of Von Schroeter et al. was implemented [4]. The algorithm derives the reservoir response function by solving a least square problem with the unique feature of imposing only implicit constraints on the solution space. To investigate the theoretical performance of the algorithm with respect to stability and error propagation a sensitivity analysis was conducted. The results for Waiwera were obtained by subjecting the implementation to a bootstrapping method which selected time periods to analyse on a random base.

Results throughout all years show radial flow during middle-time behaviour and a leaky flow boundary during late-time behaviour. As opposed to the expected model, a double-porosity flow or a constant head boundary were not determined. For middle-time behaviour, the findings agree very well with prior results of a pumping test. The late-time behaviour cannot be observed during the short pumping test but is in accordance with the expected model.

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