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Shape optimization for layer detection in geothermal reservoirs: new insights and recent developments

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Fluid [U+FB02]ow and heat transport in geothermal reservoirs is strongly controlled by the spatial distribution of relevant petrophysical properties. We investigate here if we can solve the inverse problem to determine the location of boundaries between regions with distinctively different properties on the basis of temperature measurements in geothermal reservoir studies. More speci[U+FB01]cally, we aim to obtain the shape of a layer boundary, described with a level-set function, through a shape optimisation method. In order to reduce computational cost, we implement our method on the basis of the adjoint equation for temperature and avoid the full calculation of the sensitivity matrix in each optimisation step.

The method was tested to determine the interface position in a set of two-layer models with differently shaped interfaces, based on synthetic observation data of temperature. We extend previous work in this direction with the investigation of both head conduction and advection and investigate in synthetic case studies the ef[U+FB01]ciency of the method, and, more importantly, the possibility to determine shapes even in cases of strongly advective heat transport. To more realistically simulate the measurements, we also take into consideration the noise on data, and the case when only shallower borehole data is available. The results show that with our method it is indeed possible to obtain shapes of layers and we discuss the relevance of parameter ratios which enable this detection, including an analysis for the potential error of the obtained layer. The results presented also show how the quality of optimization might be affected by some factors such as number and location of boreholes, and the regularization parameter, but their detailed relationship is still one of our fugure work. Another next step will be the extension to multiple layers, and an application to case studies.