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Analysis of Time-Drawdown Data from Heterogeneous Leaky Aquifer Systems

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Leaky multilayer aquifer systems are often encountered in the field. Pumping tests performed in leaky aquifers are routinely interpreted using analytic or graphical techniques, such as the inflection point method (Hantush, 1956) or the Walton (1962) method, that are based on the assumption that the aquifer is homogenous. In reality, however, subsurface flow parameters are almost always spatially variable. In this paper, we examine the use of the time derivative of the drawdown to infer information about the spatial variability of the flow parameters in heterogeneous leaky aquifer systems. The proposed method uses the observed drawdown and its time-derivative at a single point to estimate the hydraulic parameters. By applying the procedure to different portions of the time-drawdown data, variations in the flow parameters with radial distance from the pumping well are detected. For demonstration the method is applied to several pumping test data from an alluvial leaky aquifer in California. Various data smoothing and differentiation techniques were evaluated for the estimation of the time-drawdown derivative. Optimal estimates of the drawdown derivative were obtained by first fitting the drawdown data to high order polynomials and splines and then differentiating the fitted functions with respect to time. Results of this study show that the described methodology can be used as a diagnostic tool to identify the type of aquifer system present. It can also provide information about the continuity of the aquifer layers. By jointly analyzing the estimated parameters from the individual pumping tests, information about the heterogeneity of the aquifer, in particular the characteristic length scale and variance of the transmissivity field may be inferred.

Key words: well hydraulics, analysis of pumping test, groundwater flow modelling, heterogeneity, transmissivity, leaky aquifers