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Identification of hydraulic transmissivity of a confined aquifer with the "Differential System Method": a tomographic approach

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The differential system method (DSM) allows the computation of the transmissivity field of a confined aquifer when two independent sets of data are available, namely two couples of piezometric head and source terms corresponding to different flow situations, and the value of transmissivity at one point only. The sets of data are independent if the hydraulic gradients are not parallel. Let A be the matrix whose entries are the x and y components of the hydraulic gradients of the two flow situations. The sets of data are independent if A is not singular; the balance equations can be reduced to the normal form grad$T$ = -$T\underline{a}$+$\underline{b}$, a first order equation that can be solved by integration along an arbitrary path starting from the point where the value of T is known. The DSM has now been extended to handle multiple sets of data. The domain can be divided in subregions in each of which a different couple of data sets can be used to apply the DSM in the standard way. The choice of the two "best" data sets to be used is based on criteria that take into account: (1) the independence condition; (2) the value of $|\underline{a}|$, that must be small to limit the error propagation; (3) the condition number of the matrix A. Numerical tests with synthetic fields show that this approach reduces the dependence of the final solution on the starting point, an important result for applications.