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Constraints on hydraulic anisotropy from periodic pumping tests using a double-packer system

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Periodic pumping tests are gaining in popularity for the characterization of hydraulic parameters of the subsurface owing to several advantages over conventional tests, e.g., option of superposing periodic excitations on transients because of the data processing in the frequency domain; well defined testing time. From the perspective of developing theoretical models or performing numerical modeling, it also has the advantage that the inverse Laplace transform is avoided saving computing time and increasing accuracy. We derived an analytical model for a double-packer system isolating an injection interval in a confined or an unconfined anisotropic aquifer. Injectivity analysis (injection flow rate vs injection pressure) and vertical interference analysis (injection pressure vs pressure below or above packers) are treated. The model is validated and compared to previous models by considering appropriate limits regarding interval length, storage capacity of the interval, and specific yield of the aquifer. The vertical interference analysis provides horizontal diffusivity and conductivity anisotropy (vertical conductivity divided by horizontal conductivity). Horizontal and vertical conductivities, and specific storage are then determined from the injectivity analysis. The model is applied to two sets of field data where conventional pumping and periodic tests were performed. The results of the approaches are compared assuming radial flow. The exploratory modeling of a double-packer system shows its potential for analyzing hydraulic anisotropy and constraining hydraulic properties.