The variation of flow rates and solute concentrations with depth in open flowing wells

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ABSTRACT
Intensive groundwater sampling with depth-dependent hydrochemistry in deep basins could aid in interpreting the pattern of groundwater circulation. Unfortunately, sampling from existing deep production wells with a long screen would probably lead to mixed groundwater from different depths over the screen, which causes ambiguity of the depth-dependent hydrochemistry. Based on the MODFLOW 2005 and MNW2 Package, we simulated the groundwater flow to open flowing wells in the unconfined aquifer of 3-D unit basins under different ratios of basin length to depth, water table undulations, distances of wells away from the valley and well depths. Numerical results show that a flowing well has the characteristics of groundwater inflow in the lower part outweighing outflow in the upper part. According to the vertical profiles of flow rate in flowing wells, it was found most water at the outlet is from the deep part of the well. Moreover, for fully penetrating flowing wells, the vertical profiles of the ratio of unit flow rate to the maximum unit flow rate in the inflow segment almost coincide, which are independent of the ratios of basin length to depth, water table undulations and distances of wells away from the valley. Taking the directly modeled groundwater age and ^{14}C concentration as examples representing the components subject to zeroth-order accumulation and first-order decay, respectively, it was found the water sampled at the outlets of flowing wells can represent the groundwater quality near the base of the well, which is little affected by the ratios of basin length-depth and water table undulations. Therefore, sampling groundwater at the outlets of open flowing wells could be employed to understand the groundwater circulation in deep basins.

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