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Evaluation of simulated cross-formational travel times using water age measurements in layered aquifer systems

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The recent hydrologic droughts in the southwestern USA have brought forward the necessity for sustainable management of groundwater that was recharged several thousands of years ago, also known as fossil water, as this resource is not directly rechargeable even through heavy rain events. Groundwater age studies can enable water authorities to map the origins of groundwater, quantify water ages in aquifers and plan sustainable water resource policies on local and regional scales.

In this study, numerical groundwater availability models (GAMs) are combined with water age measurements to perform a water age analysis of the Wilcox, Carrizo, Queen City, Sparta, Jackson and Yegua aquifers that span central Texas dipping toward the coast of the Gulf of Mexico. The 3D GAMs have initially been calibrated using well data. The water age analysis is carried out using 2D simulations to characterize down dip flow, cross-formational flow in the aquifers and the impact on associated water ages in representative transects extracted from the 3D models, including a discussion on bridging the gap between the 3D hydrogeological system and its simplified 2D representations. A systematic quantification of water age sensitivity to formation hydraulic conductivities and recharge at the aquifer outcrops is performed, whereby travel times in the simulated aquifers are compared to water age measurements obtained from C-14 and Tritium age dating techniques. The analysis therefore delivers the spectrum of water age isolines under consideration of model parameter uncertainty, evaluating the predictive ability of cross-formational water age studies when using 2D transect models.