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Diffusive contaminant transport in a multi-layered aquifer-aquitard system

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A flow chamber experiment was conducted to investigate solute diffusion in a multi-layered aquifer-aquitard system. The two-dimensional flow chamber consisted of a finite thickness aquitard (kaolinite, 2 cm) bounded by two parallel aquifers at the top (unconfined aquifer, 2 cm) and bottom (confined aquifer, 4 cm). New Coccine (red dye) of 500 mg/L in the top aquifer and distilled water in the bottom aquifer were injected with 0.02 mL/min for 13 days. One-dimensional analytical solutions were developed for advection and diffusion through a finite aquitard and compared with the measured data to evaluate experimental validation. The simulated aquitard concentration profiles ($E > 0.97$) and breakthrough curve ($E = 0.95$) showed good agreement with the measured data. During the experiment, the penetration distance in the aquitard increased over time and the vertical concentration distribution showed a linear profile through the aquitard after 7 days of loading in the top aquifer, indicating steady-state diffusion. The New Coccine diffused across the aquitard to the bottom aquifer after 1 day of loading. The bottom aquifer concentration increased at early times and was maintained after 7 days of loading (11 ~ 12 mg/L). This study provides experimental validation of the developed analytical solutions and quantitatively evaluates contaminant occurrences of the confined aquifer through the aquitard.