Experimental laboratory observation of freshwater lens under gaining river conditions

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Buoyant freshwater lenses may result from fluvial processes in saline aquifers common to arid and semi-arid regions. Freshwater lens is the precious freshwater resource in the riverine ecosystem, and revealing its occurrence mechanism is very important for the management of freshwater lens. Riverine lenses formed here under losing river conditions are conceivably unambiguous, and moreover recent mathematical analysis also indicates that a lens may persist under gaining conditions.In this study, we performed physical sand tank modelling of a riverine freshwater lens with gaining conditions. The experimental procedure is analogous to a steady-state unconfined head-controlled physical seawater intrusion model except that the saltwater is mobile ensuring that both density and hydraulic forces act towards the river at all times. A continuously flushing in-tank freshwater reservoir was implemented to ensure density contrast between fresh river water and saline groundwater remained consistent throughout each experiment.The experiment was replicated three times using different head gradients in each case. Results are presented as photographs of the sand tank lens at steady-state. Predictions made by the analytical solution for lens interface, surface extent and maximum thickness are compared with those observed in the photographs. Each experiment successfully reproduced the lens predicted by the analytical solution, notwithstanding the limitations of steady-state sharp-interface solutions. The results of this experiment constitute the first physical evidence of this lens type.

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