Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.13667

Understanding of sediment-water interaction processes in coastal aquifers through laboratory based column experiments

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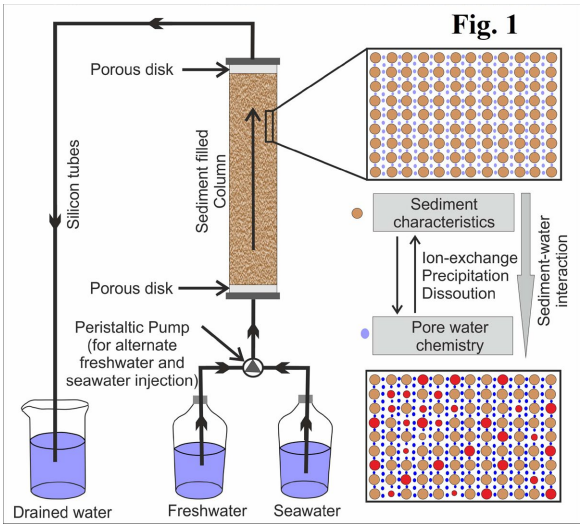

Laboratory based column experiments were conducted to understand the sediment-water interaction processes in coastal aquifers. The natural coastal aquifer condition was simulated in the laboratory by exposing the alluvial sediments to freshwater and seawater alternatively for a period of one year, and the changes in pore water chemistry due to its interaction with the sediments were observed at regular intervals (Fig. 1). It was observed that the periodic exposure of sediments to freshwater and seawater triggered the sediment-water interaction processes leading to changes in pore water chemistry as well as aquifer properties. The processes such as ion-exchange, mineral precipitation/dissolution, and elemental adsorption/desorption were found to play crucial roles in controlling the pore water chemistry. The major ions (Na, K, Ca, and Mg) along with some trace elements (B and Li) were found to be associated with ion-exchange processes, while mineral precipitation/dissolution processes controlled HCO_3, SO_4, Ba, and Mn concentrations in the pore water.

The changes in pore water chemistry also brought changes in aquifer properties such as grain size distribution and element concentrations of aquifer sediments. Aquifer sediments with relatively higher silt and clay contents offered higher changes in grain size distribution pattern due to dissolution/precipitation of minerals as a result of sediment-water interaction within the columns. Enrichment of elements in column sediments and their subsequent depletion in pore water indicated adsorption/precipitation of elements on the sediments. However, the processes such as ion-exchange and adsorption-desorption were found to be reversible with changes in the freshening and salinization phases. Further, the impact of salinization on coastal aquifers were observed to be lasting for longer periods, and the effectiveness of the freshening phases to bring back the aquifer to normal condition diminished over time. The study demonstrated that the trace elements, including B, Ba, Br, Li, and Sr, can be used as more sensitive tracers of saltwater intrusion in coastal aquifers than the traditional major ions. It was further expected that the changes in grain size distribution caused by prolong salinization affect the hydraulic properties of the aquifer, including porosity and permeability.