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Trace element responses to salinity variations in coastal aquifers: Insights from field study and laboratory experiments

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A study involving fieldwork and laboratory experiment was conducted to understand the responses of trace elements to salinity fluctuations in the coastal aquifer. The fieldwork was carried out to collect water and sediment samples from the coastal tracts of Odisha, India. The collected sediments were packed into columns, which were subjected to freshwater and seawater alternatively in a controlled manner using peristaltic pumps. In this way, the column sediments were periodically exposed to freshwater and seawater conditions, mimicking the natural coastal aquifers influenced by periodic freshening and salinization caused by water table fluctuations. The laboratory experiment was carried out over nearly a year, and pore water samples were collected at regular intervals. The pore waters from the laboratory experiment along with water samples collected from the field were analyzed for major ion and trace element concentrations.

Significant changes in pore water chemistry were observed because of sediment-water interaction processes caused by alternate exposure of sediment packed columns to freshwater and seawater. The principal processes affecting pore water chemistry were identified as cation exchange, mineral precipitation/dissolution, and elemental adsorption/desorption [1]. The association of these processes with the salinization of coastal aquifers was also observed from the hydrochemistry of the field samples [2]. In addition to the major ions, trace elements such as boron (B) and lithium (Li) were influenced by ion exchange processes, while barium (Ba) and manganese (Mn) concentrations were affected by mineral precipitation/dissolution. Strontium (Sr) concentrations, on the other hand, remained conservative to the alternating freshwater-seawater variations. However, the rates of such processes were found to vary over time with the progress of the experiment. Processes like ion exchange and adsorption/desorption were observed to be reversible, responding to the freshening and salinization phases. In contrast, precipitation/dissolution processes were irreversible as observed from the hydrochemistry of the pore water. These irreversible processes are suspected to induce inevitable changes in aquifer properties, such as porosity and permeability.

[1] Prusty & Farooq (2021) *J Hydrol.*, 603 (Part C, December): 127060. [2] Prusty et al. (2020) *Int. J. Eng. Sci. Tech.*, 17 (6), 3313–28.