Changes in aquifer sediments and water quality due to periodic exposure of aquifer to freshwater and seawater

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The depth of freshwater-seawater interface indicates a balance between the freshwater and seawater in the coastal aquifers. The processes such as excessive pumping activities, tidal surges, sea-level rise, changes in climatic conditions, etc. disturb the interface and lead to seawater intrusion which deteriorates the freshwater quality in the coastal regions. A study has been conducted to observe the effects of fluctuation in freshwater-seawater interface on metal partitioning in water and sediment. For this purpose, aquifer sediments consisting of a mixture of sand, silt, and clay were filled in columns, and with the help of peristaltic pumps, freshwater and seawater were pumped into these columns alternatively. This mimicked the natural freshening and seawater intrusion phases of the sediments by exposing them to freshwater and seawater, respectively. The experiment was conducted continuously for one year, and leachate samples were collected at regular intervals. The collected leachate samples and acid-digested column sediments were analyzed for major and trace element concentrations.

Hydrochemical studies indicate that the water facies are evolved from Ca-HCO_3 type to Na-Cl type through Ca-Na-HCO_3 type in the Piper diagram with the change in freshwater and seawater phases. It is observed that the major ion concentrations have increased in the water samples during the freshening phase due to the residual seawater. Among the trace elements, B, Ba, Li, Mn, Sr, and Zn show changes in their concentrations in the water samples with the change in water phases. Over time, the concentrations of B, Br, and Sr in the water samples are found to increase in the freshening phase. Higher concentrations of Li are obtained in the water samples collected from the column having higher proportions of sand. An increase in the concentrations of Ca, Li, Mg, and Na has also been observed in the column sediments. This indicates that the sediments have partially captured these metals during the intrusion phase. Simultaneously, the release of the metals such as Al, K, Fe, and Mn from the column sediments has resulted in a decrease in their concentrations in the sediments. This indicates that these metal concentrations can effectively be utilized for monitoring the water and sediment quality in the coastal aquifer.