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THE GEOCHEMISTRY OF A SEAWATER INTRUSION EXPERIMENT IN A SHALLOW SANDY AQUIFER, SKANSEHAGE DENMARK.

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ABSTRACT.

A seawater intrusion experiment was carried out in a phreatic coastal aquifer. The aquifer is 9 m thick and consists of Holocene sand and gravel deposits of marine origin, containing thin lenses of peat. The intrusion was provoked by pumps installed 140 m from the coastline and operated for about 10 months, abstracting a total of about 200,000 m^3. The water composition was monitored in about 100 piezometers, as the sea-/freshwater mixing zone migrated from a position near the coastline to about 85 m from the coastline.

In the freshwater part of the aquifer the groundwater composition is dominated by calcium, bicarbonate and elevated methane concentrations. The geochemical signature of the preexisting fresh/seawater mixing zone is anoxic brackish water depleted in sulfate and enriched in sulfide and bicarbonate. The presence of methane and sulfide clearly indicates a decomposition of organic matter.

Much of the distribution of dissolved ions during the intrusion experiment was due to an advective landward migration of the preexisting sea-/freshwater mixing zone followed by the intrusion of "new" seawater. However geochemical processes associated with the intrusion were observed as well. Ion exchange took place at the salinity front between the freshwater and the preexisting mixing zone, releasing Ca^{2+} from the exchanger. Released Ca^{2+}, combined with the high bicarbonate concentration in the preexisting mixing zone, causes super-saturation and possibly precipitation of calcite. Behind the ion exchange front, further towards the sea, freshly intruding sulfate is being reduced by organic matter. The acid production associated with the sulfate reduction causes a decrease in pH and thereby sub-saturation and possibly re-dissolution of calcite. These results show that the spatial separation of ion exchange- and redox-processes may trigger a sequence of calcite precipitation and dissolution in an aquifer affected by seawater intrusion. These reactions could lead to changes in aquifer properties though modeling indicates that the amount of mineral reacting is small in this case.

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