Introducing initial findings on geochemical interactions of partly desalinized water infiltration into a salinated dune sediment

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Water scarcity is one of the world's most important problems. The global rise of water consumption and contamination of fresh water resources endanger our water resources. Notably, groundwater salinization due to salt water intrusion at coastal regions or nitrate and sulphate input by fertilizers demand adapted desalinization techniques to secure the fresh water supplies. Common used desalinization processes require a post-treatment of the product water to increase its total dissolved solid (TDS) concentration for the further application. However, the still low TDS concentration can induce severe problems caused by geochemical reactions. Studies on them are scarce and depend strongly on the aquifer material. Main results are carbonate dissolution affecting the aquifer stability and reducing the permeability, clay mobilization/swelling causing clogging and permeability reduction up to health risks by leaching of nitrate, bromate or several metallic elements.

Therefore, the cooperative project "InnovatION" focus on the development of an ion selective membrane, the monovalent Membrane Capacity Deionisation (mMCD), to reduce or even avoid those environmental impacts. By reducing 80 – 85 % of the monovalent ions but just 5 % of the divalent ions of a saline water (SW), the partly desalinated water (PDW) can stabilize the sediment-water interactions.

Initial findings to estimate the geochemical interactions of the different water types SW (TDS = 5.2 g/l), PDW (TDS = 0.8 g/l) and totally desalinated water (TDW) (TDS = 0.006 g/l) were obtained by column experiments with initially equilibrated saline dune sediment from Langeoog. The infiltration of TDW results in leaching of all major ions, especially Cl^- and Na^+, the TDS of the effluent is sextupled comparing to the infiltrate. A clear increase of pH with TDW infiltrations indicates replacing of SW by TDW in the column and also favors redox reactions. With infiltration of PDW adsorption can be interfered by decreasing concentrations of the main cations Ca^{2+} and Mg^{2+} in the effluent below their input concentrations. Those cation exchange processes are most visible with PDW infiltration. Carbonate dissolution is indicated by Ca^{2+} concentrations in the effluent rising higher than the intially infiltrated concentrations.

Summarized, the differences between TDW and PDW infiltration emerge from different geochemical processes. TDW infiltration causes redox- and dissolution processes causing problems in groundwater chemistry or nutrient cycles. Whereas ion exchange processes are more dominant with PDW infiltration. Carbonate dissolution occured with all water types but the PDW inhibits high amounts. In total, the use of PDW instead of TDW is advisable to reduce environmental impacts but there is a need for further studies.