Accepted Manuscript

Hydrochemical evolution of a freshwater lens below a barrier island (Spiekeroog, Germany): The role of carbonate mineral reactions, cation exchange and redox processes

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PII: S0883-2927(18)30052-0

DOI: 10.1016/j.apgeochem.2018.03.001

Reference: AG 4049

To appear in: Applied Geochemistry

Received Date: 18 October 2017

Revised Date: 26 February 2018

Accepted Date: 2 March 2018

Please cite this article as: Seibert, S.L., Holt, T., Reckhardt, A., Ahrens, J., Pollmann, T., Giani, L., Waska, H., Böttcher, M.E., Greskowiak, J., Massmann, G., Hydrochemical evolution of a freshwater lens below a barrier island (Spiekeroog, Germany): The role of carbonate mineral reactions, cation exchange and redox processes, *Applied Geochemistry* (2018), doi: 10.1016/j.apgeochem.2018.03.001.

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ACCEPTED MANUSCRIPT

- 1 Hydrochemical evolution of a freshwater lens below a barrier island
- 2 (Spiekeroog, Germany): The role of carbonate mineral reactions, cation
- 3 exchange and redox processes
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- 16 **Keywords**: coastal aquifer, apparent groundwater age, decalcification, aquifer freshening,
- 17 carbon isotopes, southern North Sea
- 18 **Abstract**: Freshwater lenses below barrier islands are a precious resource for the local water
- 19 supply and important for coastal ecosystems. The aim of this study was to investigate the
- 20 hydrochemical evolution of a freshwater lens, using the barrier island Spiekeroog, Germany,
- 21 as an example. For this purpose, groundwater samples were obtained during several
- campaigns, and hydrochemical data and ¹³C/¹²C isotope ratios of dissolved inorganic carbon
- were linked to apparent groundwater ages. Results show that apparent groundwater ages
- 24 increase with depth and range between 4 to 51 years. All groundwater samples were close to
- equilibrium with respect to calcite and considerably enriched in calcium and bicarbonate,
- 26 suggesting calcite dissolution in the unsaturated zone of the dune sediments. The estimated
- 27 average rate of decalcification was ~ 13 mm/a, resulting in a decalcification depth of ~ 4.6 m
- for the oldest sediments of an approximate age of 350 years. Moreover, ¹³C/¹²C isotope

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