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Wisam M. Khadra, Pieter J. Stuyfzand, Boris M. van Breukelen

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4 Wisam M. Khadra<sup>a,b\*</sup>, Pieter J. Stuyfzand<sup>a,c</sup>, Boris M. van Breukelen<sup>d</sup>

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6 <sup>a</sup>Delft University of Technology, Dept. of Geoscience and Engineering, section Geo-environmental Engineering,  
7 P.O. Box 5048, 2600 GA Delft, Netherlands.8 <sup>b</sup>American University of Beirut, Dept. of Geology, P.O. Box 11-0236, 1107 2020 Riad El-Solh Beirut, Lebanon.9 <sup>c</sup>KWR Watercycle Research Institute, P.O. Box 1072, 3430 BB Nieuwegein, Netherlands.10 <sup>d</sup>Delft University of Technology, Dept. of Water Management, section Sanitary Engineering, P.O. Box 5048,  
11 2600 GA Delft, Netherlands.12 \* Corresponding author: e-mail: [w.m.khadra@tudelft.nl](mailto:w.m.khadra@tudelft.nl); Tel: +961-3-388078; Fax: +961-7-738702.

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## 14 Abstract

15 This study demonstrates groundwater quality differences between a limestone and a dolomitic  
16 limestone, (sub)oxic coastal aquifer in the Eastern Mediterranean (Lebanon), with and without  
17 ongoing moderate salinization since the last decades. For this purpose, 8 major and 50 trace elements  
18 (TEs) were analyzed in 80 water and 65 rock samples, and interpreted with a quad-fold approach  
19 utilizing: (1) nonparametric statistical tests, (2) concentration deviations from ideal conservative  
20 freshwater–seawater mixing lines, (3) a new parameter called Mixing Enrichment Factor to assess the  
21 mobility of chemical constituents under salinizing conditions, and (4) 1-D dual porosity flow path  
22 modeling with PHREEQC. Dissolution/precipitation of  $\text{Ca}_x\text{Mg}_y\text{Sr}_z\text{CO}_3$  and cation exchange were the  
23 main disclosed hydrogeochemical processes besides minor signs of organic matter oxidation. In the  
24 dolomitic limestone aquifer, less carbonate dissolved as compared to the limestone aquifer, partly  
25 because of lower  $p\text{CO}_2$  in addition to seawater inflow triggering Mg-calcite precipitation by cation  
26 exchange. Saltwater intrusion led to mobilization of As, Ba, Cu, Ni, Rb, Sr and U in both aquifers,  
27 sometimes likely by cation exchange (e.g. Ba and Sr). Some of these TEs (notably Cu and Ni)  
28 recorded higher concentrations in the dolomitic limestone regardless of salinization. Other elements  
29 like Al, Be, Ce, Cr, Nb, Pb, V, Y and Zr revealed no or a low mobilization tendency. The  
30 concentration of all TEs in groundwater remained below drinking water limits notwithstanding  
31 moderate salinization. This classifies carbonate rocks as a weak geogenic source of TEs, whereas  
32 encroaching seawater appears to be a more important source.

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34 **Keywords** (dolomitic) limestone aquifer; hydro(geo)chemistry; trace elements; reactive transport  
35 model; Lebanon.

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## 37 1 Introduction

38 Coastal aquifers are known for their complex hydrochemical nature due to (1) different inputs from  
39 precipitation, infiltrating rivers, intruding seawater, irrigation return flow, and wastewater infiltration

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