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Could coastal groundwater discharge close the ocean's carbon budget?

NURIT WEBER AND YAEL KIRO

Weizmann Institute of Science

Presenting Author: nurit.weber@weizmann.ac.il

Ocean chemistry is dictated by weathering and transporting elements from the land to the ocean and their removal through precipitation and adsorption. While the role of rivers was established decades ago, other sources, like submarine groundwater discharge (SGD), have been recognized more recently. SGD may release large amounts of trace metals, nutrients, carbon, and other dissolved species to the coastal ocean. The element fluxes may be comparable to surface water flow due to groundwater interaction with the aquifer sediments and the high ratio between rock and water. Recent attempts to calculate the dissolved inorganic carbon (DIC) and alkalinity ocean budgets have shown that marine carbonate burial cannot be balanced by riverine input and SGD. Fresh and recycled seawater flows are highly uncertain since SGD flux is highly variable worldwide. In this study, we attempt to obtain a better understanding of the field's variability as well as its actual fluxes.

The mechanisms driving groundwater flow in the subsurface influence the DIC and alkalinity fluxes, affecting the flow paths, residence times, and redox states. Our study shows a significant alkalinity contribution by fresh groundwater discharge and during long-term seawater circulation in the East Mediterranean coastal aquifer. As carbonate levels drop and sand levels increase from north to south in the Israeli Mediterranean coastline (150 km), we observed a decline in alkalinity and DIC. Coastal aquifers worldwide were surveyed to compile a comprehensive global data archive on alkalinity fluxes through SGD. This data is used to characterize the interactions between groundwater and country rocks depending on the rock's type (Fig. 1). Most of the groundwater samples lie below the 1:1 Alkalinity-DIC ratio line indicating that the primary cause of the excess CO_2 in most waters seems to be the respiration or decomposition of organic matter in the subsurface. In addition, carbonate dissolution and deposition create a "buffer" that prevents the alkalinity/DIC ratio from exceeding 1. According to preliminary estimates, the SGD contributes significant quantities of DIC and alkalinity of a similar magnitude to the rivers.

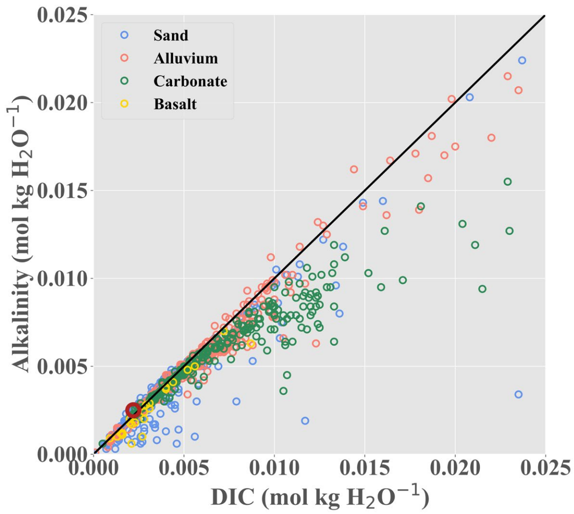

Figure 1: DIC versus alkalinity in an extensive data archive of water samples from different aquifers wordwild.