Influence of wave-induced groundwater flows on behaviour of arsenic in a nearshore aquifer

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Coastal forcing including waves and tides affect the distribution and transport of pollutants in a nearshore aquifer and their ultimate flux to receiving coastal waters. The objective of this study was to evaluate the changes in geochemical conditions and behavior of arsenic in a nearshore aquifer in response to vary wave conditions. While numerous studies have demonstrated the impact of tides on nearshore groundwater flows and pollutant fate, the impact of waves, in particular, varying wave conditions, is not well understood. This study was conducted at a freshwater beach on the Great Lakes which provides an ideal field setting to investigate the effect of vary wave conditions as perturbations to the groundwater flows and geochemistry can be directly attributed to waves alone without the complicating effects of tides and density.

Detailed pore water and sediment chemistry data are presented that illustrate distinct changes in dissolved iron and arsenic concentrations in response to redox and pH shifts during a period of varying wave conditions. Wave-induced groundwater flows numerically simulated in MODFLOW-2000 are used to provide insight into the wave-induced water exchange and groundwater flow patterns that underlie the observed geochemical changes. Mixing ratios were used to determine whether changes in the distribution of arsenic were due to conservative transport or geochemical processes associated with the mixing of different end members (e.g. change in redox state, precipitation, dissolution). Sediment analyses were combined with the pore water distributions to assess the release of sediment-bound arsenic in response to the varying wave conditions. The rapid geochemical changes and variations in arsenic concentrations observed illustrate the importance of transient forcing in controlling the fate, mobility and ultimate flux of pollutants including arsenic from nearshore aquifers to coastal waters.