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Biodegradation of organic contaminants in a tidally-influenced coastal aquifer

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Groundwater contamination in coastal zones is a growing problem due to increased urban and industrial developments around the world's coastlines. As contaminants released to coastal waters via submarine groundwater discharge can lead to significant degradation of the receiving marine ecosystem, there is a need for effective assessment of contaminants released in such environments. The combined influences of oceanic oscillations (tide and waves), terrestrial groundwater and variable-density effects result in complex and dynamic flow, transport and biogeochemistry in near-shore aquifers. Understanding these processes is essential for accurate prediction of contaminant loading to coastal waters.

The groundwater flow and salt transport processes in a tidally-influenced coastal aquifer have previously been examined in detail. Here we investigate the extent to which these processes control the fate of biodegradable contaminants and thus contaminant fluxes to coastal waters. The coupled density-dependent flow and multi-species reactive transport model PHWAT is used to simulate the transport and biodegradation of organic contaminants released in a coastal aquifer. A simple aerobic biodegradation model is adopted with reactions between organic species, oxygen and biomass. Simulations with and without tidal forcing are presented to examine the tidal effects on the reactive transport process. In particular we determine whether tide-enhanced mixing between fresh groundwater (reduced) and seawater (oxygenated) in

the near-shore aquifer leads to enhanced biodegradation and thus reduction in the flux of contaminants at the aquifer-ocean interface. Further simulations are performed to investigate the affect of the organic contaminants being released into the aquifer as part of a complex pollutant plume with a greater density than the ambient groundwater. Finally, some options for enhanced degradation of the organic contaminants are investigated.