Influence of Sediment Composition on Redox Speciation Within a Hawai'ian Coastal Fishpond

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ABSTRACT

In aquatic systems, benthic microbial respiration can have a profound effect on nutrient cycling and overall ecosystem health. Respiration results in the release of bioavailable nutrients as well as series of redox species which can be used as a proxy to identify reduced benthic conditions. He'eia Fishpond, located in Kane'ohe, Hawai'i, is a low energy, shallow coastal system influenced by an influx of both riverine freshwater and marine seawater, as well as by mangrove forests located along its terrestrial periphery. Voltammetric solid-state microelectrodes were used to simultaneously identify and measure changes in redox speciation over time in dark incubations of fine grained to coarse grained sediment core samples taken from the pond. The primary objective of this study was to evaluate the synergy between sediment heterogeneity (i.e., varying grain size, permeability, mineralogy and organic matter content) and sediment redox chemistry.

In addition, because coring and relocating sediment samples can lead to confounding effects within sediment cores, voltammetric microelectrodes were also used in a separate experiment to investigate the correlation between sediment core sample conditions and *in situ* conditions. Redox chemistry profile measurements taken *in situ* were compared to redox chemistry profile measurements taken from a sediment core sample collected from the same location. The *in situ* versus core experiment revealed that voltammetric sediment core profiles replicate *in situ* profiles to within ± 2.5 mm.

Sediment cores for the dark incubations were taken from four sites within the pond along a gradient of fine grained to coarse grained sediment with a range of organic matter input. Major sources of organic matter input to the pond include mangrove, macroalgae

and phytoplankton. As expected, incubation results showed that sediments most rich in fresh organic matter, those sites in close proximity to the mangroves, are most likely to induce rapid benthic respiration, resulting in increased production of reduced organics. In contrast, sediments containing less organic matter, the sandy sites with more of a marine end member influence, are likely to induce slower benthic respiration and less production of reduced organics.

Also, there was indication that sediment at the pond under the greatest riverine influence are iron rich. This is significant because reductive dissolution of iron oxyhydroxides results in the release of both reduced iron and bioavailable phosphorus. Under anoxic sediment conditions, free reduced iron is likely to sequester sulfide via pyrite precipitation and phosphorus that enters sediment pore water is liable to flux upward into overlying waters. Phosphorus diffusion into phosphorus limited overlying water can lead to increased primary productivity and eventually hypoxic water column conditions. Consequently, results of this study, in conjunction with nutrient budget studies and further investigation into end member input, can prove useful when developing future sustainability management practices at He'eia Fishpond.