

Anaerobic metabolism in freshwater sediments as a methane source: A modelling study

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In freshwater sediments, carbon flow is controlled by microbially mediated processes such as hydrolysis, fermentation, and terminal metabolism. These processes act to break down organic matter, whose fate is dependent upon the terminal electron acceptors available in the environment. One such fate is methane (CH₄) production, and freshwater wetlands have been estimated to account for ~20% of global CH₄ emissions. However, methane dynamics in these settings are generally not well understood. Because methane serves as a potent greenhouse gas, more detailed knowledge on the physico-chemical controls and biological processes affecting its production is needed.

In order to predict the effects of changing environmental conditions on methane production, process-based models developed from comprehensive datasets on freshwater systems are needed to help better understand benthic carbon cycling. Here, we present results from model simulations based on a detailed analysis of organic matter breakdown in sediment from the coast of Georgia, USA. This habitat represents a complex setting where intertidal dynamics and chemical and microbial processes influence anaerobic carbon metabolism. Data obtained from laboratory and field studies, including measurements of carbon dioxide and methane fluxes across the sediment surface, depth profiles of pore water and solid phase constituents, and rates of microbial processes, are used to constrain flow dynamics and to determine controls on biological processes taking place. This information is incorporated into a multi-component 1-D sediment model that takes into account physical transport and biomineralization of species involved in organic matter breakdown. For comparison, the analysis is carried out at sites with varying latitude and datasets from multiple seasons are investigated.

Speciation of selenium by facultative bacteria in phosphate mine waste

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Facultative beta-proteobacteria present in groundwater from the Meade Peak member of the Phosphoria Formation in southeast Idaho have been shown to reduce soluble selenate Se (VI) concentrations using native carbon under saturated, micro-aerophilic to anaerobic conditions in batch reactors containing mined chert and shale. Operational waste management strategies that seek to promote such Se (VI) reduction in facilities constructed with materials must account for long term stability of reduced selenium in predicting future potential for transport within mine waste. Samples of sterile chert and shale exposed to a live consortium of groundwater bacteria, which demonstrated Se (VI) reduction in batch reactors, were studied using ion chromatography (IC), high performance liquid chromatography-inductively coupled mass spectrometry (HPLC-ICPMS), FEM-EDS (field emission electron microscopy with energy dispersive spectroscopy), synchrotron-XRD (s-XRD), and bulk X-ray adsorption near edge spectroscopy (XANES) to determine the aqueous and solid phase selenium reduction products in shale and chert lithologies. Aqueous analysis by IC and HPLC-ICPMS, suggest a two-step reduction process, with selenate transformed to selenite Se (IV), which was rapidly removed from solution as the reduction process proceeded. Solid phase analyses, using s-XRD and XANES, identified reduced mineral phases including selenite, elemental selenium, and selenide minerals. The relative abundance of minerals varied between the shale and chert, suggesting lithologically distinct reaction pathways and products.