PL 4

Combining in-situ measurements with speciation techniques to characterize biogeochemical processes in sediments

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Metals play a central role in the biogeochemical cycling of elements in freshwater and marine environments. In sediments, most processes responsible for the transformation of metals occur near redox interfaces, usually within millimeters to centimeters from the sediment-water interface. As a result, analytical techniques developed to analyze metal speciation in these environments must be able to provide information with at least one millimeter resolution. Mercury voltammetric microelectrodes have proven very useful in gaining insight into the speciation of metals in these environments. These microelectrodes provide fast responses, display low memory effects, are capable of detecting many chemical species involved in the transformation of trace metals with good sensitivities (e.g., $O_{2(aq)}$, ΣH_2S, Mn^{2+}, and Fe^{2+}), and display some speciation capability (i.e., soluble organic-Fe(III) and $FeS_{(aq)}$ complexes) which is very useful in characterizing biogeochemical processes in most natural and impacted sediments. Using mercury-gold (Au/Hg) voltammetric microelectrodes deployed in situ from benthic landers and other platforms, we are currently investigating the biogeochemical processes responsible for the transformation of iron, manganese, and sulfur, and their role in the diagenetic processes of carbon in marine sediments. Simultaneously, we are using Au/Hg voltammetric microelectrodes as supporting tools to investigate the role of biogeochemical processes on the transformation of arsenic and uranium in freshwater environments. I will provide examples of these studies and focus on the existence and characterization of soluble organic-Fe(III) complexes in marine sediments.