Geochemistry of the Changjiang (Yangtze) River: Natural versus anthropogenic impacts?

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The Changjiang is the longest and largest river sourced from the Tibetan Plateau, and has played a significant role in sedimentation and biogeochemical cycle in East Asian marginal seas at present and in the geological past. Despite the rapidly increasing research attentions over the last decade, natural and anthropogenic impacts on geochemistry of the Changjiang remain to be clarified, and especially, intergrated and multidisciplinary studies are urgently needed. How about the chemical evolution of the Changjiang-derived sediments during the Holocene and its impact on the coastal and marginal seas? Whether is the present Changjiang of heterogeneous nature in chemical and mineralogical compositions? How does hydrodynamic sorting affect the river chemistry? To answer these questions, we carried out systemaic field work to the Changjiang drainage basin and adjoining seas, and collected water and suspended particulate samples for mineralogical, elemental and isotopic measurements.

The heterogeneous nature of the Changjiang can be clearly seen from the spatial and temporal variations of river chemistry between the major tributaries and mainstream. The variable source rocks and weathering intensities in the sub-catchments exert a predominant control of geochemical and mineralogical compositions of the river sediments. Nevertheless, strong anthropogenic activities such as the land-use change during the late Holocene and the world largest Three Gorges Reservoir have changed the transport patterns of the fine-grained sediments from the upper reaches to the lower valley and estuarine area, and thus, considerably altered the chemical compositions of the river-borne particulate matters into the sea. The seasonal variability of water and sediment loads regulated by the large reservoirs complicate the natural and anthropogenic impacts on river geochemistry, which may have a profound influence on ecological and biogeochemical processes in the East Asian marginal seas.

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Biotransformation of selenium in multispecies biofilm

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Selenium's toxicity depends upon which chemical forms, such as selenite or selenate, are present. Selenium may be transformed to less toxic forms and sequestered in microbial biofilms. Biofilms are a complex and tightly-regulated microbial systems that may act in natural detoxification processes. In this investigation, we studied naturally occurring selenium resistant microbial biofilms exposed to elevated levels of different selenium species to explore the fate and the transformation of selenium in aquatic systems.

Our study utilized a suite of laboratory and synchrotron-based tools at the micro and nano-scale. Confocal laser scanning microscopy (CLSM) demonstrated changes in the biofilm architecture with Se concentration. Se K-edge X-ray absorption spectroscopy (XAS) and micro X-ray fluorescence imaging demonstrated biotransformation of the selenium oxyanions in the biofilm microenviroment. Scanning transmission X-ray microscopy (STXM) using X-ray absorption near edge structure (XANES) as its contrast mechanism was used to simultanously visualize selenium species and the biofilm architecture at a nanoscale resolution. STXM at the carbon K-edge allowed quantitative mapping of protein, lipids, and polysaccharides in multispecies biofilms. In the same structures, the Se L-edges revealed a unique distribution of selenium including 200 nm size microbially generated elemental selenium in the biofilm (Figure 1).

This study is anticipated to elucidate the bio-detoxification processes of selenium in multispecies biofilms and to contribute to developing a model for the bio-transformation of selenium in relation to bio-remediation.

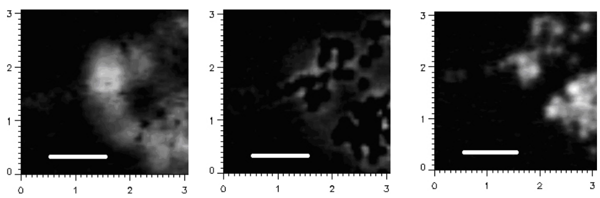

Figure 1: STXM optical density images on the same area of multispecies biofilm showing protein, polysaccharide, and elemental selenium (left to right). Scale bars indicate 1 μm.