

Preface

The Diffusion Gradients in Thin films (DGT) technique is an advanced sediment sampler, which can measure concentration and flux of pollutants in porewater on high spatial resolution. DGT has the functions as following, (1) in situ measurement; (2) time-averaged concentration; (3) the speciation of analyte (labile species); (4) bioavailability (effective concentration); (5) concentrations in solution and pore water in sediment/soil; (6) kinetic or thermodynamics parameter; (7) the measurement at high spatial resolution (<1 mm); (8) 2-dimensional concentration image; (9) DIFS (DGT-induced fluxes in sediment) model. However, the previous DGT papers have seldom researched P-release across sediment/water interface (SWI) or P-transfer across sediment/root interface, and the conventional research methods (linear distribution coefficient (K_d), a non-linear adsorption isotherm (Freundlich or Langmuir), or sequential extraction procedures) cannot perform in situ measurement of elements at environmental interface with high spatial resolution or reveal the “real” kinetic P-release or bioavailability at microzone. In this book, DGT and the related techniques have been developed in order to reveal the P-transfer and the kinetic exchange at SWI (Dianchi lake) or sediment/root interface (Erhai lake). Dianchi is an eutrophic lake and the extensive blue algal blooms have happened frequently since 1993. The nutrient level of Erhai lake is changing from mesotrophication to eutrophication in recent years. “Internal P-loading” in Dianchi lake, can engender P-release from the sediment and increase total dissolved P in overlying water and porewater regardless of “external P-loading.” So, it is important to research the mechanism of “internal P-loading” and the geochemical reactions for P-release. The roots of aquatic plants play a key role for the uptake of appreciable quantities of nutrient from sediments. The new technique in the field of ecological engineering—the cultivation of aquatic plants has been used for the ecological restoration of lake eutrophication in Erhai lake. So, it is significant to research the P-uptake mechanism of roots and P-transfer across sediment/root interface. In this DGT research for lake interfaces, DGT and the related techniques have been developed in order to perform the following tasks: (1) the simultaneous measurement of P and the related elements (Fe and S(-II)) at fine scales at SWI,

(2) the numerical simulation of kinetic exchange of P across DGT/porewater/sediment interface, (3) the measurement of S(-II)- and Fe- microniches, (4) the DGT test at rhizosphere of aquatic plants, and (5) the assessment of mechanism of “internal P-loading” (Dianchi lake) or P taken up by roots (Erhai lake).

DGT technique and the related methods (the multi-layer-binding gel DGT, DIFS-DGT Induced Fluxes in Sediments, CID—computer imaging densitometry, LA-ICP-MS-laser ablation inductively coupled plasma mass spectrometry and DGT method for rhizosphere), were used to solve the following problems related to P-release and -transfer across SWI or sediment/root interface, including: (1) What geochemical reactions determine the “internal P-loading” and P-release in sediment; (2) How do the kinetic parameter and sediment-P pool determine P-release/-diffusion across DGT/porewater/sediment interface? (3) How are Fe- or S(-II)-micro-niche in sediment microzone measured for the prediction of the P-release or the coupled Fe-S(-II)-P reaction? (4) DGT’s function to mimic P taken up by roots. Using DGT probes and the related methods, the above questions have been answered perfectly. This book consists of four parts, including the following contents: Part I The Basic Theory and Methodology, mainly introducing the basic theory of P-process at SWI in lake, the eutrophic problem; the DGT techniques used in this book (multi-layer-binding-gel DGT probe, DIFS, CID, LA-ICP-MS, DGT test method at SWI and rhizosphere), and the element uptake mechanism by plant root; Part II “Internal P-Loading” at SWI, mainly introduces the P-process at SWI of lake, the assessment of “internal P-loading,” kinetic P-exchange across DGT/porewater/sediment, S(-II)- and Fe-microniches assessment for the prediction of P-release; Part III The P Behavior at the Sediment/Root Interface of Aquatic Plants, mainly introducing the DGT test in situ at rhizosphere and in rhizobox; and DGT as a surrogate to mimic P taken up by plant root; The Conclusion and Prospect (Chap. 9), mainly introducing the main conclusions about “internal P-loading” mechanism, geochemical reactions for P-release, the calculation for kinetic P-release at SWI, the assessment for “internal P-loading,” Fe- and S(-II)-microniche for the prediction of the P-release and the coupled Fe-S(-II)-P reaction, the assessment of DGT as a surrogate to predict P-uptake by root and P-content in plant tissues, and the prospect for the sensing techniques such as: DGT-optode sandwich sensors for the images with multi-parameters in sediment microzone or rhizosphere.

The DGT investigate for lake interfaces in this book should reflect the latest research advances for P-transfer across SWI or sediment/root interface and assessment methods for “internal P-loading” of eutrophic lake, and may develop the new directions for the research of the mobility of P and other elements in lake interfaces or chemical images of solutes in sediments.

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Please forgive us due to the time constraints for writing. If the reader has found anything that needs to be improved in the book, please propose the valuable suggestion

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Microzones and Rhizospheres

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