Physics and Chemistry of the Earth xxx (2017) 1–6

Contents lists available at ScienceDirect

Physics and Chemistry of the Earth

journal homepage: www.elsevier.com/locate/pce

Vertical distribution of mercury and MeHg in Nandagang and Beidagang wetlands: Influence of microtopography

Ruhai Liu, Yanyan Zhang, Yan Wang*, Jin Zhao, Huayao Shan

Key Lab of Marine Environmental Science and Ecology, Ministry of Education, College of Environment Science and Engineering, Ocean University of China, Qingdao 266100, China

ARTICLE INFO

Article history:
Received 15 November 2016
Received in revised form
10 February 2017
Accepted 1 April 2017
Available online xxx

Keywords:
Mercury
MeHg
Vertical distribution
Microtopography
Wetland

ABSTRACT

Wetlands often show different small-scale topography, such as riffle, habitat island, deep water, shallow water zone and dry zone. Core soils in different micro topographical landforms of Nandagang and Beidagang wetlands in North China were sampled for THg and MeHg to analyze the influence of microtopography. Results showed that THg content in surface soil (<2 cm) was little higher than that at depth 2–4 cm of all stations. There were several peaks in the profile, which reflected mercury pollution in past. High THg content in undisturbed natural wetland soil implied accumulation of mercury. Harvest of plant, drained water decreased the accumulation of mercury in wetlands. Water level caused by microtopography affected the production of MeHg. Depth of the highest MeHg content decreased from N1, N2, N6, N3 to N4 following the increase of water level. Plant type and coverage also affected the vertical distribution of MeHg. More detailed profiles of MeHg, organic matter and total phosphorus in different sites show strong differences in soil chemistry, suggesting a complex interplay among hydrology, biogeochemistry and microtopography.

1. Introduction

In aquatic ecosystem, mercury is easy to accumulate and be biomagnified through the food chain. Therefore, consumption of predatory fish could risk human health since mercury is a powerful neurotoxin (Mergler et al., 2007). In low-lying topography area, mercury could accumulate in wetlands because wetlands collect waste water discharge, atmospheric deposition and runoff of watershed. Mercury methylation in wetlands is thought to be the consequences of activities of anaerobic bacteria, mainly sulfate-reducing bacteria (SRB) (King et al., 2001), methanogens (Hamelin et al., 2011) and iron reducing bacteria (Fleming et al., 2006; Kerin et al., 2006). In wetlands, abundant organic matter and anaerobic environment caused by water inundation are benefit to the formation of methylmercury (MeHg) (St. Louis et al., 1996; Barkay et al., 1997; MacMillan et al., 2015). High concentration of mercury and MeHg appear in wetlands in general, and are discharged to river, lake and other aquatic ecosystems (Driscoll et al., 1994; Branfireun and Roulet, 2002). Therefore, wetlands are the source and sink of mercury, and the source of methyl Hg (Allan and Heyes, 1998; Driscoll et al., 1998; Grigal et al., 2000; Back et al., 2002; Galloway and Branfireun, 2004; Selvendiran et al., 2008; Hall et al., 2008). Studies in remote area showed that the methyl Hg, produced in wetlands caused high concentrations of MeHg in fish and wading bird (Driscoll et al., 1994; Hurley et al., 1995; Beyer et al., 1997; Fitzgerald et al., 1998). Compared to other crop plants, high MeHg concentration was found in rice, grown in paddy field polluted by mercury (an artificial wetland) (Qiu et al., 2008). High concentration of MeHg might risk wild wading birds and their predators. There are high mercury pollution risk to wild life and human, especially pregnant women (UNEP, 2002).

Since mercury methylation in wetlands is thought as the consequence of the activities of anaerobic bacteria, environmental factors including temperature, saturation conditions, plant type, and soil type will affect the activities of anaerobic bacteria (SRB, methanogens, iron reducing bacteria, etc.). Wetlands often show different small-scale topography, such as riffle, habitat island, deep water, shallow water zone and dry zone. The difference of saturation conditions, plant type and activity of anaerobic bacteria are often controlled by microtopography. Microtopography may be

* Corresponding author. College of Environment Science and Engineering, Ocean University of China, No.238, Songling Road, Qingdao 266100, Shandong, China.
E-mail address: ruhai@ouc.edu.cn (Y. Wang).

http://dx.doi.org/10.1016/j.pce.2017.04.003
1474-7065/

Please cite this article in press as: Liu, R., et al., Vertical distribution of mercury and MeHg in Nandagang and Beidagang wetlands: Influence of microtopography, Physics and Chemistry of the Earth (2017), http://dx.doi.org/10.1016/j.pce.2017.04.003

important for production and distribution of MeHg.

According to Pacyna et al. (2006), about 2190 Mg of anthropogenic Hg was emitted to environment in 2000, with 28% contributed by China. Due to the rapid economic development in China, atmospheric pollutants increased significantly in North China especially in winter (Zhang et al., 2015). Atmospheric mercury input, runoff and waste water are important sources of mercury in wetland of North China (Wang et al., 2002). Some metals in wetlands were found to exceed the background values (Bai et al., 2015; Lu et al., 2016; Zhao et al., 2016). The behavior of metals in wetlands was researched in Yellow River Delta wetlands (Xiao et al., 2015; Zhang et al., 2016; Liu et al., 2017). Nandagang and Beidagang wetlands are located in border of Hebei province and Tianjin City where severe atmosphere and water pollution issuers exist. There are deep water, shallow water zone and dry zone affected by micro topography. Reed is the dominate species in the wetlands. These wetlands are on the migration route of the birds from East Asia to Australia, and can provide food and habit for many rare migrant birds. Mercury and MeHg in wetlands might bring risk to these wild lives.

In this study, determination of THg and MeHg in soil core of Nandagang and Beidagang wetlands to understand: 1) the distribution and accumulation of THg in wetlands; 2) vertical variance of MeHg in soil core; 3) the influence of microtopography on the MeHg and THg.

2. Methods

2.1. Sampling

Nandagang wetland is a marsh with reed, a typical wetland distributed in North China. The altitude of wetland is 0.9–2 m. Most of the surface of wetland is covered by reeds. There is also water surface. This wetland is a natural protection area for rare birds. Although the water coming from watershed decreased in recent years, water shortage does not appear by the artificial water transfer in general. Beidagang wetland is an unused reservoir because of high salt content in water and soil. Water in this reservoir comes mainly from Duliujian River and precipitation. There is wide water surface in low place, calamus and reed distribute from low to high place around water. There are other small wetlands, salterns and aquiculture fields between two wetlands. Soil cores (20–32 cm) were sampled in the wetlands (Fig. 1). The environment parameters of stations are shown in Table 1. The soil cores were sealed and put in box with ice bags and then were cut with 2 cm interval in lab. One part was used to analyze the mercury and MeHg, the other part for water content, organic matter and total phosphorus.

2.2. Determination of THg and MeHg

Soil samples were homogenized and digested with concentrated HCl/HNO_3 (3 mL: 1 mL), at 100 °C, for 1 h (GB 17378-2007).

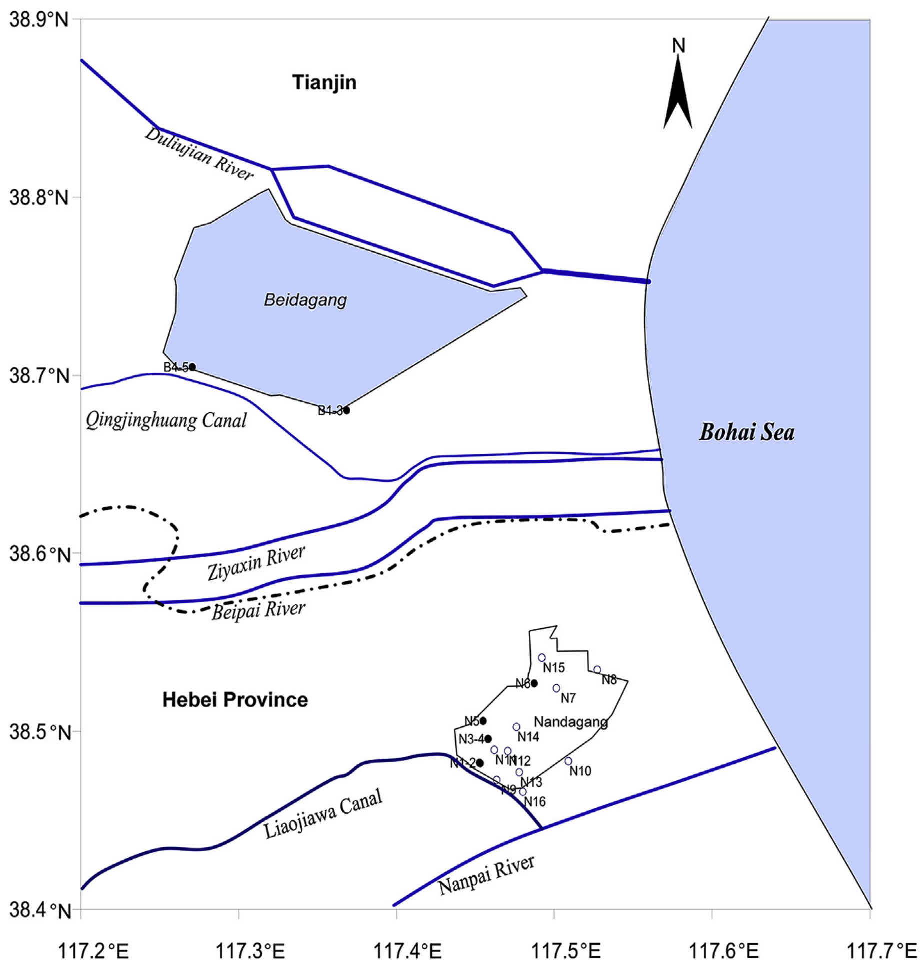

Fig. 1. Map of the sample collection sites within wetland. Soil samples were collected during October 2014. Soil core samples are shown in solid circle. Surface soil samples (0–10 cm) are shown in hollow circle. Stations N1-N16 and B1-B5 are in Nandagang wetland and Beidagang wetland individually.

Please cite this article in press as: Liu, R., et al., Vertical distribution of mercury and MeHg in Nandagang and Beidagang wetlands: Influence of microtopography, Physics and Chemistry of the Earth (2017), http://dx.doi.org/10.1016/j.pce.2017.04.003