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Baseline

Mercury profiles in surface sediments from ten bays along the coast of Southern China

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ABSTRACT

Spatial and temporal variations of mercury (Hg) were investigated from ten representative bays along the coast of Southern China. The total Hg (THg) in surface sediments varied widely with concentrations from 25 to 264 ng/g. As a whole, Hg pollution in several bays occupied by busy sea traffic and industrial activities, such as Shantou (ST) Bay and Dapeng (DP) Bay were remarkably more serious than others, which reflected the direct effects of anthropogenic activities around the coastal areas. Hg variations in sediment cores clearly display upcore rising trend which obviously correlates with the trend of economic development and urbanization in the last five decades. No significant correlations were found between Hg and organic matter and particle size, suggesting that the distribution of Hg is not fully controlled by these variables.

Mercury (Hg) has received global concern due to its high toxicity, bioaccumulation, and persistence in different environments. Mercury can cause health problems not only at high and acute exposures, but also at chronic low doses (Harada, 1995). Further, it was listed as a priority pollutant by many international agencies due to its volatility and thus could globally transfer (Dastoor and Larocque, 2004). The global Hg environmental burden is presently three times heavier than that in preindustrial times due to human activities and industrial development (Mason et al., 1999). The environmental exposures mainly originate from atmospheric deposition, soil erosion, urban discharges, mining discharges, and combustion/industrial discharges (Wang et al., 2004). China has become one of the largest mercury emission countries in the world (25% or more) due to its rapid urbanization and industrialization in the past four decades (Feng, 2005; Jiang et al., 2006).

Global oceans, coastal zones in particular, are acting as reservoirs in the global Hg cycling and many other types of contaminants derived from various sources. In addition, it is significant for Hg to be methylated from inorganic to organomercury in water and sediment and bioaccumulated in aquatic organisms through the food chain. Hence, the biogeochemistry of Hg in coastal environments has received particular attentions (Conaway et al., 2003; Horvat et al., 1999). Sediments are often considered as an mercury sink due to its high affinity to suspended particles and simultaneously a potential source to overlying water and biota through diffusion and resuspension (Conaway et al., 2007).

Guangdong Province, with highly developed industry, has a population of more than 100 millions. The Pearl River Delta (PRD) region, accounting for half of Guangdong Province in size, has been recognized as "World Factory" and become one of the most industrialized and urbanized regions in China. The rapid economic development in Guangdong province has led to serious contamination of heavy metals and organic pollutants in both aquatic and marine environments (Ip et al., 2004; Wong et al., 2002). Guangdong province has more than 4000 km coastline, accounting for a third of total China. With development of marine economy, the harbors and bays distributed in the coastline of Guangdong province has become highly densed areas of human activities and played an important role in promoting the economy of Guangdong province. Studies have demonstrated these harbors or bays acted as main contaminants reservoir as well as for the persistent toxicity compounds (Lin et al., 2009; Wang et al., 2008). However, few Hg data are available from these bays, especially based on large-scale investigation. Hence, the objectives of the current study are to study the spatial distribution and temporal variation of Hg from ten selected bays distributed in the Guangdong coastline and to demonstrate the relationships between Hg and sediments characters.

130 Surface sediment samples (top 10 cm) from ten representative bays along coastline of Guangdong province were collected with a stainless steel grab sampler from January to May in 2008 (Fig. 1). Brief information of the ten bays is shown in Table 1. All the samples were placed into polytetrafluoroethylene bags and

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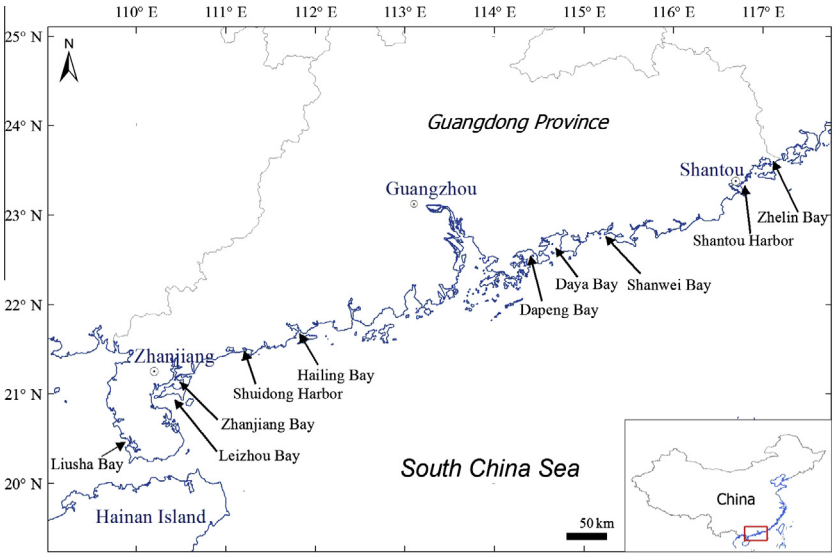

Fig. 1. Map of the study area.

Table 1
Some information of the selected bays.

Bays	Station code	Locations	Samples	Description	Main functions
Zhelin	ZL	116.90–117.16°E 23.47–23.60°N	12	Mouth of rivers	Cage mariculture area; Bathing beach
Shantou	ST	116.56–116.98°E 23.23–23.43°N	15	Mouth of rivers	Shipping port; Mariculture area
Shanwei	SW	114.95–115.26°E 22.60–22.79°N	12	Mouth of rivers	Shipping port; Fishing harbor
Daya	DY	114.50–114.82°E 22.44–22.75°N	16	Bay area	Mariculture area; Tourism area; Fishing harbor
Dapeng	DP	114.37–114.58°E 22.48–22.57°N	8	Bay area	Mariculture area
Hailing	HL	111.66–112.25°E 21.50–21.75°N	14	Channel	Mariculture area; Tourism area
Shuidong	SD	110.90–111.40°E 21.35–21.40°N	12	Offshore	Shipping port; Mariculture area
Zhanjiang	ZJ	110.44–110.70°E 20.88–21.15°N	17	Bay area	Shipping port
Leizhou	LZ	110.24–110.52°E 20.82–20.98°N	12	Channel	Fishing ground
Liusha	LS	109.80–109.92°E 20.34–20.58°N	12	Offshore	Mariculture area; fishing harbor

immediately stored at −20 °C until further required. Four sediment cores (ZL, ST, HL, and ZJ) were collected from the ZL, ST, HL, and ZJ bays, respectively. The sediment cores were taken using a gravity corer with an automatic clutch and reverse catcher. The diameters of the outside steel corer and the inside sampling PVC coring tube were 56 and 46 mm, respectively. After collection, sediment cores were stored frozen in the dark and then transported to the laboratory. Core samples were defrosted and sampled at 5 cm intervals using a plastic spatula. All samples were ground in an agate grinder until fine particles were obtained after freeze-dried.

Previous studies have demonstrated little exposure of mercury at organic form in marine sediments (Lin et al., 2012). Therefore, we only determine the total mercury (THg) from the sediment samples. 0.5 g sediment was treated with 5 mL aqua regia in a water bath at 95 °C for 12 h. Once cooled, the solution was diluted to 25 mL with deionised water and centrifuged at 3000 rpm for 10 min. The samples were analyzed by the flow injection mercury system (FIMS, Perkin Elmer) using $SnCl_2$ for the reduction step (Shi et al., 2011). Reagent blanks, replicates, and standard reference materials (NIST 1646a and GBW07310) were used as the QA/QC protocols in the analysis. The results showed that the relative standard deviation of the replicate sample analysis was generally <5% of the mean concentration. The recovery rates of reference materials were between 81% and 95% with mean of 87.5% (n = 5). The limit of quantification was 0.5 ng/g.

Table 2
Hg contents and sediments characters of the bays.

Bays	Hg concentrations (ng/g)			TOC (%)	Silt–clay (%) (mean)
	Range	Mean ± SD	Median		
ZL	69–207	124 ± 47	118	0.45–0.93	78
ST	105–214	159 ± 30	157	0.25–1.50	82
SW	25–98	55 ± 20	52	0.35–0.88	75
DY	25–95	51 ± 17	52	0.28–0.93	68
DP	137–264	185 ± 43	162	0.56–1.10	74
HL	76–229	119 ± 48	87	0.60–0.98	85
SD	55–176	123 ± 38	133	0.22–0.93	69
ZJ	32–136	55 ± 27	49	0.24–0.95	39
LZ	98–163	127 ± 21	130	0.06–0.62	45
LS	64–165	113 ± 39	114	0.22–0.87	92