HORIZONTAL AND VERTICAL PROFILES OF PCBS IN SEDIMENTS FROM THE SOUTHEASTERN COASTAL AREAS OF KOREA

Hee Gu Choi, Sang Soo Kim, Hyo Bang Moon and Pil Yong Lee

Environment Management Division, National Fisheries Research & Development Institute, Pusan 612-900, Republic of Korea

Introduction

Polychlorinated biphenyls (PCBs) are ubiquitous pollutants, and have been widely used by a large variety of industries over the past 50 years. PCB mixtures are thermally stable, resistant to chemical degradation and are of low flammability[1]. Environmental contamination by PCBs has arisen exclusively from human activities and their heavily contaminated areas tend to be located around industrial areas[2]. Jinhae, Busan, Ulsan, and Pohang coasts on the southeastern part of Korea, have been subjected to pollution by effluent and accidental discharges from a large number of engineering works and the dumping of sewage sludge. They are accumulated in sediments due to the characteristics caused by their low solubility and their tendency for association with particles[3]. The objective of this study was to examine the concentrations and patterns of individual CBs in sediments from the southeastern coastal areas of Korea and to explore the input history of organic contaminants to these coasts by the interpretation of the sediment record.

Materials and Methods

Surface sediment samples were obtained from 21 sites by box core in November 2000 (Fig. 1). Sediment cores were also collected by diver using an acrylic tube (8.5 cm × 200 cm) at Masan site (St. 1') and Ulsan site (St. 3) in September 1999 and Busan site (St. 1) and Pohang site (St. 2) in September 2000. Freeze-dried sediments were extracted using ASE system with hexane and acetone (1:1). Activated copper was added to the extraction vessel to desulfurize the extract. The sample was filtered and the total organic extract reduced to a small volume using a rotary evaporator and then purified on silica micro-column. In this study, 20 PCB congeners were identified (CB 8, 18, 29, 28, 52, 44, 101, 87, 110, 118, 153, 138, 187, 128, 180, 170, 195, 205, 206, 209). PCB quantifications were conducted on a Hewlett-Packard 6890 gas chromatograph (GC) with an electron capture detector equipped with HP autosampler 7683. A capillary column DB-XLB was used (60 m × 0.32 mm internal diameter × 0.25 μm film thickness, J&W). The recovery of certified PCBs in a standard reference marine sediment (CRM, NRC) extracted using the same methodology was 70-80%. Detection limits were about 0.1 ng/g for individual PCB congeners. Total organic carbon (TOC) was measured by CHN analyzer. Sedimentation rates using ^{210}Pb and ^{137}Cs profiles were determined.

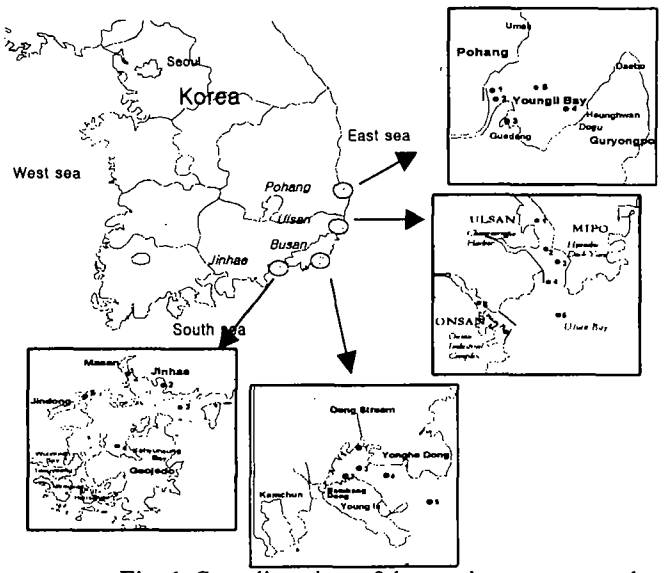

Fig. 1. Sampling sites of the southeastern coastal areas.

Results and Discussion

Horizontal distribution

The total PCB concentrations in the southeastern coastal areas were found to be in the range of <2 – 143.26 ng/g dry (Fig. 2). The highest concentration was found at St. 1 of Ulsan, whereas PCBs were not detected at 7 sites (St. 2, 3, 4 and 5 of Busan coast and 6 of Ulsan coast and 3 and 4 of Pohang coast) among 21 sites. The PCBs levels of southeastern coast sediments except St. 1 of Ulsan coast seemed to be comparable with those from polluted foreign regions[4,5]. The levels of PCBs in the sediment normalized to organic carbon (p=0.203) were not significant difference with that of total PCBs among areas (p=0.273). Correlation between PCB concentrations and the contents of fine particles was not observed in this study. Composition of PCB homologues was found at four coasts contained higher proportions of penta-, hexa- and hepta-CBs, accounting for 74-93% of total PCBs. However geographically differences of CBs congener composition for hexa-CBs with higher percentages of total PCBs occurred among Jinhae, Busan, Ulsan and Pohang coasts. This evidence points that the pollution sources among coasts might be different.

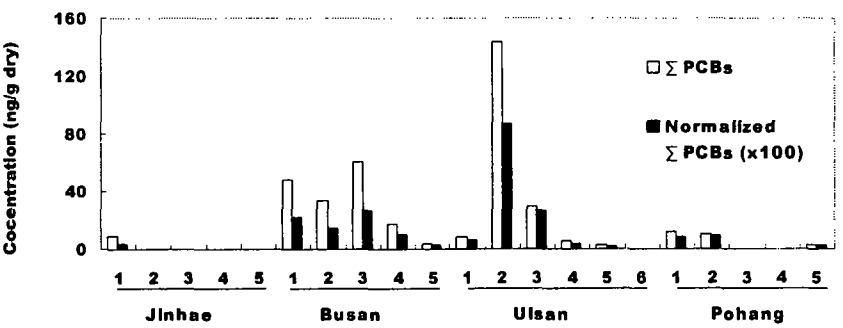

Fig. 2. Distribution of ∑PCBs and normalized ∑PCBs concentrations in the sediments From the southeastern part of Korea.

Vertical profiles

The historical trends in PCBs in Jinhae, Ulsan and Pohang cores were dominated by distribution of subsurface maximum with decreased contaminant levels both to the surface and with depth in the cores (Table 1). The maximum sections of the core approximately corresponded to the early 1960s in Masan coast, in the late 1970s/late 1960s in Ulsan coast and in the late 1960s in Pohang coast. In 1960, Korea entered a period of rapid industrial. The uniformity on pattern profiles of PCB congeners in sediment cores suggested that the PCB contaminant sources have not changed over time largely. The accumulation rates of Ulsan coast were 1-2 order of magnitude higher than that of Masan and Pohang coast. However, the rates similar to those of Tokyo Bay[6].

Table 1. Sediment accumulation rates (ng/cm^2/yr) and PCB concentrations (ng/g dry) in the sediments of the southeastern coastal areas of Korea

	Masan			Ulsan			Pohang		
Depth (cm)	Time period of core	Conc	Rate	Time period of core	Conc	Rate	Time period of core	Conc	Rate
0-2	1995-1999			1998-1999			1983-2000	72.75	4.37
2-4	1991-1995	10.56	2.53	1996-1998	62.48	43.42	1967-1983	106.34	6.38
4-6	1986-1991			1995-1996			1950-1967	57.82	3.47
6-8	1982-1986	2.75	0.66	1993-1995	90.55	62.93	1933-1950	51.17	3.07
8-10	1978-1986			1992-1993			1917-1933	34.71	2.08
10-12	1974-1978	7.48	1.80	1990-1992	68.51	47.61	1900-1917	17.13	1.03
12-14	1970-1974			1989-1990				8.00	0.48
14-16	1966-1970	10.29	2.47	1987-1989	110.34	76.69		6.26	0.38
16-18	1961-1966			1986-1987				3.63	0.22
18-20	1957-1961	9.17	2.20	1985-1986	64.23	44.64			
22-24	1949-1953			1982-1983	116.65	81.07			
26-28	1941-1945	4.79	1.15	1979-1980	70.37	48.91			
30-32	1932-1936	2.48	0.60	1976-1977	335.80	233.38			
34-36				1973-1975	81.31	56.51			
42-44				1967-1969	63.97	44.46			
46-48				1964-1966	301.75	209.72			
50-52				1962-1963	25.01	17.38			
58-60				1956-1957	4.51	3.13			

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