【SII-3】
Material Flow and Environmental Behavior Analysis on PCB and POPs Related Compounds

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The purposes of this project have been to study time-series changes in environmental levels of PCBs in relation to their treatment status to accumulate scientific knowledge on effective PCB control and also to discuss management strategies and treatment technologies for emerging POP control measures and treatment of existing POP waste in society. A material flow model was applied for estimating PCB emissions depending on thermal processes and PCB-containing products during the period of 1950 to 2030. A decreasing trend in PCB emissions after the introduction of full-fledged control measures was found (Fig. 1). A significant decrease was observed with the reduction of electrical equipment since approximately 2008. New destruction processes could be attributed to the reduction of PCB emissions into the environment. We obtained time-series scientific data on PCBs and found that the total PCBs in sediment core samples and sediment flux collected from Beppu Bay, Osaka Bay and Lake Biwa decreased after the late 1970s (Fig. 2). This decrease in the environmental load was also revealed from PCB flux analyses after 2000. A considerable amount of time is needed to decrease accumulated PCBs in biota. We surveyed wild archived biological samples, such as from kites and cetaceans, and found a significant POPs decrease, including PCBs in those species during the 1970–80s and 2000–2010s.

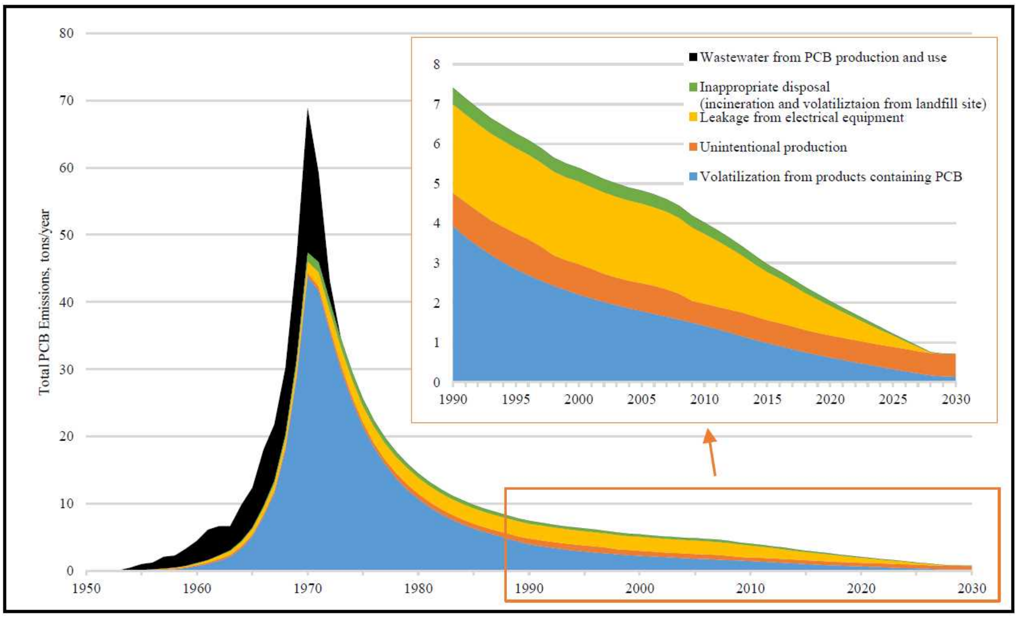

Fig. 1 Estimation results for total-PCB emissions for each emission category[1).

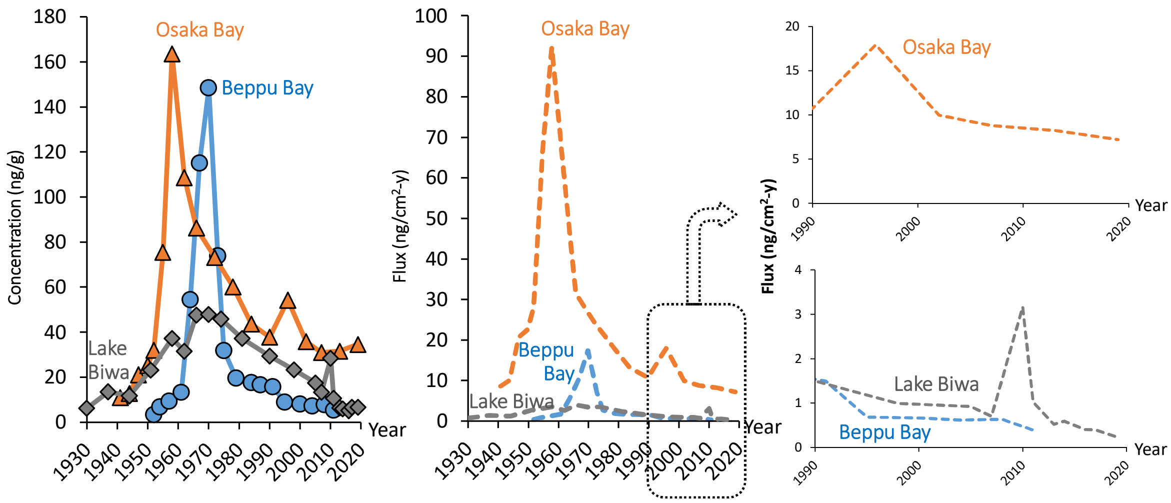

Fig. 2 Time trends in PCB concentrations and fluxes in some sediment cores[2].

The environmental behavior and decomposition characteristics of some POPs other than PCBs, such as short-chain chlorinated paraffins (SCCPs) and phosphorus flame retardant (PFRs). We measured the vapor pressure, aqueous solubility and octanol/water partition coefficient (K_{ow}) of PFRs. The partition plotting of K_{ow} and the air/water partition coefficient (K_{aw}) showed that SCCPs, MCCPs with a carbon number plus chlorine number ≤20 and a ratio of over 40% chlorine, and some PFRs have similar characteristics to PCBs (Fig.3). We confirmed that they tend to accumulate in soil containing organic matter and sediment. Among PFRs, tris (isopropylphenyl) phosphate (TIPPP) was detected from the sediment core, a new finding of this study.

The destruction efficiency of SCCPs and decabromodiphenyl ether (DecaBDE) in solid or liquid waste was over 99.999% after 2 sec. at 850°C. It was also revealed that the metallic sodium dispersion method of the chemical treatment attained over 99.999% of the decomposition of highly concentrated SCCPs in wax under 90°C with an appropriate amount of Na dispersion. These results indicate that these laboratory-scale conditions can be applied in a pilot demonstration and for full-scale implementation.

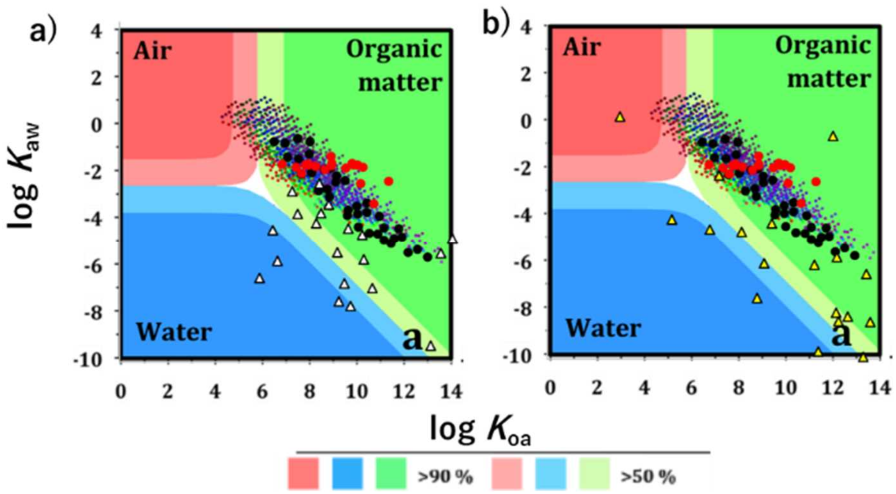

Fig. 3 Environmental behavior distributions of PCBs, SCCPs and PFRs in air, water and organic matter (Red circles: PCBs, Black circles: SCCPs, Triangles: PFRs)

<References>

1) Koshiba, J., Hirai, Y. and Sakai, S. (2019) *Chemosphere*, 232, 387-395

2) Takahashi, S., Anh, H.Q., Watanabe, I., Aono, D., Kuwae, M. and Kunisue, T. (2020) *Science of the Total Environment*, 743, 140767.