

MONITORING OF HEXACHLOROCYCLOHEXANES IN SNOW FROM THE EAST ANTARCTICA

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Introduction

Hexachlorocyclohexanes (HCHs) are one of most most widely studied organochlorine pesticides (OCPs) that is available in two commercial formulations¹. Technical-grade HCH is a mixture of isomers containing mostly 64% α -HCH, 10% β -HCH, 13% γ -HCH, 9% δ -HCH, and 1% ϵ -HCH. The other commercial formulation contains more than 99% γ -HCH (lindane) which is the only active insecticide of technical-grade HCH.

Snow and ice is critically important environmental components in Antarctica. About 98% of Antarctic continent is covered with snow and ice. Falling snow significantly contributes to the deposition of airborne contaminants by washing out the aerosol with particulate matter and absorbing the gas phase vapor. Atmospheric OCPs appear both in particulate phase and gas phase. Although they are lipophilic, the organic contaminants are stored in snow and ice after deposition and thus snow and ice serve as a reservoir of the atmospheric OCPs.

The presence of OCPs in Antarctic snow was discovered by Peterle et al. (1969)¹ and Peel et al. (1975)². The snow collected from the Plateau station and inland of Halley Bay station contained measurable amount of DDTs which were banned in most countries as agricultural application since 1970s. There are few recent studies determining the concentration of OCPs in snow from limited coastal areas of Antarctica, due to the difficult accessibility^{3,4}. Little is known about the distribution of OCPs in interior regions of Antarctica, despite the spatial distribution patterns of OCPs in snow from wide region in Antarctica provide valuable information on identifying the extent of atmospheric dispersion of OCPs and the most important processes related to deposition of OCPs in Antarctica and further in a hemispheric scope. Moreover, monitoring of OCPs in sufficiently extended regions of Antarctica make possible to understand the effects of snow on the environmental behavior of hydrophobic organic chemicals and reduce large discrepancies between the levels found by various researchers from different geographic locations.

The aim of this study is to determine the concentration levels of HCHs in surface snow collected from the coastal areas to the interior plateau of East Antarctica to investigate geographical distributions of HCHs in Antarctica.

Materials and methods

During the Japanese Antarctic Research Expedition (JARE) on November to December 2007, 35 surface snow samples were collected from Syowa Station (S27; 69°02'327" S, 40°33'186" E) near the coast via Dome Fuji (DK10; 77°14'940" S, 39°14'160" E) to the turning point (DK360; 76°01'140" S, 26°17'610" E) over a distance of ~ 1400 km in East Antarctica by the JARE team (Fig. 1). All sample handlings were performed under a class 10 clean bench in a class 1000 clean room at the Korea Polar Research Institute (KOPRI) and analytical operations were performed at Pohang University of Science and Technology (POSTECH). A full description of the analytical procedure is provided in Kang et al. (2009)⁵. Briefly, the snow samples were thawed at room temperature in a class 10 bench and the melted samples were extracted using liquid-liquid extraction with dichloromethane. Without the further cleanup, the extracted mixture was concentrated, and then analyzed using a gas chromatograph (Agilent 6890N) coupled with a high resolution mass spectrometer (Jeol JMS-800D).

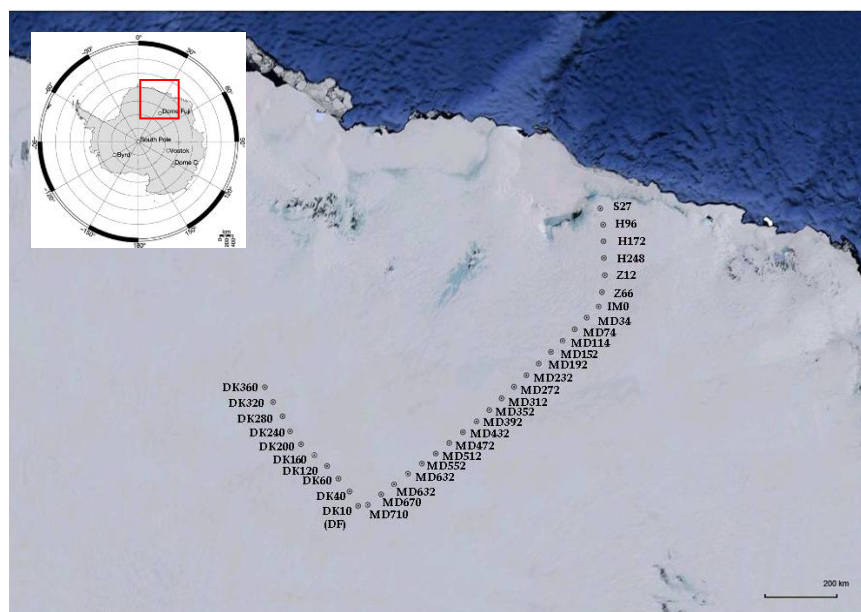


Fig. 1. Map of the snow sampling sites in East Antarctica

Results and discussion:

Among the four HCHs investigated, α -HCH and γ -HCH were detected in all the samples, while β -HCH and δ -HCH were below the detection limits in the snow samples. Total concentrations of HCHs in snow samples ranged between 58.7 and 204 pg L^{-1} . α -HCH ranged between 17.5 and 83.2 pg L^{-1} and γ -HCH ranged from 33.3 to 137 pg L^{-1} and. The mean concentrations of α -HCH and γ -HCH were 44.5 and 69.9 pg L^{-1} . Snow concentrations of HCHs in this study showed relatively narrow variations compared to those from Arctic snow. The concentrations of γ -HCH in this study were much lower than those measured in the snow from Arctic. The mean concentrations of γ -HCH were 1500 pg L^{-1} in the snow at Tromsø on Storsteinen Mountain in Arctic collected between February and March 2003⁶. The surface snow samples collected from Ny-Å lesund of the Norwegian Arctic also showed higher γ -HCH concentrations with the mean concentration of 1150 pg L^{-1} ⁶. The snow concentrations of HCHs in this study were much lower than those of the previous study in Antarctica. Surface snow samples were collected from Mizuho Station, Tottuki Point, and Lake Nurume in East Antarctica during May to September 1981³. Total HCHs (sum of α -, β -, and γ -HCH) concentration in snow showed 2300 pg L^{-1} at Mizuho Station, 2800 pg L^{-1} at Tottuki Point, and 4900 pg L^{-1} at Lake Nurume, respectively. The snow HCHs concentration in East Antarctica decreased from >2000 pg L^{-1} to approximately 100 pg L^{-1} during past 26 years. On the other hand, fresh fallen snow concentrations of α -HCH and γ -HCH along the Western Antarctic Peninsula were lower than those of our study⁴. The mean concentrations of α -HCH and γ -HCH in snow collected upwind of the Cruiser ship during the winter 2001 of the Western Antarctic Peninsula were 1.76 and 4.28 pg L^{-1} , respectively. These differences may be attributed to snow types, sampling locations, and analytical methods.

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References:

1. Peterle T.J. (1969); *Nature* 224: 620
2. Peel D.A. (1975); *Nature* 254: 324-325

3. Tanabe S, Hidaka H, Tatsukawa R. (1983); *Chemosphere* 12(2): 277-288
4. Dickhut RM, Cincinelli A, Cochran M, Ducklow HW. (2005); *Environ Sci Technol* 39(2): 465-470
5. Kang JH, Choi SD, Park H, Baek SY, Hong S, Chang YS. (2009); *Science of the Total Environment* 408(1): 57-63
6. Herbert BMJ, Halsall CJ, Villa S, Jones KC, Kallenborn R. (2005); *Environ Sci Technol* 39(9): 2998-3005