Bull. Environ. Contam. Toxicol. (1994) 52:9–12

Environmental Contamination and Toxicology

# Volatile Chlorinated Organic Compound Levels in Rain Water from Kobe City in Japan

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Water pollution by volatile chlorinated organic compounds has become a serious environmental problem. The Environment Agency of Japan has defined the regulations on trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane and carbon tetrachloride in wastewater in 1989. In order to protect against water pollution, it is important to keep concentrations of these compounds in environmental water as low as possible. Therefore, the determination of these compounds in rain water is very important to evaluate the loading amounts of these compounds into environmental water. Since few detailed reports have been made as to the assay of these volatile substances in rain water, we investigated this and compared these compound levels in rain water collected from three different locations in Kobe, Japan. The assayed values were compared to each other.

## MATERIALS AND METHODS

One hundred seventeen samples of rain water were collected through a year( January, 1991 - December, 1991 ) at the three different points as shown in Figure 1. The distances from the highway ( Hanshin Highway ) are 50 meter at the A point, 1,500 meter at the B point and 2,900 meter at the C point, respectively. Concentrations of volatile compounds in water samples were assayed by a gas chromatographic method as described in the following. One hundred mL of a water sample was placed in a separatory funnel, and 5 mL of o-xylene was added to the water. The mixture was shaken for 1 min. The separated o-xylene layer was subjected to gas chromatography ( GLC ) to assay the concentation of these compounds. The peak heights were estimated on the gas chromatograms obtained from a sample and organohalides standard solutions (carbon tetrachloride : 0.0005 mg/L , the other compounds : 0.001 mg/l ). The assay was performed on a Shimadzu Model GC-3BE gas chromatograph equipped with an electron capture detector and a glass column (2.6 m x 3 mm I.D.) packed with 20 % silicon DC 550 on 60 - 80 mesh Chromosorb W was used. Both the column and the injection port were operated at 70 ℃ and the detector at 130 ℃.

## RESULTS AND DISCUSSION

The concentrations of trichloroethylene, tetrachloroethylene, 1,1,1 - trichloroethane, carbon tetrachloride and trihalomethane in water samples were assayed. The respective amounts of rainfall were close to each other. Figure 2 shows the gas chromatograms of standard compounds and sample water. Peaks corresponding to chloroform and carbon tetrachloride

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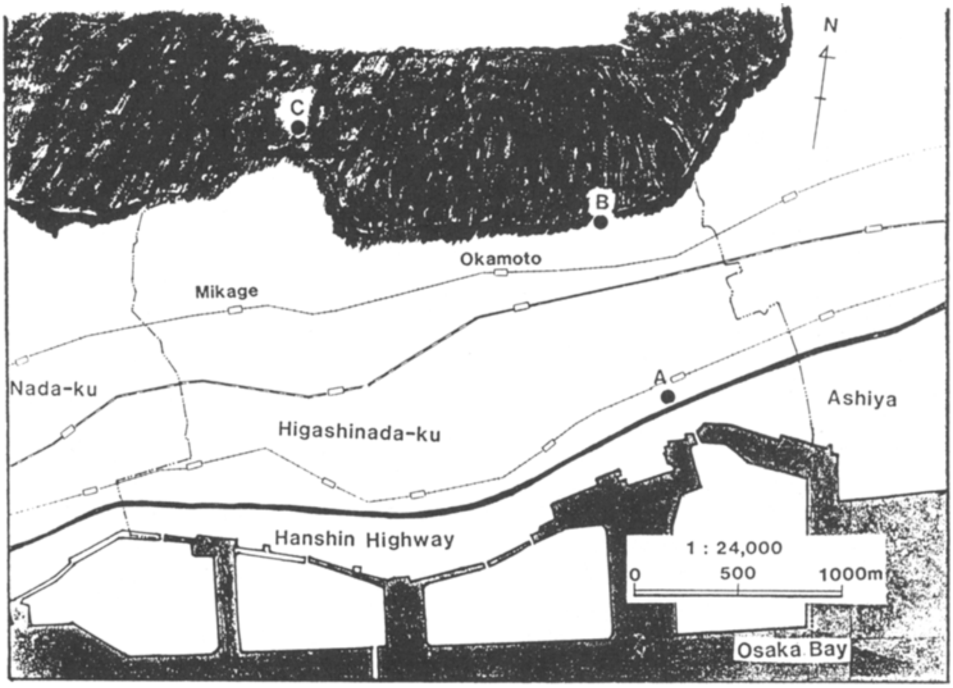

Figure 1. Sampling points of rain water

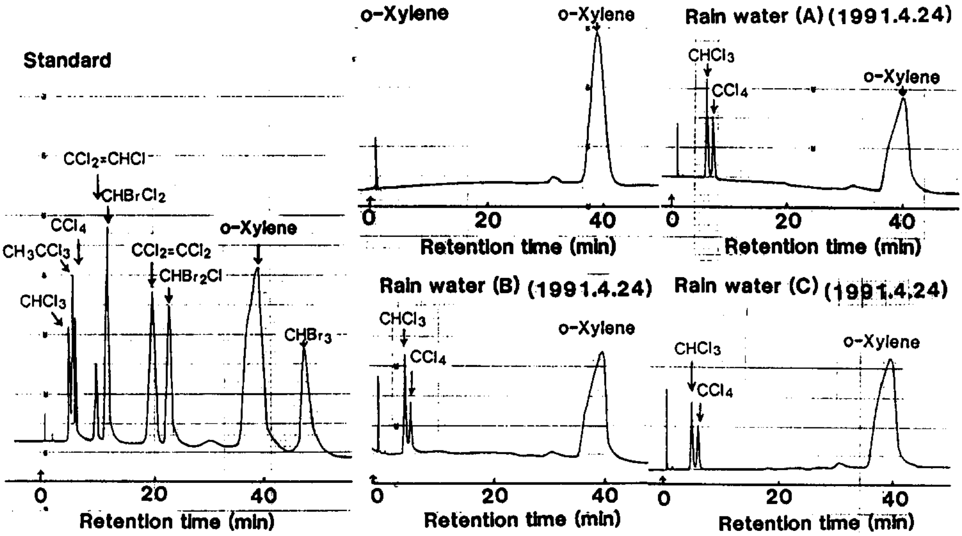

Figure 2. Gas chromatograms of volatile chlorinated organic compounds in rain water

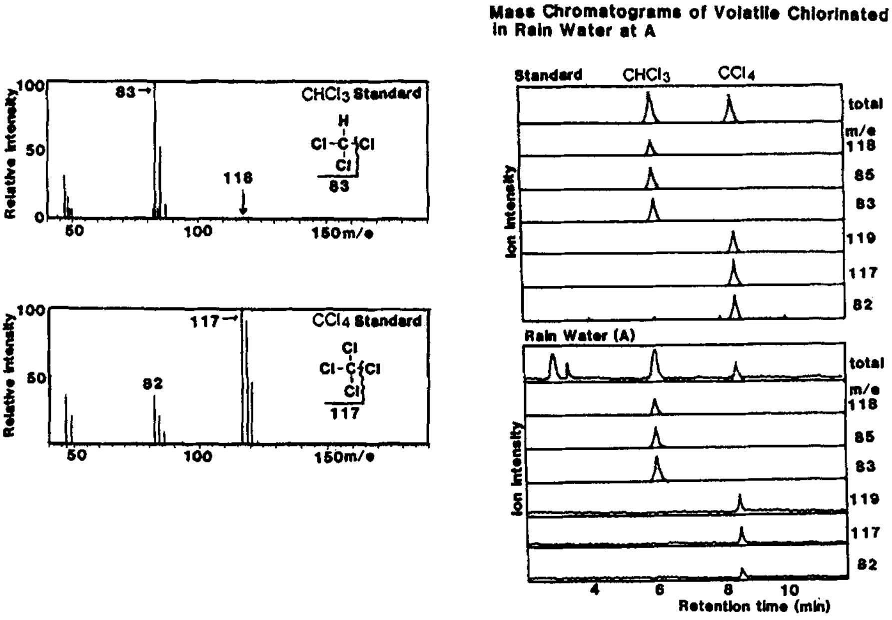

Figure 3. GC-MS of volatile chlorinated organic compounds in rain water at A point

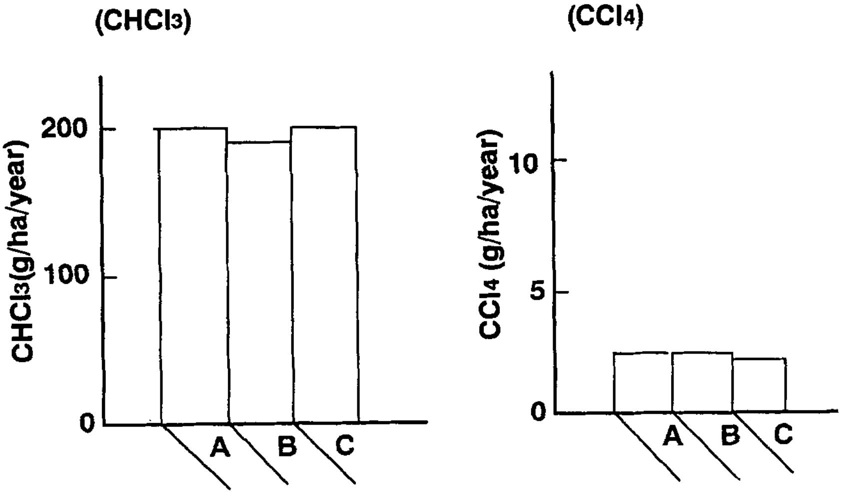

Figure 4. Cumulative amounts of chloroform and carbon tetrachloride in rain water collected from the three points

Table 1. Assayed values of volatile chlorinated organic compounds in rain water at A, B and C from January of 1991 to December of 1991

| Substance | A (μg/L) | | B (μg/L) | | C (μg/L) | |
|---|---|---|---|---|---|---|
| | Min. - Max. | M±SD | Min. - Max. | M±SD | Min. - Max | M±SD |
| $CHCl_3$ | 0.9 - 125.6 | 20.9±28.9 | 0.8 - 116.7 | 20.5±30.4 | 0.1 - 93.3 | 19.2±24.8 |
| $CCl_4$ | 0.1 - 0.7 | 0.2 ± 0.2 | 0.1 - 0.8 | 0.2 ± 0.2 | 0.1 - 0.8 | 0.2±0.2 |
| $CHBrCl_2$ | n.d. | — | n.d. | — | n.d. | — |
| $CHBr_2Cl$ | n.d. | — | n.d. | — | n.d. | — |
| $CHBr_3$ | n.d. | — | n.d. | — | n.d. | — |
| $CH_3CCl_3$ | n.d. | — | n.d. | — | n.d. | — |
| $CCl_2=CHCl$ | n.d. | — | n.d. | — | n.d. | — |
| $CCl_2=CCl_2$ | n.d. | — | n.d. | — | n.d. | — |

n.d. : not detected

were observed in the chromatograms of the rain water samples and these were separated completely from the other peakes. These peakes were confirmed as chloroform and carbon etrachloride by gas chromatography mass spectrometry ( Figure 3 ). Table 1 shows the assayed values of sample waters from the three points. The average concentrations of chloroform at the A, B and C points were 0.0209, 0.0205 and 0.0192 mg/L, respectively. Those of carbon tetrachloride at the A, B and C points were 0.0002 mg/L. There was no significant difference among the assayed values obtained from the three different sampling points. Other volatile chlorinated organic compounds were below the detection limit ( 0.001 mg/L ) in all rain water tested. Figure 4 shows the yearly cumulative amounts of chloroform and carbon tetrachloride in rain water collected from the three points. Both compounds showed a similar results among the three locations. We have previously reported that significant correlations were observed between the $NO_3^-$ and $Ni^{2+}$ levels in the rain water obtained from the A and B points. Since these ions are usually included in motor vehicle exhausts, it was concluded that both A and B points were influenced by the air pollution due to motor vehicles ( Adachi et al. 1992 ). As for chloroform and carbon tetrachloride, no significant difference was observed between the assayed values obtained from A or B point and those from C point. Thus, these compounds were not thought to be derived from air pollution due to motor vehicles. Yung et al. (1975) reported that contamination from industrial sources makes chloroform a common air pollutant. Chloroform has also been detected as a photochemical product in simulated ambient air containing trichloroethylene, and it is suggested that a portion of the atmospheric chloroform may result from photochemical reactions of trichloroethylene in air (Appleby et al. 1976).

## REFERENCES

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Received October 3, 1992; accepted June 10, 1993.