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Mercury in air in an area impacted by strong industrial activities

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Abstract

The concentrations of total gaseous mercury (TGM) and its relevant environmental parameters were measured at a highly industrialized area in the Ban Wall industrial complex (BWIC) in An San city, Korea from March to May 2005. The mean concentrations of Hg measured during the entire study period were computed to be 6.32 ± 8.56 ng m^{-3} (range of 2.32–181 ng m^{-3}; $N = 1160$). Due to the effects of strong man-made activities, the significantly high Hg concentration levels (e.g., at or above 10 ng m^{-3}) comprised about 7.5% of all data with the mean of 21.8 ± 26.3 ng m^{-3} ($N = 87$). By separating the data into daytime and nighttime periods, the Hg values exhibited a notable daytime enhancement possibly due to strong man-made activities during working hours. The results of the correlation analysis indicated the possible relationship between the Hg concentration and the temperature as well as several pollutant species (e.g., NO_2 and NO_x). Evaluation of the Hg data in relation with the air mass transport pattern confirms that the Hg concentration levels in this industrial area are affected most eminently by local, rather than distant, pollution sources.

Keywords: Mercury; Airborne; Industrial; Pollution; Anthropogenic

1. Introduction

Mercury (Hg) is naturally emitted or re-emitted into the atmosphere by degassing from various reservoirs on the earth's surface. The emissions of anthropogenic mercury however occur via the combustion of fossil fuel, waste incineration, industrial processes, and metal ore treatment (roasting, refining, and processing) (Ebinghaus et al., 1999; Pacyna et al., 2006). It is in fact inferred that anthropogenic sources contribute about one third of the total Hg emissions to the atmosphere (Mason and Sheu, 2002). Nriagu and Pacyna (1988) estimated that the global anthropogenic emissions of Hg decreased from 3560 ton yr^{-1} (median value) in 1983 to 2140 ton in 1990 (Pacyna and Pacyna, 2002). Although the decreasing trend was further maintained to reach 1990 ton yr^{-1} in 1995, it then increased up to 2190 ton yr^{-1} in 2000 (Pacyna et al., 2006). Moreover, the Hg emissions in the future are predicted to be within ±20% of the current estimates until the year 2020 (Pacyna et al., 2006).

Numerous studies have investigated the behavior of Hg under the conditions of urbanized environmental settings (e.g., Kim and Kim, 2000, 2001a,b, 2002; Carpi and Chen, 2002; Liu et al., 2002; Denis et al., 2006). It has been confirmed that the Hg concentration levels measured in many Asian countries are clearly distinguishable from those of Europe and North America (Denis et al., 2006). These differences may be ascribable to the combined effects of large-scale coal consumption with inefficient flue gas cleaning, along with the rapidly expanding economies (Kim and Kim, 2000). As one good example, the amount of coal used for heating purposes by most

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households in Beijing is estimated to be 10% of the total coal consumption in China (Liu et al., 2002). There is however a line of evidence that the reduction of Hg levels has been achieved over various locations worldwide since the 1990s (Slemr et al., 2003) to cover a number of developed countries with the aid of improved control techniques (Mukherjee et al., 2000).

To account for the environmental behavior of Hg impacted by strong source processes, a preliminary study was undertaken to monitor Hg levels from a highly industrialized area in An San city, Korea during spring 2005. Because the selected study site is confronted by diverse source processes, including massive industrial activities, acquisition of Hg data in the study area is expected to offer valuable insights into the behavior of Hg under the polluted atmosphere.

2. Materials and methods

In this study, the concentrations of total gaseous mercury (TGM) and its relevant environmental parameters were measured continuously from an urban Air Quality Monitoring station in the Won Si district of An San city for about a 3-month period (March to May 2005). The city is 50 km south of Seoul, the capital of Republic of Korea with a population of 550 000. The city hosts the Ban Wall Industrial Complex (BWIC) on the western side, while the bordering twin city of Shi Hung also encompasses Shi Hwa industrial complex (SHIC) with the similar area coverage (Fig. 1). About 8000 identified companies are located in both industrial complexes which cover diverse industrial sectors such as: (1) compound and chemical product; (2) food and beverage; (3) leather, bag, and shoes production;

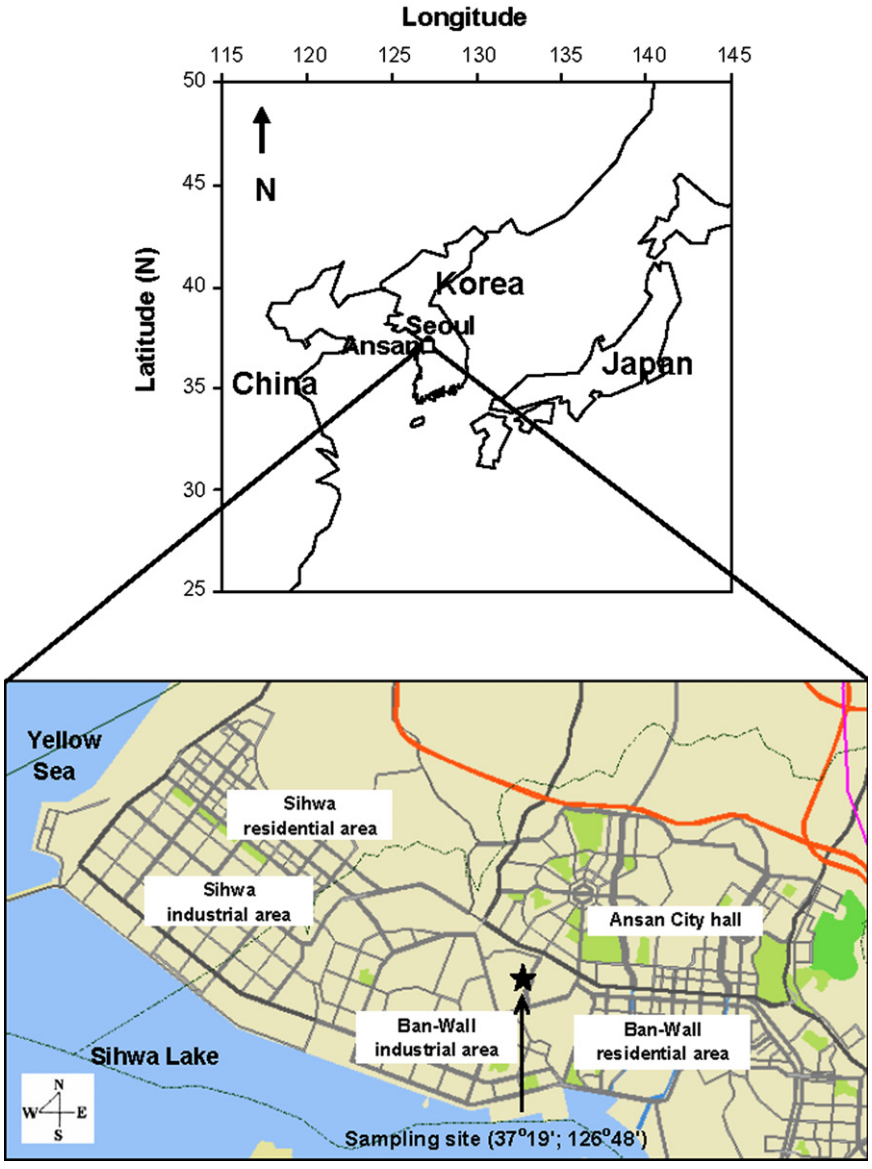

Fig. 1. The geographical location of the study site in An San city, Korea.