

Chapter 14

Eco-Friendly On-Site Water Analyses for Ultra- Trace Harmful Ions

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ABSTRACT

Governments in developed countries specify water quality standards to be applied in their own countries. Recently the allowance values of harmful metals are getting tighter for environmental water and industrial wastewater throughout the world. For example, World Health Organization (WHO) recommends the criterion value of 3 ppb for cadmium for protection of human health, furthermore, governments of some countries provide the wastewater standard for zinc for conservation of aquatic life. High-performance analytical instruments such as AAS, ICP, and ICP-MS have been employed as official analytical methods of ultra-trace elements. Besides the costly initial and running expenses and the material and energy consuming of the instruments, specific technical skills and long analytical time are required for sample pre-treatment. Therefore, simple yet highly sensitive and eco-friendly on-site methods have been demanded for quick judgment of industrial and environmental water in developed countries as well as evaluation of drinking water in developing countries.

INTRODUCTION

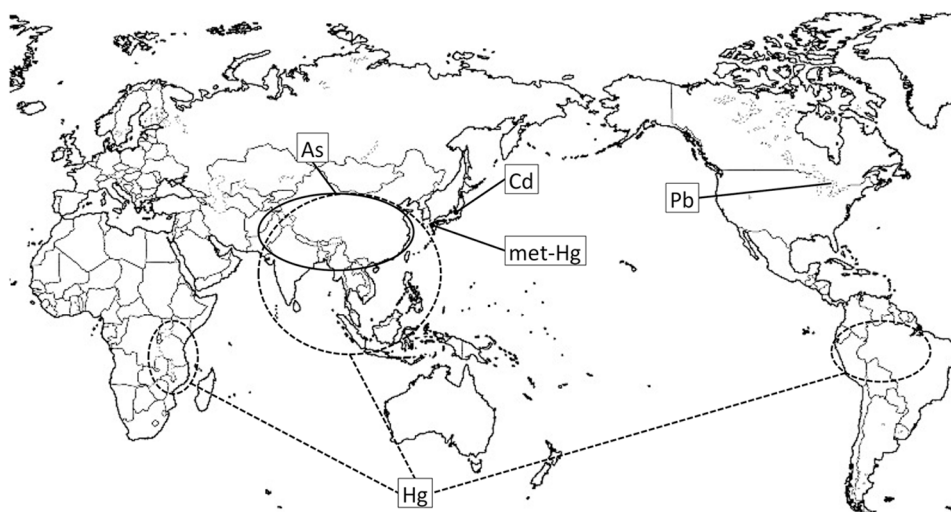
Harmful Ions in Public Water

The total volume of water on the earth surface contains liquid, solid, or gaseous is stated in the atmosphere, on the earth surface, and in the crust down to the depth of 2000 meters. By approximate estimates, its volume is an abundant 1,386 million km³ (Shiklomanov, 2000). However, 97.5 percent of this amount is salty water, and only about 2.5 percent is fresh water. The greater portion of the fresh water is locked up in the form of ice in the Antarctic and the Arctic, permafrost area and mountainous regions (68.7 percent of total fresh water resources). Besides except for fresh groundwater (30.9 percent) and gaseous

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water, only about 0.3 percent of the total amount of fresh water on the earth is concentrated in lakes, reservoirs, and river systems. The latter water sources are most accessible for human activities such as drinking water, domestic water, agricultural water, and industrial water, as well as very important for all terrestrial animals and water ecosystems. Mankind has utilized freshwater by uptaking mainly from river and lake, and then after use for each purpose domestic wastewater, agricultural and industrial effluents, mine drainages have been discharged to a public water area including river, lake, canal and sea. In this process, public water has been artificially polluted by various toxic materials, which has resulted in serious environmental pollutions all around the world. In addition, naturally originating contaminations based on soil composition have severed damage to water quality. Figure 1 shows examples of contaminated area by inorganic substances worldwide, however they are only a part of historical and geographical water pollution. Especially heavy metals among them are indispensable and industrially utilizable to human being. Such local cases of inorganic contamination are too numerous to be reported in many developing countries as well as advanced countries. As a well-known example, an extensive arsenic (As) contamination in groundwater in south and east Asian countries is derived from strata which highly concentrated arsenic accumulates (The World Bank, 2005), an estimated 60 million people are at risk from high levels of naturally-occurring arsenic in groundwater, and at least 700,000 people in the region have thus far been affected by arsenicosis. Besides, there is a lot of artificially-occurring contamination all over the world; *Minamata disease* that is a type of poisoning caused by industrial methyl mercury (met-Hg) contamination in Japan (Harada, 1995), inorganic mercury (Hg) pollution around gold mines that have been reported in the Amazonian valley in Brazil and around Lake Victoria in Tanzania (Ikingura, Akagi, Mujumba, & Messo, 2006) from the end of the 1970's, a recent lead contamination in tap water in US state of Michigan (Ganim & Tran, 2016), *Itai-Itai disease* caused by cadmium (Cd) poisoning due to mining in Japan (Järup & Åkesson, 2009), etc. These heavy metals have accumulated in living bodies through foods and drinking water, and then cause serious health damages. In environmental water, these inorganic substances are dissolved as particular ionic forms by surrounding of H₂O molecules having high dielectric constant, for instance, Cd²⁺, Pb²⁺, and HAsVO₄²⁻, etc., so that they easily spread in public water.

Figure 1. Man-made inorganic contaminations on a world map



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