



Evaluation of trace elements and identification of pollution sources in particle size fractions of soil from iron ore areas along the Chao River

Qin Fei^a, Ji Hongbing^{a,b,*}, Li Qian^a, Guo Xinyue^a, Tang Lei^{a,c}, Feng Jinguo^c

^a Civil and Environmental and Engineering School, University of Science and Technology Beijing, Beijing 100083, China

^b State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550002, China

^c Beijing Geo-engineering Design and Research Institute, Beijing 101500, China

ARTICLE INFO

Article history:

Received 12 August 2013

Accepted 12 December 2013

Available online 21 December 2013

Keywords:

Soil

Size fraction

Cluster analysis

Principal component analysis

Enrichment factor

Potential ecological hazard index

ABSTRACT

This study examines the distributions and potential environmental risk posed by trace elements in various particle size fractions. Element concentrations in soil samples from the study site exceed those of background levels in Beijing, except for Pb and As. The element concentrations generally increased with the decrease of particle size. Both correlation and linear analyses showed positive correlations between element concentrations and organic matter content. The PCA and CA analyses showed that: (1) Cu, Co, Zn, Cd, and V originated from mixed sources; (2) Be, Pb and As came from natural sources and were mainly affected by weathering and erosion of parent rock material; (3) Cr, Ni, and Ba resulted from fine particle pollution; and (4) Hg originated from anthropogenic sources, mainly driven by mining, beneficiation, smelting and acid mine drainage. The Enrichment Factor and Potential ecological harm-indices suggested that the enrichment degree of RI and E_i increased with the decrease of the particle size, especially for Hg and Cd. This conclusion provides a scientific basis for the prevention of environmental pollution from mining and the protection of the Miyun Reservoir in Beijing. It also provides reference for the further study of trace elements in various particle size fractions internationally.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

Soil is one of the natural resources on which the human beings rely, and is a place for interaction of environmental elements (Chen et al., 2003; Zhao and Tang, 2011). In recent years, public attention has been increasingly focused on soil contamination as well as its effect on human beings and other creatures. Among the various pollutants, trace elements are particularly important. Because they contaminate soils and plants and enter food chains, posing health problems to human beings. However, there is considerable variation in the level of these contaminants in soil, depending on their natural and anthropogenic sources. The natural sources are primarily rocks (Tuchschmid et al., 1995), minerals, and atmospheric deposition (Nriagu and Pacyna, 1988; Oliva and Espinosa, 2007), while anthropogenic sources mainly include direct or indirect emissions of trace elements from human activities, such as, mining, smelting (Adriano, 1986; Al et al., 1997; Jordan, 2009; Navarro et al., 2008), the burning of fossil fuels, waste incineration and disposal, sewage irrigation, the use of leaded gasoline and motor traffic, production and extensive use of chemical fertilizers and pesticide, daily activities, aerosolized trace elements, etc. (Dong et al., 1984; Lagerwerff and Specht, 1970; Purve, 1977;

Rybicka, 1987). Trace elements in soil cannot be degraded by microorganisms (Harte et al., 1991; Nuremberg, 1984), but they can accumulate and be absorbed by crops (Zhong et al., 2009), enter the human body through direct contact or the food chain (Government of Canada, 2001; Lin et al., 1998; Wenzel and Jockwer, 1999) and harm human health (Agbozu et al., 2007; Luo et al., 2012a).

Soil particle size is an important factor in determining the mobility of trace elements. Since the 1980s, international scholars have carried out research on the distribution of particle size of trace elements in surface soil (Ahmed and Ishiga, 2006; Viklander, 1998). The concentration (Förstner and Wittmann, 1979), migration, and transformation of trace element pollutants are all closely related to the particle size, because, fine particulate matter acts as a carrier for trace elements in soils, bringing potential risks to the environment and human health (Dominici et al., 2006; Vallejo et al., 2006). The concentrations of trace elements in soils increase with the decrease of particle size, because, fine particles have greater specific surface area, a negative charge, high clay content and high organic content. (Baek et al., 1997; Barberis et al., 1992; Charlesworth and Lees, 1999). The different types of clay minerals, particularly montmorillonite, kaolinite and illite, also adsorb trace elements (Brady, 1985). Research and evaluation on the activity and potential environmental risk resulted from trace elements in different size fraction components can further strengthen our understanding on the transfer and transformation of trace elements, and may provide strategies to repair and control the pollution. However Chinese scholars mainly focus on the study of characteristics and spatial distribution of

* Corresponding author at: State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550002, China. Tel./fax: +86 10 62332747.

E-mail address: hongbing_ji@163.com (H. Ji).

trace elements in the surface bulk soil sample (Li et al., 2008; Qu et al., 2008; Wang et al., 2003). Analyses of the effect of grain size on trace element pollution and potential risk assessments have only been carried out by a few researchers (Zheng et al., 2010).

The primary objective of the study was to examine iron ore area along the banks of the Chao River in Miyun. We gathered soil samples which are typical of iron ore mining, and established the source and distribution of trace elements in the region through multivariate statistical analysis such as clustering analysis and factor analysis. Furthermore, we aimed to determine the level of trace element pollution by applying an enrichment factor and calculating a potential ecological damage index, and to reveal the relationship between the concentrations of trace elements and particle size distribution. This work will provide a scientific basis for preventing and controlling trace element contamination.

2. Materials and methods

2.1. Study area

The study area centered on iron ore deposit located east of Beijing near the Miyun Reservoir. The Miyun Reservoir (40°23' N, 116°50' E) was built in 1960 and has a surface area of 188 km², with a catchment area of approximately 15,788 km². It is the largest reservoir in northern China and consists of eastern and western reservoirs as well as a closed independent water body referred to as the inner lake. Two main rivers, the Chao and the Bai, flow into the Miyun Reservoir. Surface runoff roughly mirrors precipitation, with large interannual fluctuations and an uneven distribution throughout the year. The Miyun Reservoir has been used as drinking water storage for Beijing since 1997. The water quality of Miyun Reservoir directly affects the health and safety of the residents of Beijing.

On the eastern side of the reservoir, there are rich iron ore resources. Frequent mining activities produce dust, mill tailings and large quantities of acidic drainage from the oxides generated by mining, beneficiation and smelting. Each of these influences the soil and water of the area. This study took place in the iron ore area along the banks of the Chao River. Soil samples were gathered from typical iron ore mining areas (Fig. 1).

2.2. Sampling and analytical methods

Thirty soil samples were collected from separate locations in an area of iron ore along the bank of Chao River according to the sampling grid shown in Fig. 1. Each soil sample (or bulk sample) was taken from the surface (0–15 cm) using a soil spade and stored in plastic bags. We took precautions to ensure that, the samples were not affected by metal equipments or tools. At each sampling site, composite samples were obtained by mixing subsamples from four points taken from each corner of a 1 m² square. We used surface soil because trace element additions to soils occurred mostly in top-soil. Soil samples were stored in polyethylene bags and kept at 4 °C prior to sample preparation and analyses. Samples were air-dried, gently crushed and sieved at 2 mm with a plastic sieve and then ground, homogenized with an agate mortar and sieved again through a 200 mesh sieve for laboratory analyses.

In according to the method that choosing the first and third in singular line of the grid, selecting the fourth and sixth in dual line, we selected 10 samples. Then according to the principle of clay (<2 μm), fine powder sand grains (2–5 μm), coarse powder sand grains (5–50 μm) and sand (>50 μm), the selected 10 samples were partitioned into seven size fractions: <2 μm, 2–5 μm, 5–10 μm, 10–50 μm, 50–74 μm, 74–165 μm and 165–350 μm. To separate them, the air-dried soil samples were passed, through a 40 mesh (350 μm), 100 mesh (165 μm)

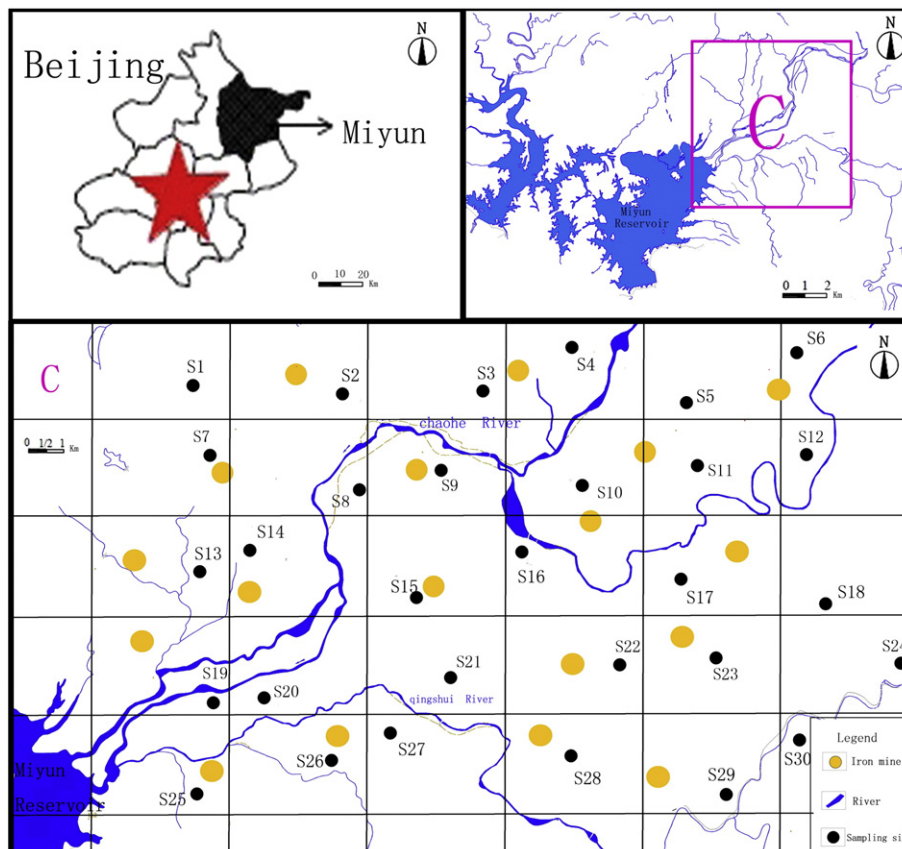


Fig. 1. Schematic map of the study area and sampling points.

Download English Version:

<https://daneshyari.com/en/article/4457447>

Download Persian Version:

<https://daneshyari.com/article/4457447>

[Daneshyari.com](https://daneshyari.com)