Accumulation of trace elements on the surface soil around the Trail smelter, British Columbia, Canada

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Abstract The quantities of six elements (As, Cd, Cu, Hg, Pb, and Zn) were determined in surface soil from 21 stations around the zinc–lead smelter in Trail, British Columbia, Canada. The flux of elements into a unit of soil was then calculated by extrapolating aerial deposition monitoring data obtained from flat square moss bags, which act as traps for airborne particles/elements. The net increase in the quantity of elements in a 10 cm deep by 1 hectare soil unit over a 3-month time interval was estimated as 0.02, 0.65, 0.07, 0.29, 0.22, and 0.65% for As, Cd, Cu, Hg, Pb, and Zn, respectively. The results of this study can be used for elemental inventory of soil in the Trail area and to predict the long-term degree of accumulation of trace elements in the soil. The significant correlation between the deposition rate of Pb, Zn, Cd, and Cu as registered by moss monitoring stations and the quantity of these elements in surface soil indicate the possible effect of airborne material on the geochemistry of the soils in the study area. In contrast, the poor correlation for Hg and As indicates that the variations of these elements in soil samples are likely related to soil chemistry rather than atmospheric deposition. This demonstrates the importance of monitoring for atmospheric deposition of elements since soil is not always a good indicator of the spatial influence of a point source in the study area.

Keywords Soil · Pollution · Trace elements · Metals · Zinc · Lead · Trail smelter · British Columbia

Introduction

Trail, British Columbia, is situated within the Columbia River Valley, and is the site of a large zinc and lead smelting operation. Major stack and discharge sources of the Trail operation are equipped with baghouses, electrostatic precipitators, and scrubbers. Despite these preventative measures metals are still released into the atmosphere. The atmospheric deposition of airborne particles and their associated elements in the surrounding area of Trail smelter has been assessed using flat moss bags (Goodarzi and others 2001). This monitoring method provides a quantitative understanding of the impact of a point source on its surrounding environment for a given period of time (Temple and others 1981; Martin and Coughrey 1982; Tripathi and others 1993). Moss monitoring provides information on the flux and deposition rate of airborne particulates and elements on land by using an artificial deposition surface, which simulates the deposition on the soil surface (mainly covered by undecomposed organic matter). Flat square moss bags of known dimensions facilitate calculating deposition rates on a unit area basis (Martin and Coughrey 1982), which can be extrapolated to larger areas. Cross calibrations between flat moss bags and several types of standard deposition gauges show good correlation, which enhances confidence in extrapolating from moss monitoring data to deposition units (Goodman and others 1975a, 1975b; Ratcliffe 1975). However, it is prudent to calibrate the estimation of deposition rate obtained by moss monitoring stations with standard deposition monitoring methods (Martin and Coughrey 1982).

In this paper, the concentration of trace elements in surface soil, prior to the monitoring study is presented.