Perspective on smelter emissions of metals in the environment: an introduction

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Mining industries and metal refineries represent an important economic sector for many countries. However, environmental issues are gaining interest and sustainable development requires that metal industries minimize threats for air, water and soil quality. For years, smelters represented the dominant sources of metals and SO₂ released to the environment in Canada. Recently, the smelter operators have lowered their atmospheric releases in the environment by up to 90% depending on the chemical species of interest and on the type of smelting (e.g. Cominco Ltd 2000; Pollution Probe 2003). The pertinence of studying releases from smelters is underscored by the prominent role smelters played as anthropogenic point sources. One key scientific question relating to smelter releases is the evaluation of the past and present contributions of smelters in mining districts where metals released by the smelting process are added to extensive geogenic contributions. Quantifying and understanding the fate of current emissions of metals and their accumulation during the twentieth century in mining districts requires methodical investigations.

This Special Issue of Geochemistry: Exploration, Environment, Analysis includes papers produced through the research activities of the Geological Survey of Canada’s Metals in the Environment programme (GSC-MITE), the Metals in the Environment Research Network (MITE-RN) and the Toxic Substances Research Initiative (TSRI), which were conducted in Canada during the period 1997–2004 in an effort to advance the understanding of accumulations of metals due to point source releases. Three facilities, Noranda’s copper smelter at Rouyn-Noranda, Quebec, Cominco’s zinc smelter at Trail, British Columbia, and Noranda’s Brunswick lead smelter at Belledune, New Brunswick, were selected for detailed studies. In these three cases, the regional geology is well known, the emission records are partly available and the temporal changes in metal emissions since 1980 indicate that the new regulations and resulting controls on emissions have significantly lowered the smelter releases of Pb and Cd during the 1990s.

The particular interest of this issue resides in its combination of plume characterization from the point sources with various spatio-temporal records of receptor media. In other words, this geoscientific, spatio-temporal approach surveys the space around the smelters using complementary types of records such as air (sampled in the plumes emitted and at surface-based stations), snow, peat bogs, soil horizons, marine and lake sediments, plus lake fossils and tree rings for historical perspectives. The smelter impacts are evaluated using shape, size and chemistry of emissions; distance from the source at which the emissions are deposited to the surface; specific protocols to consider when investigating diverse media such as plumes or lake sediments; methods to distinguish between geogenic and anthropogenic metals in the environment; methods to delineate aureoles of influence; and temporal evolution of metal accumulations in the environment. The assorted characteristics of smelter-emitted metal-bearing solids allow their identification and the quantification of their contribution to metal loads of air, snow, soils, trees, lake sediments and water. Delineation of smelter anomalies is approached by mathematical estimation, direct measurement of multi-element ratios and analyses of isotopic ratios at progressively higher distance from the point source, and investigations are assessing whether time series reflecting the point source inputs can be provided using archival geological systems.

Overall, the man-made cycle of extraction of metals from their natural setting through mining, and their concentration for industrial and commercial use through smelting, release a fraction to the surface environment of the Earth. This transfer system creates a significant dispersion of potentially toxic metals in various sinks in which the persistence of metals should be understood. It is hoped that the scientific knowledge provided in this Special Issue will help decision-making for sustainable development in metal-producing countries.

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REFERENCES
