ASSESSMENT OF TRANSBOUNDARY METAL DEPOSITION FROM A COPPER-NICKEL SMELTER COMPLEX USING PEAT FROM AN OMBROTROPHIC BOG

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Introduction

Emissions of airborne potentially toxic elements (PTEs) from large industrial complexes contribute to the long-range transboundary pollutant transport covered since 1981 by the EMEP co-operative program, but also create environmental problems in the vicinity of an enterprise location. An extent of hazard to the environment is determined by the cumulative spatial dry and wet deposition during the entire history of enterprise operation, independently upon its current pollution control status. This has been exemplified here in the study on trace element concentrations in peat cores taken from a peat bog in the Svanvik area (northern Norway, 69.41743^{0}N, 29.95375^{0}E, 26 m ASL) predominantly affected by the transboundary transport and deposition of trace elements from one of the world largest Cu-Ni smelter complexes in Nikel and Zapoliarnyj located in Russia close to the Norwegian border, about 10 km east of Svanvik. The complex is operated since 1933, with increasing production since the 1950s (SFT, 2002; Norwegian Environment Agency, 2015).

Methods

Three undisturbed peat cores were collected down to 46 cm depth. The sampled peat bog was an apparent ombrotrophic bog containing peat of *Sphagnum* type, 4.33<pH<5.19, mean pH 4.75, Eh 218.7-275.5, mean 238.6, low decomposition rate (12 to 35%), moisture content 73.9- 91.4%, and ash content 2-3%. In the laboratory the cores were sliced in layers 3 cm thick. All samples were air-dried, digested in 14 M HNO_3, and analysed at NTNU for 61 elements using ICP-MS. Core chronology was assessed by the use of ^{14}C dating.

Results

Almost all elements occurred in the highest concentrations in the uppermost 0-3cm layer representing the contemporary period since 1990 (Table 1). In the layers from 9 cm upward (since 1950), a regular concentration increase was observed, in general conformity with the reported dynamic increase of Cu-Ni production and growing emission from the above source. Rare earth metals, platinum and gold that accompanied Cu and Ni in ores and emitted in very low concentrations followed the same pattern. The element concentrations in the layers 21-9 cm, reflecting the beginning of smelting activity (1930-1950), showed a generally weakly increasing trend. In the layers from 26 cm upward (since 1910) iron ore mining in Bjørnevatn, NE from Svanvik, or long-range atmospheric transport may have contributed to some extent to element deposition (Fe, Cu, Zn, Ag), while below 30 cm there should not be any anthropogenic impact. However, the majority of elements show downward redistribution related to their mobility rate distorting the original element enrichment pattern resulted from dry and wet deposition (Fig. 1).

Table 1. Maximum concentrations (C_{max}, µg/g) and enrichment factors(EF_{max}) of selected elements in the uppermost 0-3 cm layer in Svanvik peat bog receiving deposition from the Nikel and Zapolarnyj Cu-Ni smelting plants in Russia

Ni		Cu		Cr		V		As		Sb		Pb	
$C_{max,}$	EF_{max}	$C_{max,}$	EF_{max}	$C_{max,}$.	EF_{max}	$C_{max,}$	EF_{max}	$C_{max,}$	EF_{max}	$C_{max,}$	EF_{max}	$C_{max,}$	EF_{max}
715.6	1154	579.7	392	19.65.	123	7.37	67	7.49	20	7.744	18	16.22	15

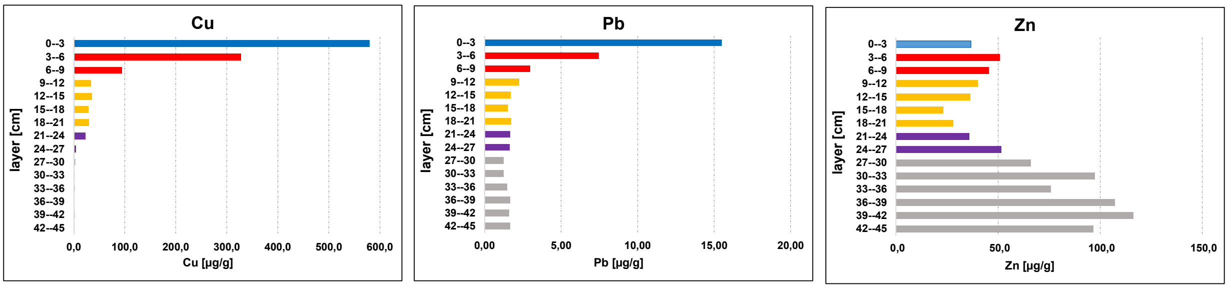

Figure 1. Patterns of vertical distribution of trace elements along peat bog profile influenced by element mobility: (a) weak impact (Cu); (b) moderate impact (Pb); (c) strong impact (Zn). ■ – 2014-1990; ■ – 1990-1950; ■ - 1950-1930; ■ – 1930-1910; ■ – older than 1910.

Conclusion

Peat from an ombrotrophic bog may be a valuable tool for retrospective assessment, qualitative identification of pollution with airborne trace elements and quantitative evaluation of cumulative pollution loads of contaminants, provided that the vertical redistribution of elements caused by their mobility is considered. Studies on the effect of large single sources may greatly contribute to clarification of element mobility rates in peat profiles and adequate corrections of evaluations.

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