

Major and Trace Element Accumulation in Peat from Bogs in Latvia

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Raised bog peat can serve as an efficient capture of trace and major elements appearing in atmospheric precipitation or wastewaters from local sources in adjacent areas and thus can be considered a good indicator of recent and historical changes in the pollution load. In this study trace and major elements and the character of their accumulation in peat, with a particular emphasis on peat properties and the impact of local and regional pollution sources on the character of element accumulation in ombrotrophic bogs in Latvia, have been analyzed. The values of the element concentrations and their frequency of occurrence in peat taken from 44 bogs in Latvia reflect the local processes that affect element concentrations in the peat mass, indicating accumulation of trace elements, apparently of anthropogenic origin (Pb, Cd, Co, Ni, and others) in the upper layers of the peat profiles. In addition, they indicate accumulation of several elements (for example, As, Cr, and others) in the deeper layers of peat, possibly due to the feeding pattern, depending on the saturation of the groundwater. The trace element sorption capacity onto peat is influenced by peat properties and depends on the concentration of oxygen-containing functional groups in peat, and it grows with the increase of the degree of decomposition and humic/fulvic acid ratio of peat humic matter. Peat seems to be largely unsaturated in respect to metal ions, but the peat sorption capacity can be correlated with the presence of nitrogen-containing ligands and humic/fulvic acid ratio.

Keywords: peat, trace and major elements, accumulation, pollution.

INTRODUCTION

Bogs are considered to be an important nature value throughout the world. Bogs have been formed by accumulation of peat – a light brown-to-black organic material, built up from partial decomposition of mosses and other bryophytes, sedges, grasses, shrubs, or trees under waterlogged conditions (Coccozza et al., 2003). The developed surface area and large number of acidic functional groups are common to peat, and determine the ability to bind trace elements included in remains of living organic matter, either as a sedimentary, deposited, particulate matter or as sorbed or complexed metal ions (Brown et al., 2000). The major sources of metals in the peat mass thus can be attributed to metals present in the peat-forming plants as well as in supply of groundwater and atmospheric

precipitation. The ability of peat to accumulate trace metals depends on the affinity of metal ions to bind with the common functionalities in the structure of peat (Rinquist and Ohorn, 2002). Other factors influencing trace metal accumulation in peat are pH of the bog waters, the presence of complex-forming substances of low molecular weight (for example, carboxylic acids), as well as a number of other dissolved substances (for example, sulphate ions or hydrogen sulphide) (Tipping et al., 2003). As it has been demonstrated in numerous studies carried out over the last decades, significant increases of accumulation of trace metals in peat have been observed due to an increasing anthropogenic pollution. Peat serves as an efficient trap for trace elements brought with atmospheric precipitation or wastewaters from local sources in the adjacent areas (Martinez Cortizas et al., 2002; Coggins et al., 2006; Shotyky et al., 2001; Kalnina et al., 2003). It has been stated that peat can serve as a good indicator of both recent and historical changes in the pollution loading (Shotyky et al., 2002). At the same time, the metal accumulations in peat depend on the region; therefore, it is important to analyze trace elements regionally with regard to their distance from the pollution source. Another reason why trace metal analysis in peat mass is important is the possible environmental and human health implications in cases when peat is used as fuel, or in agriculture and other applications in the case the accumulated trace metal amounts are released in concentrated forms (by ash) and contaminate the environment. Also, a significant amount of organic carbon is stored in the form of peat, and thus peat use could play a significant role in the trace metal biogeochemical cycling. Metal accumulation in peat has been quite widely studied in west European countries (Damman, 1978; Martinez Cortizas et al., 2002; Ukonmaanako et al., 2004; Coggins et al., 2006; Shotyky et al., 2001; Shotyky et al., 2002; Shotyky, 2002), as well as in various territories in the vicinity of pollution sources, including Latvia's neighbor country Estonia (Syrovetsnik et al., 2004; Orru and Orru, 2006). In Latvia the area of peatlands covers 10.7% of the entire territory and raised bogs occupy 41.7% of the whole area covered by peatlands (Pakalne and Kalnina, 2005). There are numerous raised bogs where peat mining is of a definite industrial importance (Snore, 2004); at the same time, the territory of the country is relatively unpolluted as attested by the moss monitoring results (Nikodemus et al., 2004).

The objective of this article is to study the characteristics of trace metal accumulation in peat with respect to peat properties and the impact of local and regional pollution sources on metal accumulation in ombrotrophic bogs.

MATERIALS AND METHODS

Site Location

Peat sampling was carried out in 44 representative raised bogs in Latvia (Fig. 1). To choose the most important sampling sites, certain locations of the bogs on the territory of Latvia were selected to ensure representative geographical coverage of

the geomorphological setting of the sampling sites (Pakalne and Kalnina, 2005). Several of the sampled bogs are of industrial importance (Olaines, Stružānu, Sedas, etc).

Multidisciplinary proxy studies have been done in 2 ombrotrophic bogs located in the central part of Latvia in the Rīga District: the Eipurs Bog and the Dzelve-Kronis Bog (Fig. 1) located in lowlands (Coastal Lowland and Middle Latvia Lowland). They are of similar origin, but of very different lithology. Both bogs have developed due to ground paludification and are typical raised bogs containing a number of bog lakes and pools. The studied bogs have not been affected by direct pollution sources either in the past or at present.

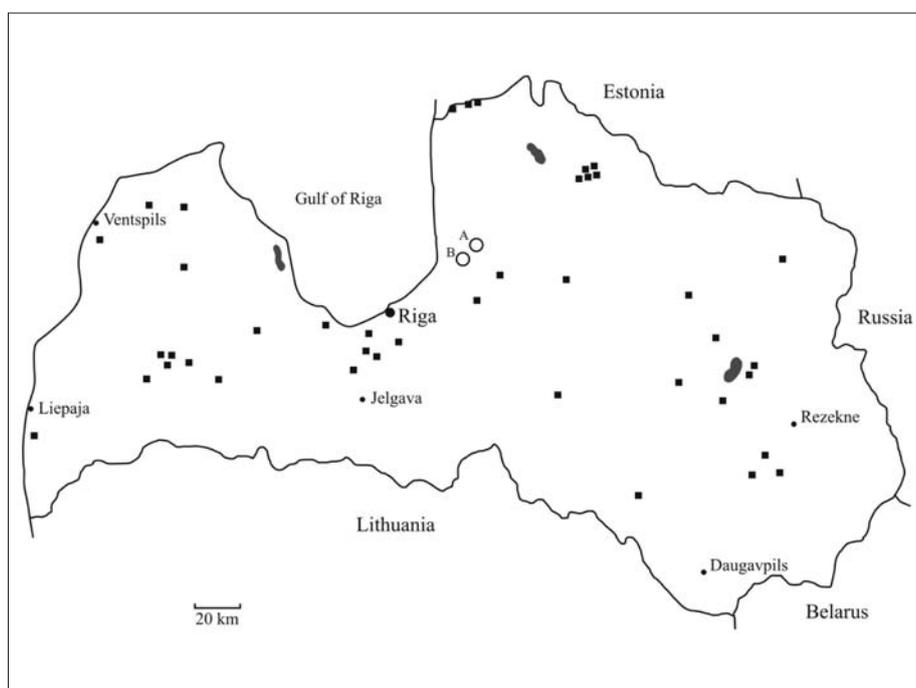


Figure 1. Sampling sites – ■; sites for in-depth studies – ○; A – Eipurs Bog; C – Dzelve-Kronis Bog

Sampling

Coring and peat sampling have been accomplished in the cupola area of each bog, where the surface peat layers are elevated up to 2–4 m beyond the edge of the bog and have not been influenced by peat sliding (as suggested by Shotyk et al., 2001, and Coggins et al., 2006). The peat samples (50 cm long monoliths) were put in a special cartridge and wrapped in polyethylene film to preserve natural moisture, brought to the lab and sliced into 5 cm sections using a stainless steel

knife. The outside edges were systematically discarded, as those could have been contaminated during the sampling. The first slice (+3 to 0 cm) corresponded to the living plant material on the bog surface. For survey of metal concentration in peat in the remaining 42 studied bogs, in each site three peat cores were sampled using a corer ($\phi = 10$ cm). Excess surface vegetation was removed *in situ* to facilitate penetration of the peat surface. Samples of peat were taken up to a depth of at least 50 cm. In the case of industrially mined bogs (where the surface layer has been already removed), the upper layer (~ 20 cm) was removed and the sampling done starting from that depth.

Peat Sample Preparation and Analysis of Physical and Chemical Properties

Peat material was oven-dried at 105 °C in Teflon bowls and ground in a centrifugal mill. The ash content, expressed as a percentage of the initial dry weight, was determined by combustion at 550 °C for 12 h; all peat samples were analyzed twice.

All the reagents used in the procedures were of analytical grade. Cleaning of plastic and glassware was carried out before the procedure by soaking in 14% (v/v) HNO₃ for 24 h and then rinsing with Millipore water.

Major elements and trace metals and elements were determined after acid digestion (Krachler et al., 2001; Tan, 2005). Acid digestion consisted of a two step dissolution in Savilex beakers: 1) 100 mg of peat sample were transferred into beakers placed in the aluminum heating block (Biosan, Latvia) and digested with 5 ml of nitric acid, 65% cc. (Merck) and 1 ml of H₂O₂ 30% p.a. at 130 °C for 12 h for organic matrix dissolution; 2) addition of 5 ml of nitric acid, 65% cc. (Merck) and 0.5 ml HF suprapur (Merck) for additional 6 h at 130 °C. When room temperature was reached, the completely clear, homogeneous solutions in the digestion vessels were quantitatively transferred into 10 ml calibrated flats and filled up to the mark with 10% HCl.

Metal (Fe, Mn, Zn, Cu, Mg, Ca, Cd, Pb, Co, Cr, Ni, Mo) and As concentrations were measured with graphite furnace atomic absorption (GFAA) (Perkin-Elmer AAnalyst 200) with background correction. Na, K was measured using flame photometer PAZ-3 with air-propane flame. Trace element (Se, V, Sr) concentrations were measured with total-reflection X-ray fluorescence spectrometry (TXRF). The acid digested peat samples were pre-spiked with 100 ng/ml Ga(III) as internal standard and dried (30 μ l aliquots) on pre-cleaned quartz glass carriers, mostly resulting in homogeneous and transparent "polymer" films. The analytes were determined with a TXRF spectrometer (Röntec PicoTAX TXRF, Röntec GmbH); excitation: Mo tube operated at 50 kV and 1 mA, (live time 1000 s) equipped with a Ni/C reflection module (reflectivity 80%) and Be detector (area 10 mm², thickness 7.5 μ m). Quality assurance was ensured with reference materials: NIST SRM 1547 peach leaves, NIST SRM

1575 pine needles, BCR 482 lichen. Accuracy was between 1–10% for major elements and 1–2% for trace elements. Detection limits were lower than 1 mg/kg for major elements. Detection limits for trace metals and other trace elements were lower than 1 µg/kg.

Peat Decomposition Analysis

Peat decomposition degree is a very important property of peat for evaluation of element accumulation. It was estimated using the centrifuging method according to Standard GOST 10650-71.

Peat Botanical Composition and Pollen Analysis

Peat botanical composition is closely related to plant-feeding conditions, characteristics of bog depression, relief, underlying deposits and the degree groundwater mineralisation, which substantially affect the degree peat decomposition, moisture, and physical-mechanical properties (Tjuremnov, 1976).

Sorption Capacity (by Sun et al., 2004)

To remove absorbed major and trace elements, acid washing was performed, treating 5.00 g of peat with 0.1 N HNO₃ in a glass beaker overnight, carefully washing with Millipore water until H⁺ ions were removed, and drying at 105 °C. 1.00 g of acid-washed peat was thoroughly mixed into 100 ml of 100 mg/l of Cu(NO₃)₂ in a glass bottle. The peat suspension was shaken for 24 h at 20 °C and 175 rpm to ensure that adsorption equilibriums were established. After filtration the Cu concentration in the filtrate was determined with GFAAS, and the sorbed Cu amount calculated as a difference. Each sorption experiment was done in triplicate.

Data Treatment

Statistical analyses were performed using SPSS 16 software. Fitting of the obtained data to normal distribution was checked with the Kolmogorov-Smirnov test. In further analysis non-parametric methods were used. Relationships between different characteristics were assessed with the help of Spearman rank correlation coefficients. In all cases the significance level was $p = 0.05$.

RESULTS AND DISCUSSION

Major and Trace Element Concentrations in Peat of Latvia

The absolute values of element concentration and their intervals (Fig. 2) determined in peat of Latvia are in general similar to that reported in Estonia, Sweden, Belgium, and other countries (Frontasyeva and Steinnes, 2005; Orru and Orru, 2006; de Vleeschouwer et al., 2007); at the same time, the data reflect

the local processes affecting element concentrations in the peat mass. This may be related to major elements (Na, K), which are found in lower concentrations than, for example, in Norway, where sea salt aerosol-containing precipitation causes elevated concentrations of them, as well as to elements such as Ca, Mg, and Fe.

In the peat bulk mass, which is of industrial importance, the trace element concentration is low, especially if compared with element concentrations in other countries (Table 1). This aspect may be of importance considering the industrial uses of peat in agriculture. We can assume that the determined concentrations of trace elements in peat ash composition (if peat is used as fuel), especially if compared with the concentrations of major elements (Mg, Fe, Ca), could not cause significant harm.

Table 1. Major and trace element concentrations (mg/kg) in peat from 44 bogs in Latvia and other countries

Element	This study	Peat, Norway ⁱ	Peat, Estonia ⁱⁱ	Peat, Belgium ⁱⁱⁱ
Na	101	698	n. d.	n. d.
Mg	569	2210	n. d.	n. d.
K	65	1465	n. d.	n. d.
Ca	4784	3830	n. d.	n. d.
Sc	0.31	0.52	n. d.	n. d.
V	1.33	3.75	0.51	n. d.
Cr	1.17	12.5	0.39	n. d.
Mn	14.47	75.4	14.16	n. d.
Fe	1062	2050	n. d.	n. d.
Co	0.14	0.93	0.09	n. d.
Ni	1.38	4.30	0.71	14.2
Cu	2.19	5.00	1.36	8.4
Zn	10.6	48	8.54	106
As	1.19	0.50	0.89	n. d.
Se	0.16	0.37	n. d.	n. d.
Mo	0.32	0.85	0.21	n. d.
Ag	0.07	0.06	n. d.	n. d.
Cd	0.14	n. d.	0.19	n. d.
Pb	4.77	n. d.	9.62	61.6

ⁱ Frontasyeva and Steinnes, 2005

ⁱⁱ Orru and Orru, 2006

ⁱⁱⁱ de Vleeschouwer et al., 2007

The correlation matrix calculated for 14 elements analyzed in the studied peat is presented in Table 2. The element pairs Mn-Fe, Ca-Mn, Co-Mn, Fe-As, Fe-Ni, Fe-Ca, and Na-K were all significantly correlated. Strongest correlations were amongst the element pairs of evidently natural origin, for example, Na-K, Fe-Mn, Fe-Ca (Table 2). Correlations such as Cu-Cr, Cd-Co, Fe-Ni, Fe-Pb might be

attributed to industrial activity and long-range transport of pollutants (Percy and Borland, 1985). For some elements (Cu, Zn, Mn, Ni, As) of importance could be both anthropogenic and natural sources.

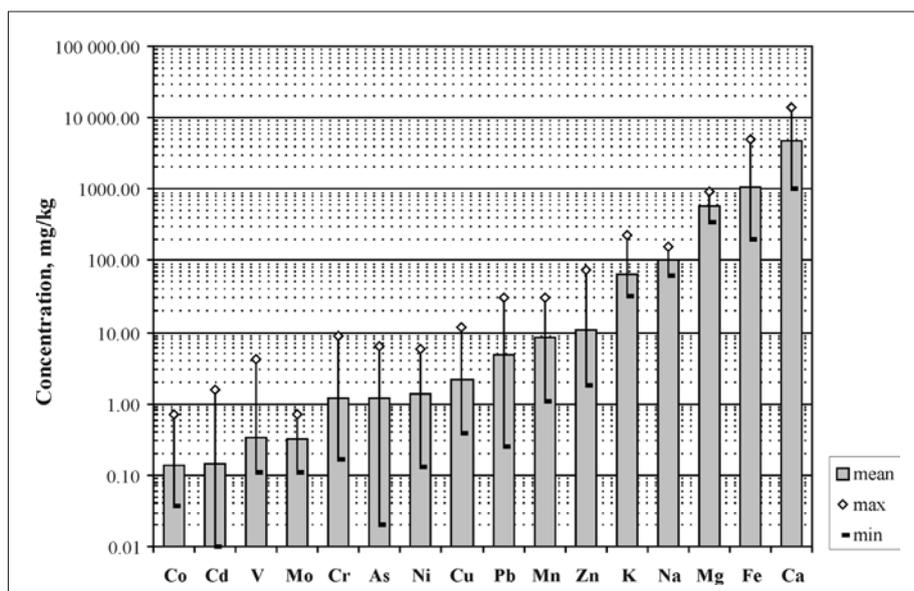


Figure 2. Concentrations of major and trace elements in peat of Latvia

Table 2. Correlation coefficient matrix of analyses of major and trace elements in peat of Latvia

Mn	0.93													
Zn	-0.27	-0.02												
Cu	0.45	0.42	-0.12											
Mg	0.11	0.21	-0.03	0.04										
Ca	0.90	0.83	-0.32	0.52	0.14									
Cd	0.08	0.23	0.37	0.39	0.06	0.16*								
Pb	-0.20	-0.03	0.61	0.03	-0.15	-0.29	0.50							
Co	0.79	0.73	-0.08	0.30	-0.25	0.58	0.04	0.05						
Cr	0.45	0.47	0.05	0.70	-0.03	0.49	0.49	0.20*	0.32					
Ni	0.77	0.75	-0.11	0.59	0.15*	0.86	0.42	-0.02	0.52	0.64				
As	0.83	0.77	-0.07	0.48	-0.01	0.71	0.23	0.10	0.80	0.48	0.75			
Na	-0.42	-0.33	0.15*	-0.28	0.48	-0.52	-0.08	0.08	-0.46	-0.29	-0.44	-0.41		
K	-0.42	-0.25	0.30	-0.14	0.49	-0.52	0.13	0.33	-0.40	-0.12	-0.32	-0.39	0.75	
Fe		Mn	Zn	Cu	Mg	Ca	Cd	Pb	Co	Cr	Ni	As	Na	

* Correlation is significant at 0.05 level (two-tailed); **bold** – correlation is significant at 0.001 level (two-tailed).

Variations of Major and Trace Element Concentrations in the Peat Profiles

One of the aims of this study was to determine whether the element distribution in peat profiles from ombrotrophic Sphagnum bogs can help to identify anthropogenic activity (not only lead accumulation, as it has already been determined in many other studies, for example, by Martinez-Cortinas et al., 2002; Shotyk et al., 2001; Shotyk, 2002), as well as the degree to what the variability of peat properties influence trace metal accumulation patterns. For in-depth studies of the metal accumulation patterns in peat sections, two raised bogs in central part of Latvia have been selected. The results of the paleobotanical investigations (botanical composition, pollen analysis) indicate both differences and similarities in the development of the studied bogs and peat properties.

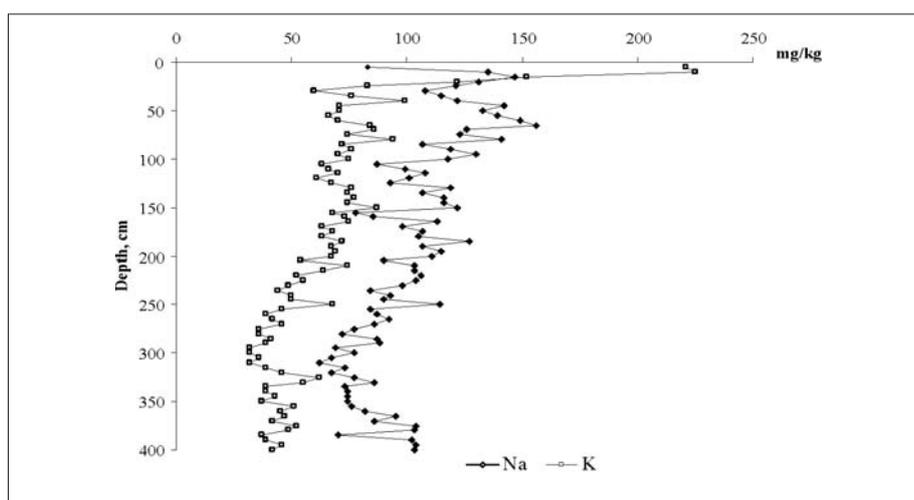
The trace element accumulation in peat is directly related to the record of human impact both on a regional and global scale (Shotyk, 2002). The history of the human impact on the territory of Latvia is characterized by the comparatively low industrial activity (especially if compared with many regions in southern and central Europe), since farming and land clearing was the dominant form of agriculture in this area for centuries. Only in the second half of the 19th century intensive development of industrial production began, first in Rīga and some other biggest cities; nevertheless, we could assume that the loading on environment, especially pollution with trace elements, was not very intense. The situation changed after World War II. Since the 90s of the 20th century, large-scale industrial production ceased again.

Concentrations of major and trace elements in the peat profiles of the studied bogs in Latvia demonstrate high variability (Fig. 3–6). Variability of the concentrations of the studied elements is equally high – major elements, possibly of natural origin (Na, K, Ca, Mg, Fe etc), and trace elements, presumably of anthropogenic origin (Pb, Cu, Cd, Ni, As).

Peat sections serve as an archive of storable profiles of major and trace elements. An exception to this is Na and K, as far as these elements are mobile, but their source could be atmospheric precipitation (sea salt and soil-born dust), released during the decay of living plants. As we can see in the example of the Eipurs Bog peat profile, Na and K concentrations (Fig. 3) are the highest in the top layer, then gradually decrease and slightly increase in the bottom layer. Na and K changes can influence the biogenic recycling and cause high mobility of these elements, considering the changes of the water table as well (Gorres and Frenzel, 1997). In contrast, the concentrations of other naturally occurring elements – Fe, Ca, Mg, Mn in the Eipurs Bog (Fig. 3) or in the Dzelve-Kronis Bog (Fig. 5) – are low in the upper layer and increased starting with depth of ~ 3 m in the Eipurs Bog, and 2.5 m in the Dzelve-Kronis Bog. The behavior of Fe could be related to high stability and mobility of Fe⁺² ions under reducing conditions to the extent that under such conditions these ions are readily soluble and may be

transported upward with the groundwater flow until conditions favor oxidation to the immobile Fe^{+3} . Fe and Mn behavior is also influenced by redox conditions, and these elements may behave similarly in peat. The enrichment in element concentration in the peat profiles is not limited to the uppermost peat layer of recent origin, where active moss growth and decay processes take place, involving metabolic mobilization of nutrients (including also K, Fe, but also elements as Ca, Mg, Cu, Zn).

Pb and Zn concentrations follow a similar trend at both sites: concentrations within the bulk of the peat profile are stable (and they can be considered background concentrations for corresponding elements in peat), but then steeply increase towards the surface of the bog, again slightly decreasing at approximately 10–20 cm below the surface. A sub-surface maximum is also observed for As, Ni. Increase in Pb accumulation coincided with the maximum use of leaded petrol in the USSR and west European countries. We could suppose that control of the use of leaded petrol in the late 1970s explained the decreasing trend of this element in the peat profiles. The timing of increased lead accumulation is similar to findings in peat cores from Ireland (Coggins et al., 2006), Germany (Shotyk, 2002), and other countries. We could assume that the increased levels of the studied trace elements, such as Cr, Ni, Co, As, Cu, Cd in the upper layers of the peat cores, can be related to air pollution due to industrial production. The studied elements are largely immobile in peat (Gorres and Frenzel, 1997); thus, they can be used as indicators of anthropogenic activity. Accumulation in deeper layers of the bog is characteristic of most of the dominant anthropogenic trace elements in the peat profiles, possibly due to the feeding pattern with the groundwater. The changes of the pattern of element concentration in the peat profiles from the studied bogs indicate that the major source of this element is weathering processes at the bottom layer of the bogs (Kalnina et al., 2003).



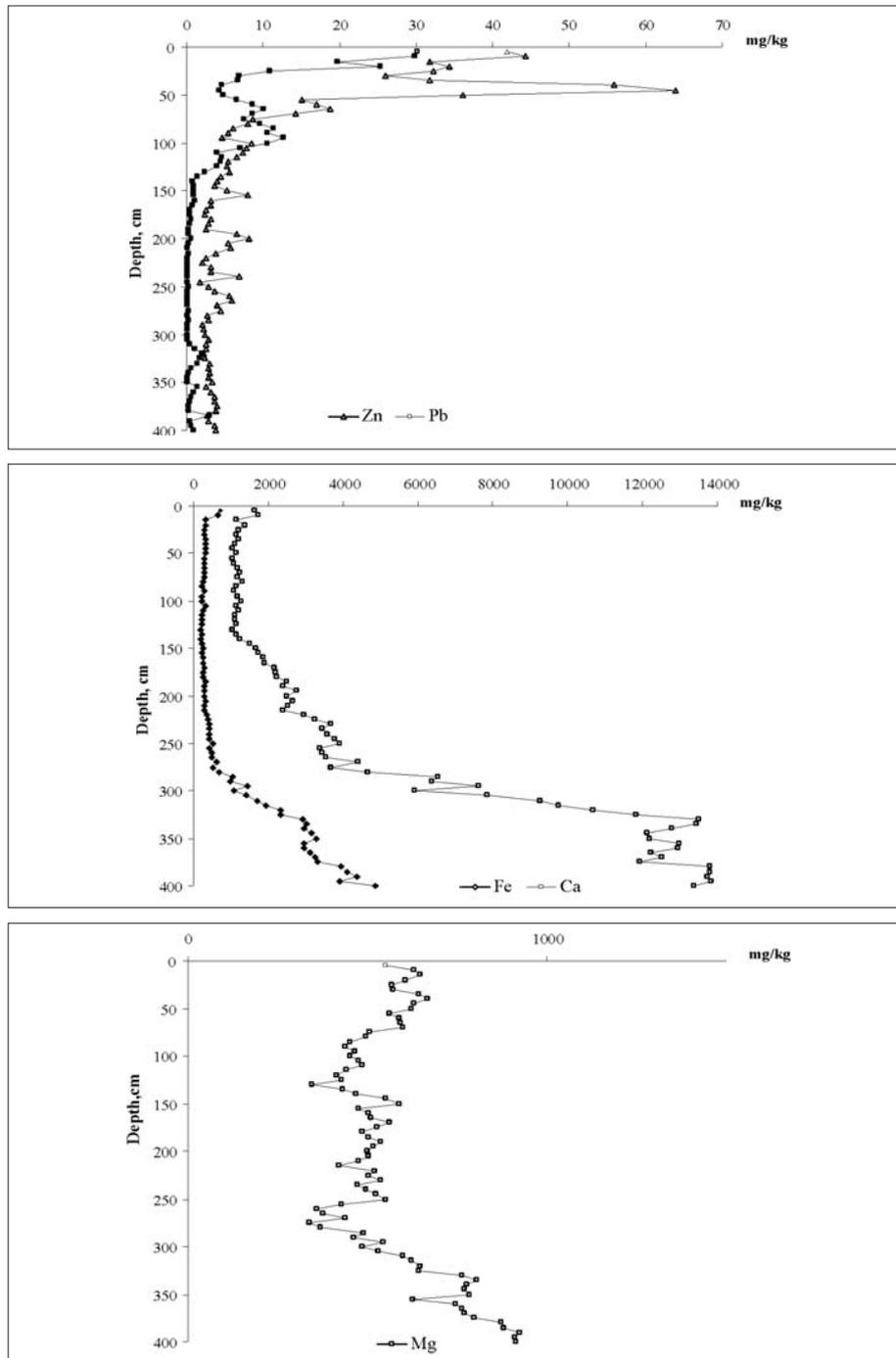
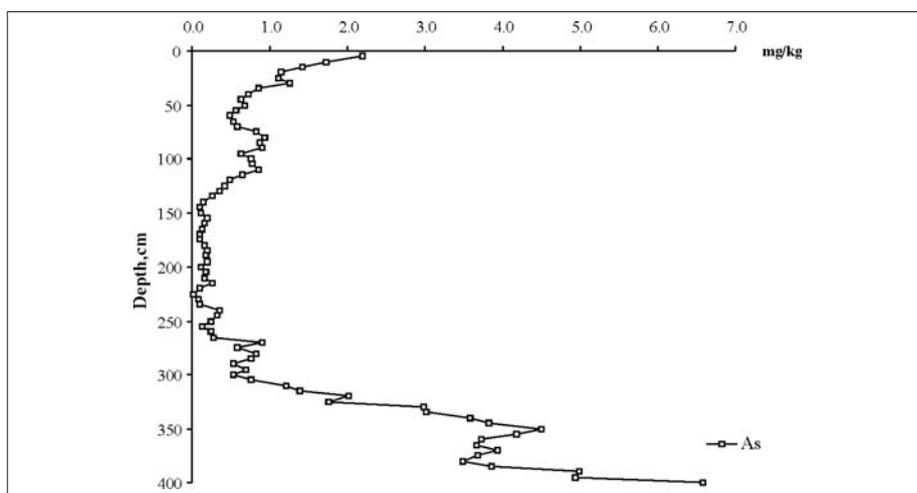
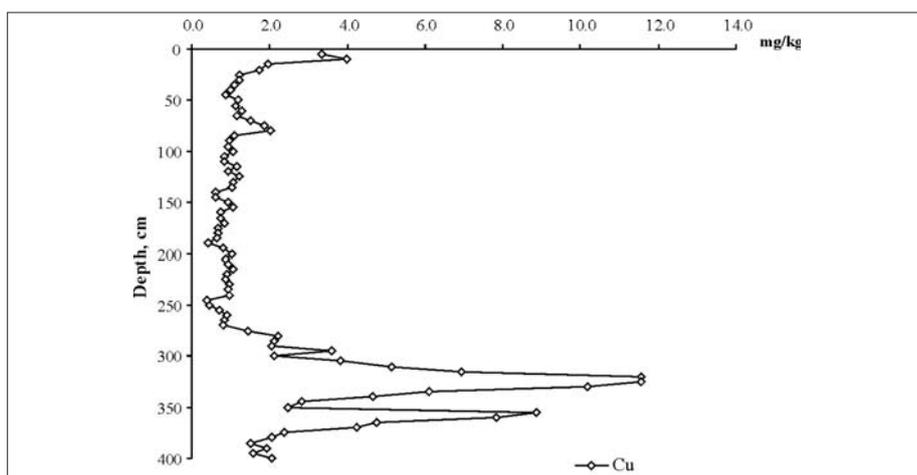
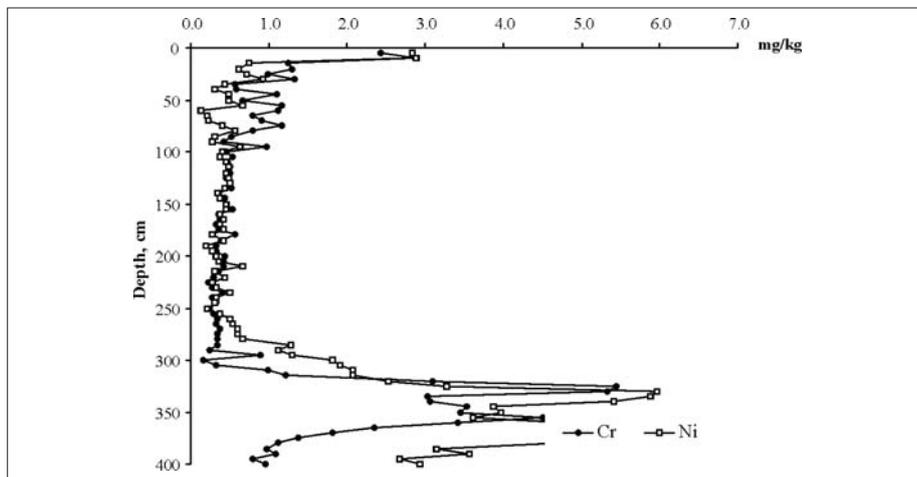


Figure 3. Na, K; Zn, Pb; Fe, Ca; and Mg concentrations (mg/kg) in the peat core from the Eipurs Bog



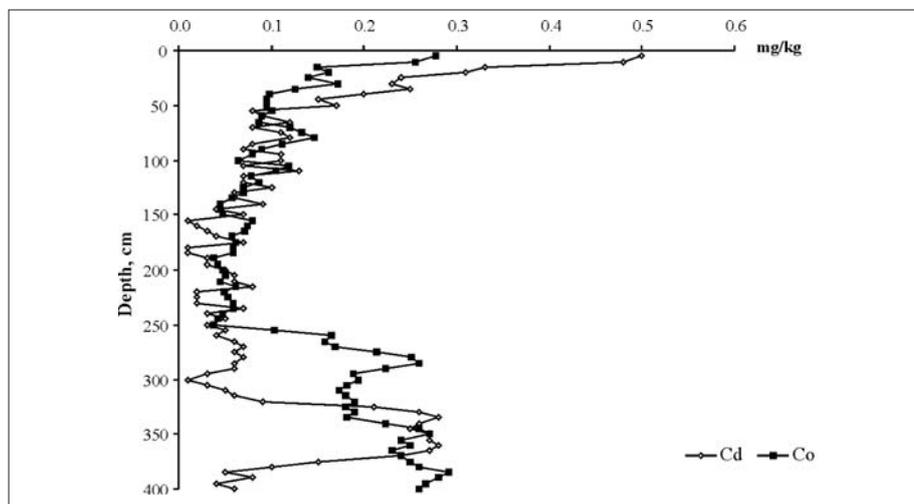
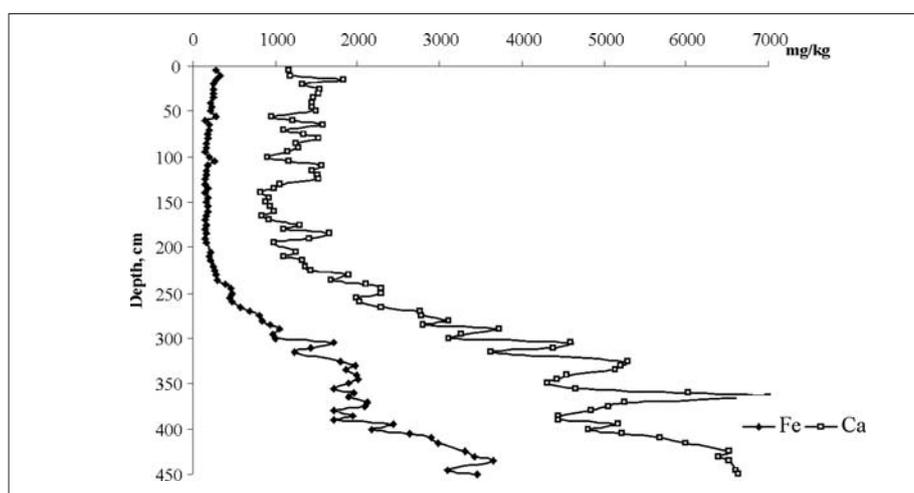


Figure 4. Cr, Ni; Cu; As; Cd; and Co concentrations (mg/kg) in the peat core from the Eipurs Bog

Comparatively increased values of As concentration are found in the upper 50 cm of the peat core (Fig. 4, 6). Arsenic concentrations decrease with depth, reaching lowest levels, and significantly increase again in the lowest part of the peat section. As Shotyk (1996) suggests, trends of As concentration changes in a peat column can reflect an increased anthropogenic load, for example, increased use of As-containing pesticides, use of P fertilizers, as well as coal burning. Behavior of As could also be influenced by redox conditions.



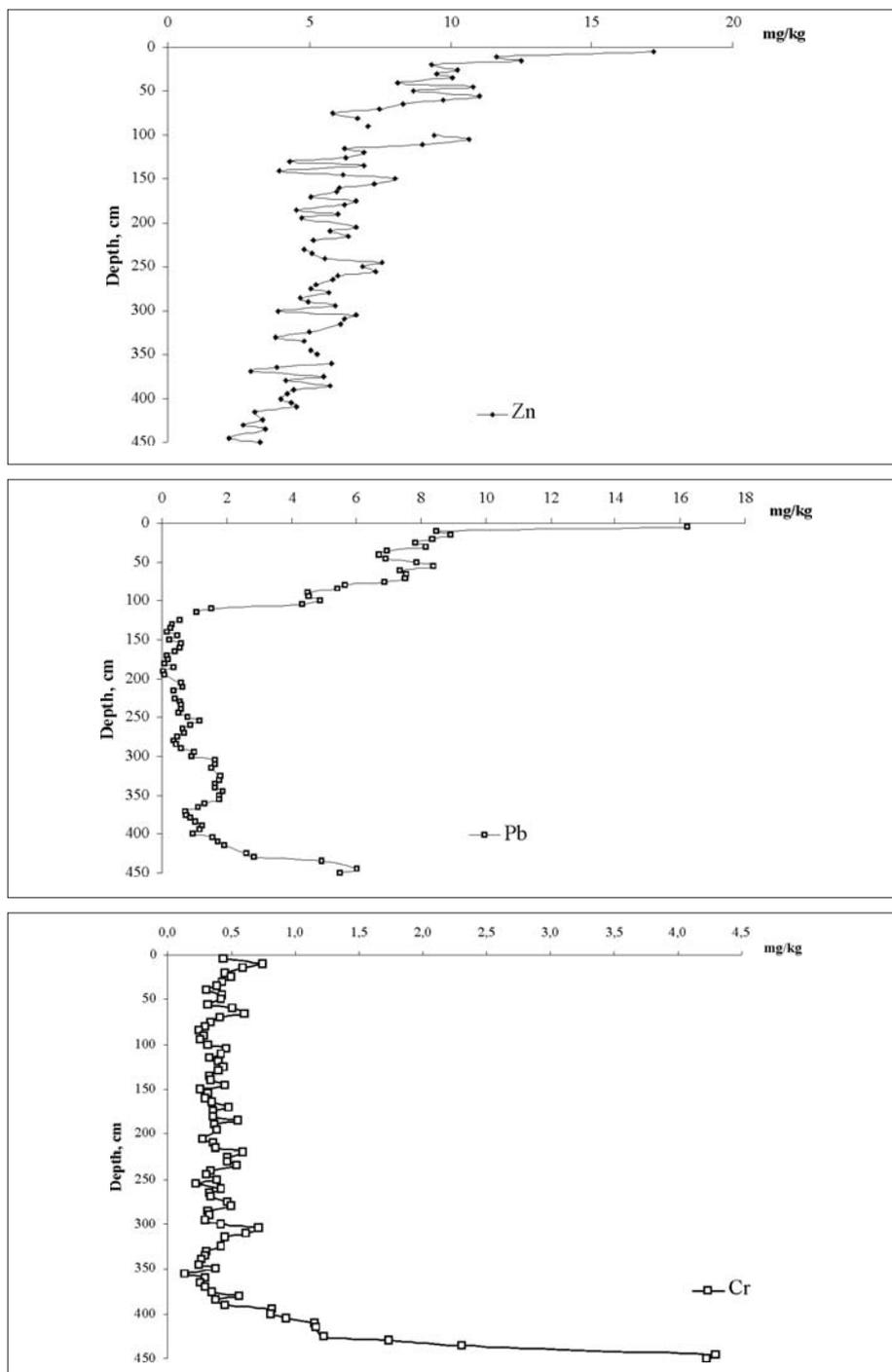
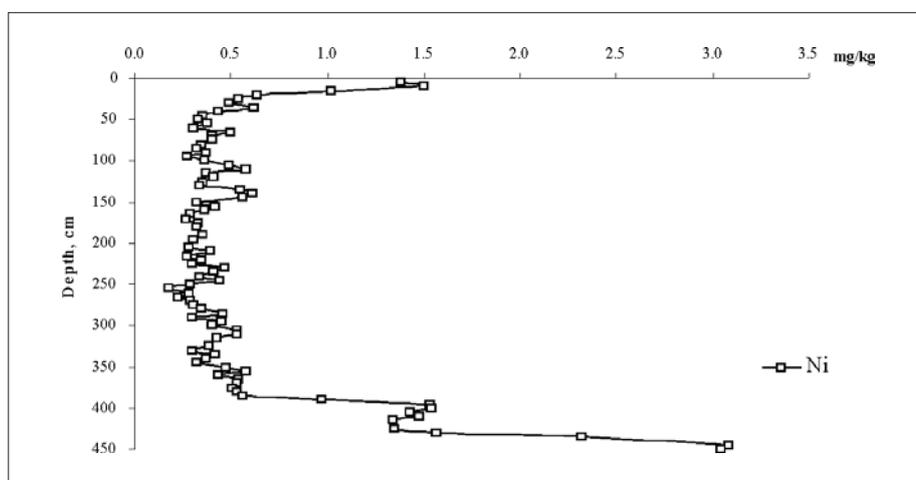
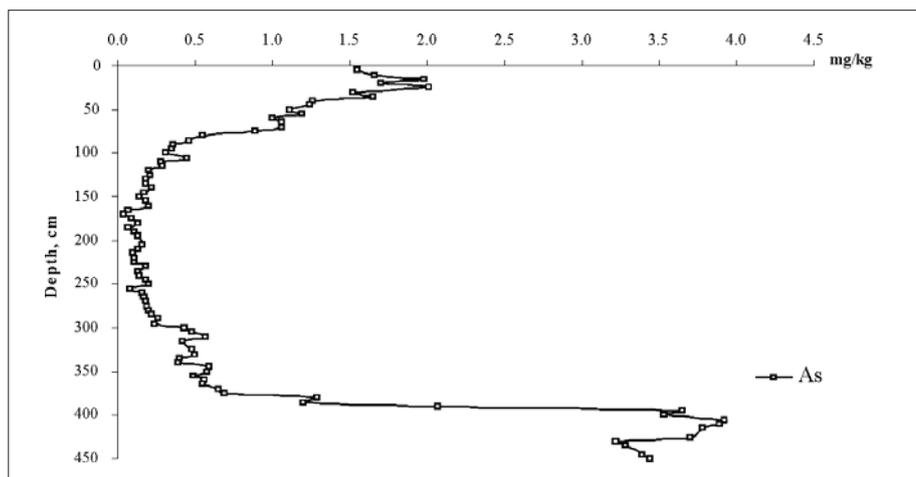
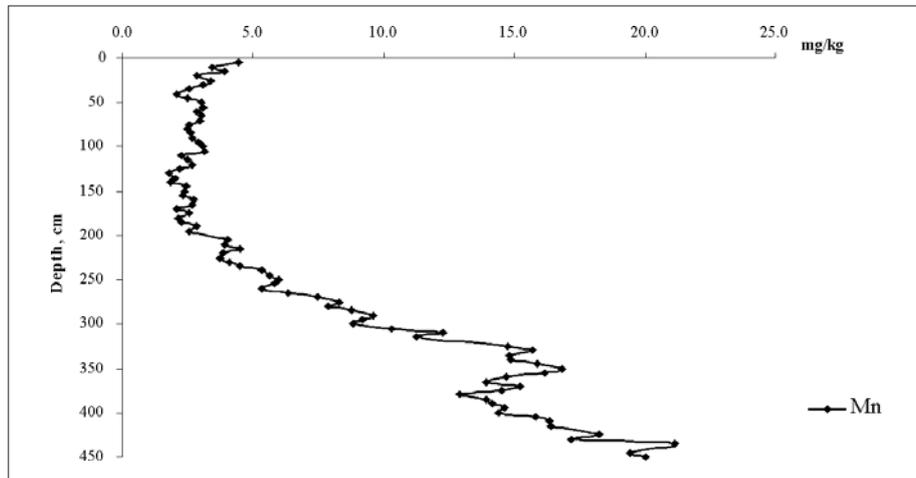


Figure 5. Fe, Ca; Zn; Pb; and Cr concentrations (mg/kg) in the peat core from the Dzelve-Kronis Bog



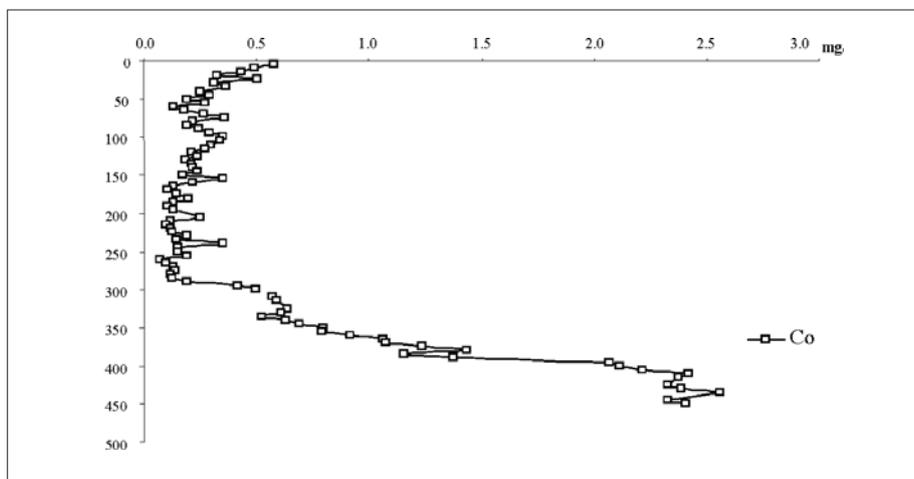


Figure 6. Mn; As; Ni; and Co concentrations (mg/kg) in the peat core from the Dzelve-Kronis Bog

Table 3. Correlation between trace elements in the peat from the Dzelve-Kronis Bog in depth of 0–50 cm

Mn	0.726*									
Zn	0.149	-0.088								
Cu	0.927	0.677*	-0.028							
Cd	0.025	0.272	-0.465	0.078						
Pb	0.784	0.658*	-0.148	0.898	-0.006					
Co	0.899	0.829	-0.185	0.922	0.323	0.869				
Cr	0.894	0.743*	0.046	0.947	0.240	0.846	0.934			
Ni	0.938	0.758*	0.015	0.962	0.209	0.789	0.934	0.969		
As	0.840	0.706*	-0.253	0.874	0.301	0.863	0.962	0.867	0.855	
	Fe	Mn	Zn	Cu	Cd	Pb	Co	Cr	Ni	

* – correlation is significant at 0.05 level (two-tailed); **bold** – correlation is significant at 0.01 level (two-tailed).

The character of correlations between metals depending on the sampling depth (Table 3, 4) reflects the processes affecting trace element concentrations in peat. In the upper layers (0–50 cm) of the Dzelve-Kronis Bog peat, the strongest correlations were amongst the element pairs of evidently anthropogenic origin, for example, Pb-Cu, Cu-Co, Cr-Cu, Ni-Cu, As-Cu, Pb-Co, Pb-Cr, Ni-Pb, As-Pb. The element pairs Cu-Fe, Pb-Fe, Co-Fe, Cr-Fe, Ni-Fe, As-Fe also were significantly correlated, thus indicating that the industrial activity and long-range transport of pollutants associated with particular matter with high Fe concentration might be a major source of trace metals. The character of correlations between major

and trace elements in peat in deeper peat layers (100–200 cm) formed before intensive anthropogenic impact (the age of peat from these horizons is 700–2500 years, by ¹⁴C dating) (Table 4) very much differs – the strongest correlations were amongst the element pairs of possibly natural origin: Mn-Zn, Mn-Co, Mn-As, Cu-Zn, As-Zn, Pb-Co, Pb-As, Cr-Ni.

Table 4. Correlation between trace elements in the peat from the Dzelve-Kronis Bog in depth of 100–200 cm

Mn	0.440								
Zn	-0.085	0.526*							
Cu	-0.476*	0.378	0.645						
Cd	-0.379	0.159	0.296	0.413					
Pb	-0.123	0.531*	0.530*	0.462*	0.565				
Co	0.000	0.623	0.478*	0.356	0.334	0.834			
Cr	-0.332	0.120	0.167	0.330	0.056	0.158	0.142		
Ni	-0.464*	0.101	0.170	0.469*	0.197	0.225	0.237	0.938	
As	0.104	0.609	0.570	0.302	0.474*	0.938	0.851	0.127	0.143
	Fe	Mn	Zn	Cu	Cd	Pb	Co	Cr	Ni

* – correlation is significant at 0.05 level (two-tailed); **bold** – correlation is significant at 0.01 level (two-tailed).

Table 5. Correlation matrix of parameters describing peat properties, sorption capacity and amounts of trace elements found in the peat from the Dzelve-Kronis Bog and Eipurs Bog

Cu	0.323							
H	0.004	0.067						
N	-0.133	0.664	-0.142					
O	-0.346	-0.582	-0.454	-0.617				
C	0.448	0.439	0.477	0.423	-0.963			
O/C	-0.384	-0.534	-0.394*	-0.615	0.929	-0.972		
Sorption capacity	-0.973*	-0.299	-0.210	-0.431	0.767	-0.835	0.832	
HA/FA	0.848	0.660	0.293	0.649*	-0.840	0.736	-0.805	-0.688*
	Decomposition	Cu	H	N	O	C	O/C	Sorption capacity

* – correlation is significant at 0.05 level (two-tailed); **bold** – correlation is significant at 0.01 level (two-tailed).

The influence of the variability of the peat botanical composition and decomposition degree on metal accumulation in peat has not been widely studied, which may account for some variation in concentrations observed. In our study we have selected two bogs with contrasting lithology (Fig. 2, 3), consequently,

peat composition, as indicated by elemental composition (Table 2, Fig. 4). Furthermore, the metal sorption capacity in an example of copper sorption and its correlation with the peat properties has been tested – elemental composition, as indicated by the C, H, N, O concentrations and peat decomposition indicators such as humic and fulvic acid ratio (HA/FA), decomposition degree (in %), and O/C element ratio illustrate changes of oxygen-containing functional groups (-COOH, -OH) in peat (Table 5).

Testing metal sorption capacity on example of copper (II), this study proved that sorption capacity of peat depends on the concentration of oxygen-containing functional groups in peat, taking into account the significant and positive correlation with O concentration and O/C element ratio and the fact that it increases with an increasing degree of decomposition and HA/FA ratio of the peat humic matter (Table 5). However, peat seems to be largely unsaturated regarding metal ions, since sorption capacity cannot be statistically significantly correlated to trace element concentration, as we can see on the example of copper. The actual metal concentration is more related to the presence of nitrogen-containing ligands and humic/fulvic acid ratios.

CONCLUSIONS

The degree of trace element concentrations in bogs of Latvia can be considered low (especially in comparison with regions where intensive anthropogenic activity has influenced trace element accumulation in upper peat layers). Element distribution within peat layers clearly shows conformity between element concentrations and the respective histories of local and regional environmental pollution. Furthermore, local geochemical processes may significantly influence trace element accumulation in the peat mass (for example, of arsenic in the deepest layers of peat), possibly influencing the use of peat for industrial purposes. Trace element concentrations in peat profiles support the concept of using element concentration records to track regional and global environmental pollution problems with the help of trace elements. Trace element sorption capacity onto peat is influenced by peat properties and depends on the concentration of oxygen-containing functional groups in peat. It increases with an increasing degree of decomposition and HA/FA ratio of the peat humic matter. However, peat seems to be largely unsaturated regarding metal ions. Peat sorption capacity correlates with the presence of nitrogen-containing ligands and humic/fulvic acid ratios.

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