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HIGH PEATS AS THE INDICATOR OF CLIMATOLOGICAL AND ECOLOGICAL CHANGES OF ENVIRONMENT

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Abstract

There is an enormous amount of lakes and bogs and also peats in the area of the Tyumen region (Russia). It is worth noting that the part of high peats is small. In the process of peat formation the material is constantly accumulating, elements and substances that migrate inside the natural object are depositing. As a result, it can conduct layer-by-layer dating, appreciate biogeochemical situation in the different periods of time and the degree of both local and global human intervention. The purpose of this research work is the study of some geochemical indexes dynamics in holocene by chemical analysis and layer dating of peat deposit of high bogs located in the forest-steppe zone (the Tyumen region, Russia); reconstruction of climatological condition impact on peat formation; assessment of iron and manganese content dynamics including the last period of anthropogenic diffusion of elements. The object of investigation is peat samples collected layer-by-layer (step 3-5cm) from deposits of three high peats located in Priishimje. Such main geochemical indexes as ash content, pH, Eh and iron and manganese content have been defined. General geochemical indexes afford to separate geochemical peculiarities of peat formation and basic periods of their development. In our vision, the proportion of iron and manganese content is very important. Accumulation of these metals is directly related to mire formation and also can be a factor of humidity change in the past.

Keywords: High peat · Geochemistry · Lakes · Layer-by-layer analysis · Iron · Manganese

1 INTRODUCTION

In the world science the study of wetland systems has the great importance. Peat deposits afford to consider sufficiently long time period including pre- anthropogenic period (Keiko, Hamilton) and the period of industrial development on the planet. The modern period of anthropogenic activity is characterized by the dispersion of a wide range of metals, which leads to an increase of their content in environment (Moiseenko, 2006) as well as - in the upper layers of peat deposits. Peat deposits also are used for evaluating space activity in the holocene (Franzen, 2002). The high sorption capacity of peat allows them to keep substances falling from the atmosphere as a result of global and local pollution (Shotyk, 2002; Silamikele, 2011). This enables the use of peat deposits as an object to obtain some information about the climatic conditions and changes in the purity of the atmosphere during the peat accumulation.

There is a large number of lakes and bogs inside the territory of the Tyumen region (Russia). In terms of paleoreconstruction the high peats are of the utmost interest. Peat deposits often are formed in case of lake overgrowing and due to the formation of stagnant surface water (Larina, 2004). While peat formation the material is being accumulated, it allow to carry out the layer-by-layer dating of the horizons to assess the biogeochemical conditions in different time periods, the degree of both local and global anthropogenic impacts on the environment.

The aim of this work was the study of dynamics of a number of geochemical parameters in the holocene on the basis of chemical analysis and dating of peat deposits layers of raised bogs located in the steppe zone of the Tyumen region (Russia); reconstruction of climatic condition influence on the formation of deposits$ assessment of the dynamics of iron and manganese contents, including the latest period of anthropogenic dispersal of elements.

2 MATERIALS AND METHODS

The object of the analysis is peat samples collected layer-by-layer (step 3-5 cm) from three high peats located in Ishim (Fig. 1). Main geochemical indexes (ash content, pH, Eh) as well as the content of iron and manganese various forms have been determined.

In the laboratory samples were brought to the air dry state at room temperature, milled and sieved through a sieve (d = 2 mm). Determination of ash content and ignition loss were conducted by gravimetric method. To determine pH, Eh (potentiometric method) aqueous extraction of peat was prepared. To determine the total concentration of iron and manganese 1 g peat was ashed at 550°C, the ash was dissolved in 10% nitric acid. For determinating the mobile form of manganese 1 g peat was dissolved in buffer. The determination of metals was carried out by AAS (ContrAA 700 Analytic Jena).

Figure 1. Placement of examined peat bogs: 1 – Sartamskiy riam, 2 – Toporkovskiy riam, 3 – Kyzyltunskiy (Bokarevskiy riam)

3 RESULTS AND DISCUSSION

Calculating average data for the profiles of examined peat deposits shows that they are formed 5-6 thousand years ago (border of the Atlantic and subarea) despite the significant differences in the capacity of deposits (Table 1). Peat samples are low-ash (the average ash is 3,1-5,7%) and acid (pH 4,5-5,6). Redox conditions are similar to Sartamskiy and Toporkovskiy riams. The iron content varies widely in the examined profiles. The average contents and ranges of manganese in Kyzyltunskiy and Sartamskiy riams differ slightly, but in Toporkovskiy - much lower. The contents of these elements in soils is usually associated with the wet of areas.

Comparison of the average contents of metals with literature data shows that in the examined profiles iron content is less than its clarke in the crust, more than 2 times its clarke in peat ash. The obtained average manganese content in the ash is commensurate with the clarke of this metal in soil and is 3-4 times lower than the clarke in peat ash. The low metal contents are related to the nature of power and features of upland peat formation in comparison with lowland ones which absolutely dominate in Western Siberia.

Table 1. The main characteristics of the examined peat bogs

Index	Kyzyltunskiy riam	Sartamskiy riam	Toporkovskiy riam
Power of peat profile, cm	480	246	510
Total radiocarbon age of peat deposit early formation, years ago	5735 ± 60	5065 ± 60	5155 ± 60
Average rate of accumulation, mm/year	0,84	0,49	0,99
pH	4,46±0,05* 4,11 ÷5,21**	5,28 ±0,07 4,44 ÷ 6,06	5,61 ±0,11 4,37 ÷ 6,68
Ash content, %	5,66±0,69 0,63 ÷ 54,33	5,45±0,99 1,07 ÷ 62,4	3,10±0,26 1,37 ÷ 10,37
Redox potential, V	0,410±0,003 0,340 ÷ 0,456	0,288±0,007 0,178 ÷ 0,400	0,285±0,007 0,200 ÷ 0,353
Fe (ash), %	1,52±0,09 0,27 ÷ 6,11	2,60±0,24 0,10 ÷ 6,73	1,60±0,16 0,24 ÷ 4,60
Mn (ash), %	0,074±0,010 0,002 ÷ 0,260	0,076±0,002 0,002 ÷ 0,291	0,058±0,002 0,007 ÷ 0,104

Layer-by-layer distribution of the main indexes in the examined peat deposits is presented in Figures 2-4.

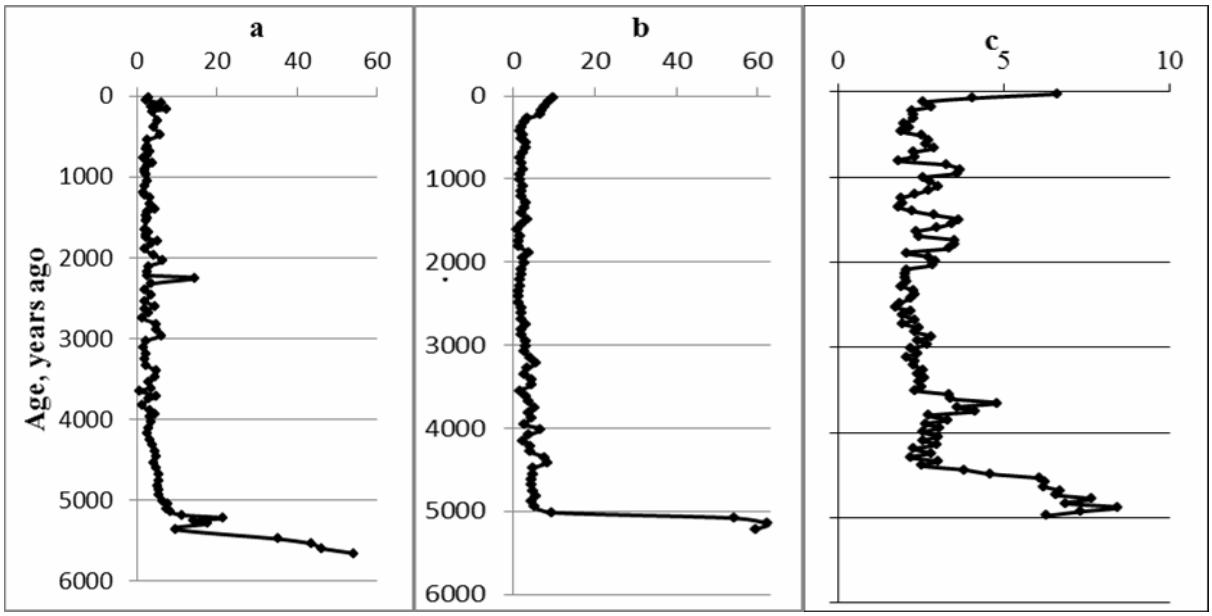

Figure 2. Ash content distribution (%) in the profile of Kyzyltunskiy (a), Sartamskiy (b) and Toporkovskiy (c) riams

Ash content. Analysis of ash distribution these peatlands allows to a number of general regularaties (Fig. 2). All the peat deposits were formed on the basis of paleolakes as the high value of ash content, although time and rate of bogginess differ. Earlier there was bogginess on the site of Kyzyltunskiy riam (about 6 thousand years ago). According to morphological description the layer 460-480 cm (5400-5700 years ago) is represented by black loam. There is a sharp decrease of ash content in this interval (from 60 to 10%). This layer is the mineral humous what is characteristic for sediments of eutrophic lakes. Taking into consideration dynamics of ash change it can result that significant increase organic matter content took place in this time period. After a brief stabilization of conditions (5200-5400 years ago), accompaning the increase of ash content, the period of decline is (4600 years ago). Toporkovskiy riam formation was at the same period (4200-4900 years ago), but this formation was slow.

pH. The change of pH that characterizes acid-base properties is depicted in Figure 3.

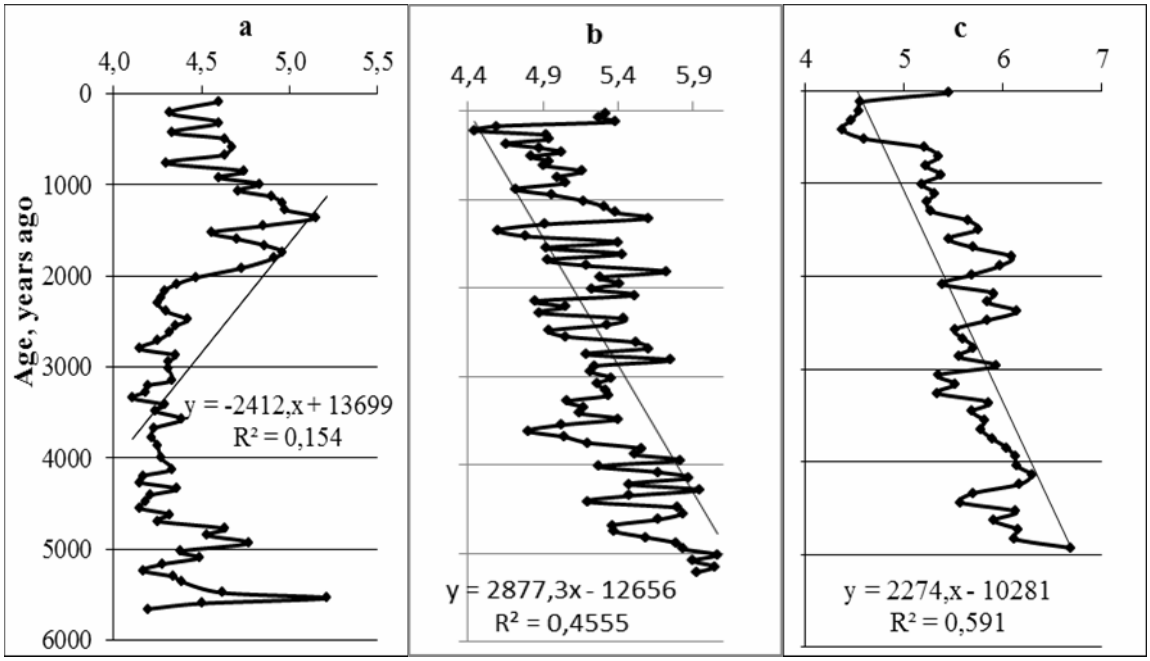

Figure 3. pH distribution in the profile of Kyzyltunskiy (a), Sartamskiy (b) and Toporkovskiy (c) riams

It should be noted that pH fluctuations are within 1,5-2,5. The minimal interval is characteristic for Kyzyltunskiy riam (from 4,1 to 5,2). The maximal value is observed in the mineral layer at the depth 470 cm (4500 years ago), and the minimal – in the high and middle part of peat bog. It is obvious that more slow accumulation of humus was in the periods corresponding high pH value. There are clearly marked minimums (3700, 3400, 2800, 1100, 170 years ago) and maximums (4300-4600, 3500,3300, 2300, 1000 years ago) at Sartamskiy riam. pH distribution in the profile of Toporkovskiy riam has a trend to acidulation.

Iron. Fe content hesitates within 0,3-3% in the profile of Kyzyltunskiy riam (fig. 4). The mineral layer and formation period of lowland peat and transition moor are characterized by the minimal values. Sartamskiy riam is marked by small amount of extremums. The maximal amount of Fe is at the middle part of the profile (1900 years ago); minimums - 3400, 2500, 1100 and 600 years ago. The amount of extremums is high at the profile of Toporkovskiy riam (average content 1,6 ± 0.3 %).

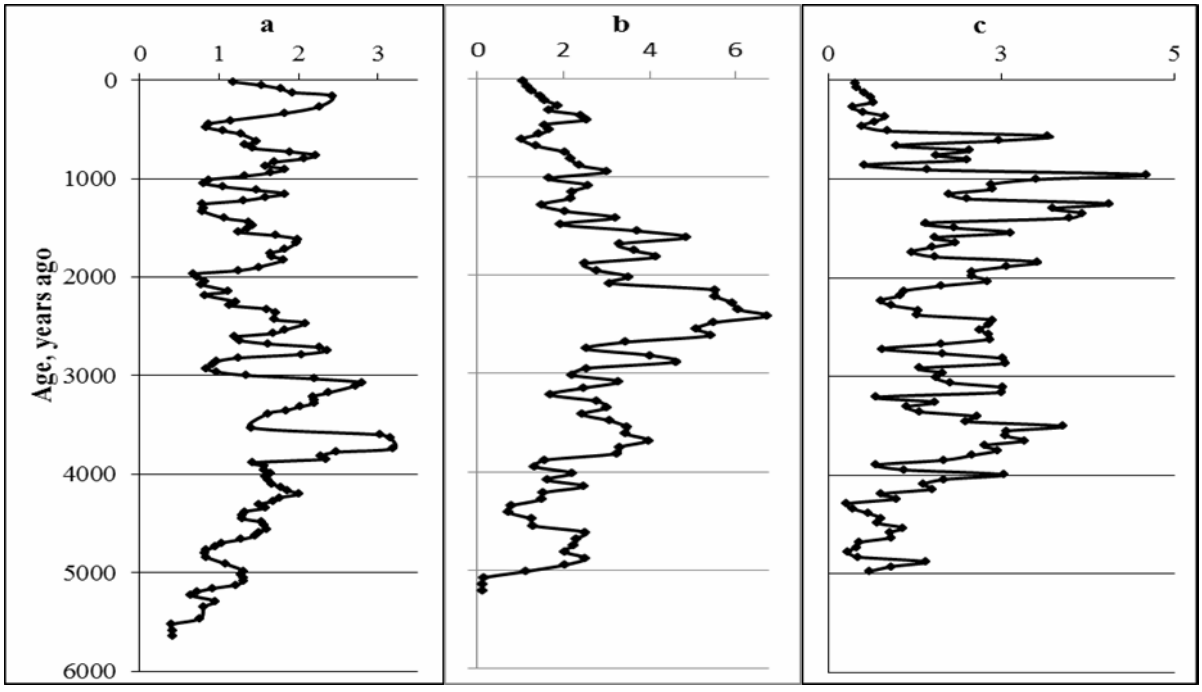

Figure 4. Fe distribution (%) in the profile of Kyzyltunskiy (a), Sartamskiy (b) and Toporkovskiy (c) riams

Mn and Fe distribution differ in the upper layer (last 500 years). In this part the progressive decrease of Fe content begins while Mn concentration increases.

4 CONCLUSION

General geochemical characteristics allow separating geochemical features of the peat formation, to identify the main periods of their development. The presence of radiocarbon dating allows to make the temporary binding of the changes. The change character of the indexes differ depending on a depth of peat deposits. Also there are essential differences in the ratio of metal various forms. Using radiocarbon dating and linking the content of various forms of metals eliminate the effect of peat accumulation rate at various sites of the research and allow to compare the distribution of metals. The accumulation of these metals is directly related to water-logging areas and can be a marker of moisture changes in the past, i.e to be used for climate reconstructions.

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