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Soil Biogeochemical Features of Nadym-Purovskiy Province (Western Siberia), Russia

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Abstract. An elemental composition of soils has been studied on the example of northernmost merge of taiga zone in Westerns Siberia, namely in Naym-Purovskiy district. The trace elements (As, Cd, Cu, Mn, Ni, Pb, Zn) content has been determined with the use of atomic absorption spectrometry method. Chemical soil composition was determined with the use of X-ray fluorescence analyzer. It was shown that the silica content in studied soils were about 69-74%, which indicated the long cryogenic transformation and related weathering alteration. The indexes of soil fertility were low due to percentages of nitrogen, which is in maximum is about 0.02 %. The pyrogenic podzols are considered as most fertile, while the C/N ratios here are minimal and the pH indexes are highest. The content of all studied trace elements were low in sampled soils. An average clark values were fixes as following Zn - 0.73; Cu, Mn - 0.32; Ni -0.31; Pb 0.24; Cd and for As was lower than 0.1. The studied province are characterized by extremely low content of elements even if one compare with low background concentration, which is typical for West-Siberian geochemical province. The Cu and Mn concentrations are comparable with the lowest level, described by V.V. Kovalskiy or lower. The biological accumulation of the elements is expressed in low rates in soils of both taxonomy trenches: organogenic and postlithogenic ones (namely in the superficial horizons). Cd is fixed been accumulated in the topsoils of peat eutrophic soils (Dystric Hystosols). Pb was dominated in Histic Gleysols. Other elements did not showany trends of biological accumulation. There is evident eluvial-illuvial profile distribution of iron in Podzols. The differences in elemental composition of organogenic and mineral horizons are low due to penetration of the fine earth into superficial soil horizons.

Key words: soils, trace elements, Western Siberia.

Introduction

The biological role of trace element is well-known, the low concentration or elevated content of these biochemically active compounds can cause adverse reactions of organisms, even presented by developing of endemic diseases. In the system of biogeochemical regionalization of KOVALSKY & ANDRIANOVA (1970) the territory of the North of Western Siberia is classified as a taiga- forest biogeochemical zone which main properties are the lack of calcium, phosphorus, potassium, cobalt, copper, iodine, molybdenum, a pine forest, zinc and elevated concentration of strontium. At the same time on sites in the affected the wide range of elements belonging to pollutants are accumulated in topsoils and this result formation of geochemical anomalies in landscapes. The evident accumulations of Ba, Sr, Pb, Cu on gas fields is noted (OPEKUNOV *et al.*, 2012; MOSKOVCHENKO, 2013; CUCKOO, 2016). The pollution by nickel and mercury on the southern Yamal (JI *et al.*, 2019) is also confirmed. Distant transfer and translocation of pollutants from areas with high concentration of the population and industrial production has a certain impact even on merged areas of the Russian Arctic. In the north of Siberia atmospheric losses of Cu, Ni, Pb which sources are industrial regions of the Urals and Norilsk are comparable with transport of these elements by the Ob River (VINOGRADOVA *et al.*, 2009).

The formation of biogeochemical structure of tundra and taiga landscapes of Western Siberia is substantially defined by active biogenic and water migration of the key of trace elements. The soils of the region are characterized by an acid reaction which promotes *in situ* soil weathering and further mineral part alteration of the parent material components. This result in translocation of trace elements (TM) to soil solutions with the following replacement of the cations in to waters of the rivers and lakes, into plants, and, on the component of the food chains including the animals and human. The intensive immobilization of soluble substances from friable rock mass and soils is typical for cold and over moisted environment and is caused by genesis of taiga soils (TARGULYAN, 1971). It is possible serious accumulation of trace elements in amounts which are higher than threshold concentration due to intensive weathering of mineral of initial parent materials in could and humid pedoenvironments. In tundra plants the are known as intensively uptaken and accumulated (MOSKOVCHENKO, 1995; DOBROVOLSKY, 2003). Due to intensive biogenic migration of the trace elements even at low concentration in soils excess of threshold concentration in live organisms is possible. The low concentrations of the low level of content of Cd and Hg in soils of Yamal region is fixed simultaneously with increased concentrations of this element in the plants of region (AGBALYAN & LISTISHENKO, 2017). The increased content of mercury is revealed in blood at 41.7% of the investigated the Yamalo-Nenets Autonomous Area, in particular at representatives of indigenous people (AGBALYAN & SHINKARUK, 2018; AGBALYAN *et al.*, 2018).

The necessity of the assessment of geochemical state of the benchmark ecosystems in the North of Western Siberia is especially relevant in the conditions of strengthening of technogenic influence. In the territory of Yamal region more than 20% of world reserves of natural gas are concentrated. It is proved that the pollution of the environment caused by gas production is hazardous to health of people and can lead to developing of congenital anomalies. Understanding of biogeochemical features of the region is necessary at recultivation of the disturbed sites, calculation of indicators of geoenvironmental risk and development of methods of this management risk management (BASHKIN, 2014; 2017).

In this context, the aim of this research is to estimate the biogeochemical state of the territory of Nadym-Purovsky geochemical region, located in the southern part of Yamal autonomous region. This region is key and very important both for industrial development of the all Russia, and for preservation of traditional environmental management of indigenous ethnic groups of the Far North. Here the considerable part of the local indigenous population of Yamal autonomous region is concentrated, winter reindeer's pastures are located and intensive natural gas exploration is implemented. The following objectiveshave been formulated for achievement of the stated aim of the research: (1) to analyze the concentration of the trace elements in the soil fine earth samples, and (2) to evaluate possible threshold concentration of the trace elements in geochemical region mentioned.

Materials and Methods

Soil profiles in surrounding of benchmark ecosystems of the Nadym city and Pangody settlement (Fig. 1) were describe and sampled. Sites are located on Arctic peats and taiga landscape. The soils of this area are acid and show the stagnant and gley properties of water migration and nitric type of biogeochemical circulation prevail (NECHAYEVA, 1990). In the surroundings of Nadym a pleistocene-holocene sediments of alluvial genesis prevail. Close to the Pangody settlement the alluvial and marine deposits of the fourth sea terrace dominate (Atlas, 2004). The sampling was conducted in the profiles illuvial podzols (including their pyrogenic suborders), peat soils and gley soils. Sampling was made from the soil horizons within an active layer which thickness varied from 35 cm in peat soils to > 1 m in podzols. On the texture class the soils were mainly classified as sandy class.

Determination of content of trace element concentrations (Cd, Pb, Cu, Zn, Mn, As, Ni) and iron content was carried out by method of an atomic absorbing spectroscopy. The content of microelements was determined by method of the X-ray fluorescent analysis on the SPEKTROSKAN MAKS-GV device in the center of collective use of Institute of physical and chemical and biological problems of soil science of RAS (Pushchino). In samples from four soil pits values of the pH a salt extract ($CaCl_2$), hydrolytic titrated acidity and content of carbon and nitrogen were determined according to routine methods procedures.

Statistical treatment of results – arithmetic-mean value of concentration of elements (M), a median (Me) and a mean square deviation (SD), are calculated with use of the SigmaPlot software package. For assessment of biogeochemical features of the surveyed territory clarks of concentration of KK - the relation of maintenance of elements in the soil horizons to clark of the top part of continental crust on (RUDNICK & GAO, 2003) and Shaw's coefficient – average value of clark of concentration of separate elements are calculated. The influence of acidity levels and content of organic matter on elemental composition was estimated with use of the correlation analysis (coefficients of correlation of Spirmen).

The following coefficients has been calculated for evaluation of the soil minerals transformation degree:

-coefficient of an elluviation of Ke (LIU, 2009)

$Ke = SiO_2/ (MnO + CaO + K_2O + MgO + Na2O)$ (1)

-the index of chemical change of CIA (chemical index of alteration) reflecting a ratio of primary and secondary minerals and characterizing leaching process (NESBITT & YOUNG, 1982):

$CIA = 100xAl2O3/(Al2O3\ CaO\ Na2O\ K2O)$, (2)

- coefficient of oxidation of $Kok = (Fe_2O3\ MnO)/Al_2O_3$ (3)

-index of potential soil fertility of FI (Taylor et al., 2008)

$FI = (CaO\ MgO\ \ 10P_2O5)/SiO_2$ (4)

Results and Discussion

The soils investigated belong to trench the Podzols, Histosols and Gleysols according to current Russian soil taxonomy (2004) and WRB (2014). In some soils at few horizons demonstrate the signs of the pyrogenic influence are traced. Results of definition of physical and chemical indicators, amounts of the total carbon and nitrogen in the surveyed soils are given in Table 1.

The soils investigated have acid and strong acid reaction of the fine earth. The pH in salt extracts values changes within 3.8-5.7. The most acid samples are in peat soils (average value pH = 4.1). An acid reaction of soils of the tundra and forest-tundra was repeatedly noted by various authors for the Yamal Peninsula (VASILYEVSKAYA *et al.*, 1986), Nadym-Pur-Tazovsky region (CUCKOO, 2016). In the conditions of low temperatures and over moistening transformation of the plant remnants transformation results in formation of mobile organic acids which are deeply capable to penetrate into the mineral layers (TARGULYAN, 1967). The pyrogenic podzol are less acid, than their undisturbed mature analog, in particular in the superficial horizons that producing organic acids after the fire is limited. In Podzols the gradient of increasing of pH values with a depth in proportion to reduction of content of organic matter is not revealed. The much less acid reaction was noted the horizon of E as it was described in Poodzols of Siberian Ridge (SMOLENTSEV, 2002), and in BF horizon. The hydrolytic acidity values have a similar trends of profile distribution. Thus, the acidity depends not only on intake of organic acids, but also on processes of fine earth leaching and sesquoxides transformation.

Total organic carbon in peat soils makes more than a half of a bulk composition while in the suprapermafrost horizons of Gleysols and Podzols its contents does not exceed the parts of percents. The decreased mineralization rates of carbon of over moisted soils resulted in accumulations of organic carbon in high values, especially in case of acid soil reaction. The mineral horizons of soils contain extremely small amount of nitrogen which is not exceeding 0.02%. The maximum content of nitrogen (0.28%) is characteristic of the superficial layers and peat horizon Histic Gleysol, while in the suprapermafrost layers the nitrification is practically absent. The amount of nitrogen in the surveyed soils varying within 0.0001 - 0.28% is less than values given for soils of the tundra of Fennoscandia (MASLOV, 2015) that demonstrates weaker activity of microorganisms. Extremely low content of nitrogen in soils of the tundra of Western Siberia, in particular in the Arenosols, was published earlier in (TOMASHUNAS & ABAKUMOV, 2014). C/N ratio in the surveyed soils significantly varies. The low C/N values is typical to fertile soils with an intensive mineralization of organic matter are noted in the near-surface mineral horizons of the pyrogenic podzols. In undisturbed podzol of C/N value in the eluvial horizon is significantly higher that demonstrates to weak biogeochemical circulation that together with the low maintenance of mineral elements does them extremely infertile.

Aeration substantially defines geochemical properties of polar soils and the parent materials. Owing to intensive implementation of soil and weathering processes, the prevailing mineral constituents of soils are friable deposits is the quartz making usually about 70%, and the content of the silicates and alumosilicates presented by potassium-sodium feld-spars, no more than 15-20% (DOBROVOLSKY, 1994). The research of bulk soil composition showed that as a part of the mineral horizons prevail silica dioxide which content varies in small limits, from 69 to 74% (on average 71.2%). Then, in decreasing order, Al_2O_3, Fe_2O_3, K_2O (table 2) follow.

The dominance of silica dioxide can be considered as the evidence of long cryogenic transformation and aeration of rocks (DOBROVOLSKY, 1994). In cold and dry environments here is increasing of the relative contents of silica (VITAL & STATTEGGER, 2000; LIU *et al.*, 2015). The total maintenance of SiO_2 prevailing as a part of soils and Al_2O_3, makes 82-85% that corresponds to the sizes peculiar to the Arctic soils in general (80-90% of fine earth substance) (DOBROVOLSKY, 1994). In organogenic soils the content of silica dioxide averages 9.3%. Accumulation of SiO_2 in peat soils happens, first of all, to the form of the dust mineral particles brought by wind or melt water. The enrichens of peat in a tundra zone by silty and dusty sized particles was noted by many authors (IGNATENKO & DRUZIN, 1972; VASILYEVSKAYA, 1980). It was noted (DOBROVOLSKY, 2003) that the maximum content of mineral admixture in peat is characteristic of flat sites on which there is a drain of melt water. Ashes of a peat layer in the top part of a soil profile in the subarctic tundra can reach about 28% (DEDKOV, 1995) that testifies to dust Aeolian accumulation. Penetration onto the deep into mineral particles, judging by silica dioxide distribution, variously - from 5 cm in the oligotrophous peat soils of peatlands to 20-25 cm in the dry Histic moor horizons of well drained landforms spaces. Sharp decreasing of silica values at depths of 20-25 cm is observed. So, in the dry Histic horizons soil the values of SiO_2 were 15.7% at a depth of 18-22 cm but decreased to 3.7% for 28-32 cm.The values of the index of chemical change of CIA vary in mineral soils in small limits, from 67.6 to 77.7 (average value of 73.9 units). Within the depth extent of chemical change decreases (Fig. 2). It is known that not weathered parent materials are characterized by values of CIA about 50, but in well altered materials values of CIA reaches 100 units (SYSO, 2007). Thus, the surveyed material is characterized by average extent of aeration. In sandy Podzols the values of CIA is higher, than in loamy Cryosols. The coefficient of an eluviation of Ke is also much higher in Podzols that is explained by carrying out of oxides Ca, K, Mg, Na as a result of mobilization by organic acids.

In a reduction pedoenvironment the lower horizons of Cryosols showed the value of coefficient of oxidation significantly decreased, while in Podzols these values were significantly higher and are distributed more homogenous (Fig. 2). It is obvious that the topsoils are aerated highly, then lower, but gradient reduction of sizes oxidation coefficient with a depth it is not revealed. In the superficial layers of Cryosols and Podzols of value coefficient of oxidation increase in comparison with a middle part of a profile a little. Possibly, it is connected not with strengthening of intake of oxygen in the lower part of a profile, and c accumulation of Fe_2O_3 on a permafrost geochemical barrier during an illuvial redistribution of soil components. In general, according to gross structure eluvial and illuvial differentiation in soils of a postlitogenic type of profile organization is expressed rather poorly in comparison with Podzols of Siberian Ridge where it, it agrees (SMOLENTSEV, 2002), where it was substantiated was very sharply changed in profile. The greatest distinctions characters for CaO which percentages in the horizon E Podzols make 0.91%, and in BC horizon – 1.33. The content of Fe_2O_3 changes in a profile of podzol from 4.3 to 5.0%. Possibly, weak differentiation is connected with weaker development of preferential flow in soils because of a smaller amount of precipitation, and youth of soils which development began after more southern analogs.

In the dry Histic soil of value of Ke and CIA in the organogenic horizons up to the depth of 20 cm are similar to values of these coefficients in mineral soils that testifies to considerable impurity of fine earth. The index of potential soil fertility determined mainly by amount of phosphorus in organogenic soils repeatedly above, then in soils of a postlitogenic trunk among which the least fertile are sandy podzols. Content of bulk phosphorus as much as possible in the dry Histic soil where in the top 30 cm exceeds 1%. Low temperatures also lead to decreasing microbiological activity and a mineralization of phosphorus, especially during the winter period that leads to its accumulation (BOWMAN *et al*., 2003). In the mineral horizons the average content of P_2O_5 was about 0.12%. Distinctly expressed gradient of reduction of content of bulk phosphorus with a depth is observed. Thus, a considerable part of phosphorus is involved in biological circulation, collects in the live phytomass, peat, the superficial horizons of soils. Down a profile phosphorus migrates with organic acids (MASLOV, 2015). According to YANG *et al.* (2016) content of organic phosphorus is 73%–83% of its general contents in soils of the tundra.

Table 1. Soil basical chemical indexes

Soils	Hori zon	Depth, cm	pH $CaCL_2$.	Hydrolitic acidity, cMP+/100 p	TOC, %	N,%	C/N
Podzol	O	0-10	4.1	96.5	38.27	0.07	547
	E	10-18(20)	3.8	5.73	0.8	0.03	27
	BF	18-60(65)	4.6	6.25	1.1	0.03	37
	BC	60(65)-90	4.6	6.25	0.6	0.02	30
	C	>90	4.4	5.98	-	-	-
Histososl, Eutric	TE_1	0-30	3.9	116	59.86	0.21	285
	TE_{2h}	30-75	4.2	116	58.01	0.13	446
Histic Gleysol, Antric	OT	0-10	4.7	106	58.45	0.28	209
	TE_1	10-15	4.5	106	57.09	0.21	272
	TE_{2h}	15-20(28)	4.8	98.7	56.44	0.19	297
	G_1	20(28)-40	4.9	13.3	0.39	0.009	43
	G_{2ox}	40-55	4.9	11.7	0.2	0.004	50
	G_3	55-80	5.2	10.3	0.17	0.001	170
Podzol, Pyrogenic	Opyr	0-3	5.4	78.8	24.57	0.11	223
	E	3-10(20)	5.1	4.92	0.19	0.02	10
	BF_1	10(20)-25	5.7	7.28	0.28	0.02	14
	BF_2	25-40	5.6	7.28	0.40	0.001	400
	BF_3	40-50	5.4	6.81	0.31	0.019	16
	BC	50-65	4.9	6.38	0.32	0.001	320
	C	65-100	5.0	6.38	0.16	0.02	8

Table 2. The bulk soil chemical composition.

Oxide s	Mineral Layers			Organic layers		
	M	*Me*	*SD*	*M*	*Me*	*SD*
Na_2O	0.85	0.83	0.12	0.53	0.54	0.07
MgO	1.17	1.20	0.13	0.09	0.02	0.13
Al_2O_3	11.8	11.9	0.44	2.51	0.99	2.90
SiO_2	71.2	70.2	2.12	9.3	2.8	14.48
P_2O_5	0.12	0.10	0.07	0.70	0.39	0.57
S	0.017	0.017	0.007	0.38	0.35	0.12
K_2O	1.99	1.91	0.17	0.14	0.02	0.46
CaO	1.15	1.23	0.18	2.9	2.8	2.1
TiO_2	1.01	1.02	0.02	0.19	0.11	0.23
MnO	0.045	0.040	0.012	0.024	0.025	0.026
Fe_2O_3	4.15	4.31	0.66	3.9	3.7	0.9

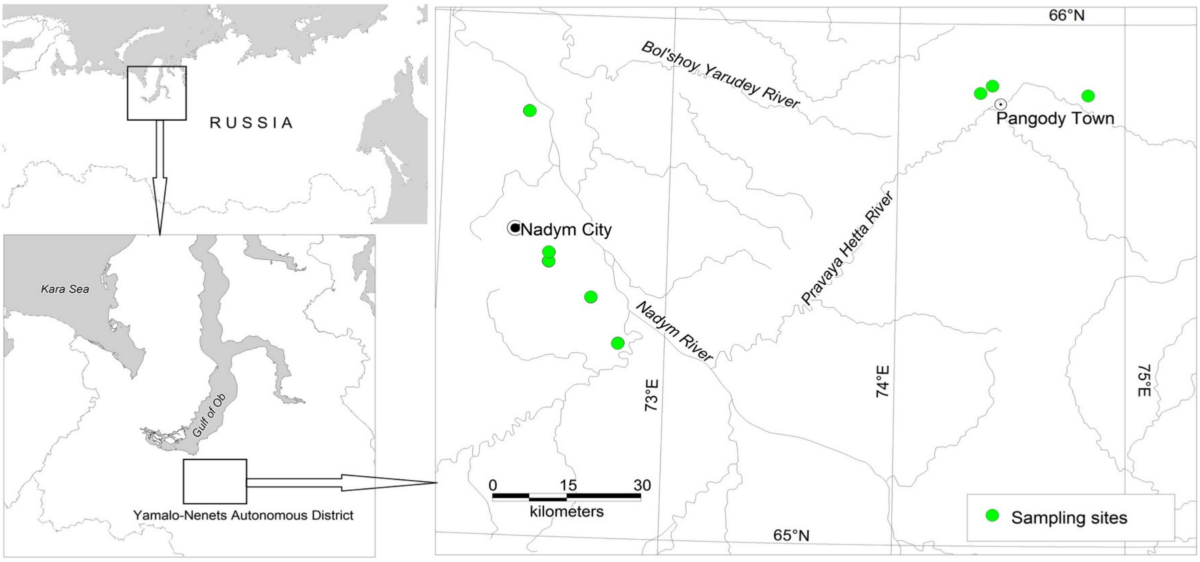

Fig. 1. The study sites locations

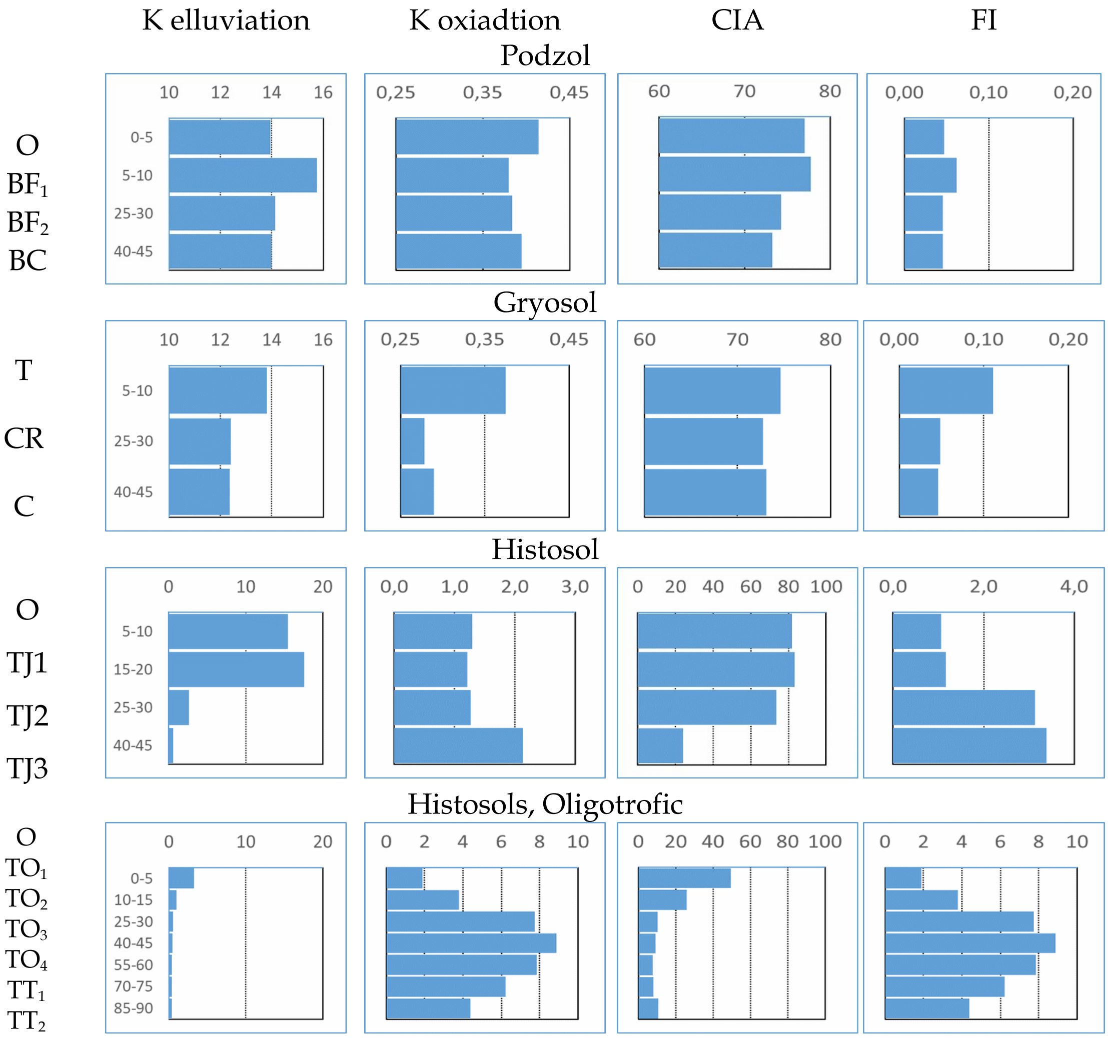

Fig. 2. Geochemical indexes values for various soil horizons.

The bulk content of the trace elements for soils studied is given in Table 3. The percentages of all studied elements in soils below the average world values. Extremely low concentration are noted for Cd, Pb, Fe, As. In Clark's size of concentration elements are ranged as follows: Zn 0.73 > Cu 0.32 > Mn 0.32 > Ni 0.31 > Pb 0.24 > Fe 0.16 > CD 0.08 > As 0.02. The similar results testifying to the low content of heavy metals in soils were received for the adjacent regions of the Yamal Peninsula (TOMASHUNAS & ABAKUMOV, 2014). Lower concentrations of elements were revealed during the research of structure of soils of the Beliy Island (the Arctic tundra of West-Siberian sector) where the average content of elements in the Gleysols of watersheds was: Mn-212; Cu-3.5; Fe-8595; Zn of-20.9 mg/kg (MOSKOVCHENKO *et al.*, 2017). The low portions of minerals which have Clark of concentration < 1 is the general property of weathering layer of parent materials and soils of the Arctic environments (DOBROVOLSKY, 1994) The average content of copper is at the level of the lower threshold concentrations of this element in the soil (KOVALSKY & ANDRIANOVA, 1970), 6-15 mg/kg, and the content of manganese is lower than this border (400 mg/kg). Content of zinc is close to an optimum value.

The average value of coefficient of Shaw for soils Nadym - Purovsky region was 0.3. Earlier when studying element structure of soils of YaNAO it was revealed that sizes of coefficient of Shows average 0.64 (SOROKINA *et al.*, 2007). Thus, even in comparison with poor soils of the North of Western Siberia the surveyed area is characterized by extremely low concentrations of elements in soils. The data obtained confirm a conclusion that soils of Nadym-Pur-Taz region are characterized by the content of heavy metals of 3-9 times below the Clark of values and considerable dispersion of values (CUCKOO *et al.*, 2018). The reasons of low contents are the dominance of sandy textured parent materials with absolute prevalence of silica dioxide and the chemical, mechanical and biogeochemical barriers which are grown poor by minerals, intensive leaching in the conditions of acid reaction and over moistening and simultaneous low expression of chemical barriers.

The lowest concentration are peculiar to Cd and As that is connected with a lithology the parent materials and intensive leaching. It was noted that in the parent materials of the north of Western Siberia contents the Ca and As of elements is decreased (MOSKOVCHENKO, 2013). Intensive leaching of elements under the influence of organic acids is confirmed by the correlation analysis which showed existence of positive relation between the values of Cd, Fe, Cu and the pH values. Most strongly the percentages of Cu (r=0.85) are affected by acid-base conditions of the fine earth. Only the portions of As (Table 4) are connected to amount of carbon and nitrogen – key elements of organic matter. The content of Cu, on the contrary, decreases at increase within soil organic matter increment.

Comparison of elements content in the organogenic and mineral horizons of the surveyed soils (Table 3) demonstrates biogenous accumulation not only of As, but also Cd while concentration of Fe, Cu, Pb, Ni is higher in the mineral horizons. However distinctions are small and statistically not evident, except for Fe which concentration in the mineral horizons 1.3 times higher (value of criterion Student of t =-2.4; α=0.05).

The weak relationship between the concentration of minerals on organic matter and small distinctions of element structure of the organogenic and mineral horizons are not typical for soils in general and tundra soils especially. Normally trace elements content are connected with organic matter of soils (KABATA-PENDIAS, 2011). In tundra gley soils distribution of the biogenic elements Mn, Zn, P, has an appearance of the decreasing curve with a maximum of concentration in the top part of the peat horizon (MOSKOVCHENKO, 1995). It was noted that peaks of content of the majority of heavy metals in soils of Yamal coincide with maximal content of soil organic matter (TOMASHUNAS & ABAKUMOV, 2014). It should be noted that the superficial and accumulative distribution of trace element proportional to amount of organic substances content is characteristic not of all soils and in the tundra it is shown mainly fo Ca and As and manganese. Thus, in alluvial sod soils of the Yamal Peninsula in the superficial horizon phosphorus, zinc is typical, while in Histic-Gley soils Zn and Mn accumulate intensively (MOSKOVCHENKO, 1995, 2013).

Data of profile distribution of trace elements are given on the fig. 1 The lack of significant correlation between the content of metals and organic matter (carbon and nitrogen) and also statistically reliable differences between element structure of the organogenic and mineral horizons of soils is connected with a variety of reasons. The presence of fine earth at the superficial peat horizons of soils described result in leveling the impact of biogenous accumulation. Also, rather weak accumulation of trace elements by green mosses – the main precursor of Histic materials in oligotrophous peatland. It was noted that green mosses differ characterizes by the smaller biogeochemical activity in comparison with those typical dominants subarctic tundra as bushes of *Betula nana, Salix glauca, S. lanata* (MOSKOVCHENKO, 2011).

For more clear understanding of features of biogenic accumulation of elements and their illuviation, the graphs of profile distribution has been created (Fig. 3)

Profile distribution of chemical elements in Podzols shows distinct eluvial and illuvial differentiation of distribution of Fe which minimum content is noted in E horizon, maximum in BF horizon. Cd also accumulated in the illuvial horizon at with minimal concentration in Histic horizon. Pb and Cu show moderate decrease in concentration in E horizon. Content of Zn decreases with a depth slightly. Distinct eluvial and illuvial differentiation of distribution of sesquioxides, silicates, alkaline and alkaline-earth metals in iron-illuvial podzols was previously described (SMOLENTSEV, 2002). However, distribution of elements in a profile of Podzols can be essentially changed by the processes of a cryogenic mass exchange leading to changes of stratification of the horizons and further change of distribution of elements. Cryogenic mass exchange does not change the typical profile distribution of elements, however, the general regularities of distribution of elements - falling of concentration of Fe in the horizon of E, the maximum concentration of CD in the top part of the illuvial horizon (BF1) (Fig. 3)

In a Histic Gleysol the sharp increase in percentages of Cu in the gley horizon is noted that indicates weak biogenic concentration of this element. At the same time lead content as much as possible in peat topsoil layers, this is probably, connected with accumulation of this element mosses and lichens in the conditions of increase in atmospheric emissions on sites of anthropogenic influence.

In soils of an organogenic taxonomy trunk the small concentrations of Cd is typical, while in opposite, the Fe, Pb and Zn are increased in mineral layers. Decrease in concentration of Fe in the horizon of BCg of the peat oligotrofic soils with features of cryogenic perturbations soil is caused by leaching of iron from the gley horizons, typical for soils with a reduction environment. It is important to note that processes of a cryogenic mass exchange can change the nature of profile distribution of trace elements, depending on a ratio of an organic and mineral component. Thus, biological accumulation of elements is shown for Cd in peat oligotrofic soils, while the Pb increased concentration was typical for a Histic Gleysols.

It is obvious that the botanical composition of peat defines its chemical composition. There is a number of estimates of intensity of biological accumulation of elements plants of the West Siberian tundra. It was noted high biogeochemical activity of dominant of the subarctic tundra – bushes of *Betula nana*, *Salix glauca* while green mosses play low role in biochemical transformation processes (MOSKOVCHENKO, 1995). TENTYUKOV (2010) revealed vigorous accumulation by tundra plants of Yamal of such elements as Zn, P, Mn, and the polar birch acts as the most active concentrator of zinc. In the tissues of plants of the Urengoy tundra an intensive accumulation of Cu, Pb, Zn, and weak – the siderofilic elements (Fe, Co) has been recorded (MOSKOVCHENKO *et al.*, 2017).

We have conducted a comparison of elemental composition of oligotropous and autotrophous peats at Histic topsoil horizons of the Podzols (Fig. 4)

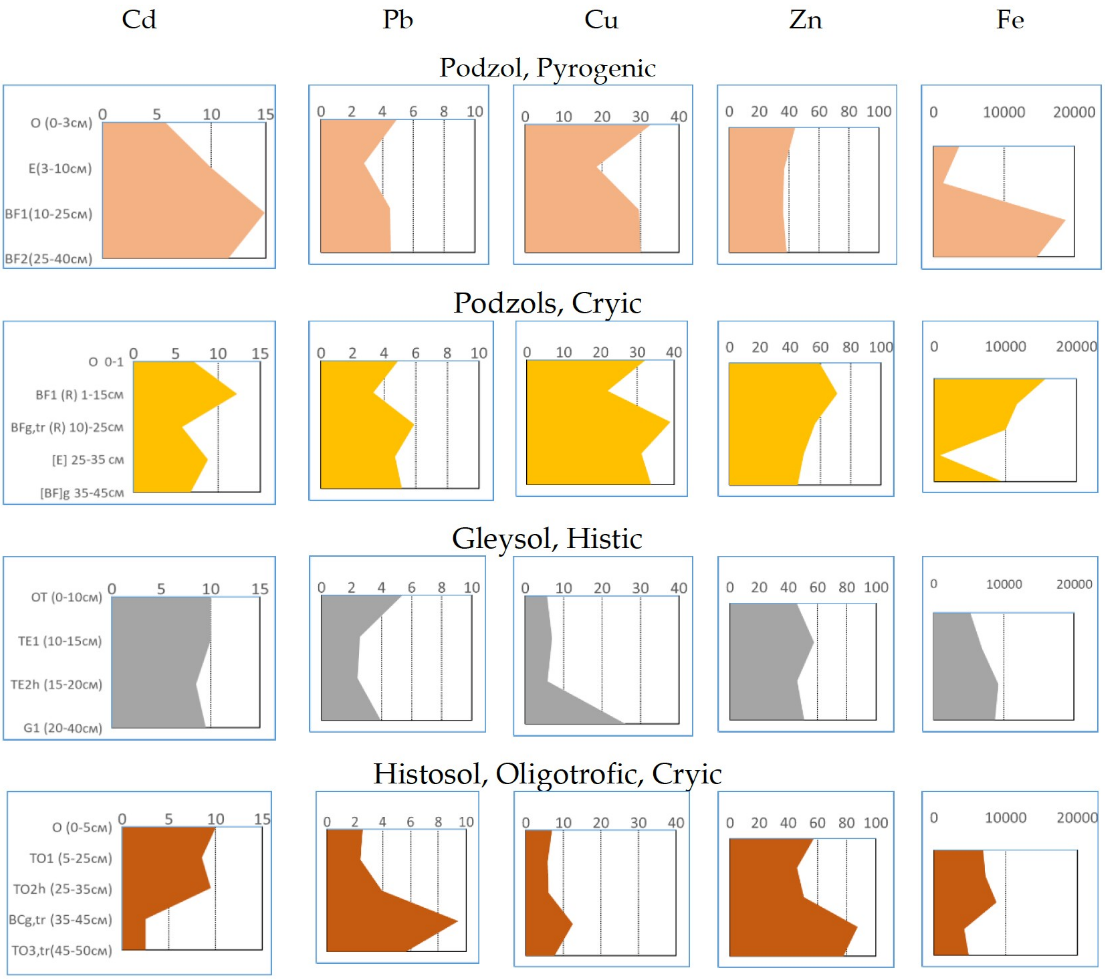

Fig. 3. Vertical soil profile distribution of key trace elements (Cd, Fe, Pb, Cu, Zn)

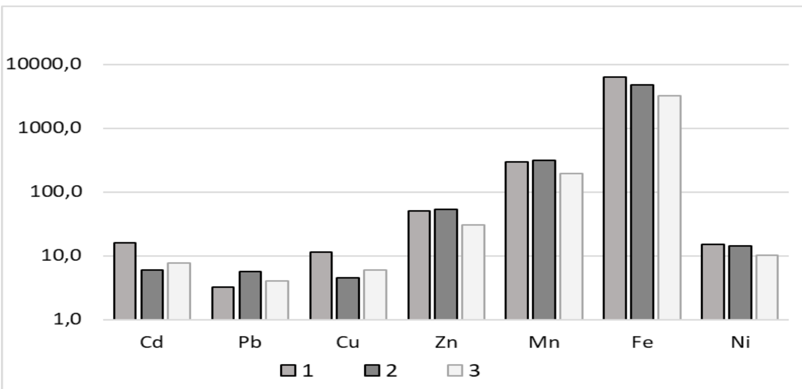

Fig. 4. Elemental composition of topsoil organic layers: 1 – oligotrofic peat, 2 – eutrofic peat, 3- organic topsoils of Podzols.

Table. 3. Statistic parameters of data obtained (mg/kg, Cd- µkg/kg).

Parameter	**Cd**	**Pb**	**Cu**	**Zn**	**Mn**	**Fe**	**As**	**Ni**
				Mineral layers				
M	7.1	5.0	14.1	50.8	264	8574	0.10	16.3
Me	6.1	4.7	9.6	45.6	262	8221	0.08	16.2
SD	4.9	1.8	12.2	15.7	119	4653	0.05	5.8
n	41	27	27	27	27	27	27	27
				Organic layers				
M	12.5	4.1	10.1	50.0	288	6563	0.12	15.4
Me	8.4	3.9	8.2	46.2	275	5999	0.12	14.2
SD	17.9	1.8	6.8	13.6	153	2601	0.06	6.6
n	44	40	40	40	40	40	40	40
The soil Clark (KABATA–PENDIAS, 2011)	410	27	38.9	70	488	-	6.83	29
The Lithosphere Clark (RUDNICK & GAO, 2003)	90	17	27	67	774	39180	4.8	47

Table 4. Values of Spearmen correlation coefficients.

Parameter	Cd	Cu	Fe	As
TOC		-0.53		0.55
N				0.51
pH	0.66	0.85	0.52	

According to data obtained, oligotrofous peat demonstrate higher concentrations of Cd, Cu, Fe. Eutrophic peats demonstrate higher portions of Pb. Zn poorly is fixed on a biogeochemical barrier. In the topsoil Histic layer of Podzols the concentrations of elements is less, than in peat materials of organogenic soils. This can be connected with peculiarities of mineral substrate and the weak accumulation of elements by the *Cladonia* lichens dominating in structure of a vegetation on sites with domination of Podzols. It was noted that superficial soil lichens of the *Cladonia genera* accumulate significantly less elements, than an epiphytic lichen of *Hypogymnia* (VALEEVA & MOSKOVCHENKO, 2002). Thus, weak accumulation of elements on geochemical barriers, including biogeochemical barriers is characteristic of the surveyed territory.

Conclusions

The investigations of main types of soils of Nadym-Purovskiy region, located in the southern part of Yamal autonomous region showed the dominance of the representatives of following soil types: Podzols, Cryosols and Oligotrophic and Eutrophic peat soils. Data obtained for the first time give important information about the biogeochemical peculiarities of the territory. Soils of the Nady-Purovskiy region are formed under the effect of long-term cryogenic alteration and it-situ soil weathering. These processes resulted in accumulation of the silica oxides in main mineral horizons. The content of SiO_2 varies from 69 to 74% while the Al_2O_3 varies from 11,1 to 12,1% in soils investigated. Soils investigated characterizes by acid or strong acid reaction. This is a reason of intensive leaching of trace elements and their low accumulation degree on the geochemical barriers. The low content of main element (which is close to deficit) in comparison with Clarks and average content in soils has been fixed. An average value of the concentration coefficient was 0.73, 0.32, 0.31, 0.24, 0.16, Cd and lower than 0.1 for Zn, Cu, Mn, Ni, Pb.

Fe. Cd As correspondingly. The profile distribution of elements in soil profiles showed that Cd was accumulated in the superficial soil layers of oligotrophic peats. The lead concentrations were increased in peat-gleyic soils. There was not an essential accumulation of the trace elements in organic topsoils of the pits investigated. The differences between organic and mineral soil horizons are not essential because the fine earth penetration of the mineral particles into superficial layers of the peat soils. Evident eluvial-illuvial differentiation is characteristics only for iron in soil profiles investigated. The podzols, affected by pyrogenic impact have much lees acids pH values. The region surveyed is characterized by very low concentrations of the trace elements, even one compare with other soils of West-Siberian geochemical province. At the level of threshold border and below it there were concentrations of Cu and Mn. Thus, the Nadym-Purovskiy region can be classified as a specific geochemical province of the North-Western Siberia, which is characterizes by very low concentration of all trace element investigated.

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