

Environmental and geochemical characteristics of sod podburs near the Bolshiye Koty settlement (Lake Baikal)

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ABSTRACT. We studied soils at the foot of slopes in the eastern and western exposition of the Primorsky Range, along the valleys Chyornaya, Zhilische and Bolshaya Kotinka located in the vicinity of the Bolshiye Koty settlement. Sod podburs prevail in the soil cover of the foot of the valleys. Along the western exposition slopes of the valleys, slightly acid sod podburs prevail, and along the eastern exposition slopes – acid ones. Leaching regime of soil profiles and the acid reaction of soil solution contribute to the significant migration of most chemical elements with radial runoff from the soils. The presence of exchange aluminium in soil adsorption complex indicates an increase in humidity and a decrease in the amount of solar insolation at the foot of the eastern exposition slopes compared to the western exposition slopes. This may be a marker of the geochemical situation with more efficient acid weathering of soils on a scale of several hundred meters.

Keywords: sod podburs, soil solution, soil adsorption complex, cation exchange capacity, soil acid-base buffering, Lake Baikal

Since the early 20th century, the surroundings of the Bolshiye Koty settlement located on the west coast of the southern basin of Lake Baikal have been an experimental base for limnological studies of the oldest, deepest and freshest oligotrophic lake in Eurasia. Since the 21st century, annual (seasonal and weather depending) biogeochemical studies of the coastal and splash zones of the Bolshiye Koty Bay have been conducted at the permanent research station of Limnological Institute Siberian Branch of the Russian Academy of Sciences. The determined levels and rates of eutrophication in the water edge zone, an increase in the concentrations of heavy metals in interstitial waters and waters from the edge zone of this bay are often due to the runoff of the surface and ground waters saturated with rock weathering products as well as due to the destruction of the soil cover, mineralization of forest litter and discharge of anthropogenic waters from cesspits and septic tanks by filtration through the soil (Kulikova et al., 2012; Timoshkin et al., 2018). Kulikova et al. (2012) indicated that, regardless of the beach type in the Bolshiye Koty Bay, a specific biogeochemical barrier of finely dispersed fractions of beach soils enriched with the remains of spring-autumn macroalgae species and various invertebrates is typical of the interstitial waters in the splash zone. The silt component of this barrier is presumably of soil origin.

Soil cover for terrestrial ecosystems, on the one hand, serves as buffer screen, keeping pollutants (heavy metals, radionuclides, etc.) that came from the atmosphere, and, on the other hand, transforms and involves new components in the ecosystem, destroying parent rocks by changing permanent forms of trace elements to toxic mobile ones. The capacity of soil acid-base buffering is one of the most important factors that determine the migration parameters of substances and their involvement in the migration flows of small biological and large geological cycles of substances both for background areas and areas subjected to high anthropogenic pressure and technogenic pollution. In terms of geochemical transformations of soils, the most important are, therefore, acid-base characteristics of the soil solution, which control the migration ability of most chemical elements.

According to terrain analysis and geomorphological zoning, the area of the Bolshiye Koty settlement belongs to the taiga of the Baikal-Dzhugdzhur and South Siberia regions with subarctic altiplanation mountain and taiga landscapes with light coniferous vegetation and deeply dissected erosion relief. According to soil-ecological zoning, the study area is part of the province with sod podburs, podzolic and soddy forest soils of the mountains in the Baikal region and The Stanovoy Highlands with the medium resistance of the soils to

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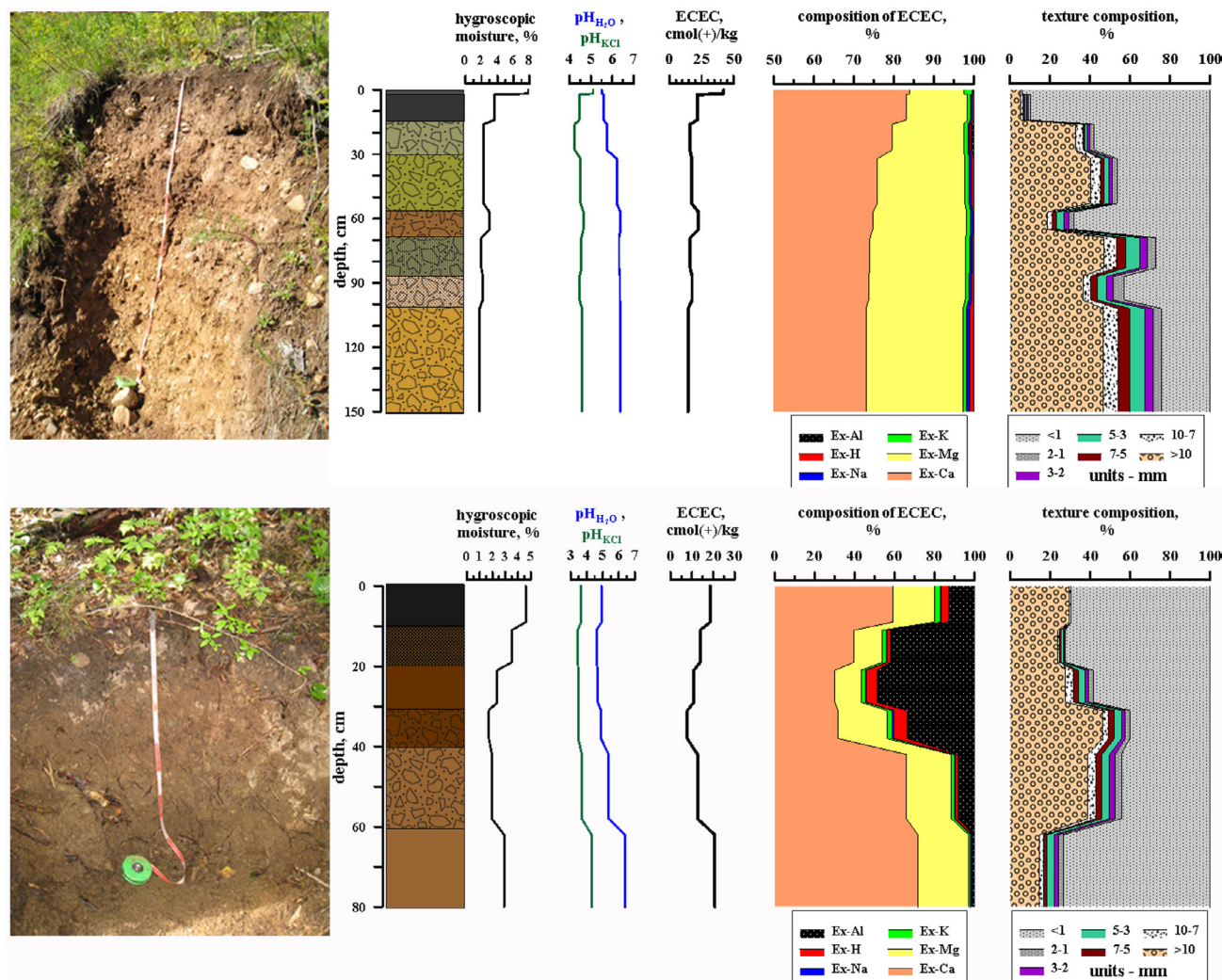


Fig. Chemical characteristics of the investigated soils near the Bolshiye Koty settlement. The upper panel is the BK-2013-4 soil profile laid at the foot of the western exposition slope in the Zhilische Valley, this are the sod podburs with buried horizons (of proluvial) (WRB: Enti-Umbic Podzols (Endoleptic, Thapto-Protic); the lower panel is the BK-2013-6 soil profile laid at the foot of the eastern exposition slope of the Bolshaya Kotinka Valley, this are the gleic illuvial-humus sod podburs (WRB: Enti-Umbic Podzols (Carbic, Spodic, Endo-Gelistagnic)).

anthropogenic impact and with the activation of linear erosion (Ecological atlas..., 2015). Parental rocks are represented by eluvial-diluvial and proluvial weathering products of the Middle Jurassic conglomerates overlapped by the allochthon of crystalline Archean granitoids of the Angara thrust fault and show the low thickness and high gritty consistency.

In the vicinity of the Bolshiye Koty settlement, ten soil profiles were laid along the valleys Chyornaya, Zhilische and Bolshaya Kotinka at the foot of the slopes in the western and eastern expositions of the Primosky Range under natural vegetation. Sampling was carried out by genetic horizons of the soils. To comply with the requirements of the international project of the acid deposition monitoring in Southeast Asia, EANET, in the case when the genetic horizon had thickness of more than 10 cm, samples were taken every 10 cm to a depth of 40 cm. The soils of the study area in the Bolshiye Koty settlement belong to the division of alfhumic soils, the type of sod podburs and subtype of iron illuvial sod podburs. The soil profile formula is AY-BF-C. The soil profile of the slope in the western exposition at a depth of 57-60 cm indicates the profile of the buried strata having typical features of the

same soil (Fig., upper panel). Based on the results of the chemical analyses, we clarified the following characteristics: genus – carbonate-free, species – small, variety – medium-textured loams, medium and highly gritty consistency, category – with a medium-developed profile (Klassifikaciya..., 2004).

Chemical analyses of the soil were performed in Laboratory of Hydrochemistry and Atmosphere Chemistry according to (Technical Manual for Soil..., 2000) and the results are shown in figure. To calculate cation exchange capacity (CEC), we used the following equation: $CEC = Ex-Ca + Ex-Mg + Ex-Na + Ex-K$; to calculate effective cation exchange capacity (ECEC): $ECEC = Ex-Ca + Ex-Mg + Ex-Na + Ex-K + Ex-Al + Ex-H$; to calculate the degree of soil unsaturation with bases, we used the equation according to (Sokolova et al., 2007): $Q = (100 - CEC / ECEC * 100)$.

The chemical analysis of the soils revealed the following results: 1) the content of hygroscopic moisture is directly proportional to the content of fine-grained soil (particle of less than 2 mm in diameter); 2) for humus horizons, the CEC is 18-20 cmol(+)/kg, and for mineral horizons, BC and C – 15-25 cmol(+)/kg; Q is very low and equal to 0.5-7.6% and 0.3-1.0%,

respectively; 3) calcium (60-85%) and magnesium (10-25%) mostly represent exchange cations; 4) in more humid conditions of the slopes in the eastern exposition, in the BF alfehumus horizon, the fraction of exchange aluminium significantly increases with an decrease in the exchange acidity (Ex-Acid) to $\text{pH}_{\text{KCl}} < 4$, and with a pH_{KCl} of 3.5 or less, the Ex- Al^{3+} content is 33-48% of ECEC (Fig., lower panel), whereas Q increases to 18-54%.

In general, sod podburs in the study area belong to slightly acidic soils along the slopes of the western exposition and to acidic ones along the slopes of the eastern exposition. Leaching regime of soil profiles and the acid reaction of soil solution contribute to the significant migration of most chemical elements with radial runoff from the soils. Acid sod podburs of the eastern slopes in all three investigated valleys form in colder and more humid conditions than slightly acid sod podburs of the western slopes. The presence of exchange aluminium in soil adsorption complex indicates an increase in the rate of weathering and release of aluminium from minerals as well as intensification of formation of aluminium-fulvate complexes of humic acids characterized by greater mobility and increased removal of elements, which causes podzalization processes (relative accumulation of humus-iron compounds, quartz and silica) in soils below the humus horizons.

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