Soils of unique phosphorites’ landscapes of lake Khovsgol’ depression (Mongolia) of Baikal rift zone: ecological features of functioning and necessity for their conservation

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Abstract. A comprehensive study of ecological functioning features of the soils, formed on outputs of phosphorites' layers of Ongolignur deposit of Khovsgol phosphorite basin of South-Western branch of Baikal rift zone was conducted. The understanding of the soil-ecological potential of the soil cover of the studied area both in the conditions of natural development of geosystems and under the influence of destabilizing anthropogenic factor was expanded. The possible consequences of the technogenic pressure to the unique natural ecosystem of lake Khovsgol have been studied in aspect of potential mining of the phosphorite deposit. Within the study, it was found that the soil formation, soil chemistry and biogeochemical migration of phosphorus and other elements, the humus state of soils and biological productivity of biocenosises (that is the natural-resource potential) of the study area is strongly determined by the influence of lithogenic basis (matrix) of soil, intrazonal factors and cryogenesis.

1. Introduction

The Baikal-Khovsgol basin belongs to the territories, the sustainable development of which is not only national, but also of great international importance. Investigated area (figure 1) is included into the Altai-Sayan-Mongolian mountain land and refer to south-west ending of Baikal rift zone (BRZ) (figure 2) with planetary boreal taiga and Asian boreal steppe types of nature, which was formated on boundary of Neogen and Anthropogen.

Lake Baikal and lake Khubsugul (Khovsgol) and their landscape environment represent of the united natural system of regional level, in which the preservation of the unique properties of lakes is determined by the processes taking place in the landscapes of their basins. The basin of lake Khovsgol, which is one of the stable main feeding sources of the Selenga river, and therefore lake Baikal, has not yet been affected by human influence (75% of endemics in the open ecosystem, the center of speciation of separate groups of fauna and flora, etc.) and can serve to recreate and decoding of the model of the standard' nature system.

One of the important tasks for today is to identify the factors and conditions to ensure the unique features of the ecosystems of lake Baikal and lake Khovsgol, because there is a danger of degradation of their unique ecosystems to usual through anthropogenic and technogenic impact on these factors and conditions, which will be a violation of national obligations with respect to the world heritage site. This depends of many factors such as: land surface, topography, soil distribution and soil quality, availability of water, biodiversity and activity of natural biota and climatic conditions [1, 2, 3]. The
necessary tool and basis for sustainable land use and development of territories is their physical and geographical zoning [4, 5].

**Figure 1.** Location and physical and geographical features of the lake Khubsugul depression – Study area.

**Figure 2.** Depressions and crackings of Baikal Rift Zone and lake Hovsgol.
Now the main goal of environmental protection is not the preservation of its individual components (mainly biological), but the preservation of nature as a whole with all its components. In achieving this goal, the conservation of soil diversity is one of the central problems. Today the increasing attention is given to research of soils bodies, which are known among all components of geosystems by the greatest capacity of information storage about main stages of landscape development and changes of the environment.

2. Objects and methods
The objects of research were the soils, which have been formed on the outputs to the daily surface of phosphate layers’ rocks of Ongolighur deposit of Khubsugul phosphorite basin of Mongolia, extending across all high-altitude zones of Khovsgol lake area. The field studies of phosphorite soils and landscapes were carried out during the field seasons of the work of Soviet-Mongolian complex Khubsugul expedition of Irkutsk and Mongolian state universities with using of soil-morphological, pedo-lithological, botanical, geological-geomorphological and comparative geographical research methods. More than 30 soil profiles have been dug up and described on the territory of the deposit and at surrounding landscapes of South-Western part of the depression of lake Khubsugul.

Physical and chemical properties of soils were determined by conventional methods of potentiometry, titration, photo-colorimetry [6, 7]. The granulometric composition of soils has been determined by the pipette method of N.A. Kachinsky [8]. The mineralogical composition of the large fractions and silt of soils was determined by using of scanning electron and polarization microscopy and x-ray diffractometry methods. The gross chemical composition of elements of aleurolite and silt soil’ fractions have been determined by methods of melting with carbon dioxide salts K+ and Na+ with using of flame photometric and atomic adsorption spectroscopy. Organic matter of phosphate soils was evaluated through the fractional composition of humus (determined by Ponomareva-Plotnikova method). Migration mobility of phosphorus has been determined by the assessment of the fractional composition of mineral and organic phosphorus compounds. In the study of the classification position of investigated soils Russian and international approaches in determining the types of soils were used [9, 10, 11, 12].

3. Materials and results
The structure of the soil cover of Bailal-Khovsgol area is of high spatial-temporal heterogeneity and complexity [13, 14, 15, 16, 17] due to various geological history of the region, to wide spread of young mountain systems, of islands of permafrost (especially in valleys and depressions), to the influence of seismic and tectonic processes of Baikal rift zone, influence of loess deposits, karst processes, riggestness of terrain, hillock-pit relief and other factors. The Foundation of the Baikal-Sayan-Mongolian fold belt of the South-Western wing of the BRZ consists of fragments of two geostructures of Asia: Siberian platform and the Central Asian belt, which was separated by the Proterozoic main fault of the Eastern Sayan and is represented by three terranes (Eastern Tuva, Djidinskiy and Tuva-Mongolian). Rift depressions are confined to zone of articulation of the ancient continental massif with the Caledonian folded system, formed on the site of the Late-Riphean ocean.

The mountain systems of the southern part of Eastern Siberia were formed due to high tectonic activity, which led to periodic cooling and development of multiscale mountain-valley glaciations [18] around the mountain frame of lake Baikal, including the Sayan mountains (above the mantle plume) [19, 20]. The thickness of glaciers reached 3 km. At the end of the Pliocene the formation of the Altai mountain country was completed [21], warming and aridity of the climate contributed to change of broadleaf forests to small-leaved biocoenoses and to formation of steppe and semi-desert vegetation. Dry and cold small ice period of Pleistocene caused of permafrost cracking of soil cover of valleys [22, 23]. Further warming of climate promoted to the processes of xerophytization of coenosises [24].

The geological and tectonic history of the BRZ contributed to the formation of a large Khubsugul phosphorite basin at the southwestern part of the lake Hovsgol, which consisting of more than thirty deposits and occurrences of phosphorites’ rock with a total area of 30000 sq. km [25, 26]. Main
Khubsugul’ deposit stretches along the Western shore of the lake by a strip of 50 km and a by a width of 30 km [27]. The content of P2O5 is submitted by fluorapatite (francolite) with a mixture of carbonatapatite and varies widely, reaching of 31-32 % [28]. The reserve of deposit are close to 1 billion tons [29].

Geological features and natural conditions around lake Khovsgol defined the uniqueness of its soil. Its common feature is low energy level of soil formation, small differences in heat supply between genetically distant soils [30], which are appeared against the background of different lithology of soil-forming rocks [31], perennial and seasonal permafrost [32].

Phosphorite soils are characterized by a large quantity of total (up to 3% P2O5) and mobile phosphorus, which determines their peculiar morphological and physico-chemical properties (table 1).

Table 1. Physico-chemical properties of soils formed on phosphorite rocks at South-Western part of lake Khovsgol of Mongolia.

| Horizon | Depth cm | pH H2O | Elettrophilic potential | C, % | N, % | CcA | CcFA | Exchangeable cations, mg-eq/ 100g | Mobile P2O5, mg/100g | FeOx* (Mobile Fe2O3) mg/100g | CaO, % | CEC, mg-EQ/100g | ≤0.001, % | ≤0.01, % | ≥0.01, % |
|---------|----------|--------|------------------------|------|------|-----|------|---------------------------------|----------------------|------------------------|------|----------------|------|--------|--------|
| Tundra zone. WRB**: Rendzic-Cambic Calcaric Leptosol (Eutric, Humic, continuous rock), (SKR****: Dark-humic clay-illuvium carbonate Litozem), formed on eluvium of phosphorite rocks (soil cut № 5-OG). Tundra association (fescue-dry) of watershed part of the South-Eastern slope of mountain’ massif (peak Uran-Dushe-Uul, 2300 m above sea level) | A0k 0-8 | 7.60 | 9.16 | 7.98 | 0.98 | 1.83 | 16.6 | 8.5 | 15.6 | 380 | 62.7 | 37.6 | 9.5 | 16.3 |
| A1k 8-18 | 7.95 | 8.64 | 3.72 | 0.34 | 1.80 | 21.4 | 7.5 | 8.5 | 360 | 56.2 | 43.7 | 8.6 | 27.1 |
| C1k 18-90 | 8.70 | 9.47 | 0.48 | n.d. | 1.82 | 17.4 | 1.3 | 7.0 | 150 | 58.9 | 24.5 | 10.4 | 21.1 |
| Forest zone. WRB**: Rendzic-Cambic Calcaric Fhaeozem (Epidystric, Loamic, Skeletic) (SKR****: Dark grey metamorphic residual carbonate soil), formed on eluvium-deluvium of phosphorite rocks (soil cut № 1-OG). Cereal-mixed grass-legume larch forest of the North-Eastern slope of the valley of the Ordogin-Gol river (altitude up to 1800 m above sea level) | AH 4-9 | 6.95 | 8.13 | 7.28 | 0.74 | 1.70 | 19.5 | 5.2 | 27.0 | 850 | 51.6 | 29.8 | 15.3 | 45.7 |
| A 9-17 | 7.00 | 8.89 | 2.77 | 0.16 | 1.70 | 11.3 | 3.7 | 25.2 | 980 | 51.2 | 26.1 | 13.2 | 41.6 |
| ABt 17-30 | 7.05 | 8.29 | 1.23 | 0.18 | 2.20 | 7.4 | 2.0 | 25.6 | 810 | 48.3 | 28.1 | 10.5 | 38.6 |
| BCk 30-47 | 8.00 | 8.75 | 1.19 | 0.09 | 1.20 | 5.5 | 3.5 | 10.6 | 300 | 64.9 | 25.8 | 11.0 | 28.9 |
| Ck 47-90 | 8.55 | 8.83 | 0.32 | 0.04 | n.d. | 1.5 | 1.7 | 10.0 | 120 | n.d. | 27.4 | 7.3 | 16.1 |
| Steepe zone. WRB**: Chernic-Calcic Endo-Leptic Chernozem (Eutric, Epi-calcaric, endodolomite) (SCR****: Dispersed carbonate Chernozem), formed on eluvium of phosphorite shale rocks (soil cut № 2-01) of the watershed part of the slope South-Eastern exposure at the starboard side of the valley of river Ordogin-Gol (at 1700 m above sea level). Grass cereal steppe | Ak 0-15 | 7.75 | 8.49 | 5.16 | 0.58 | 1.71 | 10.2 | 3.0 | 15.0 | 270 | 69.0 | 31.9 | 7.85 | 12.7 |
| ABk 15-30 | 7.95 | 9.06 | 3.21 | 0.31 | 1.19 | 8.4 | 5.8 | 12.4 | 280 | 82.4 | 24.9 | 6.80 | 17.7 |
| BCk 30-55 | 8.35 | 8.66 | 0.85 | 0.20 | 0.89 | 2.5 | 2.9 | 4.60 | 110 | 78.0 | 24.9 | 5.65 | 14.9 |
| Ck 55-85 | 8.75 | 8.44 | 0.39 | 0.05 | n.d. | 1.1 | 2.0 | 6.08 | 50 | 81.6 | 17.9 | 5.80 | 12.6 |

* FeOx – Iron eluted by acidic ammonium oxalate extract
** CEC – Cation exchange capacity (mg-EQ/100 g)
*** Σ fractions (mm), %: <0,001; 001-0,005; 0,005-0,01
**** WRB – World reference base of soil resources
***** SCR – Soil classification of Russia
# n.d. – not determined

In the area of distribution of phosphorites rocks of Mongolia, at all high-altitude zones (tundra, taiga and steppe) formed an original soils, that by the sum properties of that is identified in a
special group of «siliceous-calcareous-phosphatic soils». In the tundra zone there are formed mostly dark-humus clay-elluvium soils - *Rendzic-Cambic Calcaric Leptosols*; in the forest zone are distributed dark-grey metamorphic residual-carbonate soils - *Rendzic-Cambic Calcaric Fhaeozems*; in the steppe zone are formed humic soils with dispersed carbonates - *Chernic-Calcic Endo-Leptic Chernozems*; in bogy depressions are formed dark-humus-gley residual carbonate soils – *Histid-Stagnic Calcic Gleysols*.

At the wide areas of the Khubsugul phosphorite deposit (which has been stretching through tundra, forest and steppe landscapes) the model of “climate-driven zoning” of soil formation, complicated by lithogenic matrix [33], is realized and determines the direction and efficiency of soil formation at the region [34]. Soil pH is alkaline - probably due to the presence of carbonate fluorapatite and dolomite. Intensive biological activity of soils contributes to the high accumulation of C and N in them and their gradual decline down the profile. The composition of humus is predominantly humate with a predominance of calcium humates and humates, associated with clay minerals. Exchange cations are relatively few due to intensive leaching processes in the mountains. The cation exchange capacity (CEC) varies from 20 to 40 mg-EQ/100 g of soil, reaching a maximum in humus horizons.

During the pedogenesis on phosphorites, the severity of the processes of metamorphic claying, leaching of soluble substances and colloidal clay particles, etc. is determined by the degree of transformation of the aluminosilicate, carbonate and phosphate part of the soil, by the structural features of the lithogenic rock' base. The fractions of fine sand and coarse dust are predominantly accumulated inside investigated soils during cryogenic hydration weathering and transformation of mineral part of the soil, which are more typical and active for soils of taiga zone.

Our research revealed, that the weathering of phosphate-bearing soil-forming rocks of the deposit leads to a significant accumulation of silicate fine-thin aleurolite compounds (figure 3) as the decomposition and carrying out of carbonate component and also - contributes to the residual accumulation of clay minerals and silty organic matter.

![Figure 3](image-url)  
**Figure 3.** Total elemental composition of investigated soils, formed on phosphorite rocks (% on calcined soil): A - Rendzic-Cambic Calcaric Leptosol (Eutric, Humic) (5-OG); B - Rendzic-Cambic Calcaric Fhaeozem (Epidystric, Loamic, Skeletic) (1-OG); C - Chernic-Calcic Endo-Leptic Chernozem (Eutric, Epi-calcaric, endodolomitic) (2-OF).
Carbonates are “hiding” the impact of phosphate material of parent rocks for soil genesis, promoting to the formation of hydro-mica-chlorite-illite composition of the clay’ part of soils with signs of weak crystallization and super-dispersion’ fineness of illites. Phosphorus and carbonates are promoted to the stabilization of the humus accumulation process at the studied soils through the coagulation of solid carbonate-phosphorus-humus complexes, the mineralization of which has been inhibited by the formation of protective thin carbonate layer on them.

Our fractional analysis of mineral phosphates showed that under the influence of phosphate layers clay substances and phosphates of Al and Fe are most active accumulated in the studied soil profiles. This we associate with active accumulation of humus substances, which promote the creation and accumulation of chemical complex compounds of aluminophosphates and iron phosphates. The high content of humic acids may be due to the presence in the phosphorites rocks of the mineral francolite (tricalcium phosphate), which “fixing” humic substances, converting them into slightly soluble forms of calcium humates and thus promoting to the preservation and “aging” of humus.

With the simplification of the energetic-informative structure of the mineral mass of phosphorite soils, there is a significant convergence of a number of basic properties, determined by the duration of interaction of soil-forming rocks with biotic and abiotic components of ecosystems. The soils on pure carbonate rocks, the weathering of which does not change the chemistry of the soil formation process, are characterized by the least reflectivity. The «sensitivity» and «reflectivity» of pedogenesis [35] is more typical for soils developed on silicon-carbonate rocks. In the climatic conditions of mountain ecosystems of depression of lake Khovsgol with open biogeochemical cycle of substances the lithogenic matrix determine the directions of soil formation because of its bioclimatic «reflectivity», forming a lithogenic spectrum of soils on rocks with different degrees of carbonate and phosphate, complicated by stratigraphic and facies variability of phosphate-(siliceous)-carbonate rocks.

In the landscapes surrounding lake Khovsgol, in addition to CA-P classes of soils and landscapes there are other “exotic”, due to the presence of fluorine, polymetals, iron, copper, rare earth elements and other chemical elements (table 2).

Table 2. The content of gross forms of trace elements in the studied soils formed on phosphorite rocks.

| № | soil cut | Hori- | Depth, cm | Mn | Zn | Cu | Co | Rb | Sr | Y | Zr | F |
|---|----------|-------|-----------|----|----|----|----|----|----|----|----|----|
| 5-OG* | AHk | 0-8 | 0.736 | 0.007 | 0.019 | 0.038 | 0.042 | 0.052 | 0.072 | 0.016 | 0.278 |
| | ABtk | 8-18 | 0.037 | 0.009 | 0.018 | 0.049 | 0.042 | 0.051 | 0.041 | 0.022 | 0.214 |
| | Crtk | 18-90 | 0.107 | 0.007 | 0.013 | 0.016 | 0.042 | 0.051 | 0.035 | 0.015 | 0.028 |
| | AH | 4-9 | 0.105 | n.d.# | n.d.# | n.d.# | 0.062 | 0.027 | 0.041 | 0.021 | 0.118 |
| | A | 9-17 | 0.062 | 0.008 | 0.016 | 0.018 | 0.062 | 0.024 | 0.037 | 0.022 | 0.742 |
| 1-OG** | ABt | 17-30 | 0.046 | 0.006 | 0.012 | 0.042 | 0.041 | 0.041 | 0.018 | 0.014 | 0.862 |
| | BCh | 30-47 | 0.032 | 0.008 | 0.012 | 0.067 | 0.934 | 0.061 | 0.021 | 0.010 | 0.278 |
| | CG | 47-90 | 0.023 | 0.009 | 0.015 | 0.046 | n.d.# | n.d.# | n.d.# | 0.158 |
| | Ak | 0-15 | 0.826 | 0.009 | 0.013 | 0.035 | 0.093 | 0.057 | 0.032 | 0.009 | 0.862 |
| 2-OG*** | ABk | 15-30 | 0.119 | 0.009 | 0.015 | 0.018 | 0.032 | 0.033 | 0.037 | 0.010 | 0.782 |
| | BCh | 30-55 | 0.037 | 0.005 | 0.013 | 0.026 | 0.018 | 0.044 | 0.017 | 0.007 | 0.758 |
| | Ck | 55-85 | 0.027 | 0.005 | 0.016 | 0.034 | 0.024 | 0.061 | 0.036 | 0.006 | 0.358 |
| Permissible concentration | | | 0.010 | 55* | 5* | 0.5* | 7* | 2* | 6* | 1*10^-3 |
| | | | | 10^-4 | 10^-4 | 10^-4 | 10^-4 | 10^-4 | 10^-4 | ** |

n.d. – not determined; # water soluble form;
*5-OG – Tundra zone; Rendz-Cambic Calcaric Leptosol (Eutric, Humic);
**1-OG – Forest zone; Rendz-Cambic Calcaric Phaeozem (Epipodic, Loamic, Skeletic);
***2-OG – Steepe zone; Chernic-Calci Endo-Leptic Chernozem (Eutric, Epi-calcic, endodolomitic)

Alternating freezing-thawing, causing the accumulation of dust particles in the soil, changes the amount of bound water and the scale of biochemical weathering. The total composition of the of the chemical elements of the studied soils and their granulometric fractions shows that carbonates of
alkaline earth metals and phosphates are leached from them during the process of soil formation. Frost cracks, gradually filling with mineral, organogenic and chemogenic material and acting as natural drainage systems, deplete the soil by many components, which creates a diversity of soil and vegetation cover. The degree of accumulation of chemical elements in individual parts of the landscape cascade-geochemical systems around the deposit depends on the mutual combination of humus formation processes, soil genesis and migration characteristics of chemical elements.

There is a strong lateral flow of substances in mountainous conditions, but around rock outcrops of the phosphorite deposit to the surface there are no favorable conditions for the growth of areas of distribution of phosphate dispersions. This is due to the fact that around the studied geosystems the carbonate geochemical barrier, represented by the transformation products of dolomites and limestones, was developed. The low content of mineral phosphorus in the waters of lake Khovsgol and nearby rivers, flowing through the ore body of the deposit [36], is confirms this. No changes in the structure of typomorphic elements of biocenoses from tundra to dry steppes were also observed by our botanical studies.

As we can see, the content of many elements (especially rare earth) exceeds the maximum permissible level of concentrations. The content of fluorine in the soils of the studied landscapes is very high, because the main mineral of phosphorites is francolite (synonyms: staffelite or hydroxyl-fluorine apatite, \( \text{Ca}_{10} \text{[PO}_{4}\text{]}_{6} \text{[F}_{2} \text{(CO}_{3}\text{)]}_{3} \text{(OH)}_{2} \text{O} \)). The largest amounts of mobile and water soluble fluorine are confined to the humus strata of forest and steppe soils of phosphorite landscapes. The excess can reach up to 800 times.

Vanadium, nickel, fluorine, mercury and other are the elements with a high content in the environment of the Khubsugul phosphorite deposit, that can be accumulated in the trophic cycles. They are "transformers", which can lead to individual genetic disorders in biota.

Of the elements, which are typomorphic to the Khubsugul deposit, mercury belongs to the first class of the sanitary hygienic danger, but its anomalies are local and low-contrast; fluorine – belongs to second class (with large areas); phosphorus is a biogenic element; the danger of rare earths has not been studied. These data make it possible to formally classify the Khubsugul deposit as an ecologically average dangerous one, according to the classification based on the parameters of anomalous geochemical fields of deposits. If we take into account the contrasting natural, social and anthropogenic situation at the ecosystem of the Baikal region, the Khubsugul deposit should be attributed to the first class of danger, despite that phosphorus was not been included in the sanitary and hygienic classification. The danger is determined by the impact on the biota of landscapes with phosphorus-manganese specialization (which leads to increasing incidence of "urolithiasis"), and by influence of very large amounts of overburden rocks (at the open mining of the deposit), containing phosphorus, which is the limiting factor of the ecosystem of lake Khovsgol. The mountain landscapes of the deposit, where the secondary areas of phosphorus and fluorine are developed, are unfavorable for permanent residence and agriculture. But this danger is, apparently, not relevant yet for study area.

Taking into account the above - it can be summarized that the study area is very relevant to monitor the state of the surrounding landscapes of the lake – that is, to identify the background characteristics of the areas of possible mining of the deposit in order to determine the natural stability of biocenoses, predict the possible consequences of increasing anthropogenic pressure and prevent pollution of the unique natural ecosystem of the lake Khovsgol. Unusual biogeochemical properties of soils and landscapes, their natural, historical and aesthetic value, along with the uniqueness of the natural complexes of the lake basin, increase the scientific and natural importance of created around the lake Khovsgol national Park to preserve the natural biodiversity of the territory [37]. In addition to protecting the unique ecosystem of lake, this park is provide of preservation of standard natural complexes, typical for Baikal and Khangai-Khentei mountainous systems.

During the mining of the phosphorite deposit, there is possible to activate of naturally balanced system of Khovsgol depression with an increase of concentrations at the local background, with an increase in its dynamics and in spread of pollutants over long distances along the wind rose. The opening of the indigenous phosphate rocks and loose sediments of deposit will break of gas regime of
the study area. Available information allows us to pay attention to the radioactive component of these rocks. The emanation radioactive flow from the layers of phosphorites allows to trace the overlapped layers under the river strips, even in the presence of shielding of emanations by the soil cover. A large role of the pelitic fraction of the unconsolidated ground sediments in this process is noted. Transpiration areas (gas-liquid) of phosphorus under the vegetation cover will also be disturbed. Their presence may be associated with abnormal phosphorus content in the filtrate of snow water in the lake Khubsugul. litho-biochemical areas are significantly exceeding up to width of phosphate layers of rocks of the deposit and will be included in the contour of career development. There are practically no water flows, no hydrochemical anomalies in groundwater. Thus, the actual natural geochemical field of the deposit as a source of pollution will be of minimal value. Its impact will be appeared only indirectly from anthropogenic processes of mining of the phosphorites deposit.

During the open mining of the deposit phosphorus (in the form of dust) will be involved in the biological cycle and in the form of phosphorus-organic compounds can migrate across the landscape, promoting to the phosphatization of lake Khovsgol. With increasing of dispersion of the material it can be possible to assume of increasing of phosphates’ solubility. But the low temperature of the waters of the lake and the high saturation of their bicarbonates of calcium and oxygen will, apparently, contribute to conservation of phosphorus, which may increase the productivity of phyto- and zooplankton, and as a consequence – to formate of secondary areas of dispersion of phosphorus. At this moment, natural complexes are in a balanced state. The mining of the deposit will can bring eutrophication to part or all area of lake Khovsgol (and of lake Baikal also through the rivers Egin-Gol and Selenga) and the death of the least stable components of the soil microbiota, a separate endemic species of fauna and flora of the lake Khovsgol. Hydrogen sulfide contamination of the lake will require of “geological” periods of time for restoration of its current ultra-oligotrophy.

4. Conclusions
The new actual information about weakly studied phosphorites’ soils, processes of soil formation, soil-ecological potential and migration of phosphorus in mountain soils, formed on phosphatic-carbonate rocks of the deposit has been received. Due to the fact that the weathering of pure carbonate rocks does not change the chemistry of soil formation processes, soils formed on carbonate rocks are characterized by the least response to changes in soil formation factors. Soils formed on siliceous-phosphatic carbonate rocks of Hovsgol lake area have a significantly greater degree of sensornet and reflectometry. Phosphate-carbonate lithogenic basis (matrix) of phosphorite soils, forming a strong organic-mineral frame of humate composition, helps to support a sufficiently high level of soil-ecological potential of the study area. Carbonate barrier creates unfavorable conditions for growth of areas of distribution of phosphate dispersion and for instability of "phosphorite soils" in case of possible industrial disintegration of the phosphate rocks of deposit.

Conducted researches of «phosphorite soils» confirm of necessity of preservation of these exotic unique landscapes of the Baikal rift zone, which have no analogues within Siberia and Mongolia, whose originality is caused by the phosphate content of soil-forming rocks. In this regard the continuation of works on creation of a system of large national parks around lake Baikal and lake Khovsgol becomes the most actual and especially significant. Large areas of natural complexes preserve biodiversity and provide environmental stability better than small ones. It is important that all ecosystems of the region should been sufficiently represented at the system of protected areas of Baikal- Khovsgol basin with interconnected among themselves of natural green belts or corridors, which provide of migration processes of populations.

Because the Baikal- Khovsgol basin belongs to those territories, whose sustainable development has not only national, but also of great international importance, to this region should be given priority attention in addressing issues of international environmental policy strategies.

Phosphorite landscapes of Mongolia can serve as a basis for implementation of international projects and programs of environmental monitoring and conservation of the unique natural systems and models of natural complexes of lake Khovsgol and lake Baikal of BRZ at the territories...
established due to intergovernmental agreements between Russia and Mongolia of transboundary protected areas, including the state natural biosphere reserve "Sokhondinskiy" and national park "Onon-Baldzhinskiy" and also national parks "Tunkinskiy" and "Khubsugulsky (Khovsgol)".

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