Unexplored soils of the Western Yakutia

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Abstract. Analyzing the developed classifications by typology of soils permafrost, the author of article comes to a conclusion about existence in it “white spots”. As additional approach in a context of expansion of systematization and classification of cryosols not studied types of soils, in a basis by which L.G. Elovskaya's classification is put are offered new early. The characteristic, properties and climatic and forest vegetation conditions of formation permafrost soils new to zone of an average taiga are given. These are forest gray and brown soils, characteristic for the forest-steppe zone, possessing potentially high fertility and which test now the intensive techno genic press, connected with production of hydrocarbons. Identification of soils of a sub boreal climatic zone in a boreal belt frozen ground happens for the first time that is connected with inaccessibility and spatial remoteness of the studied territories from the scientific organizations. Brown and gray types of soils are characteristic for the broad-leaved woods not permafrost areas and stay them under small-leaved and light-coniferous forests in conditions frozen ground is nonsense. Definition of genesis of these soils and probability of shift of the natural zones, caused by climate changes, demands further complex detailed researches.

1. Introduction

Development of natural wealth of Yakutia is followed by studying of unexplored territories of the republic. One of examples is the Western part of the republic where now the oil and gas fields providing filling of pipelines Eastern Siberia-Pacific Ocean (ESPO) and "Force of Siberia" accustom intensively and operated. Earlier here in the fifties last century, mainly, in valley sites of agricultural areas alluvial soils have been studied [1]. And now soil scientists have fragmentary explored license areas of fields [2, 3, 4].

Southwest part of Yakutia concerning all republics is the richest on a biodiversity and on biomass productivity. Here high site class wood plantings grow and in bed curtains pine-larch a forest stand not meeting types of tree species, such as Siberian larch are found anywhere any more in the republic (Larix sibirica Ledeb.), fir (Abies sibirica Ledeb.), cedar (Pinus sibirica (Rupr.) Mayr.), mountain ash (Sorbus sibirica Hedl.), fir-tree ayansky (Pisea ajanensis Fisch.) etc. At the same time, explored reserves of hydrocarbons lie in the most productive on flora and fauna of the territory of Yakutia. Development of fields is followed by data of the wood, construction of infrastructure for the prospecting, extracting, transport and serving branches of the oil and gas industry. During these works sludge depots are under construction, there are dumping of the mineralized reservoir waters, various chemicals at use of boring solutions are used, there are emergency floods when transporting, etc. [5]. Annealing of associated gases and casual floods is often applied that is fraught with emergence of the extensive wildfires causing degradation of a permafrost, which are shown in subsidence of a relief...
owing to an thawing of underground ices, bogging, a soliflyuktion, a thermoerosion, etc. Thus, development of minerals is accompanied by a complex of negative impacts on natural landscapes of permafrost. At the same time considerable transformations are noted in a soil and vegetable cover which are reflected further also in other components of ecosystems.

In this regard, studying of the changes happening in the soil at industrial influence for development of recommendations about decrease in negative consequences and development of ways and measures for a rehabilitation of the broken territories has further relevance. Therefore a main objective of our works was the research of characteristics and properties of a soil cover of the Western Yakutia. The extensiveness and inaccessibility of sites, lack of the equipped roads, a lack of financing have caused insufficient studying of a soil cover above the specified territory so far.

2. Environment
The climate of the region is characterized by continentality, shown low winter (to -58, - 62°) and high summer (to + 36°) air temperatures. In comparison with the Central Yakutia the winter is warmer here, and the summer is cooler with a large amount of the dropping-out rainfall. The annual course of rainfall is characterized by sharply expressed summer maximum and in rather dry winter. The average annual amount of precipitation makes 482 mm.

The western Yakutia occupies east half of the Siberian platform. The dominating relief types are structural denudation sheeted and step plateaus with accumulative low plains [6] here. The area of researches is included into Lena sheeted Plateau, the representing denudation relief with the deep erosive cuts developed by the rivers on deposits of the top Cambrian and Ordovician. The originality of a relief of area is caused by a complex tectonic structure and existence of young tectonic movements. The ridges expressed in a relief are large anticlinal folds which alternate with flat and wide synclines. Breeds of the lower Cambrian on which according to breeds of the Cambrian, the Ordovician and carboniferous deposits of Perm lie participate in a geological structure of the called structures. All these breeds of an intrusion sheeted and secants bodies of basic rock. Breeds of the Cambria and the Ordovician are blocked by continental and sea deposits lower Yura. The territory of the explored site on soil geographical zoning belongs to the Yakut East Siberian taiga small valley province, to Srednelensky district where average are most widespread according to the Atlas [7] turf and carbonate and loamy (places detritus), carbonate and peat and marsh soils turf and podzol soil. On forest vegetation division into districts the explored area enters to the Leno-Vitimsky foothill district of the Southern Yakut average taiga forest vegetation province pine larch a taiga with participation of dark-coniferous forests [8]. There passes the northern border of an area of many plants getting from the southern and western Areas of Siberia. Stocks of forest stands make more than 140 cubic meters on hectare.

In field conditions on key sites soil cuts were put, their morphological description was made and samples on chemical and geochemical analyses according to the existing techniques were selected [9]. Chemical analyses of soils were carried out by the standard methods [10]. In work flow under the mixed woods in Lensky District we have found permafrost gray forest soils. These soils were included into classification by L.G. Elovska [11] and are not studied in permafrost area. On classification of soils of the USSR they have three subtypes – dark gray, gray and light gray forest [12].

The following studied type of soils is the permafrost burozem in the flat territory found on the Wakunai license area, relating to the Irkutsk region and Mirinsky district of Republic of Sakha (Yakutia). The general climatic factors of the explored territory are that and here zone soils are pale-yellow-brown, early called by permafrost taiga types of soils.

3. Characteristic of soils
The paradox is that in boreal (moderate and cold) bioclimatic zone of Yakutia in the conditions of continuous distribution of permafrost types of soils of a subboreal (moderate and warm) belt are revealed. Permafrost gray soils are created on the ancient alluvial deposits, are characterized by sour reaction, light particle size distribution. At the same time high fertility of this type of soils, concerning
others the permafrost of soils productivity and a variety of vegetation testify to an optimum ratio of agrophysical and hydrothermal conditions of the permafrost gray soil. Formation of gray type of soils is caused by weakening of podzol formation process to what promotes feature of biological circulation of substances, conditions of humification and the water mode (fig. 1). The question of genesis of gray forest soils is debatable so far. Considerable part of humus acids is neutralized by the bases of herbs and the tree waste presented by generally deciduous breeds and as a result of it processes of destruction of soil minerals in gray forest soils are significantly weakened. In humus of the top horizons of gray and light gray soil fulvic acids prevail. The maintenance of humus very high 15% in the organic horizons, also have the accruing profile distribution with a depth [13]. Humus type is duff. Extent of hymification of organic substance is very high. At the same time humus content nitrogen low. The maintenance of not hydrolyzed humus rests an average. Security with phosphorus is high. The humic and eluvial horizons of the gray soil belong to light loam coarse silty gritty. The parent rock breed belongs to oozy light clay. Because of prevalence the silty loam of fractions in these soils height of a capillary rising of moisture is maximum and reaches 91 cm. And in maternal breed the prevalence of oozy fractions causes considerable molecular moisture capacity of soils.

![Fig. 1. A birch forest mixed herbs with impurity of a cedar under which permafrost gray forest soils are formed (a photo A.P. Pesterev)](image)

According to literary data the field moisture capacity varies from 40 to 45%. At the same time the distinction of particle size distribution of the soil and the maternal horizon testifies to a binomial character of a profile of the gray soil of this location. These soils have sharply sour reaction of the environment in the top horizons, saturation degree the bases makes 70-85%. Soils aren't salted. In gray soils there is a process of a illimerization with formation of an eluvial - illuvial profile of the genetic horizons. In them the steppe type of soil formation prevails. In general, impregnation of all profile humus substances is characteristic of soils of this region that sharply distinguishes these soils from soils of the Central region of Yakutia and demonstrates high fertility and huge potential stocks of humus under forests. In the region are found by us gray and dark gray, differing on the general maintenance of a humus. These soils on slope and water separate spaces are combined with calcareous soil, the last are dated by the most part for the valley of the Lena River.

As it was stated above, the brown type of soils was described by many researchers in mountain areas of South Yakutia, but in the flat territory of permafrost this type of the soil is revealed for the first time. On fertility concede to gray soils, the maintenance of humus on profile distribution sharply decreasing here. The explored territory represents hollow the plain dismembered by river network with
abundance of swamps and small lakes. The geology of the territory of distribution of brown soil (the frozen of forest brown soils) is presented by generally Jurassic system at a combination of Cambrian and Ordovician systems of Paleozoic group. Breeds are blocked by a raincoat from quaternary deposits, presented top a Pleistocene Holocene (slide-rocks), consisting of loams, sandy loams, crushed stone, blocks of radical breeds. At the same time because of boundary conditions of Lena Plateau and the Vilyuysk synclise there is a combination fluvioglacial sediments deposits (loams, sandy loams, clays) which are soil-formation rocks of this territory here.

The frozen brown soils are formed under the productive the many-tier, more, mixed forest stands, on the water separate spaces of the explored territory, in rather favorable climatic conditions (fig. 2). Soils have water strong structure, high porosity, good air-and water penetration. The lamination of the mineral horizons (mainly heavy particle size distribution) is caused by cyclic process of the freezing and thawing of the soil connected with fluctuations about zero daily course of temperature and respectively phase transitions of water to the spring period and gradual step thawing of permafrost. Such lamination in certain conditions is observed only in the illuvial horizon and in the above permafrost screen. The first is connected with the fact that at a depth of the illuvial horizon fluctuation of the daily course fades, and the second is caused, the fact that over the permafrost screen there are same changes of temperature connected with atmospheric variations, it is natural with a certain step of delay and cyclic decrease in a thermal wave.

This type hasn't entered Elovskaya [11] classification, but is available in classification of soils of the USSR [12]. Brown forest soils have wide circulation in Western Siberia and mountain regions of Russia. On the last classification [14] the burozem is included into department of metamorphic soils. Soils of department are characterized morphologically the weak differentiated profile in which the topsoil and the mineral horizon brown (brown, pale-yellow) tones, form at the expense of an ferruginization on the place and a structuration. They contain in A1 horizon 5...10% of the humus which is sharply decreasing down a profile (at a depth below 10 cm only 0,4%). As a part of humus acids prevail. Reaction of soils sub acidic and close to neutral (pH 5,5...6,0), with a depth passing to neutral, the relation C: N = 13.. 19 that testifies to a low content of humus nitrogen. Burozems, on slope sites are replaced frozen podzol soils or permafrost pale-yellow-brown (permafrost taiga) by soils, formed under cowberry pine forests.

![Fig. 2. Under a larch blueberry - cowberry, the created permafrost brown forest soil (A.P. Pesterev's photo)](image-url)
Some chemical indicators the merzlotnykh of gray and brown soils for comparison are presented in table 1.

| №  | Profile         | Horizon | Depth, cm | pH | Humus, % | N total, % |
|----|----------------|---------|-----------|----|----------|------------|
| 1  | P 5 АП         | A1      | 2 - 27    | 3.1| 15,89    | 0.719      |
| 2  |                | BC      | 50 - 74   | 3.14| 34,75    | 1.773      |
| 3  | P2АП-12        | Αп     | 0 - 4     | 4.9 | 13,4     | 0.050      |
| 4  |                | A1      | 4 - 8     | 5.5 | 5.2      | 0.050      |
| 5  |                | B       | 8 - 26    | 6.8 | 0.4      | 0.015      |
| 6  |                | Aп      | 26 - 34   | 7.3 | 0.4      | 0.008      |
| 7  |                | B       | 34 - 55   | 7.4 | 0.4      | 0.008      |

Actually recently various anthropogenic impacts on all republic on the taiga ecosystems [16, 17, 18, 19] causing degradation of a permafrost and an intensification of global warming have amplified. Influence and damage to the environment are noted in many works [20]. These processes have irreversible character and therefore demands further systematic researches.

Despite global warming of climate of transition of natural zones it isn't observed yet therefore in our opinion, formation of the considered soils is reflection of former eras with warmer climate. At the same time, because of rather soft winter and lengthening of the vegetative period they have remained till our times. But the intensification oil and gas production in these territories will destroy rare unique types of the soils having potentially high fertility. Their urgent studying, the detailed analysis of properties, delimitation of distribution and their inclusion in the Red List of soils of Russia is necessary for ensuring protection of unique soils that demands considerable financial means and consolidation of efforts of various scientists and researchers - ecologists, dendrologist, soil scientists, geologists, etc.

4. Conclusions

Thus, as a result of the conducted researches of a soil cover of the West of the Sakha (Yakutia) Republic we come to the following conclusions:

- Permafrost gray soils are formed under the small-leaved woods in continental climatic conditions on the alluvial deposits. Permafrost gray soils are geographically located in the pool of an average watercourse Lena local sites in Lensky District Republic of Sakha (Yakutia).
- Permafrost brown soils are formed more widely under the coniferous many-tier forests on a Pleistocene- Holocene deposits, in combination with Permafrost podsolic and pale-yellow-brown soils. The explored Permafrost brown soils are widespread on water separate spaces of the Western Yakutia and have, rather zone pale-yellow-brown soils, high fertility.
- On a relief brown forest soils in northern regions it is formed on the drained slope sites, upon transition to more southern areas they occupy water separate spaces.

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