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DIAGNOSTICS OF SOIL FORMATION ACCORDING TO SOIL HYDROMORPHISM DEGREE

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On the basis of the theoretical analysis of soils genesis and their hydromorphism the possibility of diagnostics soil formation by a degree of soil hydromorphism was proved to be reasonable.

Key words: hydromorphism, diagnostics of soil formation

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ДІАГНОСТИКА ҐРУНТОУТВОРЕННЯ ЗА ГІДРОМОРФНІСТЮ ҐРУНТУ

На основі теоретичного аналізу генезису ґрунтів та їх гідроморфності обґрунтовано можливість діагностики ґрунтоутворення за ступенем гідроморфізму.

Ключові слова: гідроморфізм, діагностика процесів ґрунтоутворення.

As it was shown in (Дронь, 2004а), the basis of hydromorphic soil formation is reducing condition. Such a conclusion is based on the fact, that all specific attributes of hydromorphic soils, to which concern light exposure of earth matter owing to gley or podzol formation, presence concretion and nonconcretion formations of different structure, accumulation of peat, organic substance and sulphides are formed under influence of reduction. Taking it into account any soil, in which reducing conditions are observed, is hydromorphic. The degree of change of morphological and other properties of hydromorphic soils depends, first of all, on intensity of reducing conditions, their depth and duration, and also on the character of accompanying conditions and the age of soil formation. So, the speed of formation of specific hydromorphic attributes in soils, i.e. degree of modern hydromorphism of soil is determined by the intensity of development reducing conditions in it. The approach enables quantitatively to estimate a degree of soil hydromorphism (Дронь, 2004а) and to create the uniform scale of soil hydromorphism.

This work is an attempt of theoretical analysis of interrelation of a degree of hydromorphism of soils different types and processes, which pass in them.

It is obvious, that a soil cover of deserted and half-deserted zones the most automorphic is (Дронь, 2004б). The constant absence of moisture or stable low temperatures, as it has a place in the Arctic deserts, make intensive development of biota, first of all, vegetation impossible. At increase of precipitations the density of plants and their species structure are gradually increases, but even in chestnut soils or sierozems the development of reducing conditions, except for insignificant local reduction of oxidation-reduction potential (redox potential) in rhizosphere of plants, is not observed due to lack of moisture.

Although in chernozem soils there is a number of interesting processes, which can be classified as hydromorphic. In particular, the processes of migration of salts, taking place in chernozems of steppe, in our opinion, are expedient to be divided into two groups: hydrogenic migration, which includes moving with ground waters and sedimentation high soluble salts (first of all chloride and sulphate), and hydrogenic-hydromorphic migration of carbonate (in particular calcium, and, probably, sulphate calcium). The solubility of carbonate in ground waters sharply grows at presence of carbon dioxide by formation of hydrocarbonate (Ковда, 1973; Назаренко, 2003), therefore the ratio O_2 to CO_2 in a ground solution, i.e. its redox potential, is a powerful factor of migration of carbonates and formation of limestone sedimentations in soils (Зайдельман, 2001). The degree of hydromorphism in chernozems of steppe, i.e. intensity (duration and depth) decrease of redox potential in them, assists insignificant moving of salts in a structure (maximal amplitude of fluctuations of a carbonate line is 10–20 cm (Зайдельман, 2001; Назаренко, 2003)), nevertheless permanent processes of dissolution – precipitation calcium salts cause intensive saturation of soil by «active» calcium, providing high level structure of soils, stability of specific organic substance and its accumulation.

In typical and leaching chernozems, which are characterized with higher level of moistening, on intensive migration of calcium carbonate from top horizons in to the bottom horizons or parent rock observed, which due to low contents organic matter, micro-organisms and the low temperatures are characterized by considerably lower intensity of reduce processes (Дронь, 2004б). In our opinion, it is the basic reason of carbonate sedimentation in bottom horizons and weak leaching carbonate of rock even in conditions of intensive washing.

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Leaching of calcium salts from the top horizons is accompanied, as a rule, by a deterioration of a soil structure that together with increase of quantity of precipitations causes additional increase of hydromorphism. Humus formed at this intensity of reduce processes have already some attributes of fulvic character and because of absence of coagulate action of calcium cation can be washed away from most hydromorphic zones by descending currents of reduce ground waters and to be deposited from them in more automorphic zones. It causes formation of elluvial-illuvial profile of humus distribution, inherent to many soils of podzolic type, beginning with leaching chernozem.

The specified processes appreciably intensify at change of grassy vegetation by wood. It is known, that in identical conditions woods soils always have clearer morphological marks of hydromorphism, than steppe. The different degree of hydromorphism in this case is possible to explain by features of hydrothermal modes, developed in soils of different ecosystem. The grassy vegetation first of all absorbs moisture from the top horizons, owing to what they are more automorphic (Дронь, 2004б). At the same time in a wood wetting of a surface of soils remains rather high for a long time also due to effect of vegetations. Therefore active consumption of oxygen at transformation organic in surface horizons frequently results in development of reduce conditions (Дронь, 2004б).

Nevertheless more important factor of soil hydromorphism is intensity of soils' «breath». That is an exit in an atmosphere of a part of ground air owing to expansion at heating in the day, and its replacement by fresh cooling air at the night. It is obvious, that the amplitude of daily fluctuations of temperature of the top layers of soil under grassy vegetation is higher, than in wood soils with trees shadow and great vegetations litter. This, to our mind, is the main reason of higher level of hydromorphism of wood soils.

Similarly to organic substances are the elements of variable valency, in particular iron and manganese, which while reduced become soluble and mobile. Syuta (1962) and Grechin (1957) experimentally have proved that the iron solubility in fermentation with sugar water in 200–400 times is higher, than in weak solutions of mineral acids. Thus, at the certain level of hydromorphism sufficient for reduction of iron and the manganese passage various processes are possible, of which basis is reduction – dissolution and oxidation – precipitation of elements of variable valency.

As the manganese is reducted at higher level redox potential (by the data Kanivets (1987) at Eh 450 mV), manganese formations or profile redistribution of manganese on elluvial-illuvial type can be found in rather automorfic soils. The iron is reduced at Eh = 300 mV, therefore ferric formations are inherency of more hydromorphic soils, and, it is obvious, that a degree of hydromorphism with other factors, for example, intensity of washing of a ground, relief etc. determine the type of ferric formations and intensity of its development. For example, formation of iron concretions occurs in conditions of softer reductions, than podzolic process, and considerably softer, then gleic process (Зайдельман, 1998).

Nevertheless most automorphic process connected to transformation ferric compounds is process of brown soils formation, widespread in wood soils of middle latitudes. In general, brown soils obtain rather oxidation conditions due to good drainage (Eh = 620–750 mV (Канивец, 1980)), but the presence of significant quantity of free iron oxides (are 40–60 % of total contents of this element) testifies about permanent rather deep reduce. The sharp decrease of redox potential by brown soils formations predetermine intensive destruction of aluminum silicate minerals, in particular in those zones, where soil particle are not protected by a films of humus substances, and activization of free iron, as a main cation of soil, providing its colour, structure, specific organic matter, additional exchangeable ability etc.

Formation of bogs, i.e. the accumulation of the non-decomposition vegetative remains in most cases occurs due to preserving influence of anaerobic conditions, i.e. constant high degree of hydromorphism, though in conditions of low temperatures or extreme dryness it is also possible non-hydromorphic accumulation of organic matter owing to its slow transformation. The presence of secondary sulphide in soils, hydrogen sulphide or methane testify about constant or permanent extremely deep anaerobiosis with Eh less then10 mV (Канівець, 2001). These phenomena take place in mangroves, marshes and alluvial soils of warm zones.

By means of a degree of hydromorphism can be carried out diagnostics and estimation of processes of soil formations in intrazonal soils, in particular, saline soils. Due to influence of high soluble salts these soils are characterized, as a rule, by increased water-holding ability and poor structure, providing additional increase of hydromorphism in comparison with non-salted analogues. And though the reducing of elements of variable valency, in particular of iron and manganese in alkaline conditions occurs at significantly higher level of oxidation-reduction potential (Ковда, 1973), obviously, as processes of cations exchange and processes of peptization – coagulation of soils organic substances and colloids essentially depend on a degree of hydromorphism also.

Thus, if hydromorphism of conditions for elementary soil formations processes to establish, i.e. to create a scale of hydromorphism, it would be possible to diagnose presence of separate processes, and sometimes their intensity by definition of a degree of soils hydromorphism. In general, on the basis of the theoretical analysis of conditions of soil formations and dominant processes of soil formations all types of soils can be placed in such order by the degree of hydromorphism (*table*).

Using a degree of hydromorphism of soil for diagnostics of directions and intensity of soil formations it is necessary to take into account, that the given parameter is an integrated characteristics, generalization of influence of huge amount of internal and external factors of soil formation of natural and antropogeneous origin. It is obvious, that soil hydromorphism depends on precipitation, water and air modes, temperature conditions, biogenic, quantity and structure of organic substance, cation composition, structure, density of soil, its cultivation and many other factors directly or indirectly influencing the processes of soil formation (Дронь, 2004б). The influence of these factors varies in a profile, that enables to speak not only about hydromorphism of the soil in whole, but also about a degree of hydromorphism of separate horizon or its part.

Hydromorphism of zonal and intrazonal soils

Characteristic	Soil-bioclimatic zone					Saline soils	Alluvial soils
	tropical	subtropical	subboreal	boreal	arctic		
Desert	primitive desert	primitive desert	primitive and grey-brown desert		arctic desert	salinity desert	
Semi-desert	red-brown	sierozem	brown semi-desert	cryo-taiga	arctical	automorphic alkali soils	takyr
	black tropical	grey-brown	chestnut			hydromorphic alkali soil	alluvial-sod
Steppe (savanna)	red-brown	brown	chernozem	sod	nongley sod	automorphic solonetz	
Forest-steppe	brown - red		grey-forest	sod – podzolic		auto - hydromorphic solonetz	alluvial-prairie
Forest	red- ferralic	chervonem	brown-forest	podzolic	gley-sod	hydromorphic solonetz	
Humidity forest	red-yellow ferralc	zheltozem	podzolic	bog-podzolic		solod’	alluvial-bog
Long-term overwet	gley	gley	gley	gley	gley	gley	gley
Flood conditions	mangroves	marsh	marsh	marsh		marsh	mangroves, marsh
Stagnant water	bog	bog	bog	bog	bog	bog	bog

Realization of modern diagnostics of soil formation by means of establishment hydromorphism of soil is complicated because of insufficient elaboration of theoretical and methodical aspects of a quantitative estimation of a soil hydromorphism degree. Nevertheless the investigations, carried out (Дронь, 2004а) outline the probable ways for decision of the specified problems and make the construction of a uniform quantitative scale of soil hydromorphism possible.

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