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ON CHEMICAL PROCESSES OF SUBSTANCE TRANSFER AS THE BASIS FOR THE FORMATION OF NEW CHEMICAL COMPOUNDS

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Abstract. The article describes the chemical processes of substance transfer as the basis for the formation of new chemical compounds. The role of complexation in processes of accumulation of metals in plants is considered. The dependence of the logarithm of the content of metals in plants in the function of the metal bonding energy is given. A high correlation coefficient value is represented. The process of selective absorption of metals by plants is described. Dependence of metals content in brown algae lipids on Cancer parameter, which is characteristic of complexation process, was investigated. A high correlation coefficient value is calculated. The process of recycling metals is characterized.

Keywords: *substance transfer process, complexation, metal accumulation, Cancer parameter, recycling.*

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1. Introduction

The formation of new chemical compounds can become a source of substance transfer. These can be volatile, such as ammonia, or water-soluble chemical compounds. A special place in the transfer of matter is occupied by biochemical processes occurring during photosynthesis, in the ocean, during the separation of elements and isotopes in geochemical processes. An important role in this is played by complexation reactions, due to which metal elements accumulate in plants. Water is an active participant in the transfer processes, not only as a wonderful solvent, especially thermally activated water, but also a reagent involved together with carbon dioxide in the processes of weathering of igneous rocks (Shachneva, & Khentov, 2016).

Plants accumulate significant amounts of chemical elements. For example, the concentration of iodine in kelp exceeds the concentration in seawater by 200000 times. Excellent accumulators of metal elements are microorganisms - bacteria, microscopic algae, molds.

Plants tend to accumulate nickel, cobalt, copper, molybdenum, zinc, manganese, and other elements. A study of the surface waters of Ukraine showed that dissolved metals (Fe, Mn, Cu, Zn, Pb, Cd, Co, V, Cr, Mo), with the exception of manganese, are present in reservoirs in the form of complex compounds (65-90%) (Linnik *et al.*, 2007).

Humus substances play an important role in complex formation. Humic acids easily form complex compounds. For this reason, metals accumulate in the upper horizons of

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the soil enriched with humus. Removal of metals from the soil occurs due to leaching and accumulation by plants.

2. Research methods

The experimental part was processed by the method of dispersive, correlation and multiple regression analysis with the exception of insignificant members of the regression equations. The reliability of the multiple regression equations parameters was checked by dispersive analysis and the Student's criterion ((Shachneva, & Khentov, 2016; Shachneva *et al*., 2017).

3. The discussion of the results

An important role in the processes under consideration is assigned to the accumulation of metals in plants (Fig. 1) (Khentov *et al*., 2005). The binding energy is understood as the energy that must be expended to separate a solid into individual atoms at 0 K. The accumulation of metals in plants occurs due to complexation reactions. The selectivity of the complexation process during the accumulation of metals in plants is characteristic of transition metals. Plants accumulate Mg, Al, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn and Mo. This process is selective. Selective absorption of metals by plants is presented in table 1 (Khentov *et al*., 2005).

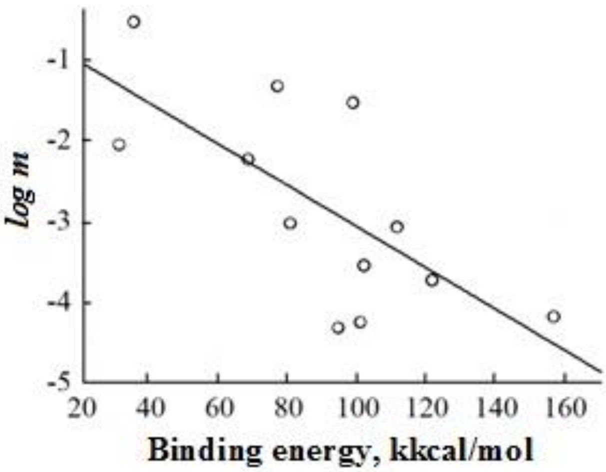

Fig. 1. The dependence of the logarithm of the metal content in plants in the function of the binding energy of the metal. Correlation coefficient 0.71

Table 1. Selective absorption of metals by plants

Plant	Increased metal content
Blue-green algae (Cyanophyta)	Fe, Co, Ni, Zn
Red algae (Rhodophyta)	Mg, Fe, Co, Ni
Green algae (Chlorophyta)	Ti, V, Cr, Cu
Brown algae (Phaeophyta)	Ti, V, Ni, Zn
Mossy (Bryophyta)	Al
Fern - like (Pteridophyta)	Al
Gymnosperms (Gymnospermae)	Mn
Angiosperms (Anthophyta)	Mn, Mo

Table 2 shows the average metal content in plants, as well as the amount of annual concentration (Khentov *et al*., 2005).

Table 2. Average metal content in plants (C), annual concentration of metals (m)

Metal	***C*, %**	***m*, tons**
Mg	$3·10^{-1}$	$1,1·10^{9}$
Al	$5·10^{-2}$	$1,8·10^{8}$
Ti	$9·10^{-4}$	$3,3·10^{6}$
V	$2·10^{-4}$	$7,2·10^{5}$
Cr	$5·10^{-5}$	$1,8·10^{5}$
Mn	$6·10^{-3}$	$2,2·10^{7}$
Fe	$3·10^{-2}$	$1,1·10^{8}$
Co	$6·10^{-5}$	$2,2·10^{5}$
Ni	$3·10^{-4}$	$1,1·10^{6}$
Cu	$1·10^{-3}$	$3,6·10^{6}$
Zn	$9·10^{-3}$	$3,3·10^{7}$
Mo	$7·10^{-5}$	$2,5·10^{5}$

The formation of sedimentary deposits of these metals is associated with the accumulation of iron, cobalt and nickel by blue-green algae in the Precambrian hydrosphere. The role of the process of complexation and accumulation of complex metal compounds in plant cells is confirmed by the dependence of the content of metals in brown algae lipids on the Cancer parameter (Fig. 2) (Khentov, 2005).

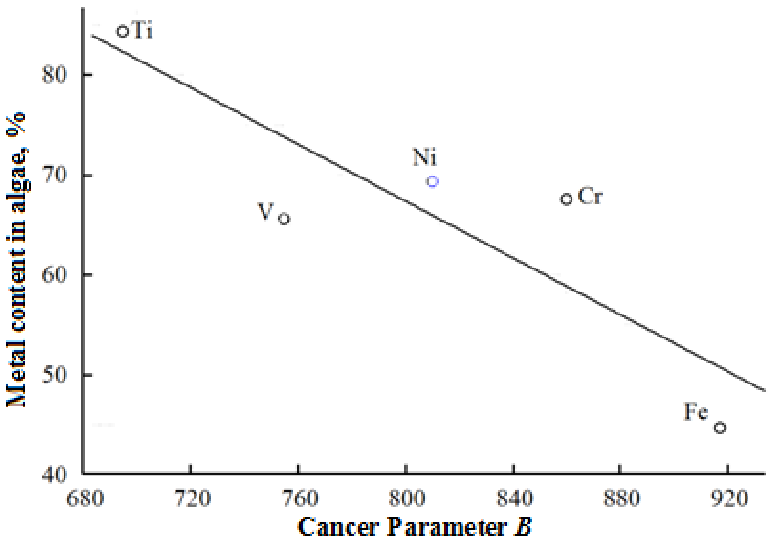

Fig. 2. Dependence of the metal content in brown algae lipids on Cancer parameter *B*. Correlation coefficient 0.87

This parameter can be considered as a sign of the complexation process. The above dependence is described by a polynomial of the first degree with sufficient reliability, as indicated by the value of the correlation coefficient – 0,87. If we take into account that the average metal content in plant lipids is about 10% of the cell weight, then we can talk about a three – to six-fold enrichment of plants with metal. After the death of plants, complex compounds of metals pass into silt. Sedimentary ores are formed.

Complex compounds of metals (Fe, Mo, Co, Ti, V, Zn, Cu, Mn and others) in the process of evolution took part in redox processes. For example, during the oxidation of molecular hydrogen and the reduction of carbon dioxide during photosynthesis. For these processes, complex iron compounds with very low values of redox potential act as catalysts. The process of assimilation of molecular nitrogen by bacteria and blue-green algae occurs with the participation of complex compounds of iron, molybdenum, titanium, vanadium and cobalt.

An important role is assigned to complex compounds in the circulation of substances in nature. Plants during photosynthesis annually recover $1,4 \cdot 10^{11}$ tons of carbon dioxide, $5 \cdot 10^9$ tons of nitrogen compounds, $8,3 \cdot 10^8$ tons of sulfur compounds (Khentov, 2005).

Every year, plants accumulate a significant amount of metal elements due to complex formation. Table 3 demonstrates the participation of complex metal compounds in the migration of chemical elements (Khentov, 2005).

Table 3. Participation of complex metal compounds in the migration of elements

Complex compounds of metals	Participation in processes	Annual migration	
		Element	**Quantity, t**
At photosynthesis			
Fe	Carbon dioxide recovery	C	$1,4 \cdot 10^{11}$
Fe	Recovery of hydrogen, water	H	$4,6 \cdot 10^{10}$
Fe, Mo, Cu, Ti, V, Co	Reduction of nitrogen compounds	N	$5,0 \cdot 10^{9}$
Fe	Recovery of sulfur compounds	S	$8,3 \cdot 10^{8}$
Mg, Mn	Oxidation of water oxygen	O	$3,7 \cdot 10^{11}$
During respiration and fermentation			
Fe, Zn, Cu, Mg, Al, Cr, Ni	Oxidation of organic substances	C	$1,36 \cdot 10^{11}$

As already noted, as a result of evolutionary processes in nature, an equilibrium has developed in the distribution of chemical elements. It can be violated only as a result of human activity. An important role is played by the process of substance transfer. It takes place at any aggregate state of matter.

4. Conclusion

As a result of human activity, as well as the development of technological processes, including the use of the latest scientific developments, a huge amount of man-made waste has appeared. Today geologists call man-made waste man-made deposits. The content of metal elements in waste is comparable to mineral deposits. Therefore, an industrially developed society faces the task of developing waste recycling technology (Shachneva *et al.*, 2017).

In a number of countries, a new branch of production is actively developing, which is based on the utilization and processing of used metals. The reuse of metal elements is the most urgent task of our time. Technologies for extracting metals from man-made waste are emerging. Technologies that provide the possibility of reuse of metal elements in the technique is called recycling of metals (recycling).

The development of recycling operations has become global. Legislation is being developed in a number of countries to regulate the secondary metals market. Conditions are being created to increase the production of secondary copper, aluminum, lead and other metals.

Of course, the collection of scrap metal is important to solve the problem of recycling. Moreover, there are huge amounts of secondary metals in various devices that differ in low mass. These are incandescent light bulbs containing nickel, molybdenum and tungsten. These are fluorescent and energy-saving lamps containing mercury. These are various electronic devices and contactors. Many of them, for example, microchips and microchips, contain precious metals.

Valuable metal elements also fall into low-tonnage industrial waste. These are, first of all, spent catalysts of the organic synthesis industry. Today, there is a reorientation of industrial enterprises extracting metals from ore raw materials to metal recycling. Fundamentally new productions are emerging (Yusfin & Zaletin, 1997; Lokshin, 2006; Hussein & Khentov, 2015; Velikanova *et al.*, 2011; Khentov *et al.*, 2007).

With the development of technology for extracting metals from man-made waste, new jobs are being created, which is of great social importance.

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