Webology (ISSN: 1735-188X)
Volume 18, Number 5, 2021

Various Elements And Composition Of PTE Accumulation And The Enrichment Of Micro Components Of Organic Matter

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ABSTRACT

The objective of study aims to figure out **Various elements and composition of PTE accumulation by organic matter**.

Therefore with qualitative model and analytical methods, then also used historical materialism method, This study finds out that: The processes of lifetime accumulation of various elements by biota are so obvious that they have long been widely used in ore prospecting by litho-biochemical surveys. Grasses in geochemically anomalous areas often accumulate excess amounts of metals. By ashing them, it is easy to fix not only areal anomalies, but even ore bodies when they are close to the surface. For oil, such a direct relationship with biota , of course, does not appear. However, complex molecular compounds and their fragments inherited from the biological molecular structures of the parent OM are often found in oil . Among them are porphyrins . The enrichment of microcomponents of organic matter continues at the earliest stages of its metamorphism - in diagenesis.

Key words: Earth biosphere, analysis, extinction, environment, geotoxicological

1. Introduction

In the course of the study, the following tasks were solved, the results of which were found display at work:

enriched with elements with impurities with potentially toxic properties (V, Ni, Co, Cd, Hg, Cr, etc.); substantiation of the list and assessment of the biological activity of toxic elements impurities common in hydrocarbon raw materials and processed products; development of criteria for forecasting the distribution of hydrocarbon accumulations with increased and high content of PTE; identification of areas of planetary distribution of oil and gas basins with HC raw materials enriched with toxic impurity elements; study of transformation processes in the surface environment of toxic impurity elements and their compounds during the transition from potentially toxic to active toxic form, free for biological contacts during the development of hydrocarbons; analysis of environmental risks in the development, processing and disposal of hydrocarbon raw materials, enriched with PTE at oil and gas industry facilities.

Research questions:

Question 1: What are previous studies and **Various elements and composition of PTE accumulation by organic matter**?

2. Methodology

Authors have used qualitative and analytical methods, then also used synthesis and discussion methods in this paper.

We also used historical materialism method.

3. Main findings

The key problem:

It is important to note one more fundamental pattern of biota evolution - the basis of all biochemical processes in living organisms are relatively light elements: C, N, H, O , Cl , S, Ca , Zn , K, etc. The higher the nuclear charge of an element, the less its content in biota , and this does not always coincide with a similar decrease in their clarks in the lithosphere. Figure 35 shows the distribution of elements according to their abundance in various biological objects and in the lithosphere. It is clearly seen that the entire terrestrial biota avoids the accumulation of heavy elements, which are fairly widespread in the lithosphere. A kind of "non-resistance" to their accumulation is shown only by seaweed - the mother of life on Earth. Apparently, their homeostasis, which was formed in the most ancient epochs of the planet's existence, withstands the presence of heavy elements without negative consequences for life, possibly repeating the geochemical appearance of the paleoocean .

For the problem we are discussing, the processes of accumulation of heavy metals in organic matter and, accordingly, in oil, this is an important factor, since it is seaweeds that are the most ancient and massive source of OM in sediments.

The processes of lifetime accumulation of various elements by biota are so obvious that they have long been widely used in ore prospecting by litho-biochemical surveys. Grasses in geochemically anomalous areas often accumulate excess amounts of metals. By ashing them, it is easy to fix not only areal anomalies, but even ore bodies when they are close to the surface. For oil, such a direct relationship with biota , of course, does not appear. However, complex molecular compounds and their fragments inherited from the biological molecular structures of the parent OM are often found in oil . Among them are porphyrins .

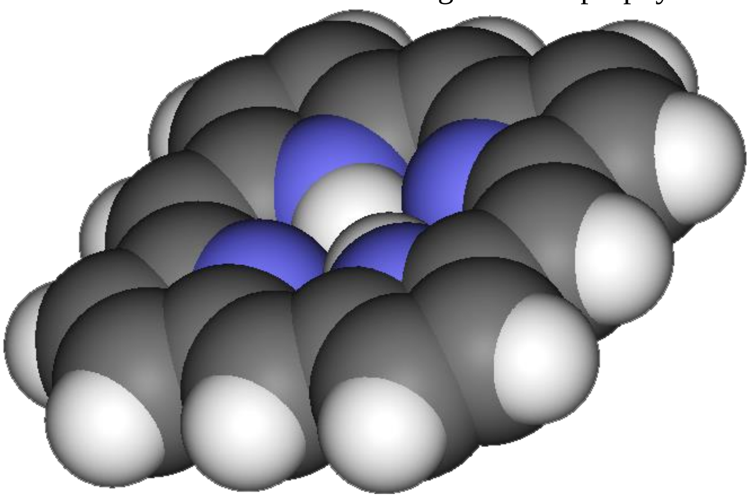

Figure 1 - 3D model of a porphin molecule $C_{20}H_{14}N_4$.

Porphyrins are widely distributed in organic matter. Figure 1 shows a 3D model of a porphin molecule $C_{20}H_{14}N_4$. Organic compounds starting for porphyrins are present in hemoproteins (hemoglobin, myoglobin), heme-containing enzymes (cytochromes , peroxidase , catalase), and in the chlorophyll of green plants. Due to the structure of conjugated double bonds , porphyrins are relatively thermally stable (up to 185 °C). They have an important property - to form very stable compounds - chelates - intra-complex compounds with metal ions. Complexes with metals are also capable of forming protoporphyrins . Their compounds with Fe^{2+} , Fe^{3+} , Mg^{2+} , Zn^{2+} , Ni^{2+} , Co^{2+} , Cu^{2+} are known . In bitumen, porphyrins are most often present in complexes with Ni and V, Figure 2.

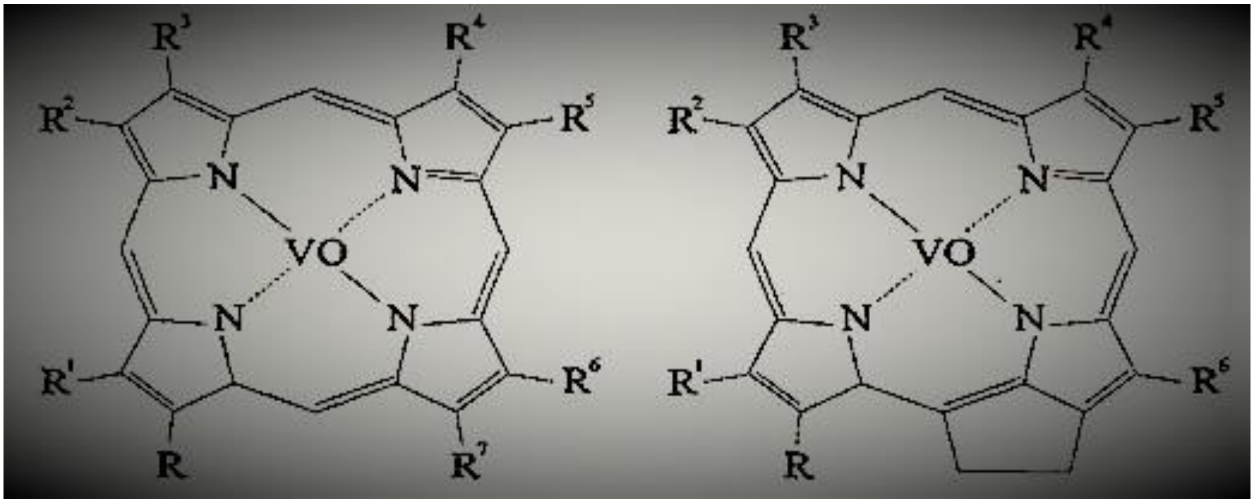

Figure 2 Vanadylporphyrin

It is peculiar that free porphyrins or their transitional compounds with Ni and V have not been found in recent sediments. Substitution of Mg in chlorophyll or Fe in hemin occurs already during diagenesis. In particular, oxides and hydroxides of Fe and M n intensively accumulate trace elements from sediments, incl . V and Ni . But in a reducing environment, they are unstable and, when decomposing, release these elements or their complexes into the environment, enriching it with V and Ni already at the early stages of diagenesis. At the same time, the reducing environment is favorable for the formation of porphyrins , and their stability subsequently leads to their accumulation in OM and, subsequently, to their preservation in geological formations.

Another large class of living substance-concentrator PTE - microorganisms capable of concentrating C r , Pb , C o, Sb , Fe , U, As , Zn , V, Cd and other elements. For example, sulfate-reducing bacteria of the genus Desulfovibrio are capable of significant accumulation of lead, tin, and antimony. They practice extracting arsenic with the mushroom concentrator Fungi imperfecti . In this case, the recovery factor reaches 99.8%. At least 25 manganese accumulating microorganisms are known. The most known PTE accumulating microorganisms are shown in Table 2. For example, Thiobacillus ferrooxidans (Acidithiobacillus ferrooxidans), a rod-shaped, chemolithotrophic bacterium, is common in pyrite deposits and converts iron and sulfur, producing sulfuric acid as a by-product, Figure 3. T. ferrooxidans is responsible for the oxidation of iron and inorganic sulfur compounds in places such as tailings , coal deposits, oil rebar and gas fields, pipelines - being a powerful catalyst for corrosion processes.

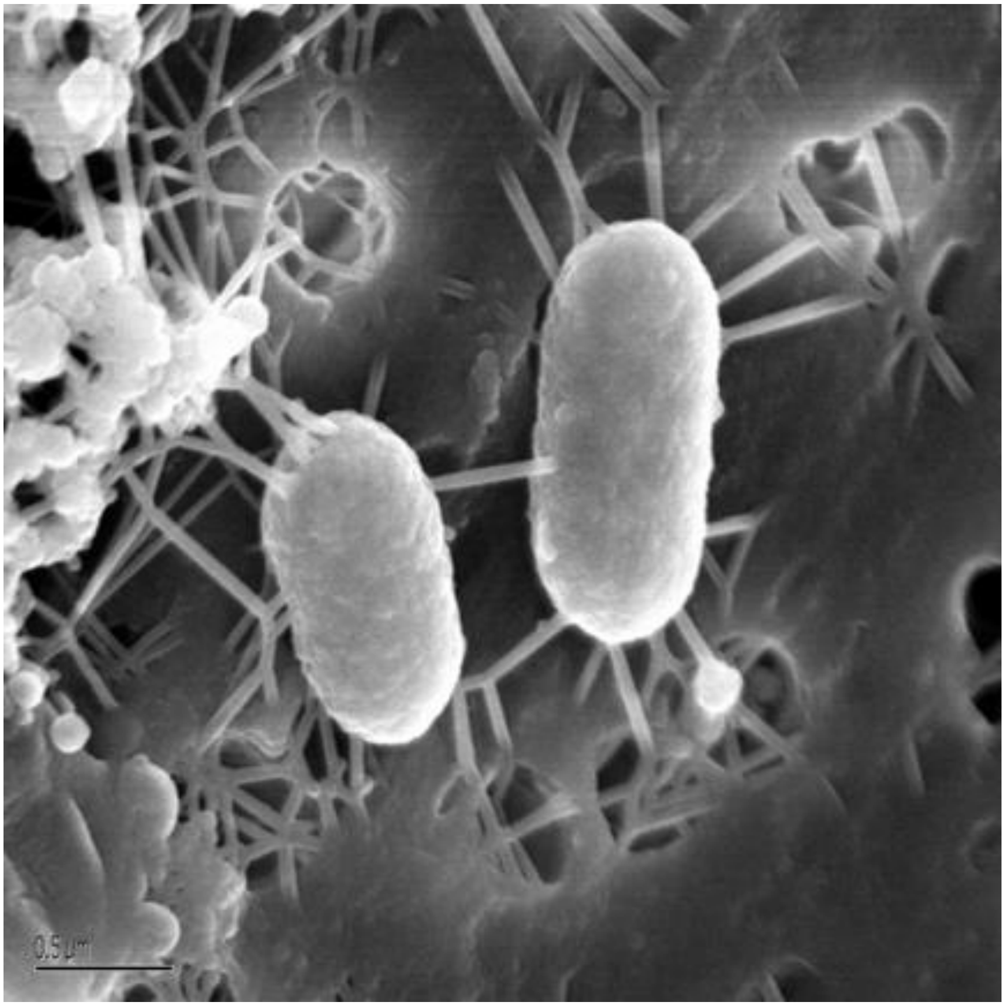

Figure 3 - Thiobacillus ferrooxidans (left) and Leptospirillum ferrooxidans (right) processed with conventional fixation. In addition to iron oxide crystals, organic polysaccharides secreted by bacteria are seen.

A number of metals, simultaneously referred to as both toxic and biophilic elements, are functionally necessary for living matter, among them: Fe , C u , Zn , M n , Co , Se , Mo, V and Ni . This is one of the classic contradictions of ecology, since it is not the substance that is dangerous, but its content at certain times and in certain environments.

They are widely found in the biota , but the biological functions are little studied and only conjectural in such components as C r , Sb , F, Si , As and Au .

Gold, as one of the most inert metals, demonstrates well the possibilities of concentration by living matter. Thus, in the cells of a number of bacteria, the content of gold is 5-60 times higher than its concentration in the mine waters of deposits. In the algae of the Barents Sea, the ratio of gold concentration to its concentration in sea water is $2x10^{4}$. In terrestrial plants, gold concentrations relative to clarke in the lithosphere reach $1.2x10^{5}$.

Table 1-The main microorganisms - accumulators of biologically active elements

Name of microorganisms	Concentrated metals
Bacterium dechromaticans	Chromium
Thiobacillus ferrooxidans	Lead, cobalt, copper, aluminum, iron, uranium, cadmium, zinc, vanadium
microscopic mushrooms	Chromium, cobalt, iron, uranium, aluminum, calcium, magnesium, copper, cobalt, europium, beryllium, scandium, technetium and others
metallogenium sp .	Aluminum, manganese, iron

Thus, there is no doubt that many compounds in living matter, especially porphyrins and protoporphyrins , can actively accumulate metals. Moreover, not a single highly organized biological species can do without the accumulation of a number of biophilic metals, which are simultaneously classified as PTEs. This situation is well illustrated, as already noted in section 3.3.2. "Properties of biophilicity and toxicity of impurity elements in hydrocarbons", modern forms of vitamins, including a wide range of mineral additives. In particular : Ca , P, J, Fe , Mg , C u , Zn , M n , K, C r , Mo, Se , Ni , Sn , V, Si , B.

The enrichment of microcomponents of organic matter continues at the earliest stages of its metamorphism - in diagenesis. In this regard, the data on the extremely diverse microelement composition of mumiyo and guano - an organic substance that is formed in an oxidizing environment, mainly in mountainous conditions, are peculiar in this respect. The mineral composition of the inorganic part of the mummy is poorly studied, but even the data that are available indicate a fairly wide representation of microelements in it, including such as V, Ni , Ti , M n , Ag , C r , Zn and others. The content of trace elements in the inorganic part of various varieties of mummy is shown in table 2.

As can be seen from this table, the mummy obtained in certain areas serves as a rather significant concentrator of various elements, which indicates effective mechanisms for the accumulation and preservation of PTE in diagenesis.

Table 2- The content of trace elements in the inorganic part of various varieties of mumiyo

Distribution area and name	Color	Solubility in water, %	Microscopic compound insoluble draft	The mineral composition of the inorganic part, %
Wed Asia : Tajik	black	48-52	No data	Si, Al, Na, K , Fe, Mg, P , Ba , Sr , Mn , Ti, Cu, Pb , Zn, Bi, Ni, Co, Sn, Be
Salajidi	black	45-45	Elements of cereals, fruits, pollen, plant trichomes	Si-1, Al-10, Fe-5, Mg-10, Ca-3, P-0.3, Mn-0.01,Zn-0.02, Ni-0.005, Co-0.002, V-0.007, Cr-0.07, Mo-0.001, Pb-0.08, Ba-0.03
Dorobi	red-brown	40-50	Elements of cereals, fruits, pollen, plant trichomes, glands labiales	Si-1, Al-3, Mg-10, Ca-3, Mn-0.001, V-0.001, Cu-0.001
Zogh	black	70-98	No data	V-0.001, Ni-0.001, With u -0.0005 and others
Asil	black	100	No data	Si -1, V -0.001, Ti -0.1, Ag -0.001, Zn -0.1, etc.
Altai Altai	black	40-48	No data	No data
Pamir Pamir	black	50-56	Elements of cereals, fruits, trichomes plants	Ni-0.0005, Ti-0.01, V-0.002, Zn-0.02, etc.
Siberia white oil	light grey	70-80	No data	Ni -0.03, Ti -0.03, V -0.0015, Zn -0.04, etc.
Transbaikalia Bragsun	black	45-52	Elements of cereals, fruits, pollen, plant trichomes, stony cells, debris insects	Si-0.1, Ni cl ., T i -0.005, V cl., Mo cl., Cu-0.0115, Pb - 0.0007, etc.

In addition, one more example of the accumulation of PTE in organic matter during early diagenesis can be cited - the high concentration capacity of guano for uranium. Guano, bird droppings and bat droppings, is the last link in the food chain in the ocean, just as shilajit is probably the last link in the high mountain biota food chain. The content of uranium in guano from the Peruvian coast was $2x10^{-4}$ %, from the Galapagos Islands - $5x\ 10^{-4}$ %, from Christmas Island (Indian Ocean) - $4x\ 10^{-4}$ %, while in sea water it contains only $3x10^{-6}$ %. At the same time, guano is actively used as a fertilizer, Figure 4.

Figure 4 - Indonesian guano. Commodity product.

When characterizing the primary accumulation of PTE in living matter, one should especially note the processes of anomalous enrichment of living matter in zones of a specific biocenosis. The geochemical heterogeneity of the biosphere is obvious. There are also obvious opportunities for the assimilation of bioactive elements by biological objects, including higher ones, leading to the concentration of toxocomponents in their organisms . Despite the great chemical and physiological intra-population variability, it is possible to single out objects of wildlife that are active accumulators of metals. In particular, plankton is a powerful concentrator of PTE from sea water.

Thus, the accumulation of technetium, uranium, radium, lead was revealed in marine phytoplankton, and it was noted that the content of these elements in plankton is 1-2 orders of magnitude higher than the background. At the same time, the content changes in the series: Tc >

Pb > Ra =U, and technetium and lead contain both waste products and organisms in the greatest amount, while uranium and radium are more indifferent to biogenic matter. Studies of plankton in the subantarctic part of the Pacific Ocean showed that it accumulates Co , Zn to the maximum, and to a lesser extent C r , M n , Ni , Fe , C u , Al , Ti , V, Si and Ca . The degree of concentration of metals by plankton is inverse to the concentration of the element in water.

A number of terrestrial plants are also PTE concentrators, multiplying this capacity in areas with high concentrations. Strontium concentrator plants are shown in Table 3. In particular, grapes are an environmentally unfavorable agricultural crop in areas with a high content of radioactive strontium.

Table 3 -Plants are strontium concentrators

Plant	Strontium content, % on dry matter			
	Biogeochemical provinces with:			
	secondary accumulated Sr		primary accumulated Sr	
	Sr	concentration	Sr	concentration
Echim italicum (Bruise)	0.9	450	0.008	4.0
Alhagi kirghisorum (Camel thorn)	0.4	200	0.018	9.0
Ampelopsis (Grape)	1.25	625	0.01	5.0
Glycyrrhiza glabra (Licorice)	0.25	100	0.075	37.0
Artemisia sp . (Sagebrush)	0.03	fifteen	0.007	0.5
Rosa sp . (Rose hip)	0.16	80	0.007	3.5

Another example of a specific metallogenic biocenosis is the uranium biocenosis of the Columbia River, studied by American biologists in the area of the Hanford plutonium production complex . Site), Benton County , Washington, USA, Figures above. As a result of the work of the factory, a significant amount of radioactive materials has entered the air and the Columbia River. Uncontrolled mass releases of radionuclides continued from 1944 to 1971.

4. Discussion and conclusion

The ability of unicellular algae to actively absorb PTE from sea water is also known. They are capable of accumulating uranium salts in an amount one hundred times higher than its concentration in sea water - up to 0.3 g/t.

Study of transformation processes in the surface environment of toxic impurity elements and their compounds during the transition from potentially toxic to active toxic form, free for biological contacts during the development of hydrocarbons; analysis of environmental risks in the development, processing and disposal of hydrocarbon raw materials, enriched with PTE at oil and gas industry facilities.

The nature of the relationship between oil and PTE, especially such as V, Ni, Co, Cd, As, U, Zn, Cz, was of interest geologists, geochemists and technologists for a long time. Received even independent development branch of geochemistry - naphthometallogeny

Acknowledgement

Thank you editors, friends to assist this publishing

Conflicts of interest

There is no conflict of interest

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