ISSN: 2634 - 8845

Journal of Earth and Environmental Sciences Research

SCIENTIFIC Research and Community

Review Article

Open Access

Conservation of Environmental Cycles of Matter and Energy in the Biosphere

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ABSTRACT

In the biosphere, as in each ecosystem subordinate to it, producers, consulates, detritophages and reducents interact with each other and with the environment. During this interaction, living organisms create a certain flow of substances and energy from some components of the system to others, which ensures the integrity and sustainable maintenance of life of the biosphere as a global ecosystem. That is, from various chemical elements and their compounds that support the life of individual species, a common (global) cycle of substances and energy is formed in the biosphere.

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Received: February 23, 2022; **Accepted:** March 03, 2022; **Published:** March 07, 2022

Keywords: Cycle In the Biosphere, Matter, Energy, Environmental Production.

Introduction

The mass of living matter is called biomass. It is expressed in units of mass of dry or raw matter relative to units of area or volume of any place of residence of organisms. The total mass of biosphere living matter in dry form is approximately 4 * 1,018 g, which is a billion times less than the mass of the Earth, equal to 5.98 * 1027g. The total amount of biomass generated during a particular period, characterizing bioproductivity. It has been established that floodplain thickenings of living matter have the highest productivity: with an area of less than 1%, they produce about 10% of living land matter, Photosynthetic living organisms make up 99% of the total mass of living matter. The mass of living matter of the ocean is less than 0.2%, of the biomass of land. But the productivity of the ocean, that is, the production of biomass per unit time and per unit area, is approximately equal to the productivity of plant biomass.

Living matter, unlike oblique matter, has this property: all chemical reactions in it occur and are sorted under less stringent conditions than in the production of substances by purely chemical methods. Thus, fats and carbohydrates are oxidized in the body at a temperature of about 37 ° C, and outside it at 400-500 ° C. In industrial conditions, a temperature of 500 ° C and a high pressure are required to obtain ammonia from nitrogen and hydrogen molecules, and in the body of microorganisms this reaction occurs at ordinary temperatures and atmospheric pressure. Continuously breeding, living organisms form a stream of generations: new creatures appear to replace the dead. Thus, modern living matter by origin is associated with living matter of past geological eras. The cycle of living matter is carried out and a great chemical diversity accumulates.

Large and small cycle of substances and energy

The cycle of substances turns out to be in the multiple participation of substances in processes that occur in the atmosphere, hydrosphere, lithosphere and, in particular, in the context of their layers that make up the biosphere. There are two main cycles of substances: large (geological) and small (biological, or biotic), which cover the entire planet.

The geological (large) cycle is the exchange of substances between land and the oceans. First of all, there is a global circulation of water, that is, first precipitation, then surface and underground runoff, infiltration, evaporation and, in the end, condensation; then precipitation falls again. Almost a third of all solar energy supplied to the Earth is spent on the water cycle. Together with water, huge masses of chemicals dissolved in it move, which in the ocean settle to the bottom in the form of deluvial deposits or sediment. Water is the main element necessary for life. Quantitatively, this is the most common inorganic component of living matter. For example, in humans, water occupies 70% of body weight, in fungi - 80%, in some types of jellyfish - 98%. The hydrosphere covers about 75% of the world's surface (363 million km2). It is assumed that the total evaporation is balanced by precipitation. More water evaporates from the ocean than falls into it with precipitation; on land, on the contrary, less. So-called excess land precipitation enters glaciers, replenishes groundwater and eventually ends up in lakes and rivers, returning gradually with runoff to the ocean. Thus, the cycle of water between the ocean and land is a prerequisite for the metabolism between organic and inorganic nature.

Particular attention should therefore be paid to two main aspects of water cycle. Firstly, the sea loses more water due to evaporation than it receives with precipitation; on land, the situation is opposite. That is, a significant part of the precipitation that supports terrestrial ecosystems consists of water evaporating from the sea. Secondly, the difference between the amount of precipitation per

year and annual runoff is 1011 tons. This is the amount of annual water supply to underground aquifers. In our time, as a result of human activity, runoff is increasing, so the replenishment of a very important groundwater fund is decreasing.

Air exchange between all latitudes and both hemispheres of the Earth occurs on average in two years. Ocean water is actively moving in currents, there are no zones in the ocean where it has been stagnant for a long time. All fresh land water flows into the ocean in 14 days, in glaciers the water is updated in 15 thousand years.

The large cycle of substances is not closed: a certain amount of substances is removed from the cycle and preserved in sedimentary rocks in the form of limestones, peat, oil and other rocks and minerals. This ensures the progressive development of the earth's crust and biosphere. According to the concept of a large cycle of substances and energy in the biosphere, erupted deep rocks of mantle origin (for example, basalts) are excreted from the Earth's bowels in the biosphere by tectonic processes. Under the influence of solar energy and living matter, they are weathered, transported, again deposited, while turning into a variety of sedimentary rocks. Solar energy is concentrated and stored in sedimentary rocks (for example, clays form from erupted minerals, and volcanic gases turn into coal, oil).

Due to tectonic movements, sedimentary rocks fall into the zones of high pressures and temperatures of the Earth, where solar energy is released from them, metamorphosis and remelting occur, which leads to the formation of granite rocks. Crystallized eruptive rocks again fall into the biosphere due to ascending tectonic movements. Thus, the cycle ends, but already at a new level, because eruptive rocks of granite composition were formed from the original basalts. So, a large cycle of substances and energy in the biosphere can also be defined as the evolution of the earth's crust from the oceanic type (basalt) to the mainland type (granite).

For the biosphere as a whole, as for the earth's crust, the characteristic rhythmicity and cyclical development is manifested in everything: in the processes of magmatism, precipitation, climate changes, etc. The most rhythmic, progressive development characteristic of living organisms. The established rhythms and cycles of different durations: from 11 years, due to solar activity, to megacycles of 180-240 million years, coincides with the Galactic year, that is, the time of the Earth's revolution along with the solar system around the center of the Galaxy. At the same time, there is not just a repetition of processes, but their progressive development.

A small, or biological, cycle of substances is the exchange of chemical elements between living organisms and non-living (oblique) components of the biosphere - the atmosphere, hydrosphere and lithosphere. In other words, these are two sides of the same process - the formation of living matter and its schedule. This cycle is characterized by the fact that first living matter is charged with energy, and then, during the decomposition of organic residues, energy is returned to the environment. Biological cycling is the circulation of substances between soils, plants, animals and microorganisms This circulation takes place in such a sequence: first, mineral substances and energy are absorbed from the environment and included in the composition of plant organisms, then from plants through trophic chains they pass to the organisms of animals and other consulates and then through the link of reducents they return back to the soil or atmosphere.

The biological cycle of substances and energy is characteristic of ecosystems of any level of organization - from a separate complex of living organisms to the biosphere as a whole. Organisms attract the atoms of biogenic substances from the oblique part of the biosphere and include them in their body, where the absorbed substances enter into a variety of biochemical reactions, and then are released into the external environment in the form of life products or dead bodies. The life on Earth thus organized has existed for billions of years.

Geological and biological circles are closely interconnected, interact with each other, sometimes merging together. Structurally and functionally, they differ significantly. The biological cycle has such characteristics compared to the geological one:

- its action takes place, as a rule, within the biogeocenosis, while the geological takes place on large territories - the continents and adjacent parts of the ocean;
- The main cause and driving force of the biological cycle is the different nature of the nutrition of producers, consulates and reducents, and the geological one is the cycle of water between the ocean and land; only biogenic elements participate in a small cycle, while in a large cycle - all chemical elements that are in the earth's crust;
- the duration of cycles of chemical elements in the biological cycle is short-term (year, several years, tens and hundreds of years), and the cycle duration in the geological cycle is tens or even hundreds of thousands of years.

Both cycles of substances - biological and geological - move thanks to the energy of the Sun and the force of gravity. The biological cycle is fast and open: the initial and final link are closed through available inorganic substances. The geological cycle is slow and closed. Part of the substances from the biological cycle enters the geological one in the form of a dead rod, forming sedimentary rocks, which over time, under the influence of pressure, temperature and other factors, are transformed into granites. Tectonic elevations cause some granite rocks to be brought to the surface. Granites are weathered, and, as a result, a fund of available substances is formed, which are later again involved in the biological cycle.

The processes of cycling of substances in the biosphere are carried out in a balanced manner. The vast majority of substances involved in the biological cycle return to the mineral state and become available for reuse by the living substance. Only a small part of them are deposited in sedimentary rocks, but these losses are compensated by substances that are released from rocks as a result of weathering processes.

The balance and consistency of biological and geological biosphere cycles is achieved by living matter, that is, by the formation of new species in the event of the emergence of new resources or new environmental conditions, as well as by the formation of numerous direct and backward links between different organisms and environmental factors. Usually, the acceleration of weathering of rocks leads to an increase in the amount of nutrients, which, in turn, stimulates an increase in the amount of living matter and increases the intensity of the processes of transferring substances to the world's oceans. Bottom sediments accumulate more intensively there, and the amount of available substances begins to rapidly decrease in the biosphere. The biosphere is moving to the so-called "hungry" regime, accompanied by mass extinction of species and increased competition for resources. At the same time, the processes of formation of new, more competitive and "economical" types are accelerating. However, extinction

occurs much faster than speciation. For example, as a result of the catastrophic extinction of many species of flora and fauna in the Paleozoic and early Mesozoic, there was an extremely rapid accumulation of sedimentary rocks during the Carboniferous and Cretaceous periods.

Ecological aspect of biological and geological cycling

Discussions by scientists about the reasons for the imbalance between biological and geological circles are still ongoing, but the catastrophic consequences are obvious. Today, the situation is similar, but, unlike previous eras, the main reason for the violation of the cycle of substances in the biosphere is human activity - the so-called anthropogenic factor [1].

Firstly, the artificial acceleration of weathering processes of sedimentary and granite rocks associated with the extraction and processing of minerals, the burning of coal, oil, peat, and natural gas is quite strong. As a result, the content of carbon dioxide and sulfur oxides in the atmosphere increases. Due to acid rain, the pH of the soil decreases, which leads to the transition of many elements to a dissolved state. Some of them in high concentrations are toxic and dangerous to all living things (for example, heavy metals - copper, zinc, lead). This leads to a slowdown in the rotation of substances in the biological cycle, since carriers of living matter die. And the more elements go into solution, the more they are washed out into the oceans, actively enriched with biogenic elements. As a result, outbreaks of "flowering" of the ocean by microscopic algae are increasing, which often suppress the development of consulates that consume them (compared to past centuries, the frequency of outbreaks of "flowering" in the oceans has increased by 50-130 times). All this accelerates the processes of extracting available nutrients from the biosphere but their "preservation" in bottom sediments.

Secondly, a person in the course of his economic activity creates numerous substances (for example, plastics), which in the future cannot be used either by producers or decomposed into available mineral substances by reducents. These substances form a special group of anthropogenic "sedimentary" rocks - the waste of civilization, which archaeologists called the "cultural layer." These wastes will eventually be transformed in the lithosphere into granites and then, in the process of weathering, will again become available to living matter, but this will happen only in millions of years. Therefore, now there is a real threat that the available resources of the biosphere can be recycled to waste faster than the cycle of the geological cycle ends. What will happen to the biosphere (including humans) is easy to predict.

In order for the biosphere to exist and the processes that occur in it to continue, the cycles of biologically important, that is, biogenic, substances must constantly function. Biogenic are elements that are necessarily included in living organisms: C, H, O, N, P, S, K, Ca, Mg, Fe, Cu, Mn, Zn, Mo, Cl, Br, I; the main ones are the first six - carbon, hydrogen, oxygen, nitrogen, phosphorus and sulfur. The continuous cycle of biogens is the main condition for the existence of life and the entire biosphere. The cycle of myogens - this mutual exchange of chemical elements of the components of the ecosystem is a structural whole. The main reason for disrupting the cycle is the constant discrepancy between the needs of organisms and the presence of available nutrients, which leads to disruption of the cycle of biogens [2-4].

Conclusion

The conservation of environmental cycles of matter and energy in the Biosphere is facilitated by the ecological life of mankind, especially in the field of the development of living spaces and industrial production. Now it is necessary to switch to environmentally balanced activities of enterprises with clean production technologies without causing environmental damage to the environment. Clean process technologies neutralize harmful waste. Transition to an environmental economy with an energy equivalent [2-4] and the ecological balance of industrial enterprises will contribute to the preservation of the environment, climate balance, the preservation of the cycle of biogens and the ecological cycle of matter and energy in the Biosphere.

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