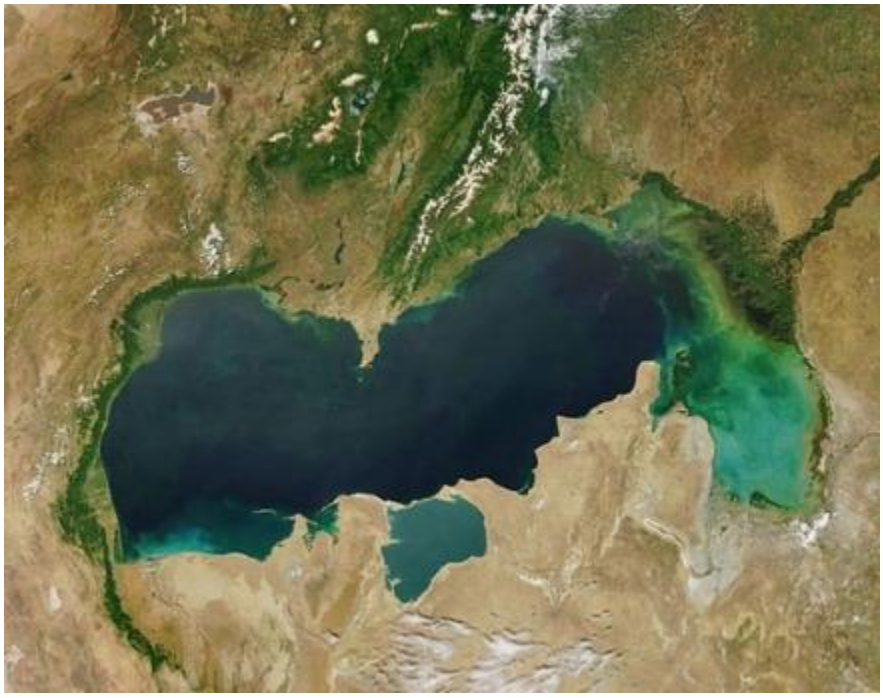
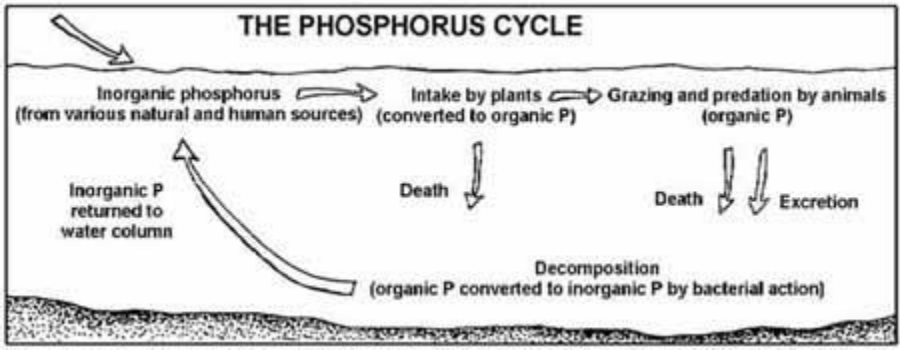
Phosphorus cycle



Caspian Sea with eutropication from man-caused interference. Source: NASA

The **phosphorus cycle** is the biogeochemical cycle which characterizes the transport and chemical transformation of phosphorus through the geosphere, hydrosphere and biosphere. Unlike many otherbiogeochemical cycles, the atmosphere does not play a significant role in the movement of phosphorus, since phosphorus and phosphorus-based compounds are typically solids at the normal ranges of temperature andpressure found on Earth. Therefore most of the phosphorus remains within rock, sediments, sand, and theocean floor, with a fraction in living biomass. Phosphorus moves among trophic levels in an ecosystem by plant growth, herbivory and carnivory.



The aquatic phosphorus cycle. (Source EPA)

Occurrence in the Earth crust

Phosphorus in the Earth's crust generally occurs in its maximally oxidized state, such as inorganic phosphate rocks. Phosphates are liberated from rocks in the weatheringprocess of the natural environment. The small phosphorus losses in a terrestrial system caused by leaching through the action of rain are countered by gains from weathering rocks. In soil, phosphate is absorbed onclay surfaces and organic matter particles and becomes incorporated.

Role in biota

Plant species dissolve ionized forms of phosphate and take the mineral into their system. Herbivores obtain phosphorus by consuming plant biomass, and carnivores by consuming herbivores. Herbivores and carnivores excrete phosphorus as a waste product in urine and feces. Phosphorus is then released back into the soil when plants or animal matter decomposes and the cycle repeats. Phosphorus is an essential nutrient for plants and animals in the form of ions, including phosphate, PO_4^{3-} and hydrogen phosphate, HPO_4^{2-}.
Phosphates are effective fertilizers, but they also cause pollution problems in lakes streams. Because phosphorus is often the nutrient in limited supply, even a small increase in availability can cause a significant effect. Over-enrichment of phosphate can lead to algae blooms. This excess of algae causes increased consumption by bacteria, which then leads to even higher bacterial concentrations. In the process the bacteria use up much of the dissolved oxygen in the water during cellular respiration and thereby cause the death of fish due to oxygen deprivation. The primary biological importance of phosphates is as a component of nucleotides, which serve as energy storage within cells (Adenosine triphosphate [ATP]) or, when linked together, form the nucleic acids deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Phosphorus, primarily in the form of hydroxyapatite, $Ca_5(PO_4)_3OH$, is a key structural component of animals. Approximately 80% of the phosphorus in vertebrate animals is in their bones and teeth. This element is also an important constituent of phospholipids, which are in all biological membranes.

Anthropogenic influence

Human influences in the phosphorus cycle arise chiefly from the introduction of synthetic fertilizers. Use of fertilizers mainly has significantly altered both the phosphorus and nitrogen cycles. Vegetation may not be able to utilize all of the phosphate fertilizer applied; as a

consequence, much of the phosphate applied as fertilizer is lost from the land through water surface runoff. The dissolved phosphate in surface runoff is eventually precipitated as sediment at the bottom of the water body. In certain lakes and ponds, this phosphate may be redissolved and recycled, often as an excessive nutrient. Animal wastes or manure are also be applied to land as fertilizer, particularly in developing countries.

If misapplied on frozen ground during the winter, much of the fertilizer may be lost when ice melts and forms runoff. In certain areas very large or intense feed lots of animals, may result in excessive surface runoff of phosphate and nitrate into streams. Other human sources of phosphate are in the out flows from municipal sewage treatment plants. Without an expensive tertiary treatment, the phosphate in sewage is not removed during various treatment operations. Again an extra amount of phosphate enters the water.

References

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