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The Sulphur Cycle in the Course of Study Related to the Biological Science at Various Levels

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Abstract **- Sulphur Cycle is the collection of processes by which moves between rocks, waterways and living systems. Such biogeochemical cycles affect many minerals and important for life because sulphur is an essential element being a constituent of many proteins and cofactors and sulphur compounds can be used as oxidants or reluctant in microbial respiration. The global sulphur cycle involves the transformed of sulphur species through different oxidants states, which pay play an important role in both geological and biological processes, this cycle shows the interdependency among organisms, microorganisms and natural environment. This is also essential knowledge for everybody studying the biology at various levels.**

Keywords: Sulphur cycle, Mineralization, oxidation, Reduction and Incorporation.

I. Introduction

Sulphur cycle through the earth's air, water soil and living organisms, circulation of sulphur through the biosphere is called sulphur cycle. Much of the earth's sulphur is stored underground in rocks in and minerals, including sulphate(SO_4^-) salts buried deep under ocean sediments. Sulphur also enters the atmosphere from several natural sources. Hydrogen sulphide (H_2S) - a colourless, poisonous gas with a rotten -egg smell - is released from Volcanoes and from organic matter in flooded swamps, bogs, and tidal flats broken down by anaerobic decomposes. Sulphur, dioxide (SO_2), a colourless, suffocating gas, also comes from volkanoes.

Particles of sulphate (SO_4^-) salts, such as ammonium sulphate, enter the atmosphere from Sea spray, dust storms, and forest fires Plant roots absorbs sulphate ions and incorporate the sulphur as an essential component of many proteins.

II. Assimilation and Release of sulphur by Plants

Sulphur enters the trophic cycle in terrestrial plants via root adsorption in the form of inorganic sulphates, are calcium sulphate and Sodium sulphate or by direct assimilation of amino acid released in the decomposition of dead or excreted organic matter, Bacterial and fungal (Aspergillus and Neurospora) mineralization of the organic sulfhydryl in amino acids followed by oxidation results in sulphate; this adds to the sulphate pool for root adsorption, under anaerobic conditions, sulphuric acid may be reduced directly to sulphides, including hydrogen sulphide, by such bacteria as Escherichia and Proteus elemental sulphur or to sulphides, including hydrogen sulphide, by such heterotrophic bacteria as Desulfavibrio, as well as Escherichia and Aerobacter. These sulphate reducing anaerobic bacteria are heterotrophic, using the sulphate as a hydrogen acceptor in metabolic oxidation in a manner comparable to the use of nitric and nitrate by denitrifying bacteria.

III. Sulphur in the Atmosphere

Sulphur in the atmosphere comes from several different sources: decomposition and/or combustion of organic matter, combustion of fossile fuels, and ocean surface and volcanic eruptions. This most prevalent form of sulphur entering the atmosphere is sulphur dioxide (SO_2), it along with other atmospheric forms such as elemental sulphur and hydrogen sulphide, is oxidized to sulphur trioxide (SO_3), which combines water to form sulphuric acid (H_2SO_4).

In the atmosphere Sulphur dioxide (SO_2) from natural sources and human activities is converted to sulphur trioxide gas (SO_3) and to tiny droplets of sulphuric acid (H_2SO_4) in addition, it reacts with other atmospheric chemicals such as ammonia to produce tiny particles of sulphate salts. These droplets and particles fall to the earth as components of acid deposition, which along with other air pollutants can harm and aquatic life.

IV. Sulphur in the Sediment

The sedimentary aspect of the sulphur cycle involves the precipitation of sulphur in the presence of such cations as iron (Fe) and calcium (Ca) as highly insoluble ferrous sulphide (FeS) and ferric sulphide (Fe_2S_3, pyrite) or relatively insoluble calcium sulphate ($CaSo_4$), of considerable ecological significance is ferrous sulphide, which is formed under anaerobic conditions. It is insoluble in neutral or alkaline water; consequently, sulphur has the potential for being bound up under these conditions to the limits of the amount of iron

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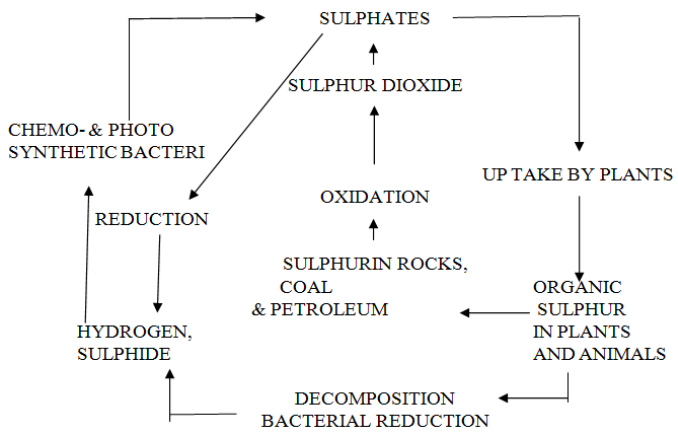
present. Once burried, pyrite appears to be geologically stable and is a primary reservoir of both iron and sulphur in salt marsh as well as other sediments.

The oxidation of sulphides in marine sediments is a key process, through poorly understood. It has been, shown, however, that thiosulphate (S_2O_3) acts as a shunt in this process constituting the bulk of the hydrogen sulphide oxidation and oxidized to sulphate.

V. Regulation of Sulphur Cycle

Plant and animal secretions and decomposition of dead organic matter hydrogen sulphide gas which is converted to sulphates by bacterial action. Plants take up sulphur as sulphates is changed to sulphates again. Sulphur in coal and petroleum yields sulphur dioxide gas upon combustion. A number of metals occur as sulphide or sulphate deposits which during their mining and processing operations give rise mostly to Sulphur dioxide gas, sulphur dioxide is changed to corresponding acid which finally yield sulphates which are ultimately added to the sulphate content of environment. Some sulphur is also added to the soil or to aquatic systems as a result of volcanic activity. Combustion of fossil fuels yields an enormous amount of sulphur dioxide, It is the injection of sulphur into the atmosphere which has been causing great concern. A lot of sulphur is added to the atmosphere as a result of mining and processing operations during extraction of metals. Volcanic emissions which are the only known natural source of sulphur dioxide have been estimated to contribute $2x10^9$ kg to $5x10^9$ kg of sulphur per year, which the annual amount of industrial sulphur injected into the atmosphere, is thought to be about $83x10^9$ kg. Sulphur dioxide is a serious local pollutant with a wide range of harmful effects. This gas is mainly responsible for causing acid rain. Rapid exploitation of sulphur deposits is another feature which causes anxiety. These deposits are believed to have been produced by the activity of anaerobic bacteria (Baggiata sp.) from hydrogen sulphide gas.



Sulphur transformations govern the compositions of the oceans, and the redox balance on the Earth's surface, it is complex due to a variety of oxidation states. Besides, some transformations occur at significant rates both bacteriologically as well as chemically. The sulphur cycle involves eight electron oxidations between reactions between the most reduced H_2S (-2) to the most oxidized and SO_4^{2-} (+6). It acts as either electron donor or acceptor in many bacterially mediated reactions. The oxidation states ken sulphur compounds are as under:

Organic S(R-SH)	-2
Sulphide (H_2S)	-2
Elemental, S. (so)	-0
Thiosulphate ($S_20_32^-$)	+2 (av./s)
Tetrathionate ($S_40_62^-$)	+2 (av./s)
Sulphur dioxide ($S0_2$)	+4
Sulphur trioxide (SO_3)	+6
Sulphate (SO_42^-)	+8

The mineralisation of soil organic sulphur was examined for two soils using an open incubation system, combination of glucose - Carbon, nitrate nitrogen and sulphate-s were added to the incubated soils as at regular intervals to examine the effects of these nutrients on Sulphur mineralisation. Soil microbial activity was monitored by Carbon-dioxide (CO_2) evolution from the incubated samples. At the end of the 14-week incubation the incubated soils were analysed to determine the sources of sulphur mineralized during the incubation.

In both soils, the addition of carbon, nitrogen and sulphur had a considerable effect on sulphur mineralisation. Additions of Carbon or sulphar decreased sulphur mineralization whereas nitrogen additions slightly enhanced mineralisation. The mineralised sulphur appeared to be derived almost exclusively from carbon bonded forms of soil organic sulphur. In both soils, there were substantial increases in hydriodic acid (HI) reducible forms of sulphur during the incubation. Additions of carbon, nitrogen and sulphur influenced the amounts of sulphur mineralised or transformed formed from or to carbon bonded and HI - reducible forms of soil organic sulphur.

Bacteria like Desulfuromonas acetoxidans are capable of reducing sulphur at the expense of acetate. Some SRBS and iron reducing bacteria are also capable of reducing sulphur. Many of these bacteria are able to generate ATP during sulphur reduction. These groups can also use organic disulphide molecules like cysteine or glutathione. Though sulphur and sulphate can coexist, the latter can produce more sulphide. Most of these bacteria belong to Achaea.

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VI. Impact of Human Activities on Sulphur Cycle

The sulphur dioxide (SO_2) is added to the atmosphere in the following three ways:

i. Burning of sulphur - Containing coal and oil to produce electric power.
ii. Refining sulphur - Containing petroleum to make gasoline, heating oil etc.
iii. Human activities convert sulphur - Containing metallic mineral ores into free metals such as copper, lead and zinc that releases large amounts of sulphur dioxide (SO_2) into the environment.

VII. Conclusion and Recommendations

The Sulphur cycle transfer enormous amounts of the biologically important element through the atmosphere every one. Despite the size of natural reservoirs, human activities have had a remarkable effect on the sulphur cycle, perhaps most notably in the production of acid rain. The Earth's surface is a source of windblown dusts, but this is influenced by grazing activities and desertification. Large amounts of sulphur and mobilized by mineral extraction and fuel use. Fossil fuel refining and combustion are the major human emissions to the atmosphere, which exceed the natural sources.

Climatologists are interested in the sulphur cycle because it results in the formation of sulphuric acid (H_2SO_4), which forms a submicron aerosol that reflects solar rays (direct effect) and that influences cloud physics (indirect effect) due to its highly hydroscopic nature. The acid is formed in the atmosphere by oxidation of sulphur dioxide (SO_2), of which 35-45 Tgyear-1 are emitted due to combustion of fossil fuels.

The rapid advances in Science and technology have put the scientists and technologists on their heels to cope up with the simultaneous changes that have occurred during the past decades. Various types of revisions, rectifications as well a modifications and sometimes even all together innovated ideas that developed in numerous fields of specialisations have required to be incorporated with the advanced level concepts in order to keep pace with the recent researches advanced to the concerning fields of the study. The innovative techniques have put the researches on consistent 'think' and 'rethink' level to entertain higher concepts related to the biology. The study of such cencept as sulphur cycle should be specially introduced in the course of study related to the biological Sciences at various levels.

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