Sulphur cycle

Definition

The **sulfhur cycle** is the collection of processes by which sulfur moves between rocks, waterways and living systems.

Such biogeochemical cycles are important in geology because they affect many minerals. Biochemical cycles are also important for life because sulfur is an essential element, being a constituent of many proteins and cofactors, and sulfur compounds can be used as oxidants or reductants in microbial respiration.[1] The global sulfur cycle involves the transformations of sulfur species through different oxidation states, which play an important role in both geological and biological processes.

Steps of the sulfur cycle are:

1. Mineralization of organic sulfur into inorganic forms, such as hydrogen sulfide (H_2S), elemental sulfur, as well as sulfide minerals.
2. Oxidation of hydrogen sulfide, sulfide, and elemental sulfur (S) to sulfate (SO_4^{2-}).
3. Reduction of sulfate to sulfide.
4. Incorporation of sulfide into organic compounds (including metal-containing derivatives).

The steps are designed as follows:

Assimilative sulfate reduction (see also sulfur assimilation) in which sulfate (SO_4^{2-}) is reduced by plants, fungi and various prokaryotes. The oxidation states of sulfur are +6 in sulfate and –2 in R–SH.

Desulfurization in which organic molecules containing sulfur can be desulfurized, producing hydrogen sulfide gas (H_2S, oxidation state = –2). An analogous process for organic nitrogen compounds is deamination.

Oxidation of hydrogen sulfide produces elemental sulfur (S_8), oxidation state = 0. This reaction occurs in the photosynthetic green and purple sulfur bacteria and some chemolithotrophs. Often the elemental sulfur is stored as polysulfides.

Oxidation in elemental sulfur by sulfur oxidizers produces sulfate.

Dissimilative sulfur reduction in which elemental sulfur can be reduced to hydrogen sulfide.

Dissimilative sulfate reduction in which sulfate reducers generate hydrogen sulfide from sulfate.

Sulphur sources and where they are sinked in major

Sulfur is found in oxidation states ranging from +6 in SO_4^{2-} to -2 in sulfides. Thus, elemental sulfur can either give or receive electrons depending on its environment. On the anoxic early Earth, most sulfur was present in minerals such as pyrite (FeS_2). Over Earth history, the amount of mobile sulfur increased through volcanic activity as well as weathering of the crust in an oxygenated atmosphere. Earth's main sulfur sink is the oceans SO_4^{2-}, where it is the major oxidizing agent.

When SO_4^{2-} is assimilated by organisms, it is reduced and converted to organic sulfur, which is an essential component of proteins. However, the biosphere does not act as a major sink for sulfur, instead the majority of sulfur is found in seawater or sedimentary rocks including: pyrite rich shales, evaporite rocks (anhydrite and baryte), and calcium and magnesium carbonates (i.e. carbonate-associated sulfate). The amount of sulfate in the oceans is controlled by three major processes:

1. input from rivers
2. sulfate reduction and sulfide re-oxidation on continental shelves and slopes
3. burial of anhydrite and pyrite in the oceanic crust.

The primary natural source of sulfur to the atmosphere is sea spray or windblown sulfur rich dust,[5] neither of which is long lived in the atmosphere. In recent times, the large annual input of sulfur from the burning of coal and other fossil fuels has added a substantial amount SO_2 which acts as an air pollutant. In the geologic past, igneous intrusions into coal measures have caused large scale burning of these measures, and consequential release of sulfur to the atmosphere. This has led to substantial disruption to the climate system, and is one of the proposed causes of the Permian–Triassic extinction event.

Dimethylsulfide [$(CH_3)_2S$ or DMS] is produced by the decomposition of dimethylsulfoniopropionate (DMSP) from dying phytoplankton cells in the ocean's photic zone, and is the major biogenic gas emitted from the sea, where it is responsible for the distinctive “smell of the sea” along coastlines.[1] DMS is the largest natural source of sulfur gas, but still only has a residence time of about one day in the atmosphere and a majority of it is redeposited in the oceans rather than making it to land. However, it is a significant factor in the climate system, as it is involved in the formation of clouds.