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The mighty causes and influences of the great oxidation period

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Abstarct. The appearance and generation of O_2 has long been discussed by the scientists. It is a fundamental topic as it can not only help us get to know the origin of lives, but can also give us the inspirations of discovering the possibilities of lives on other planets as O_2 is vital to most creatures. And the GOE is the most important discovery in the O_2-producing period.The appearance of the GOE was marvelous and is a great turning point in the earth's developing history. Of course, the GOE cannot be simply explained as a coincidence, it is an inevitable development in the earth's developing history. In this paper, we are going to focus on the mighty causes including photosynthesis in the early stage of earth and O_2 storage. Also we are hunting the influences of the GOE and a relating experiment in search of the probabilities of mighty lives in the outer space.

Keywords: Photosynthesis, Glaciations, Pyrites, M-Dwarf.

1. Introduction

We are all familiar with the world abundant in O_2 to support the lives of ours and other creatures and seemingly to take it as granted. It plays a key role in our daily lives and most of us rely on oxygen to keep alive. It seems difficult for us to imagine a world without it. However, as for the earth, there was approximately no oxygen thousands of millions of years ago and it was a long and complicated period to generate oxygen that would be enough for us to survive. In early years, scientists used the isotope of Sulphur to detect the existence of the O_2 and found its origin existing time. In the research, scientists discovered that about 2.45 billion to 2.09 billion years ago, the isotope of sulphur experienced a change thus indicated the appearance of oxygen [1]. During this period, there was a nonnegligible process called "the great oxidation period" (the GOE). It was a time when plentiful oxygen suddenly swarmed into the atmosphere and caused a bunch of chain reaction. This paper is going to talk about the GOE and its marvelous influences on the earth.

2. The mighty factors that cause the GOE

2.1. The generation of O_2

The generation of O_2 is surely a complicated process and is a magical work completed by all elements in the nature. Below are several possibilities that the O_2 was generated.

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2.1.1. The photosynthesis of cyanobacteria and other algae. When we talk about oxygen-generation, photosynthesis would always become the first for us to consider. In the early stage of earth, the green plants, which are the most well-known O_2 producer, was not existed yet. Then in 1956, a group of Canadian archeologists discovered a fossil covered with algae and took it back to study further about it. To their astonishment, it was a cyanobacteria fossil dating back to two billion years ago. That was a breakthrough in the GOE study. It provides evidence that there would be something constantly releasing oxygen in the early stage and offered the condition for oxygen generating. In further studies, some other kinds of algae were also proved to be able to generate oxygen in the early stage, and that was decisive to the early O_2 accumulation [2].It was also concluded by scientists that, however, although the photosynthesis of cyanobacteria is vital, it is not the noly reason for the O_2 generation. The nickle and Sulpher also play important roles in it.

2.1.2. The process of the study. In 2009, the Kurt Konhauser research group in University of Alberta, Canada proposed their experimental findings that the GOE is a coincidence of two substance--nickle (Ni) and bacteria which can produce Methane. The researchers investigated hydrogenic rock and found that the marine content of nickle experienced a sudden drop 2.7 billion to 2.5 billion years ago, which is during the same period with the GOE. It layed a solid fundation to the GOE, as the decrease of nickle in the sea would cause the content of Mathane to decline. This established a circumstances for the ocygen to accumulate, for the reason that the Mathane might destroy the occurance of the oxygen [3]. In 2011, it was discussed that the transformation of the element Sulphur also devoted to the oxidation. Sulphur, which was originally existed as hydrogen sulphide (H_2S), would be released in the form of Sulfur dioxide (SO_2), and this period would, to a large posibility, be the promotion of the reduction of the marine sulfate and the ultimate oxydazation of the earth[4].

*2.1.3. The result.*Scientists gradually reached a consensus that the sudden occurrence of a large amount of O_2 also could origin from the co-efficient of the interactions between Earth sub-system such as weathering and volcanism [5,6]. Also, the storage of the O_2 was significant to the GOE process. In early years, the wind blew hard and brought a large amount of dust into the sea. Among them are iron, causing the gathering of this element in the depths of the sea. Then the oxygen from the cyanobacteria and other algae combined with the iron and sank under the sea as a compound. However, the capacity of the sea for those compounds has a limit. Once the limit was reached, a large amount of oxygen was released to the air, causing the sudden jump in the content of the oxygen.

2.2. The decrease of the O_2 consumption

During the GOE period, the decrease of the O_2 consumption is also happening. The reducibility of the volcanic gases was declining, which means that the O_2 required in the reduction reaction would accordingly decrease. What's more, there are also evidence showing that the methane-producing creatures are decreased in amount, therefore, the O_2 needed for its breathing is also reduced. Thus, the O_2 content in the air would be saved to a large extent [7,8].

3. The influences of the GOE

The GOE was a tremendous change in that era, so in the stage of it there are complete change all over the world. Three main changes were listed below.

3.1. The "Snowball Earth" glaciations

At first, there was a tale that along with the GOE there also comes a coincidence----the "Snowball Earth" glaciations. However, after a deep dig of the research, the so-called coincidence seemed not to be a coincidence at all. It turns out that it would be the decided trend after the GOE. In the pre-GOE period, the dominant gas was hydrocarbon gases such as methane and ethane. The lack of oxygen ensured their abundant and steady content in the air. And they, as a role of greenhouse gases, shouldered the responsibility of increasing the temperature of the earth. However, after the GOE when the oxygen

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content largely increased, they would have reactions with the oxygen and have a steep drop in content. As the greenhouse gases suddenly decreased, the temperature of the earth was largely affected. It dropped at a dramatically speed so the whole earth cooled down like a quicksilver. After that, the global glaciation was appeared.

3.2. The oxidization of pyrites

In this section, the oxidization of pyrites would be explained. The main reason is that the GOE brought about a vast amount of oxygen to the atmosphere. Therefore, the pyrites exposed in the air would have a photochemical reaction with the oxygen, for the reason that they have a strong reducive capalbility, so they are hard to be preserved well in the aboundance of oxygen, and then they would end up being oxidized on a large scale. Also, it would cause the content of other substances to change, for example, it will decrease the content of iron in the river to a large extend [9,10].

3.3. The formation and evolving of aerobes

According to the evolution theorem of Darwin, the creatures that cannot adapt to the changes in the environment would be eliminated and those who fit the environment well would be the one survives. In the states of that, as the atmospheric oxygen increases, there would emerge a large number of species which rely on the oxygen to survive, that is, as what we call it now, the aerobes. And the anaerobe would relevantly decrease.

3.4. The shaping of some geological phemomena

The oxygen is a gas with strong ability for oxydation. Thus, it would have the capability to make destructive erosion to many of the substances on the ground. The most typical representative is rock----from which many of them were erosed by the oxygen and formed their shape wich could be seen by us nowadays. Except the rocks, other substances, though might not be as apparent and widely acknowleged by us, are also formed in the interactions of O_2, such as the shaping of rivers and coastlines. The spetacle sceneries made by the oxygen provided valuable resources for us to study and appreciate.

4. The possibilities of the “GOE” on other planets

The GOE, to some extent, represents for the sign of the life. So, scientists who are curious about the habitable exoplanets did research. This research imitated the light condition on the M-Dwarf planets and tested if cyanobacteria could produce oxygen under those lights.

4.1. The design of the experiment

The scientists exposed four independent culture replicates and performed short-term (three days) and long-term (twenty-one days) acclimation experiments for each strain. The four independent culture replicates were respectively exposed under three different light sources (one for starlight, M7, one for far-red light, FR, and one for solar light, SOL). And they were all placed under terrestrial atmospheric composition. There also comes a further experiment has also been carried out to examine whether the O2 productions capabilities were able to switch once adapted to the three light conditions mentioned above. And in this experiment, three independent culture replicates were set and each were exposed to different lights mentioned before for twenty-one days.

4.2. The result of the experiment

The growth of FaRLip (Far-Red Light Photoacclimation) and non- FaRLip cyanobacteria is not limited under M7 with respect SOL, the FaRLip response in. C. fritschii is a slow process under M7 with respect to FR, and O_2 evolution is very efficient in FaRLip and non- FaRLip cyanobacteria acclimated to M7. The experimental result shows the great oxygenic adaptation on the M-dwarf planet. According to the result, scientists raised their hopes on finding a habitable planet in the outerspace. With further sduties in other aspects of the habitability on the M-dwarf, there is hope that it becomes the first habitable planet found and bring advantages to humanities.

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5. Conclusion

In conclusion, before the GOE, the earth made quite an effort to accumulate the oxygen and storage it. Scientists used the Sulphur isotope to track the timeline of the Oxygen accumulation, and with further experiments taken, discovered serveral mighty causes to the Great oxidation Events. First and foremost is the photosynthesis of cyanobacteris and other algae. Also, the interactions between Nickle and Sulphur compounds is also of great significance. After the GOE, great impact was taken place on the earth, including the “Snowball Earth” Glaciations, which means a sudden and significant drop in the temperature globally, the oxydation of pyrites, the formation and evolving of the aerobes and the shaping of some geological phenomena, such as the shaping of river banks and coastal line. To the extension, the article cited an experiment to expect furthur development in the search for the probabilities of the habitable planets in the outerspace. And it turns out that this might not be an unreachable dream in the future, for the experiment result turned out to be cheerful.

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