

# The Snowball Earth

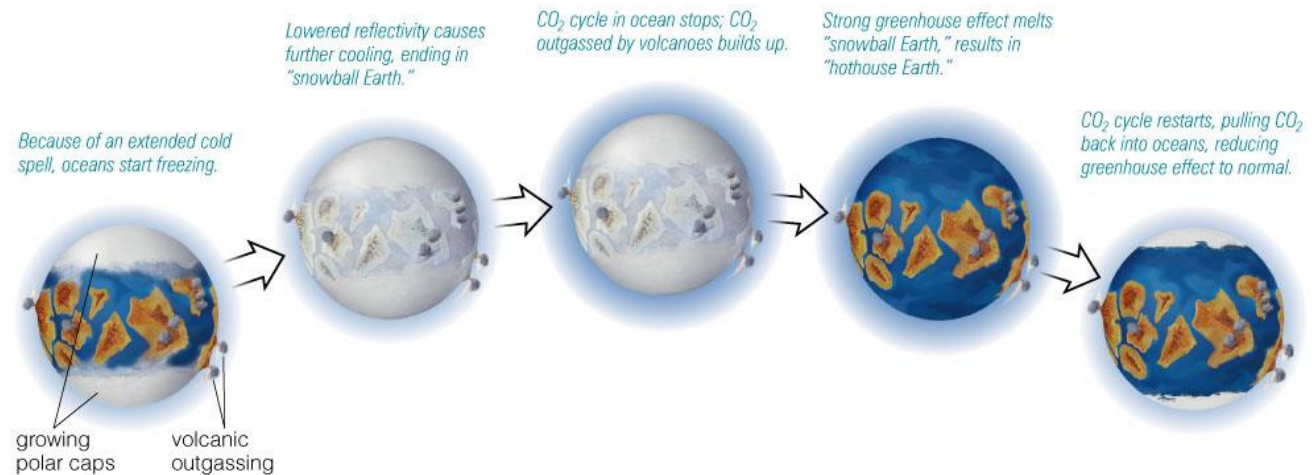
## Introduction

The Snowball Earth period is a time when the Earth's surface became almost entirely frozen from pole to pole. This concept still has the status of hypothesis as it's still a widely debated topic. It is rather interesting to know that a tropical distribution of the continents allows for the initiation of a Snowball Earth. Tropical continents are more reflective than open oceans, and thereby absorb less of the sun's heat: most absorption of solar energy on Earth today occurs in tropical oceans. This paper would examine the Snowball earth hypothesis as well as discuss the impacts of this event both on greenhouse gases and on biological life. It will also discuss the possible causes of the event.

## Snowball Earth

The term Snowball Earth refers to the hypothesis that long ago, in the distant past, the earth's surface was entirely frozen from pole to pole. That means even the equator and tropical regions were covered in ice. This massive ice age is said to have occurred long before animal life appeared, when Earth's landmasses were most likely clustered near the equator. This period is sometimes specifically called the Cryogenian period or the Marinoan glaciation and it occurred about 630 million years ago. The evidence of a Snowball Earth comes from the presence of glacial deposits around the world that date back to this period, also rock deposits that have no business being in a particular location are found, probably erratic that was deposited by the glacier in the region. The Snowball Earth hypothesis is generally accepted as being the best explanation for the presence of glacial deposits in equatorial latitudes, however, this hypothesis still is controversial

amongst paleontologists, who agree that massive glaciation actually occurred but the question is, was it of a global nature? They also ask if ice truly covered the Earth all the way to the tropics during this period of mass glaciation, how the planet sprang back to life and to its present state.



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**Inception & end of Snowball earth (Fig. 1)**

## Impacts of Snowball Earth on Life

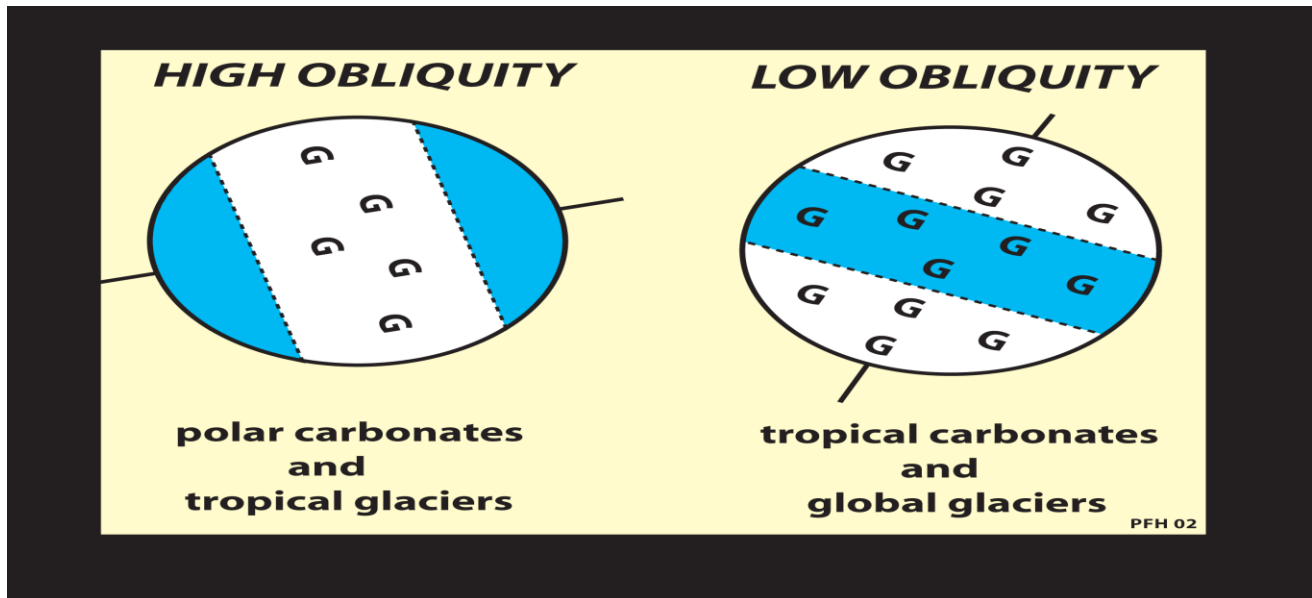
The Snowball earth period was a time of reduction in the greenhouse gases in the atmosphere, mainly CO<sub>2</sub> (carbon dioxide) and CH<sub>4</sub> (methane). As a result of this, the global climate became colder, creating larger areas of ice and snow. The Snowball event thus impacted the greenhouse effect of the earth. Ice and snow reflect more solar radiation compared to bare ground or liquid water, this is because Ice or snow has a greater albedo due to its bright colour and this creates a positive feedback. So therefore if the earth ever became half-covered by ice or snow, the feedback would become self-sustaining and keep reinforcing and glacial ice would rapidly spread to the equator. So the mass ice acted as a reflective fore that bounced incoming solar radiation back to space, thereby making the earth cooler. Global ice cover would certainly have an intense effect on ecosystems dependent on sunlight and geochemical evidence from rocks associated with

low-latitude glacial deposits have been interpreted to show a crash in oceanic life during the glaciers. The snowball event basically supported little or no biological life on earth and the physical composition of the earth surface was mainly glacier (moving ice). However, a host of microscopic organisms, both prokaryotes (archaea and bacteria, including prokaryotes (cyanobacteria) and eukaryotes (algae, testate amoebae and other protists) survived during the Snowball earth period.

### **Causes of Event**

But how did Snowball earth occur? One answer to this question is the fall of CO<sub>2</sub>, methane and other greenhouse gases. First of all, the ocean and atmosphere are in equilibrium with respect to CO<sub>2</sub> and can be treated as a single reservoir. So CO<sub>2</sub> is supplied to this reservoir by volcanic and actions, and is removed as sediment in the form of CaCO<sub>3</sub> (limestone) and organic matter. The atmospheric CO<sub>2</sub> forms carbonic acid rain, which is neutralized by silicate rock weathering and converted to soil. Silicate weathering rate is sensitive to climatic conditions, it is faster where hot and wet, slower where cold and dry. During Snowball earth period there was a rare concentration of continents in the tropics, where it is hot and wet. Therefore the global rate of silicate weathering was high, and as a result, CO<sub>2</sub> concentrations fell and the global climate cooled because there was less greenhouse warming. As for methane (CH<sub>4</sub>), early methane gas helped offset the then lower solar luminosity, which has increased by an average of ~6% per billion years since the origin of the Solar System. When oxygen (O<sub>2</sub>) levels rose, CH<sub>4</sub> levels fell concurrently, causing a loss of greenhouse warming. The cause of the sudden rise in oxygen is the development of oxygenic photosynthesis (a biological revolution). Another hypothesis put forth that tries to suggest the occurrence of Snowball earth is the Zipper Rift hypothesis, which proposes two phases of continental division - first, the breakup of the supercontinent Rodinia, forming the proto-Pacific ocean; then the splitting of the continent Baltica from Laurentia, forming the proto-Atlantic -

coincided with the glaciaded periods. The resulting tectonic uplift would form high plateaus and this high ground could then host glaciers. Another hypothesis is earth's obliquity, it is a competing theory to explain the presence of ice on the equatorial continents.



**The obliquity factor as a cause of Snowball earth (Fig. 2)**

The Earth's axial tilt was quite high, in the vicinity of  $60^\circ$ , which would place the Earth's land in high latitudes, although supporting evidence for this is scarce.

## **Conclusion**

Although the Snowball earth theory is still a hypothesis, it has a lot of evidences to support its motion. How could rocks that have characteristics of glacial deposits be found in tropical region? What other possible reasonable explanation could be given for this occurrence? Snowball earth happened as a result of a number of natural causes and supported very little life except a few microorganisms.

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