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Did Snowball Earth Exist?

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Abstract
Sediments of glaciers that were generally deposited in the poles were found in the area of the equator in various periods, which led to theories of a snowball earth. This is probablybecause the axis of the earth's rotation, following its rotation on the mantle, was located at the equator at those times. The changed location of the equator resulted from the centrifugal force of the rotational movement of the earth following the change in location of its axis, which was themain force causing the movement of the continents and especially the direction they moved in, as well as the upper part of the magma in the mantle.

Key Words
Snowball;supercontinents; centrifugal force; earth's rotation; location of equator; platetectonics.
INDEX TERMS
Astrophysics; Tectonics; Structural Geology; Geodynamics.

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I. Introduction

In different periods the poles of the earth's rotation were in places where the equator was. Thiscan explainthe appearance ofglacier sediments at the equator and is an alternative explanation of finding glaciers at the equator. However, according to this fact, it cannot be concluded that the glacier sediments necessarily covered the entire globe with the markedly thick sediments (around 1 km) that are called snowball.

II. Scientists determine that in some specific periods the earth was like a ball of snow.

The theory of Snowball Earth was first proposed by Brian Harland in 1964, who found that rocks which were deposited by glaciers in the neo-Proterozoic (about 540 million years ago) appear in all the continents in the area of the equator. From that he concluded that there was a period of glaciers when the entire earth was covered with a layer of ice.

Kirschvink (1992) suggested that Earth's oceans and land surfaces were covered by ice from the poles to the Equator during at least two extreme cooling events between 2.4 billion and 580 million years ago.

A number of scientists support the possibility that in certain periods in the course of Earth's history, it was completely covered by a thick layer of snow about a kilometer thick. Their conclusion stems from geological research that found there are sediments of glaciers in the equator area like they currently appear in the poles of the earth. There is broaddiscussion on this between different scientists.

There are those who think the earth was not covered with snow and those who think that it was covered only in part in the periods that are related to snowball around 540 million and 2.4 billion years ago and possibly in other periods.

Some of the scientists who don't accept the determination that the earth was completely covered with snow assume that the fact that glacier sediments were found at the equator as a result of the movement of continents. Thus, the sediments of glaciers that were deposited on part of the continents in the areas of the poles moved and reached the area of the equator and thus are found in certain periods at the equator.

Some of the other scientists made calculations of the balance of energy of the earth and their conclusion is that it was not possible that the earth was covered with a ~1 km thick layer of snow (ice) since with the snow melting, there is no possibility of the earth returning to its original position.

Many different opinions can be found in Wikipedia regarding the existence or not of the earth being completely covered with a thick layer of snow during different periods.

My intention in the present article is to express another opinion regarding the possibility of finding glacier sediments at the equator in accordance with the new theory I put forward, without contradicting or supporting the various theories that were published over the years.

In accordance with my research that is based on the change in the axis of the earth's rotation on its mantle (see the references below), it is reasonable that there could be sediments of glaciers that sunk in the poles in the equator area when the axis of the earth's rotation, following its rotation on its mantle, was in the location of the equator at different periods.

Following is an explanation how it is reasonable to accept that glacier sediments that were deposited at the poles were found in the area of the equator:

There are mechanisms that balance and stabilize the earth keeping it relatively stable for a long time. Some of these mechanisms were presented in a number of studies by Y. Greitzer (Jun. 2020; 10 Sep. 2020; 22 Sep., 2020; 22 Oct., 2020; Jun., 2021; 26 Feb. 2022).

Themainforcecausing the movement of the continents and especially the direction they move in, as well as the upper part of the magma in the mantle, is the centrifugal force of the rotational movement of the earth following the change in location of the axis of the earth's rotation relative to its mantle and, in accordance, a change in the location of the equator.

Thus, in different periods the poles of the earth's rotation were in places where the equator was. This can explain the appearance of glacier sediments at the equatorand is an alternative explanation of finding glaciers at the equator. However, as noted above, it cannot be concluded that the glacier sediments necessarily covered the entire globe with the markedly thick sediments (around 1 km) that are called snowball.

Actually, the present article is a continuation of the six articles noted above.

Following is a more detailedexplanation takenfrom my articles, (see references above)on why it is reasonable to accept that glacier sediments that were deposited at the poles are found in the area of the equator:

III. The Centrifugalforce Behindthemovementof Continentschange In The Axisof Therotatingearth

The movement of continents was first discerned by Wegener (1922, 1966), who in his studies established the basis for the theory of plate tectonics. Since then, there are many theories explaining the forces causing the movement of continents based mainly on internal processes in the earth.

Proposed and explained by Greitzer (June 2020), as noted above, is that the main force is the centrifugal force of the earth's rotation following the change in location of its the axis of the rotation relative to the mantle of the earth and, in accordance, a change in the location of the equator (Figs. 1, 2).

The assumption is that over an extended geological period, the axis of the earth's rotation in a pseudo-circular orbit changes its location. In the model presented (Figs. 1,2), explanations are given for the possibility of a change in the axis of the earth's rotation in a peripheral manner by about 90^0 and, in accordance, about a 90^0 change in the equator's location. The actual movement of the continents depends also on many other geological factors.

The assumption was that the location of the axis of the earth's rotation in circles of large circumferences changes its position on the globe significantly relative to the mantle of the earth. The speed of rotation of the mantle crust - Lithosphere of the earth is highest at the equator and gradually decreases towards the north and south poles. Hence the change in location of the equator will cause a significant change in the forces of movement – speed of the rotation – centrifugal force, that act on the continents and will move them. The movements of the continents will be, in accordance, related to the intensity and directions of the new centrifugal forces.

Since the creation of Earth and its beginning rotations, I assume that in the course of the geological eras there was a trend and direction change in location of the axis of rotation. The possibility of this change and, in accordance, of the change in the location of the equator that relates to the last geological era, approximately the Mesozoic to Recent (around 200 - 250 m.y.) wasreconstructed andpresented in Greitzer (June 2020, and Figs.1, 2of the present study). Likewise, the assumption is that in earlier periods, the earth's rotational axis changed its location by a scope of several rotations on the globe. This was not necessarily done in circles of full circumference, but assumedly in large circles, as noted above.An explanation is proposed for the activity of the centrifugal forces acting on the continents whereby the axis of the earth's rotation and the equator changed their locations on the earth by about 90^0 (Figs. 1, 2).

In the course of the earth's development there were a number of super-continents that split into smaller continents and parts of continents, after which they again united forming a supercontinent (Bradley, D.C 2011, Cadie, K.C 2011, Damian, R. Nace and J. Brendan Murphy, July 2013).

The main force which moves the continents and creates supercontinents, and especially the direction of the continents' movement, in my opinion, is the centrifugal force of the rotational movement of the earth following the change in location of the axis of the earth's rotation relative to the mantle of the earth and, in accordance, a change in the location of the equator.

This force is the force that caused the unification of the continents and their breakup in the course of the creation of the earth, mainly relying on the assumption that the axis of the earth in accordance with the

equator changes in a circular on the mantle. As a result of this, the continents move in a specific direction, and afterwards move in an opposite direction.

The time estimated for a change in location of the equator in a semi-circle of 360 degrees on the mantle is 1 billion years (Greitzer, Y., (Feb., 2022).

This phenomenon can explain one of the causes of the creation of glaciers at the equator in different periods, when the axis of the earth's rotation was in the same place.

IV. Conclusion

In accord with the research, based on the change of the axis of the earth's rotation on its mantle, as explained by Greitzer (Jun. 2020, Feb. 2022), it is reasonable to accept that sediments of glaciers sunk in the poles in the area of the equator, when the axis of the earth's rotation following its rotation on its mantle was at the location of the equator in different periods. Thus, that is why glacier sediments can be found in different periods also at the equator.

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In memory of Prof. L. Picard, my teacher and mentor, who established the Department of Geology at the Hebrew University of Jerusalem and after also the Department of Hydrogeology.

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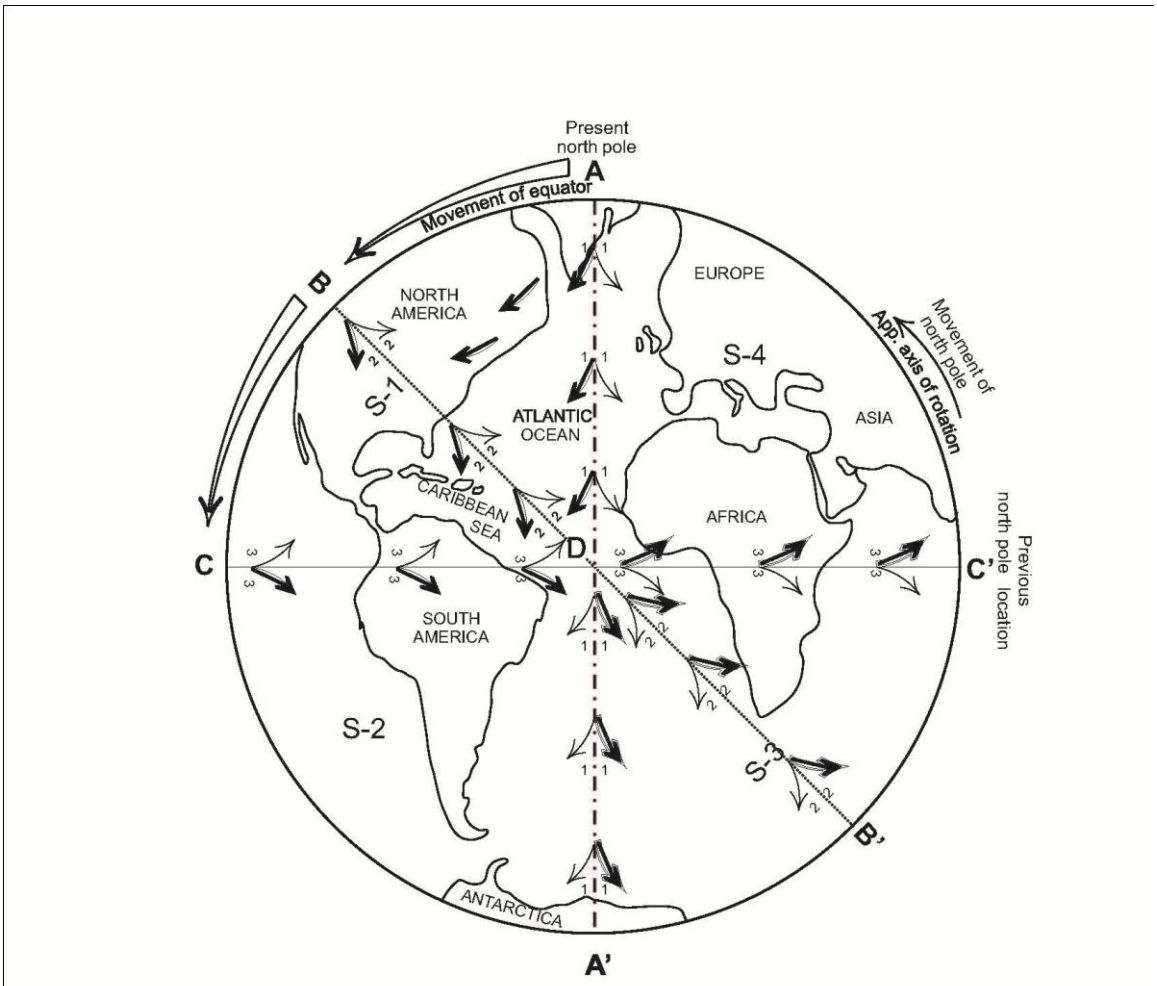

Figure 1. Movement of equator 90^0 from point A to C (movement of pole also 90^0 from point C' to A). View from Atlantic Ocean – Caribbean Sea.
By Y. Greitzer

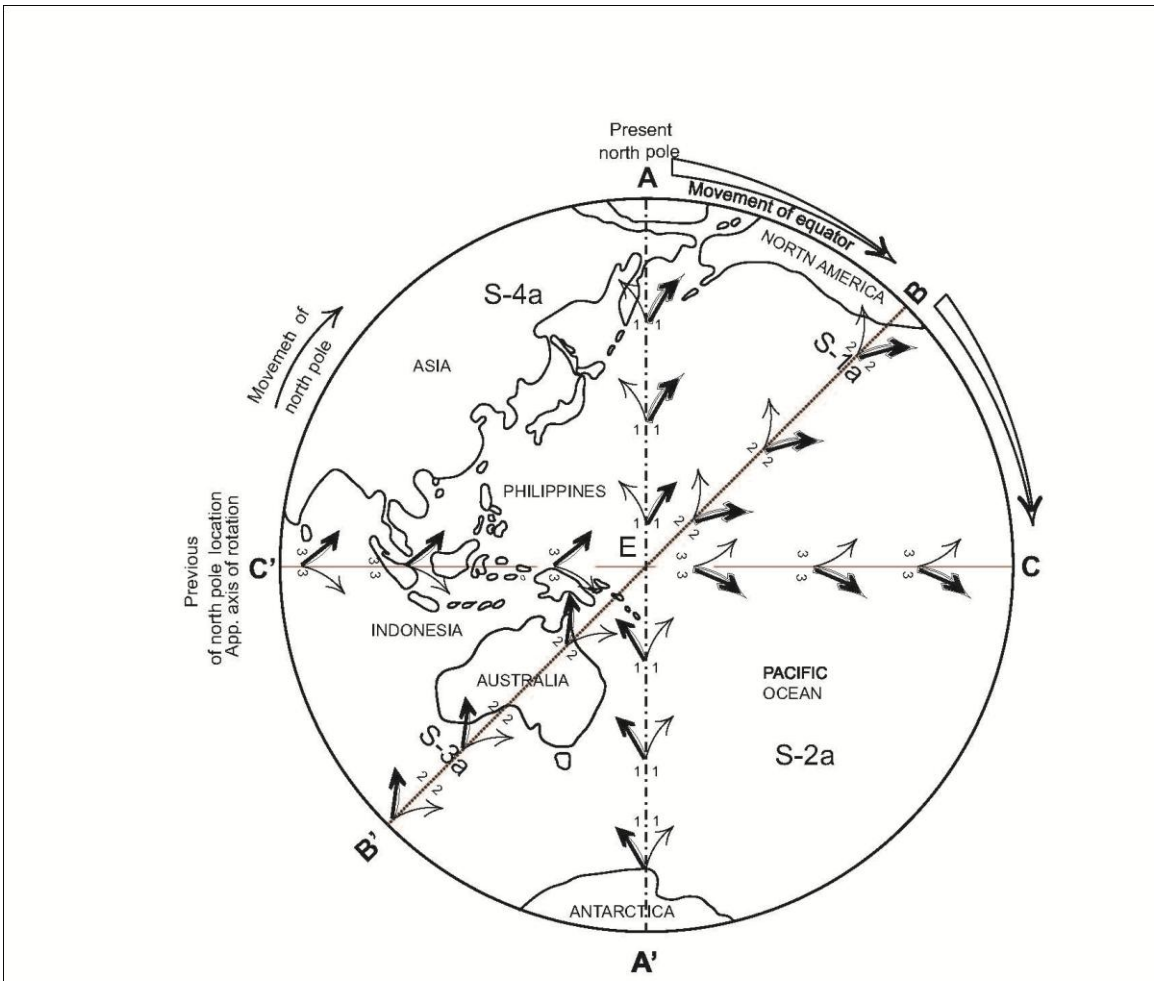

Figure 2. Movement of equator 90^0 from point A to C (movement of pole also 90^0 from point C' to A). View from Pacific Ocean, Philippines Sea.
By Y. Greitzer

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