Applying Simplest Possible Principles for the Evolution of Earth

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Summary

This paper proposes a number of hypotheses concerning the evolution of the Earth. The hypotheses are suggested outgoing from the principle "keep it simple but not too simple" and that the total entropy of the universe, and thus complexity, is increasing with time. Apart from presenting the hypotheses the purpose of this paper is also to evaluate if the hypotheses could be strengthened by facts. According to the proposed hypotheses no farfetched mechanisms are needed for explanations e.g. of why continents seem to fit together and what enabled the Cambrian explosion i.e. the dramatic increase of species.

Keywords

expansion, earth, cambrian, evolution, gas planet, tectonic plates, expanding

1 Introduction

The evolution of Earth, especially the early Earth, is of course a delicate matter to describe with credibility. However, an important source of information will probably be the analysis of planets circling around other stars than the Sun. In general, the universe becomes more and more complex as time proceeds and this is in line with the continuously increasing total entropy. Thus proposed conditions and principles should favor less complex solutions when trying to describe what happened billions of years ago. For example, an object that develops with time will need less information, corresponding to lower entropy, for describing its "then"-status than its "now"-status. This motivates the governing principle for this paper "keep it simple but not too simple" from now on called KIS. The approach of this paper is to start with basic conditions, see how principles could be applied to them, search for facts that could increase credibility and put all together in a scenario describing the corresponding evolution of the Earth. Hypotheses concern both conditions and principles and will be presented in logical order. The different hypotheses are evaluated in order to see if they could support each other and thus making it possible to improve credibility. If such support exists the hypotheses give rise to a holistic model i.e. a model which is more than the sum of its constituents. However, since some of the described hypotheses are very controversial, naturally, no facts or proofs are available in this paper. Instead this paper is hopefully an acceptable description what could result when applying simplest possible principles for the evolution of Earth.

2 The causes

As discussed in many articles, if one assumes a smaller Earth it makes it possible to put all continents together in a spherical shell, the Earth crust, perfectly covering the whole surface

of the Earth [1]. It is difficult to ignore this fact even though strongly questioned in literature. The volume would then be approximately one fifth of the volume today. This idea is in line with KIS; a sphere with a fully covering surface requires less information to be described than the more complex situation e.g. today with several irregular continents. This gives rise to the first hypothesis called H1.

H1 The Earth crust was formed as the complete shell of a sphere with the radius approximately 60 % of the Earth radius today.

The problem with H1 is to describe why the Earth was compressed and why it expanded to its size today. Many suggestions can be found in the literature but the first aspect to analyze is if the mass of the Earth has increased or not. Assuming the same density as then, four times the mass has to be added e.g. from meteorite bombardment. This would strongly affect or destroy the crust but no such violent traces can be seen. Another possibility is that the gravitational force was much stronger then and thus the gravitational constant was much larger. This was proposed by Dirac [2] but analyses have ruled out this possibility. However, if mass is the same now as then and gravitational constant is also the same we have to accept, as a consequence of H1, that the average density then was five times higher than today and this is hypothesis H2.

H2 When the Earth crust was formed the average density of the Earth was approximately 5 times higher than today.

Next we have to find a reason for why the Earth was compressed. Hypothesis H3 simply states that the Earth was compressed due to an outer pressure. Again this is in line with KIS; an outer pressure is the simplest reason for why the Earth was compressed. What pressure is needed in order to decrease the volume to one fifth? The Earth consists of an iron core with magma surrounding it and from [3] one can see that approximately 100 Mbar (10,000 GPa) is needed compared to the 160 - 360 GPa in the Earth core today.

H3 An outer pressure caused the compression of the Earth.

Each of the gas planets today, i.e. Jupiter, Saturn, Uranus and Neptune, has a solid core of approximately the size of the Earth. The mere existence of such cores gives an indication that a solid core is a natural part in any gas planet. The pressure needed for compressing the Earth volume to one fifth is assumed to be caused by the gravitational force of a surrounding gas. For a gas planet such as Jupiter an estimate is that the pressure in the core now is 3,000 - 4,500 GPa and thus the needed 10,000 GPa for compressing the Earth volume to one fifth is not unrealistic. H3 leads to hypothesis H4 that states that each planet of the solar system was created in the same way i.e. from a gas planet including a solid core but where the gas has vanished from Mercury, Venus, the Earth and Mars. Since it is more difficult to explain why these four should have been created differently compared to the gas planets H4 follows the KIS principle.

H4 All planets of the solar system were initially gas planets.

From now on in this paper Gas Planet Earth (GPE) will denote a gas planet with a GPE core called the Earth. Following the hypotheses above and since GPE does not exist today the gas must have been evaporated. Then, why did gas leave the planets closest to the Sun but not those further out? Sun radiation, i.e. solar wind and electromagnetic radiation, is naturally

assumed to be the reason. As described in the literature, the solar wind could have been much stronger in the early solar system perhaps a factor 1000 or more. Hypothesis H5 states that Sun radiation is the reason for the decrease of gas for planets and thus that the loss of gas is more effective the closer to the Sun a planet is. As a counter example, if there was a gas planet between the closest non-gas planets today it would have violated the KIS principle. The mass of the solar planets today is only 1% of the total solar system mass but there are extrasolar systems that have higher values e.g. [4] mentions a star with an accretion disk having 12 % of the star mass. The comparison of pressures between Earth and Jupiter above might indicate that the size of GPE could have been larger than Jupiter today perhaps with a factor two. Adding the masses of the assumed other gas planets, i.e. Mercury, Venus and Mars, makes 12 % of the Sun mass for the planets realistic.

H5 Sun radiation caused the loss of gas for the gas planets.

Since the Sun radiation today is weak it implies that there was only a limited time period for removing gas from the inner planets and to reduce the amount of gas for the outer planets i.e. Jupiter, Saturn, Uranus and Neptune. A theorem T1 can be given concerning the start of this period.

T1 At the creation of the solar system there was a period of time where gas loss was small.

Motivation: H1, H3 and H4 give that in order to let a solid crust be formed pressure conditions must have been relatively stable.

3 The consequences for Earth

When gas was successively removed from GPE by Sun radiation the pressure on the Earth crust was reduced accordingly and an inner overpressure started to build up. When this was high enough the crust broke up and the Earth expanded until there was a balance again between inner and outer pressure at the crust. This is hypothesis H6.

H6 The Earth expanded since an inner overpressure was built up due to the decreasing outer pressure caused by loss of surrounding gas.

Since the pressure on the surface of the Earth today can be neglected, compared to the pressure required for compression, theorem T2 below states that there is balance today i.e. the Earth has ceased to expand.

T2 The Earth will not expand further.

Motivation: Follows from H3, H6 and that the outer pressure today is so small it can be neglected.

When looking at the break up of the Earth crust into tectonic plates one can note that the process seems to have been global, continuous, slow and inevitable. These properties are all supported by the continuous decrease of gas for GPE. For example, if the expansion occurred during one billion years, which is a possibility according to the discussion below, it would correspond to only 3 mm radius increase per year. After the initial break up magma appeared

in the cracks and cooled down but since the corresponding new crust was thinner than the original crust further expansion occurred in the cracks leaving the continents unchanged. For example, the large expansion of the Pacific Ocean is natural; once started it will continue. Since the original crust was much thicker than the new crust created by cooled magma the initial break up must have been the most violent one and the one that caused the fastest change in size. For cooling the magma it is assumed that water existed according to hypothesis H7.

H7 Water covered the whole Earth.

This could be motivated by three reasons. The first reason is that the Earth was a sphere with a solid crust, according to H1, and if enough water existed it will naturally cover the whole Earth. The second reason is that water is effective in cooling down the magma and thus keeping the solidified magma localized where it appeared. This can be seen today by the sharp borders of all tectonic plates and the steep slope down to the new crust kilometers below the surface of the tectonic plates. The third reason is that fossils, billions of years old, have been found on all continents e.g. South Africa, Australia, Greenland, and since life started in the sea the spread to different continents naturally occurred in water covering the whole world. As a further strengthening aspect; a planet covered by water has been discovered see [8]. The next aspect to consider is if the amount of water has been constant or changing. There seems to be evidence that water existed on Mars and thus a mechanism exists that decreases the amount of water and this is hypothesis H8.

H8 Sun radiation caused the water to vaporize.

The vaporized water is assumed to have been spread out into outer space. Now hypothesis H9 states that land first appeared when the amount of water precisely filled the cracks created as a consequence of Earth expansion.

H9 Land first appeared when enough water had vaporized.

The appearance of land would have had dramatic effects on the weather from two main reasons; one third of the surface, i.e. land, became more or less dry and sea currents were hindered by the continents. The average depth of the sea today is 3.8 km and the average height of land is 0.8 km. Following H9 this means that the amount of water continued to decrease and an amount corresponding to 0.8 km, for the area of the oceans, has vanished since land first appeared. A theorem T3 can then be given.

T3 The expansion of the Earth finished before land appeared.

Motivation: H9 states that land appeared when enough water had vaporized and H8 states that the reason was Sun radiation. Since most of the gas must be lost in order to let Sun radiation reach the water surface the external pressure must be low on the Earth and the expansion had thus ceased.

As a consequence of T3 the moment of inertia of the Earth is constant since long and thus the slowdown of the rotational speed of the Earth is completely caused by the tidal effect as confirmed by calculations.

4 Implications on life

In [5] it is described that photosynthesis occurred 3.5 - 2.75 billion years ago and thus most of the gas was then lost since Sun light could reach the sea surface. The external pressure must then be low on the Earth and the expansion had thus ceased. Since life began in the sea about 3.6 billion years ago life began in the dark. The energy driving evolution of life must then have come from sea volcanoes in the same way as occurring today. Since water was covering the whole Earth volcanoes could be situated in the cracks or on the tectonic plates. However, most of the volcanoes would be situated in the cracks since the distance to the underlying magma was smaller there. Hypothesis H10 states that Cambrian explosion of species, which occurred about 550 million years ago, is due to the fact that land life and life in the atmosphere (which used land as a basis) was possible as soon as there was land. Thus there were suddenly three ways for evolution of species; in the sea, on land and in the air and that could explain the Cambrian explosion.

H10 As soon as land appeared land life started to evolve.

Such a discrete event is easier to accept, and in accordance with KIS, for describing that no traces of land life can be seen earlier than 370 million years ago and for plants earlier than 500 million years ago. The opposite would have been more difficult to explain i.e. that evolution of land life, which always has been seen as a continuous process with remarkable adaptation capability, started at a specific point of time without a discrete event to relate to. In [6] a big mass extinction is described which occurred in the early Cambrian epoch. This is what should be expected when land first appear; the whole fauna and flora below the surface of the sea then had to be adapted to life above the surface of the sea. How distinct was this event? From above and if a constant water evaporation rate is assumed we get it as 840 m loss of ocean water depth in 550 million years i.e. 1.5 m/Myear. Thus after ten million years there was a significant difference between land and sea i.e. a discrete event on the time scale of the Earth. Using the same rate all water on Earth will be gone in 2.5 billion years. This can be compared with the one-dimensional model used in [7] that gives 7 billion years.

Finally, according to the hypotheses, there is no coincidence that life developed on Earth; GPE was close enough to the Sun to have its gas removed and far enough to have water left for making life possible to develop in the sea. In this perspective we can say that Mercury and Venus were too close to the Sun, Mars had not enough water and Jupiter, Saturn, Uranus and Neptune were too far away from the sun.

5 Scenario

Using the hypotheses above a scenario can be described:

* 4.5 billion years ago all planets around the Sun were gas planets and created as a consequence of the accretion disk around the Sun.

* 4.5 billion years ago GPE consisted of gas and an internal core; the Earth. Due to the high inner pressure the volume of the Earth was one fifth of the volume today. The heaviest elements were gathered in the center of the Earth.

* 4.5 billion years ago up to sometime 3.5 - 2.75 billion years ago a continuous decrease of gas occurred due to Sun radiation and as a consequence the Earth expanded. Water successively filled the increasing cracks and cooled magma so it became solid.

* Sometime 3.5 - 2.75 billion years ago all gas of GPE was finally evaporated making photosynthesis possible. The pressure at the surface of the Earth became insignificant and the expansion of the Earth ceased. The size of the Earth became what it is today. Water covered the whole Earth.

* Sometime 3.5 - 2.75 billion years ago up to 550 million years ago water evaporated, due to Sun radiation, decreasing the depth of water covering the whole Earth.

* 550 million years ago so much water had evaporated that land became visible. The Cambrian explosion occurred. Land life evolved with animals first living on the border between water and land such as the Ichthyostega.

* 550 million years ago up to now water continued to evaporate, due to Sun radiation, decreasing the depth of the oceans.

6 Conclusions

The presented hypotheses are of course pure speculations but strengthened by facts available today. However, there are aspects that are difficult to estimate e.g. the period of expansion, the size of the GPE, the effectiveness of the Sun radiation and the initial amount of water. Of course the hypotheses are very far from being validated and very far from being generally accepted but at least the hypotheses do not contradict each other. On the other hand several of the hypotheses actually strengthen each other. This is shown in Figure 1 below where an x denotes “strengthens” and is placed at a hypothesis/theorem (in the From row) that strengthens a hypothesis/theorem (in the To column).

From \ To	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	T1	T2	T3
H1	.	x	.	.	.	.	x	.	.	.	x	.	.
H2	.	.	.	.	.	.	.	.	.	.	.	.	.
H3	x	x	.	.	.	.	.	.	.	.	x	x	.
H4	.	.	x	.	.	.	.	.	.	.	x	.	.
H5	.	.	.	.	.	x	.	.	.	.	.	.	.
H6	.	.	.	.	.	.	.	.	.	.	.	x	.
H7	.	.	.	.	.	.	.	.	x	.	.	.	.
H8	.	.	.	.	.	.	.	.	x	.	.	.	x
H9	.	.	.	.	.	.	.	.	.	x	.	.	x
H10	.	.	.	.	.	.	.	.	.	.	.	.	.
T1	.	.	.	.	.	.	.	.	.	.	.	.	.
T2	.	.	.	.	.	.	.	.	.	.	.	.	x
T3	.	.	.	.	.	.	.	.	.	.	.	.	.

Figure 1: Dependencies between hypotheses and theorems

From the figure we can see that hypotheses H4, H5 and H8 are truly fundamental, i.e. not strengthened, while the others strengthen each other. The strengthenings motivate that the set of hypotheses can be considered as a holistic model i.e. the model is more than the sum of the constituents. If the hypotheses can be accepted the main contributions of the model are that reasons for continents fitting together and the Cambrian explosion are given explanations. An advantage is also that no farfetched mechanisms are needed for motivations.

7 References

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