

Empirical support for the Expanding Earth hypothesis

June 29, 2025

Matti Pitkänen

orcid:0000-0002-8051-4364.
email: matpitka6@gmail.com,
url: http://tgdttheory.com/public_html/,
address: Valtatie 8, as. 2, 03600, Karkkila, Finland.

Contents

1	Introduction	2
2	Various pieces of empirical support for Expanding Earth hypothesis	3
2.1	Oxygenation of oceans did not precede CE as TGD strongly suggests and empirical study concludes	3
2.2	Strange correlation between the strength of the Earth's magnetic field and the atmospheric oxygen content	5
2.3	Anomalously high rates of tectonic plate motion and the TGD view of CE	5
2.4	Does the existence of an underground ocean floor at the mantle-core boundary relate to underground life?	6
2.5	A possible mechanism of radiative energy transfer from the Earth's core to underground oceans near the surface of Earth	9
2.5.1	Ultralow velocity zones	9
2.5.2	Ordinary water cannot survive near mantle	10
2.5.3	Pollack effect for superionic water and metabolic energy feed from the core of Earth	10
2.6	Did Earth have a ring before the Cambrian Explosion and did the rapidly expanding Earth catch the ring?	11

Abstract

In this article I discuss the empirical support for the Expanding Earth hypothesis that I have become aware of quite recently.

1. There is empirical support for the view that the oxygenation of oceans did not occur before CE. This conforms with the prediction that oxygenation was due to photosynthesis in underground oceans. TGD provides the new physics needed: dark photons from either Earth's core or Sun could have provided the metabolic energy making photosynthesis and therefore oxygenation possible.
2. Anomalously high recession velocities for the tectonic plates during CE have been observed and could be due to the radial expansion of the Earth lasting about 30 million years which corresponds to the duration of Cambrian explosion. A quantitative estimate for the expansion velocity gives an estimate consistent with the findings. Cambrian explosion would correspond to quantum tunnelling in astrophysical scale and involve "big"

state function reductions and a temporary change of the arrow of time. The change of the arrow of time in scale of 30 million years could even allow to understand the plant fossils with age about 600 million years conflicting with the fact that the Cambrian explosion (CE) occurred about 540 million years ago.

3. The finding that the mantle-core boundary looks like a seafloor having even mountains has a rather convincing explanation in terms of the subduction of tectonic plates, which sink to the mantle. This however inspired the question whether life in underground oceans as porous structures containing water in some exotic form, most naturally the fifth phase of water studied by Pollack playing a key role in the TGD inspired view of biology, could make possible the needed thermal and chemical isolation. Pollack effect could provide this isolation and is certainly needed even if the temperature of the underground ocean is not far from the physiological temperature.

Assuming that the Sun was faint so that the temperature at the surface of Earth was below the freezing point, one ends up with conflict with the isotopic determination of the temperature giving a temperature of oceans slightly higher than the temperature 38 C above which marine invertebrates cannot survive. The temperature about 30 degrees allows life but this requires a slightly lower amount of O^{18} isotope than prevailing in the recent oceans. The paradox can be solved if the warm water originated from underground oceans and mixed with the non-oxygenated water (or actually ice) at the surface of Earth so that the isotopic fraction was reduced. The optimal situation for life would have been at depths of order kilometer and one can say that life had no other option than developing underground.

Contents

1 Introduction

In this article I continue to develop a more detailed TGD version of the Expanding Earth hypothesis explaining Cambrian Explosion (CE). In earlier articles [L2, L5, L11] a rather detailed view of the pre-Cambrian biology, geology, and thermal evolution is developed and one can relate it to the standard view. This involves topics like faint Sun paradox, the mechanism of the Great Oxygenation Event, understanding the TGD counterparts of supercontinents Rodinia and Pannotia preceding CE, snowball Earth, and CE that led to a sudden emergence of highly advanced multicellulars.

Also a more detailed view of what happened in the CE induced by the increase of the radius of Earth by factor 2 emerged in [L11] (in the TGD Universe, a smooth continuous cosmological expansion is replaced with a sequence of short lasting and fast expansions). One ends up with a detailed model for the phase transition leading to the increase of the Earth radius. This phase transition requires a considerable energy feed provided by the phase transition thickening monopole flux tubes of the magnetic body of Earth and liberating energy. In analogy with the recent Mars, the pre-Cambrian Earth had a solid core analogous to the inner core. In the phase transition to a liquid outer core with much larger volume. Part of the newly formed outer core could in turn have transformed to form a part of the mantle increasing its thickness.

In this article I discuss the empirical support for the Expanding Earth hypothesis that I have become aware of quite recently.

1. There is empirical support for the view that the oxygenation of oceans did not occur before CE. This conforms with the prediction that oxygenation was due to photosynthesis in underground oceans. TGD provides the new physics needed: dark photons from either Earth's core or Sun could have provided the metabolic energy making photosynthesis and therefore oxygenation possible.
2. Anomalously high recession velocities for the tectonic plates during CE have been observed and could be due to the radial expansion of the Earth lasting about 30 million years which corresponds to the duration of CE. A quantitative estimate for the expansion velocity gives an estimate consistent with the findings. CE would correspond to quantum tunnelling in astrophysical scale and involve "big" state function reductions and a temporary change of

the arrow of time. One could even understand the plant fossils with age about 600 million years conflicting with the fact that the CE (CE) occurred about 540 million years ago.

3. The finding that the mantle-core boundary looks like a seafloor having even mountains has a rather convincing explanation in terms of the subduction of tectonic plates, which sink to the mantle. This however inspired the question whether life in underground oceans as porous structures containing water in some exotic form, most naturally the fifth phase of water studied by Pollack playing a key role in the TGD inspired view of biology, could make possible the needed thermal and chemical isolation. Pollack effect could provide this isolation and is certainly needed even if the temperature of the underground ocean is not far from the physiological temperature.

Assuming that the Sun was faint so that the temperature at the surface of Earth was below the freezing point, one ends up with conflict with the isotopic determination of the temperature giving a temperature of oceans slightly higher than the temperature 38 C above which marine invertebrates cannot survive. The temperature about 30 degrees allows life but this requires a slightly lower amount of O^{18} isotope than prevailing in the recent oceans. The paradox can be solved if the warm water originated from underground oceans and mixed with the non-oxygenated water (or actually ice) at the surface of Earth so that the isotopic fraction was reduced. The optimal situation for life would have been at depths of order kilometer and one can say that life had no other option than developing underground.

2 Various pieces of empirical support for Expanding Earth hypothesis

The new empirical findings and earlier paradoxes related to CE make it possible to build quite a detailed picture about the Expanding Earth hypothesis and CE.

2.1 Oxygenation of oceans did not precede CE as TGD strongly suggests and empirical study concludes

There was an interesting article in Futurism about the findings challenging the basic assumption related to the origin of life (<https://futurism.com/the-byte/textbooks-wrong-origin-life>). The research article "Widespread seafloor anoxia during generation of the Ediacaran Shuram carbon isotope excursion" [I3] can be found at
[urlhttps://onlinelibrary.wiley.com/doi/10.1111/gbi.12557](https://onlinelibrary.wiley.com/doi/10.1111/gbi.12557).

On the basis of empirical evidence it is claimed that the view of the gradual oxygenation of oceans is wrong. The abstract of the article explains the findings.

Reconstructing the oxygenation history of Earth's oceans during the Ediacaran period (635 to 539 million years ago) has been challenging, and this has led to a polarizing debate about the environmental conditions that played host to the rise of animals. One focal point of this debate is the largest negative inorganic C-isotope excursion recognized in the geologic record, the Shuram excursion, and whether this relic tracks the global-scale oxygenation of Earth's deep oceans.

To help inform this debate, we conducted a detailed geochemical investigation of two siliciclastic-dominated successions from Oman deposited through the Shuram Formation. Iron speciation data from both successions indicate formation beneath an intermittently anoxic local water column. Authigenic thallium (Tl) isotopic compositions leached from both successions are indistinguishable from bulk upper continental crust ($\epsilon^{205}Tl_A \simeq -2$) and, by analogy with modern equivalents, likely representative of the ancient seawater $\epsilon^{205}Tl$ value. A crustal seawater $\epsilon^{205}Tl$ value requires limited manganese (Mn) oxide burial on the ancient seafloor, and by extension widely distributed anoxic sediment porewaters.

This inference is supported by muted redox-sensitive element enrichments (V, Mo, and U) and consistent with some combination of widespread (a) bottom water anoxia and (b) high sedimentary organic matter loading. Contrary to a classical hypothesis, our interpretations place the Shuram excursion, and any coeval animal evolutionary events, in a predominantly anoxic global ocean.

The absence of oxygenation before the Explosion is also the TGD based prediction. The TGD based model predicts that the mysterious CE in which advanced multicellulars suddenly emerged involved an increase of Earth radius by factor 2 in a geologically short time scale [L2] [L5].

This view conforms with TGD inspired cosmology in which a smooth cosmological expansion is replaced with a serious rapid step-wise expansions, which are essentially quantum phase transitions involving astrophysical quantum coherence scales.

The Earth would have been like Mars now (not much water at surface, even the radius would have been very near to Mars radius) and life would have evolved in underground oceans (being shielded from cosmic rays and meteors), in the womb of Mother Gaia. The evidence for the underground life on Mars is accumulating. The water in underground oceans would have oxygenated by photosynthesizing life and the underground water would have bursted to the surface and give rise to the oxygenated oceans covering most of the Earth's surface since then.

The basic objection is that photosynthesis was not possible. The core of the Earth however produces radiation in the same wavelength range as the Sun and in the TGD framework this could allow the development of photosynthesis [L6]. Now Quanta Magazine article (rebrand.ly/jbvkwt) told that in a research [I4] published last month in Nature Communications, researchers reported that in groundwater reservoirs 200 meters below the fossil fuel fields of Alberta, Canada, they discovered abundant microbes that produce unexpectedly large amounts of oxygen even in the absence of light. Photosynthesis is the standard way to produce oxygen. But how could photosynthesis work underground? This looks like a complete mystery in the standard physics framework.

Whether the interpretation of the article that life evolved in anoxic global ocean is consistent with the TGD view that this oceans was essentially absent, is not of course clear.

The basic objection is that photosynthesis was not possible. The core of the Earth however produces radiation in the same wavelength range as the Sun and in the TGD framework this could allow the development of photosynthesis [L6].

Whether the interpretation of the article that life evolved in anoxic global ocean is consistent with the TGD view that this oceans was essentially absent, is not of course clear.

What objections can one invent against the TGD view? The first objection against the TGD proposal is that fossils of complex multicellular life forms have been found with age of 600 million years to be compared with the fossils dating back to 550 years ago when CE could have started. The story of their discovery told in the popular article "How 2 Teens Accidentally Solved Charles Darwin's Most Vexing Problem" (rebrand.ly/uk0ntuk) is fascinating.

In 1956, a teenage girl by the name of Tina Negus found a strange looking fossil in Charnwood Forest in Leicestershire, England. The plant fossil should not have been there since the rock was 600 million years old and the CE started roughly 60 million years later. Tina Negus showed a pencil rubbing to his geography teacher but he didn't believe her.

A year later, in 1957, three teenage boys were playing near the same rock face when they, too, noticed the same fossil. One of these teens, fifteen-year-old Roger Mason, found the second fossil. Roger Mason contacted Trevor Ford, a local geologist, who wrote about the finding to the Journal of the Yorkshire Geological Society. The new plant was named Charnia Masoni. Charnia is a genus of frond-like life forms belonging to the Ediacaran biota. Charnia came from Charnwood Forest in Leicestershire, England where Tina Engus found it. Masoni is after Roger Mason.

Does the TGD based view survive these findings? Note first that the Charnia Masoni does not conform with the conclusion that the oceans that possibly existed at that time did not contain oxygen. Furthermore, Charnia Masoni does not change the basic facts: complex multicellular life forms emerged as if from nowhere. The time span from Charnia Masoni fossils about 600 billion years to the beginning of CE about 538.8 million years ago is about 10 per cent.

Can one explain the finding in the TGD view of the CE?

1. If the surface of Earth did not contain much water before the CE, one can imagine that water leaked from the underground oceans locally at some places but not everywhere. Instead of oceans, there were oxygenated lakes, where multicellular life forms survived.
2. Another possibility is that the expansion of Earth involves periodic oscillation typical of resonances so that bursts of oxygenated water containing the highly evolved life forms emerged to the surface. I have considered this kind of explanation for the periodic oscillations found to be associated with the CE.

3. One can also imagine that the rock containing the fossil has emerged from the older of a sediment rock at the "bottom" underground water reservoir when a crack was formed in the geologically fast expansion.

There is also indirect evidence for the presence of life about 3.85 billion years ago ([rebrand.ly/ebz2q92](#)). The interaction of rocks with life forms lowers the C-13 ratio of rocks to a characteristic value serving as a signature for life. Any sedimentary rocks that formed before life appeared on Earth would have the high C-13 ratio of a volcanic origin. The discovery of rocks with the same C-13 ratio that serve as a signature of life support the view that very primitive microbial life existed already at that time. One can consider the possibility that very primitive life forms existed at the surface of Earth. Second possibility is that they leaked from underground oceans. Also in Mars there is evidence for the presence of water and it could have indeed leaked from underground water reservoirs.

2.2 Strange correlation between the strength of the Earth's magnetic field and the atmospheric oxygen content

Sabine Hossenfelder (see this) talked about the recently discover strong correlation between the strength of the Earth's magnetic field and O₂ content in the atmosphere [?]([seethis](#)).

This is an extremely interesting finding from the TGD point of view. It is known that the changes in the magnetic field strength and its orientation have had strong effects on biology and consciousness. The local weakening of the magnetic field strength and Schumann resonance have been assigned also with disorders of societies by Callahan [I7, I1] (see this and this). TGD suggests a model for the reversal of the magnetic field [?, L12].

As the figure 1 of the article [?] about the correlation between magnetic field strength and O₂ percent of the atmosphere shows, both the oxygen percent in atmosphere and the strength of the magnetic field characterized by virtual geometric axial dipole moment started to grow about 500 My ago and is maximum about 300 My ago. TGD view of Cambrian Explosion suggests that the strengthening of the magnetic field, perhaps by the emergence of monopole flux tubes, implied a rapid evolution of the oxygen based life forms in the oceans created by the rapid expansion and caused oxygenation of the atmosphere.

2.3 Anomalously high rates of tectonic plate motion and the TGD view of CE

The popular Arstechnica article (see this) tells that the motion between plates was surprisingly fast. The rate of the tectonic motion as relative rate for the distance increase between plates was surprisingly fast: even about 4 times the recent one.

The TGD view of expanding Earth relies on the prediction of cosmic expansion as a sequence of fast periods of expansion for astrophysical objects.

1. The model predicts that the tectonic plates were created in rather fast radial expansion of Earth: radius increased by a factor 2. Cracks giving rise plates were formed because rock is not flexible material.
2. The model explains the CE: advanced photosynthesising multicellulars emerged from underground oceans as the oxygenated water bursted to the surface. The TGD view of dark matter allows to circumvent the obvious objections against the model and conforms with the recent surprising findings [L11] (see this) and this).
3. The fast radial expansion caused a fast increase of the distances between plates. The velocity v of this recession would have been $v = dR/dt \times \Delta\Phi$, where $\Delta\Phi$ is the angular distance between the plates and dR/dt is the radial expansion rate.

The duration of CE was roughly $\Delta T = 30$ million years. Using Earth radius $R = 6,371$ km, one obtains the estimate $dR/dt = R/\Delta T \simeq 20$ cm/year. v is obtained from this by multiplying with $\Delta\Phi < \pi$. The largest rate mentioned in the popular article is $v = 64$ cm/year. The order of magnitude is correct and the rate would have been higher than the average during the fastest periods.

The estimate for v must involve a large enough angle $\Delta\Phi$ and a long enough time period so that $\Delta\Phi$ is expected to be a considerable fraction of π . For $\Delta\Phi$ slightly below π , the estimate is exact but this is probably an accident.

4. Note that the predicted contribution to v is always positive and could provide a test for the TGD view.

A fascinating, and admittedly frightening, question, which just now occurred to me, is whether the CE was gravitational expansion analogous to cosmic expansion in which the metric (!) distances between points doubled! This would have required the scaling of the induced metric by a factor about 4. Could this make sense or does it kill the basic idea?

1. In zero energy ontology (ZEO), light-cone proper time a serves in the role of the cosmic scale factor of either half-cone of the causal diamond (CD) having interpretation as empty cosmology. "Big" state function reductions (BSFRs), serving as TGD counterparts of the ordinary SFRs, change the arrow of time and a pair of BSFRs would be behind quantum tunnelling in the TGD Universe.

In the TGD framework quantum coherence and BSFRs are possible even in astrophysical scales. Could the increase of the radius of Earth be quantum tunnelling be realized as a pair of BSFRs.

2. Can one imagine a local "mini" Big Bang for the CD inside which Earth's space-time surface belongs and a scaling of light-cone proper time a by a factor 2 in astrophysical quantum quantum tunnelling? The value of the light-cone proper time a , characterizing the cosmotemporal position of Earth in a double BSFR, would have increased by factor 2. The spatial scaling by a factor 2 conforms with the p-adic length scale hypothesis stating that p-adic length scales coming as powers of 2 are of special importance.
3. One can try to form a more quantitative view of the situation. Note that the size scale of the initial CD before explosion would be $T/2$, where T is the distance between the tips of the CD would be about 30 million years. The CE occurred about $T_i = 540$ million years ago. If T_i corresponds to the cm of CD, the future tip of the initial CD would be at 570 million years. CD size would be scaled by factor 2 and the end of the cm of CD would correspond to $T_f = 570$ million years.

The quantum average space-time surface would be replaced by a new one in double BSFR and would be modified already 60 million years before T_f . This time would correspond to 630 million years. As explained, some multicellular plant fossils have been found with an age of about 600 million years. Could this replacement of geometric past explain them?

2.4 Does the existence of an underground ocean floor at the mantle-core boundary relate to underground life?

The popular article published in Futurism discussed an unexpected observation by the group led by Samantha Hansen published in Science [D1]. The mantle-core boundary in the Earth's interior contains a layer that looks like the crust of Earth in the sense that the seismic perturbations propagating through it have an ultralow velocity. There are mountains many times higher than Himalaya! How is this possible? Is this possible in standard physics?

The answer of the article to this question is based on the idea that subduction for continental plates implies that part of them sinks down because they are denser than the surrounding material and gradually gather to form a second sea floor at the mantle-core boundary. To me this idea looks rather plausible but need not be correct.

My first reaction was the question whether this second sea floor could be a genuine seafloor, the seafloor of an underground ocean! Could new physics predicted by TGD make this possible?

1. The basic prediction of the Expanding Earth hypothesis [L11] explaining CE is that life evolved in underground oceans and bursted to the surface as the radius of Earth increased by factor 2 in a rapid expansion lasting about 30 million years (cosmic expansion would occurred as rapid jerks for astrophysical objects). During the last weeks several strange findings removing the most obvious objections against this vision have emerged.

2. Could these mountains at the core-mantle boundary correspond to mountains of underground ocean floor?

Could the underground oceans have existed and carried life? Could they reside even in the extremely hostile environment at the mantle-core boundary?

1. Underground oceans near the mantle-core boundary could be imagined as a porous structure having water inside pores. Such structures are very common and if Earth's crust is formed from meteorites the water would be present from the beginning. Even biological matter is analogous to porous structure. When stone is heated it becomes a porous structure. Maybe the enormous heat flux from the core could cause porosity. In accordance with the standard vision of self-organization, this could be understood as complexity developing induced by a constant heat flux. Self-organization takes place at boundaries.
2. It is known that huge reservoirs of water exist underground. The boundary between upper and lower mantle at a depth of about 500 km contains a porous structure carrying water (see this). If the size of the pores is large enough, considerably above cell size, advanced multicellulars could evolve in the underground oceans.

It is easy to invent lethal objections in the standard physics framework.

1. The temperature and pressure increase as one goes towards the core. The temperature of pores should be around 40 C for life to survive. Also the pressure should be normal.
2. Consider the crust first. The temperature reaches the values in the range 100-600 C at the crust-mantle boundary. The temperature increase is about 30 C per kilometer in the upper part of the crust and would be about 30 C at the depth of 1 km if it is 0 C at the surface. The underground water reservoirs should not be at depths much larger than 1 km if the standard physics applies and the largest depths would be possible near the poles.
3. In the underground ocean at the boundary of the upper and lower mantle at a depth of about 500 km, the temperature and pressure are quite too high. Temperature of the surrounding solid material varies from 500 K at the lower boundary of the crust to 1200 K at the boundary of upper and lower mantle. Densities would be several times higher than the normal density of water.
4. Temperature at the mantle-core boundary is about 3000 -4500 K and pressure 1.3 trillion times the atmospheric pressure. The density of mantle is by factor about 5-6 higher than the density of crust so that the pressure is really huge since water and solid matter are almost incompressible. Water in ordinary form cannot exist in this kind of environment if standard physics applies.

Could underground oceans allow some exotic phase of water at physiological temperature around 40 C and normal pressure? This is not possible for the water of standard physics. But the water in living matter is not normal!

1. The phase of water discovered by Pollack [I6, L1, I9, I8], called fifth phase of water by Pollack himself (also the term "ordered water" is used). Pollack proposed it to be fundamental for life. Gel phases would represent a basic example of this water.

This phase of water plays a key role in the TGD based model of living matter. The model identifies dark matter based as phases of ordinary matter with non-standard values of Planck constant. The gravitational Planck constant indeed has huge values.

2. The underground life faces the same problem as the biological cell at the surface of Earth: how to isolate itself from the environment. The high temperatures and pressures make the problem orders of magnitudes more challenging. The fifth phase of water surrounding the system could provide the solution in the case of cell membrane and DNA double strand: develop a layer consisting of the fifth phase of water which thermally shields the volume of the ordinary water from the environment at a different temperature.

3. The negatively charged exclusion zones (EZs) generated in the Pollack effect as protons go to magnetic flux tubes as dark protons realizing the dark genetic code, are also able to get rid of various impurities in their interiors. This violates second law in its standard form and suggests that the arrow of time at the magnetic body of EZ controlling its dynamics has a non-standard arrow of time and induces an effective change of the arrow of time for ordinary biomater for long periods of time. This would isolate the system also chemically from the environment.
4. As a matter of fact, it has been discovered that ordinary water in air develops a thin molecular layer at its surface. This layer is neither water or ice and the identification as the fifth phase of water would be suggestive [L7]. This layer could also work at nanoscales and reduce the freezing temperature of the lattice water in materials like concrete to about -70 C. The mechanism could be essentially thermal isolation.

Could thermal isolation work also in high temperature environments, where underground life had to survive?

1. Could the darkness of the ordered water make possible a situation in which the interactions of the water inside pores with the hot high pressure environment are very weak and heat and matter are not transferred between the solid environment and water. Thermal equilibrium would be established very slowly and the temperature could and pressure could be much lower than otherwise for very long periods.
2. Magnetic bodies would carry the dark matter relevant for the biocontrol and would be shielded from the hot environment. They would be gradually heated and this would lead to biological death as it does in ordinary biology according to TGD. Zero energy ontology would however come in rescue and the change of arrow of time would reverse heating to cooling!
3. The unpaired and their chemically non-inert valence electrons of biologically important ions should be dark and reside at the flux tubes associated with very long dark valence bonds. This would generate long range quantum coherence. This would explain why living matter contains these ions although thermal ionization is not possible at physiological temperatures. Also the protons of hydrogen bonds would be dark. Only the chemically inert full electron shells would remain and the system would remain and since be effectively thermally isolated from the hot environment.

As a matter of fact, electrolytes involve ions and the mechanism of ionization is not actually understood and TGD suggest a mechanism of ionization based on the generation of dark valence electrons and dark protons [L8, L4].

While preparing this text, I learned that the standard view of CE has a problem with the Cambrian ocean temperature.

1. If the oceans existed (not clear in the TGD framework before the CE!), their temperatures should have been around 60 C. Marine invertebrates do not however survive above 38 C.
2. Isotopic estimates for Cambrian phosphatic brachiopods [I5] (see) assuming no post-Cambrian O^{18} isotopic depletion relative to the recent concentration suggests that the temperatures of Cambrian oceans were in the range 35-41 C. This range is above the recent range 27-35 C. Assuming a O^{18} depletion of -3 promille of the early Cambrian sea water relative today, one can get Cambrian temperatures around 30 degrees.
3. The problem now is that the underground oceans should have been very near to the surface (unless one assumes the TGD inspired thermal insulation hypothesis). Faint Sun paradox comes to rescue here. The luminosity of the Sun should have been 30 per cent lower than now so that the temperature at the surface of Earth should have been below the freezing point. This has motivated the snowball Earth hypothesis. The paradox disappears if life evolved in the underground oceans in a warmer environment. The temperature deduced from the

O^{18} fraction of fossils should be that for the underground ocean. Furthermore, the faint Sun makes it possible for the underground oceans to be located below 1 km depth without assuming the thermal insulation hypothesis.

4. What could have caused the O^{18} depletion of the Cambrian phosphatic brachiopods? A possible explanation is that there were non-oxygenated water reservoirs (presumably in a form of ice) at the surface of Earth and the oxygenated underground water was mixed with this water. Also the surface of Mars, to which the surface of Earth before the CE is analogous, contains some water.

To conclude, I am not suggesting that life developed at the mantle-core boundary: this might be quite too science-fiction an idea. Pole regions of the crust are the most conservative candidate for the seat of underground oceans. It is quite enough for the purposes of the Expanding Earth model that it developed in underground water reservoirs at depths of a few kilometers. Also in this case the thermal isolation from the environment could have played a key role. An interesting question is whether the critical temperature range 30-40 C of life could fix the depth for the underground oceans to about 1 km at which life most probably evolved.

2.5 A possible mechanism of radiative energy transfer from the Earth's core to underground oceans near the surface of Earth

The recent observations [D1] strongly suggest that there is an ancient seabed on top of the Earth's core, and there are also mountains with a height of about 10 km. The proposed model, in which convection moves the sea floor to the region above the mantle, is probably correct.

This finding combined with the discovery of the so-called superionic ice [D2], which could exist above the Earth's core, allows to develop a proposal for a mechanism of metabolic energy transfer from the Earth's core to the underground oceans near the surface of Earth. This would make possible the development of photosynthesizing life forms in underground oceans. The generalization of the Pollack effect [I6, L1, I9, I8] would play a key role in the mechanism.

2.5.1 Ultralow velocity zones

The following abstract of the article (see this) published by a group led by Dr. Samantha Hansen [D1] gives an overall view of what has been observed.

Ultralow velocity zones (ULVZs) are the most anomalous structures within the Earth's interior; however, given the wide range of associated characteristics (thickness and composition) reported by previous studies, the origins of ULVZs have been debated for decades. Using a recently developed seismic analysis approach, we find widespread, variable ULVZs along the core-mantle boundary (CMB) beneath a largely unsampled portion of the Southern Hemisphere. Our study region is not beneath current or recent subduction zones, but our mantle convection simulations demonstrate how heterogeneous accumulations of previously subducted materials could form on the CMB and explain our seismic observations. We further show that subducted materials can be globally distributed throughout the lowermost mantle with variable concentrations. These subducted materials, advected along the CMB, can provide an explanation for the distribution and range of reported ULVZ properties.

So called S waves (see this) are transversal acoustic waves caused by the shear force parallel to the propagation. This force is proportional to viscosity and is negligible in liquids but much larger in solid phase waves reflected at mantle-core boundary. The core of Earth is in a liquid phase. Therefore sound waves from the surface of Earth are reflected back at the mantle-core boundary.

This makes it possible to deduce information from the structure of the mantle-core boundary and it has turned out that it has a highly complex structure. First of all, these waves propagate very slowly. This allows us to conclude that there is a relatively thin layer with a high density, which could consist of the same material as the seabed. This layer contains mountains with heights of order 10 km.

The TGD inspired view of the evolution life, inspired by the Cambrian Explosion and TGD based view of cosmology, is that photosynthesizing life evolved in underground oceans and that

the expansion of the Earth radius by about factor 2 bursted these oceans to the surface of Earth in Cambrian Explosion [L2, L5, L3, L11, L10].

Could the ancient seabed above the mantle be assigned to the ocean immediately above the mantle? This is not possible. The existence of an underground ocean immediately above the mantle is impossible due to the high pressure and temperature so that the convection remains the natural explanation for the presence of seabed.

The second objection is that life in the underground oceans is not possible because solar energy needed by photosynthesis is not available. How could photosynthesis have developed in the underground oceans? The key observation is that energies of the photons of thermal radiation coming from the core are of the same order as the metabolic energy currency with nominal value of .5 eV: could this radiation have served as a source of metabolic energy.

How would this energy be transferred? The Pollack effect [I6, L1, I9, I8] and its reversal, whose TGD based understanding [L1, L9, L13, L15, L14] has increased considerably during this year, could provide a fast energy transfer mechanism, but in its standard form the Pollack effect requires liquid water. Could the so-called superionic ice [D2], which has been speculated to be found even near the mantle of Earth, make possible the analogy of the Pollack effect?

2.5.2 Ordinary water cannot survive near mantle

Although it is obvious that ordinary liquid water cannot exist at temperatures and pressures prevailing near the mantle, it is useful to look at the situation more quantitatively.

In mechanical equilibrium, pressure gradient and the gravitational force, expressible in terms of the gradient of gravitational potential, cancel each other in good approximation. One can estimate the change of pressure as $\Delta p = \rho \Delta \Phi_{gr} = \rho GM \Delta(\frac{1}{R})$. The equation of state allows an estimate for ΔT .

Pressure is estimated to increase from 100 MPa at the surface of the Earth to 139 GPa above the mantle, that is by a factor 1000. Temperature, converted to thermal energy $E = kT$, is estimated to increase from .03 eV to 0.42 eV. The increase is by a factor of 10. Ordinary water cannot survive in this kind of environment so that underground water is possible only sufficiently near to the surface of Earth.

Could one imagine a phase of water allowing the analog of Pollack effect so that the transformation of protons to dark protons at the gravitational MB could make it possible to transfer metabolic energy to the higher heights, where underground liquid water can exist. This would have made possible the development of photosynthesizing life and would also solve the "faint Sun" paradox (<https://rb.gy/mfhavz>) [L11] meaning that the solar energy feed was not enough for the metabolic needs of life at the surface of Earth.

2.5.3 Pollack effect for superionic water and metabolic energy feed from the core of Earth

Superionic ice [D2] (see this and this) existing at extreme pressures. The density of superionic ice is slightly less than 4 times the density of ordinary ice. In superionic ice O^{2-} ions form a lattice whereas H^+ ions float freely. This phase is conductor with H^+ ions serving as charge carriers. Superionic ice is proposed to appear in the mantles of giant planets such as Uranus and Neptune and in [?] the possibility that it could occur in the Earth's mantle was considered.

Could water appear as superionic ice above the Earth's core and allow Pollack effect and its reversal so that gravitational flux tubes would carry dark protons. Could dark photons emitted in the reverse Polack effect transfer the energy along gravitational flux tubes to the underground oceans near the surface of the Earth?

Let's assume that there exists superionic ice above the mantle.

1. Could the radiation from the core kick part of the protons of the superionic water to the gravitational magnetic body? The gravitational binding energy of protons at the surface of Earth is about .5 eV and now roughly by a factor 4 larger, that is 2 eV, at the top of the mantle. At the gravitational magnetic flux tubes the reduction of gravitational binding energy is therefore below 2 eV. The temperature of the core corresponds to the metabolic energy currency of about .4 eV so that the radiation could have played the same role as the solar radiation in photosynthesis.

2. If the reverse Pollack effect occurs, dark photons are emitted and they propagate to the MBs of water volumes near the surface of Earth and could provide energy for photosynthesis. Also time reversal can occur for the water near the surface of Earth and the proton can gain the energy required by darkness by emitting a negative energy dark photon propagating to the MB near the mantle. I have called this mechanism remote metabolism or quantum credit card and asked whether it could play a key role also in the ordinary biology.
3. If the temperatures of the lower part of the mantle and the core are the same, the energy input from the core could feed protons to gravitational MB, maintain the superionic water phase and compensate for the energy loss due to the reverse Pollack effect. The transfer of energy near the earth's surface would take place at the speed of light and dissipation would be very small.
4. The number of ordinary-to-dark transitions of protons per unit time determines the energy flow to the MB and the energy flow to the uppermost layers of the mantle. In a steady state, this flow must be the same as the radiative heat flow from the core. This transfer rate is determined by the rate for the photon absorptions kicking protons to the MB. The energy flow of energy coming as radiation is proportional to T^4 .

2.6 Did Earth have a ring before the Cambrian Explosion and did the rapidly expanding Earth catch the ring?

I encountered a link to a very interesting popular article "Did Earth have a ring like Saturnus?" (see this) telling about the article "Evidence suggesting that earth had a ring in the Ordovician" of Tomkins et al published in Earth and Planetary Science Letters [?].

The proposal is that the ring would have formed as a large asteroid was caught by the Earth. The tidal forces of Earth would have destroyed the asteroid so that it became a ring along the equator of the Earth. The ring created a shadow. If it formed along the equator, it could have initiated global cooling about 465 years ago: the so-called Hirnantian Icehouse followed 20 million years later. There are as many as 21 meteor strikes along the equator and this is very implausible if the meteors would have arrived from random directions.

This is a highly interesting finding from the point of view of the Expanding Earth hypothesis inspired by TGD [L11, L10]. About 524 million years ago the so-called Cambrian Explosion occurred. Highly evolved multicellular life forms suddenly emerged. A possible explanation of this mystery could be a fast expansion of the Earth: radius would have increased by about factor 2: these fast expansions could be the TGD counterpart of smooth cosmic expansion. This would have led to the bursting of underground oceans containing the multicellular life to the surface of the Earth. It is not difficult to invent objections against the idea but the new physics predicted by TGD allows to circumvent them and the model explains a large number of anomalies to the evolution of Earth.

The ring would have formed about 60 million years later and existed for a time measured 10 million years as a natural unit. Could one think that Earth had already before this time a ring and the Expanding Earth caught the ring? This could explain why the ring was along the equator, something not obvious if the ring was formed by the asteroid rotating around the Earth. This would have produced the 21 meteor strikes along the equator, a phenomenon which is extremely implausible if the meteors did not originate from the same source. The expansion of the Earth would have gradually increased the width of the shadow and the collision with the ring would have generated dust in the atmosphere and caused an additional shadowing effect causing the cooling of the climate.

Acknowledgements: I want to thank my friend Heikki Haila for enlightening discussions concerning glaciations.

REFERENCES

Condensed Matter Physics

- [D1] Hansen SE et al. Globally distributed subducted materials along the Earth's core-mantle boundary: Implications for ultralow velocity zones. *Science*, 9(14), 2023. Available at: <https://www.science.org/doi/10.1126/sciadv.add4838>.
- [D2] Prakapenka VB et al. Structure and properties of two superionic ice phases. *Nature Physics*, 17(11):1–6, 2021. Available at: https://www.researchgate.net/publication/355212207_Structure_and_properties_of_two_superionic_ice_phases.

Biology

- [I1] Earth's magnetic field regions of weakness correlated to sites of political unrest and war: the paradigm quaking measurements of professor Phil Callahan. Available at: <https://www.acacialand.com/Callahan.html>.
- [I2] The Fourth Phase of Water: Dr. Gerald Pollack at TEDxGuelphU, 2014. Available at: <https://www.youtube.com/watch?v=i-T7tCMUDXU>.
- [I3] Ostrander CM et al. Widespread seafloor anoxia during generation of the Ediacaran Shuram carbon isotope excursion. *geobiology*, 2023. Available at: <https://onlinelibrary.wiley.com/doi/10.1111/gbi.12557>.
- [I4] Ruff SE et al. Hydrogen and dark oxygen drive microbial productivity in diverse groundwater ecosystems. *Nature Communications*, 14(3194), 2023. Available at: <https://www.nature.com/articles/s41467-023-38523-4>.
- [I5] Wotte T et al. Isotopic evidence for temperate oceans during the Cambrian Explosion. *Sci Rep.*, 9(6330), 2019. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6474879/>.
- [I6] Pollack G. *Cells, Gels and the Engines of Life*. Ebner and Sons, 2000. Available at: <https://www.cellsandgels.com/>.
- [I7] Callahan P. *Paramagnetism–Rediscovering Nature's Secret Force of Growth*, volume 2003. Acres U.S.A.. Available at: <https://www.nexusmagazine.com/>, 1995.
- [I8] Zhao Q Pollack GH, Figueroa X. Molecules, water, and radiant energy: new clues for the origin of life. *Int J Mol Sci*, 10:1419–1429, 2009. Available at: <https://tinyurl.com/ntkfhlc>.
- [I9] Pollack GH Zheng J-M. Long-range forces extending from polymer-gel surfaces. *Phys Rev E*, 68:031408–, 2003. Available at: <https://tinyurl.com/ntkfhlc>.

Books related to TGD

- [K1] Pitkänen M. Expanding Earth Model and Pre-Cambrian Evolution of Continents, Climate, and Life. In *Physics in Many-Sheeted Space-Time: Part I*. <https://tgdtheory.fi/tgdhtml/Btgdcclass1.html>. Available at: <https://tgdtheory.fi/pdfpool/expearth.pdf>., 2023.

Articles about TGD

- [L1] Pitkänen M. Pollack's Findings about Fourth phase of Water : TGD View. Available at: https://tgdtheory.fi/public_html/articles/PollackYoutube.pdf., 2014.

- [L2] Pitkänen M. Expanding Earth Model and Pre-Cambrian Evolution of Continents, Climate, and Life. Available at: https://tgdtheory.fi/public_html/articles/expearth.pdf., 2018.
- [L3] Pitkänen M. Empirical support for the Expanding Earth Model and TGD view about classical gauge fields. https://tgdtheory.fi/public_html/articles/expearthnewest.pdf., 2021.
- [L4] Pitkänen M. TGD and Condensed Matter. https://tgdtheory.fi/public_html/articles/TGDcondmatshort.pdf., 2021.
- [L5] Pitkänen M. Updated version of Expanding Earth model. https://tgdtheory.fi/public_html/articles/expearth2021.pdf., 2021.
- [L6] Pitkänen M. Krebs cycle from TGD point of view. https://tgdtheory.fi/public_html/articles/krebs.pdf., 2022.
- [L7] Pitkänen M. TGD inspired model for freezing in nano scales. https://tgdtheory.fi/public_html/articles/freezing.pdf., 2022.
- [L8] Pitkänen M. A revolution in lithium-sulphur battery technology? https://tgdtheory.fi/public_html/articles/LiS.pdf., 2023.
- [L9] Pitkänen M. About the mechanism of the energy transfer in photosynthesis. https://tgdtheory.fi/public_html/articles/photosynth.pdf., 2023.
- [L10] Pitkänen M. Empirical Support for Expanding Earth Hypothesis. https://tgdtheory.fi/public_html/articles/preCEagain.pdf., 2023.
- [L11] Pitkänen M. Expanding Earth Hypothesis and Pre-Cambrian Earth. https://tgdtheory.fi/public_html/articles/preCE.pdf., 2023.
- [L12] Pitkänen M. Magnetic Bubbles in TGD Universe: Part II. https://tgdtheory.fi/public_html/articles/magnbubble2.pdf., 2023.
- [L13] Pitkänen M. Pollack Effect and Some Anomalies of Water. https://tgdtheory.fi/public_html/articles/pollackwater.pdf., 2023.
- [L14] Pitkänen M. Pollack effect, lightnings and ball lightnings. https://tgdtheory.fi/public_html/articles/balllightning.pdf., 2023.
- [L15] Pitkänen M. Some new aspects of the TGD inspired model of the nerve pulse . https://tgdtheory.fi/public_html/articles/np2023.pdf., 2023.