

This article is an attempt to fuse the existing TGD inspired ideas about the geological and biological evolution of life on Earth to a single coherent whole. The strategy is to identify weak points of the existing vision and here the language models provide an extremely powerful tool.

The evolution of life on Earth encountered several bottlenecks. In the beginning, the generation of nitrogen atoms from N_2 molecules, having a very large binding energy, was made possible by the presence of volcanoes but soon it became ineffective. Bacteria invented the nitrogenase enzyme for which oxygen was a poison. Later bacteria invented oxygen breathing and photosynthesis releasing oxygen as a waste. This led to the Great Oxygenation Event meaning a catastrophe destroying most bacteria. Ways to avoid the destruction of nitrogenase were invented.

The sudden emergence of highly evolved multicellular life forms in Cambrian Explosion (CE) with almost no fossils intermediate between them and monocellulars is an unsolved mystery. It served as the starting point of the development of the TGD based view of biological and geological evolution of Earth. There is evidence that the continents of the Earth fit nicely together along the boundaries if the radius of the Earth is taken $1/2$ of the recent radius. This inspires the proposal that CE involved a rapid expansion of the radius of Earth in a geologically short time interval and the multicellular life forms evolved in underground oceans before the CE.

In the sequel my goal is to develop an overall vision of the geological and biological ideas about the evolution of the Earth. The starting point is the explanation for the CE and the problem associated with it.

1. The contraction of the Earth radius by factor $1/2$ implies the increase of the density by factor 8. In the framework of standard model physics implies a huge increase of pressure and temperature and life could not have evolved in underground water reservoirs if they could be even present. Large scale quantum coherence could however change the situation.
2. The liberated gravitational and atomic binding energies would have served as a metabolic energy increasing the value of h_{eff} (a measure for complexity) and given rise to phases of matter labelled by biologically important p-adic length scales. Assuming that repulsive Coulomb energies decreased and that the allowed p-adic integers k are primes, a simple scaling argument implies that biologically relevant p-adic length scales characterize the quantum coherence regions space-time sheets.

The compression would have induced a Pollack effect, which transferred protons and possibly also other alkali ions from the silicate (SiO_4^{-4}) lattice of the mantle to the gravitational magnetic body of the Earth characterized by a huge value of gravitational Planck constant $\hbar_{gr}$ so that the system became quantum coherent in astrophysical length scales. The dramatic reduction of the number of translational degrees of freedom implied that the pressure and temperature could remain in the physiological range and multicellular life could evolve in underground water reservoirs and emerge to the surface in Cambrian Explosion involving an expansion of the Earth radius by factor 2.

3. p-Adic length scale hypothesis allows to make the picture quantitative. For years ago, I considered the possibility of a phase transition reducing the p-adic size scale of atoms by factor 2. The p-adic length scale $L(k = 139)$ defining atomic size scale would have been reduced to $L(137) = L(139)/2$. This would have liberated a huge

gravitational energy and thrown the surface layer out giving rise to the formation of the Moon. The liberated gravitational and atomic binding energies would have served as a metabolic energy increasing the value of h_{eff} (a measure for complexity) and generated phases of matter with long p-adic length scales. Assuming that repulsive Coulomb energies decreased and that the allowed p-adic integers k are primes, a simple scaling argument implies that biologically relevant p-adic length scales characterize the space-time sheets as quantum coherence regions.

4. The presence of gravitational quantum coherence motivates quantum model for the Earth as an elastic ball based on quantum harmonic oscillator characterized by $\hbar_{gr}$ coding Equivalence Principle and implying that the radii of harmonic oscillator states do not depend on the particle mass.

The model suggests that the compression and expansion phases could have taken place in two steps. During the first step of the compression phase the particles of the upper mantle would have been transferred to lower harmonic oscillator states. During the second step this would have happened to the particles of the lower mantle. One of the key questions is whether the oceans were at the surface of Earth before CE or not: also this question I try to answer in the sequel.

This picture provides a qualitative understanding of the geological evolution, including formation of old mountains before the first step of contraction and emergence of plate tectonics after it. Also oceans could have emerged already in the first step. The model explains why the tectonic plates for the oceanic crust differ from those for the continental crust.