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New Geophysical Mechanism Driving Major Species Extinction Events

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ABSTRACT
Numerous attempts to describe the factors underlying the five major species-extinction events over the last 500 million years have led to coincidences, but to no underlying scientific basis. The principal reason for failure to understand is that the geoscience community has, since 1940, built scientific understanding upon a flawed basis. Here I provide a brief recitation of the more correct scientific basis, and upon that basis I disclose the underlying mechanism, connected to reversals and excursions of the geomagnetic field, that is the foundation for essentially all major non-anthropogenic species extinction events.

INTRODUCTION
Numerous studies spanning more than a century, e.g. [1-4], have addressed various aspects of species extinction. In 1982, Raup and Sepkowski [5] published a definitive work, incorporating a database of 3300 marine fossil families of which 2400 are extinct, that demonstrated the existence of five major species-extinction events over the last 500 million years. Since 1970, several ideas addressing the cause of mass extinctions have been published. In 1972, Vogt [6] pointed out that massive basalt floods, also called LIPs (large igneous provinces) appear to coincide with major mass extinctions. As more data became available, others extended that concept [7-9] (Figure 1).

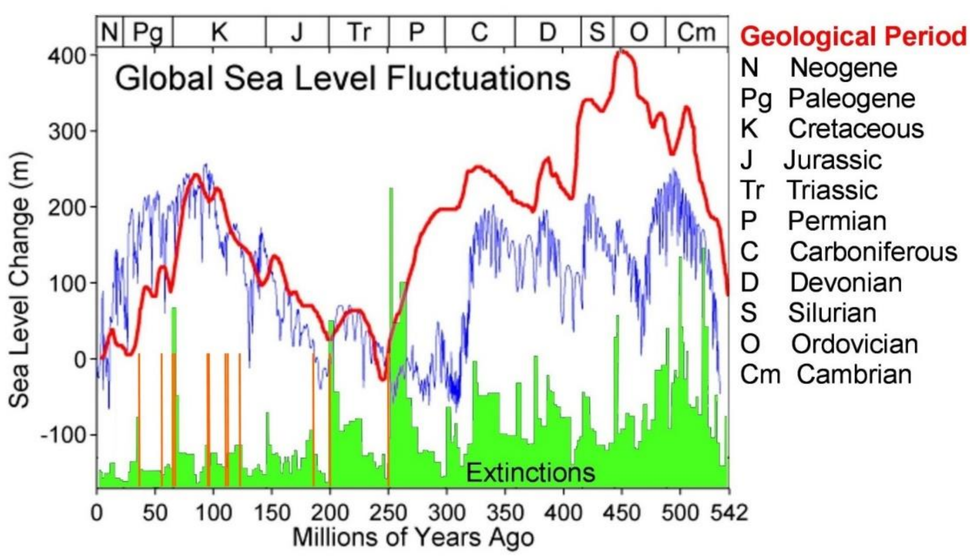


Figure 1: Spikes in seawater levels (red and blue) appear to correlate with spikes in species genus extinction intensity (green), correlate with times of major basalt floods (orange), and

correlate as well with boundaries of major divisions of geological time, abbreviated at top of graph. For details and data, see [5, 10-17]. Adapted from [18].

In 1980, Alvarez et al. [19] published a paradigm-shifting concept "Extraterrestrial cause for the Cretaceous-Tertiary extinction." These scientists had discovered marked increases in iridium in a narrow clay band precisely at the time of the Cretaceous-Tertiary (aka Cretaceous-Palaeogene, aka K-T) mass extinction event. The cause, they hypothesized, was the impact of a large Earth-crossing asteroid. Subsequent investigations showed that the iridium spike was indeed a global phenomenon, and further elemental analyses provided strong evidence of its asteroid origin [20]. Nearly a decade later, the presumptive "smoking gun" was identified, the Chicxulub impact crater on the Yucatan Peninsula in Mexico [21, 22].

A half-century of scientific investigations, while producing much data, have not yielded a clear understanding of the geophysical mechanisms responsible for the five major species-extinction events. Many fundamental questions remain unanswered, such as: Is there a connection between the Chicxulub impact and the Deccan Traps igneous basalt flood? What, if any, is the geophysical basis of the coincidence between basalt floods and species extinctions? What is the connection between geomagnetic reversals and basalt floods? What is the mechanism responsible for marine species extinctions? What mechanism is responsible for sea-level lowering associated with species extinction?

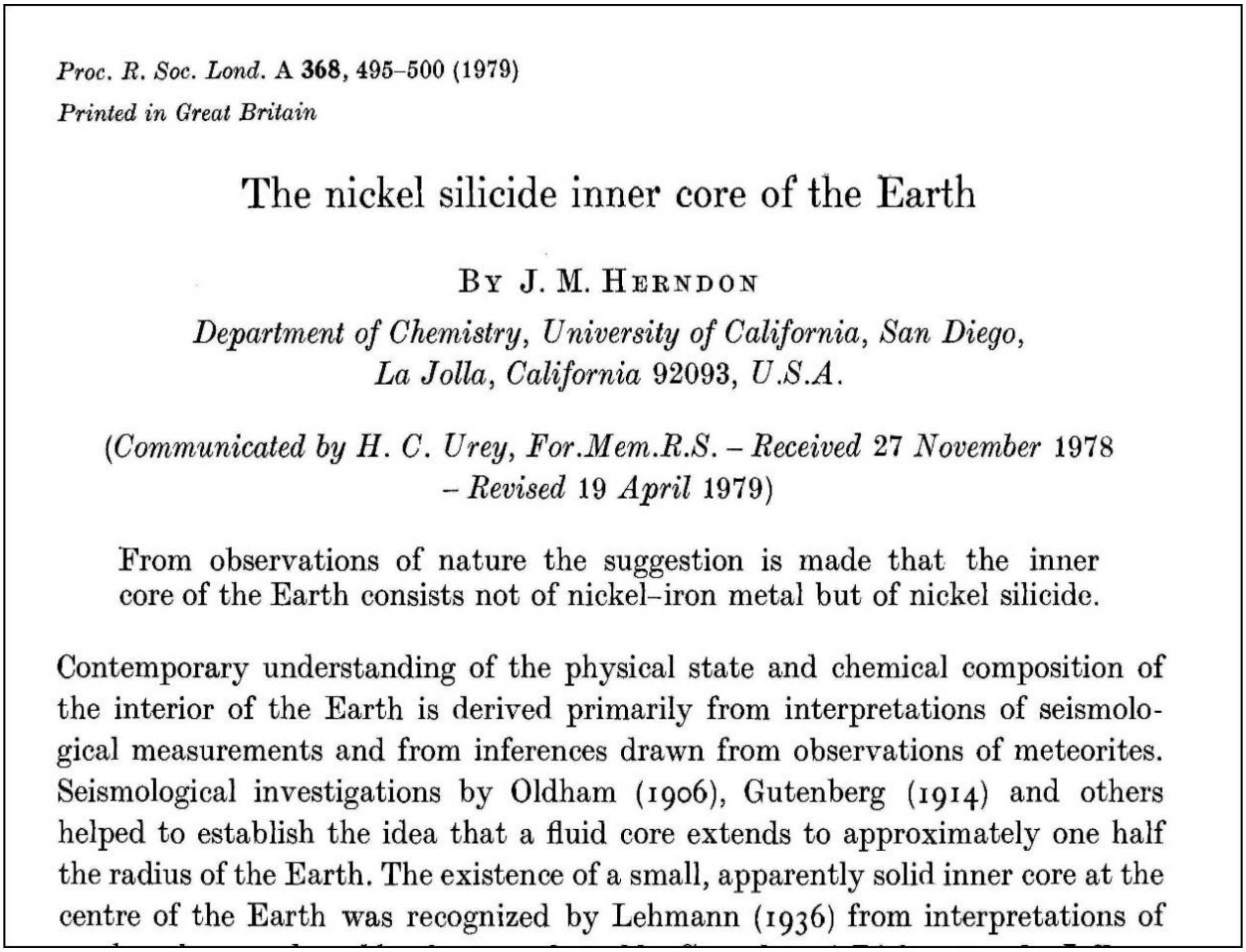
The above questions have been unanswerable by the geoscience community. It is as if the geoscience community has been unanimously seeking to navigate to a series of addresses in London using an Istanbul Street map. Such an inference becomes understandable as I present here the logical and causal geophysical relationships that form the basis for a cohesive understanding related to the above questions.

MISUNDERSTOOD EARTH SCIENCE

In 1906, Oldham [23] discovered Earth's core, the dimensions of which and its fluid state were determined by 1930 [24, 25]. In 1936, Lehmann [26] reasoned the existence and dimensions of Earth's solid inner core. In 1940, Birch [27] asserted the inner core's composition to be partially crystallized iron metal.

Birch assumed that Earth's composition is similar to that of an ordinary chondrite meteorite in which nickel was always alloyed with iron, and the sum-total of all elements heavier than nickel would be insufficient to produce an object as massive as the inner core [28].

Nearly four decades later, I was investigating the rare, highly-reduced enstatite chondrite meteorites. I realized that if Earth's interior resembled an enstatite chondrite, silicon in the core would cause nickel to precipitate as nickel silicide, producing an inner core of just the mass observed. In 1979, I published that contrary idea for the composition of Earth's inner core [29] (Figure 2).



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The nickel silicide inner core of the Earth

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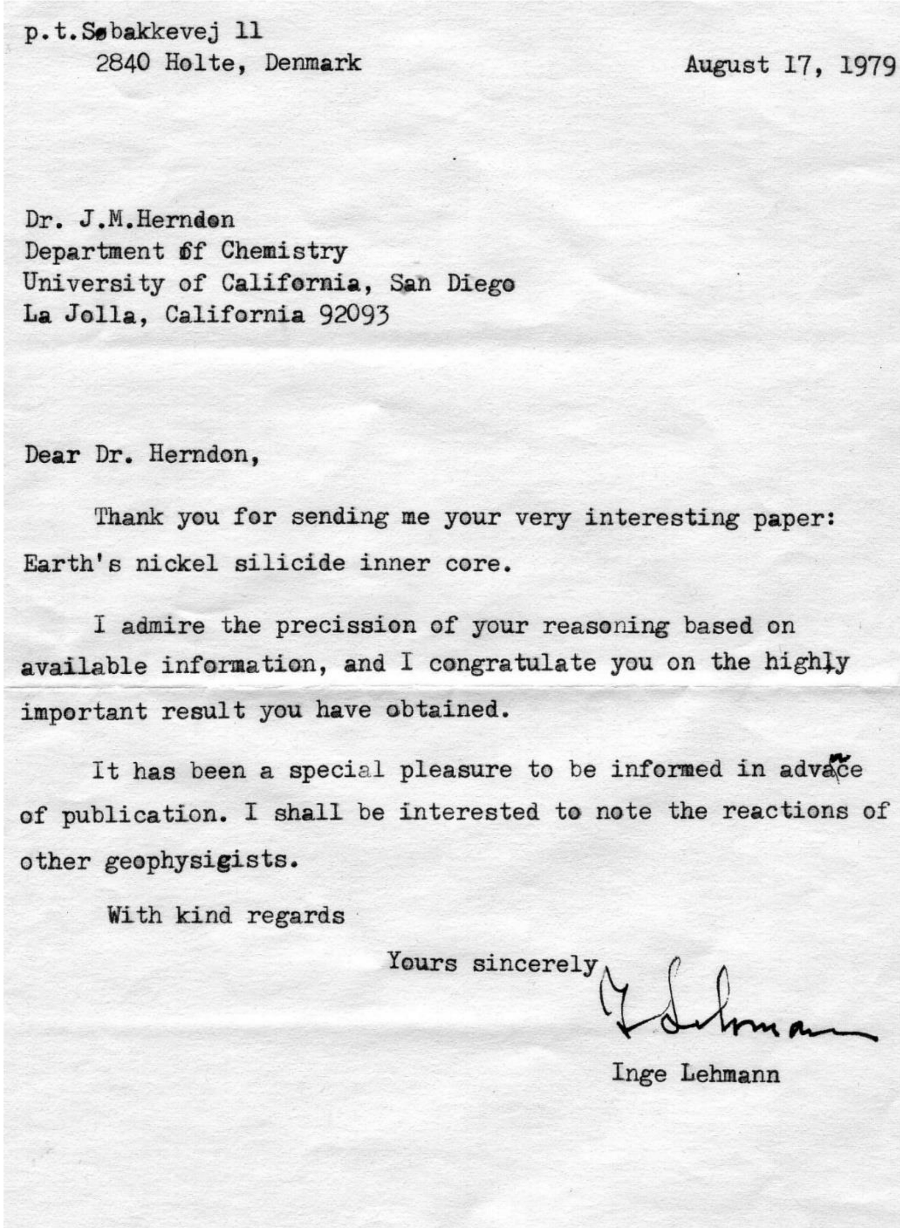
From observations of nature the suggestion is made that the inner core of the Earth consists not of nickel–iron metal but of nickel silicide.

Contemporary understanding of the physical state and chemical composition of the interior of the Earth is derived primarily from interpretations of seismological measurements and from inferences drawn from observations of meteorites. Seismological investigations by Oldham (1906), Gutenberg (1914) and others helped to establish the idea that a fluid core extends to approximately one half the radius of the Earth. The existence of a small, apparently solid inner core at the centre of the Earth was recognized by Lehmann (1936) from interpretations of

Figure 2: From [29].

Figure 3 is a scan of a complimentary letter I received from Inge Lehmann in which she expressed interest in the responses of other geophysicists.



p.t.Søbakkevej 11
2840 Holte, Denmark August 17, 1979

Dr. J.M.Herndon
Department of Chemistry
University of California, San Diego
La Jolla, California 92093

Dear Dr. Herndon,

Thank you for sending me your very interesting paper: Earth's nickel silicide inner core.

I admire the precission of your reasoning based on available information, and I congratulate you on the highly important result you have obtained.

It has been a special pleasure to be informed in advance of publication. I shall be interested to note the reactions of other geophysigists.

With kind regards

Yours sincerely

Inge Lehmann

Figure 3: Letter from Inge Lehmann to the author.

When an important new scientific contradiction arises, members of the relevant scientific community should try to refute the contradiction on a sound scientific basis. If unable to do so, they should cite the concept in subsequent relevant publications. That way others may learn and possibly advance the science.

While awaiting publication of my nickel silicide inner core concept [29], I imagined that there would be debate and discussion, as there should be. Instead, there was silence. It was as if the paper had never been published. That work was ignored and has been ignored for four decades, as evidenced, for example, by Li et al.'s 2020 paper [30] and He et al.'s 2022 paper [31].

Birch [32] provided a lengthy discussion of the importance of meteorites and lamented on the difficulty of determining which of the many diverse meteorites are a match for Earth's composition. I discovered how to circumvent that difficulty by relating by mass ratios mineralogically determined parts of meteorites to parts of the Earth determined from seismological and moment of inertia considerations (Table 1 from [33] in Figure 4).

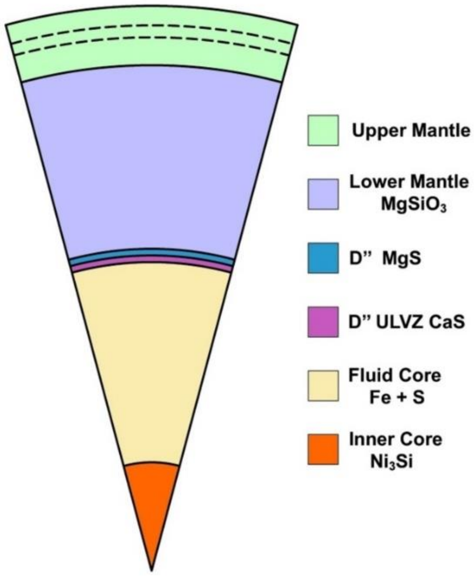


Table 1. Comparison of fundamental Earth mass ratios with corresponding ratios for the Abee enstatite chondrite

Fundamental Earth Ratio	Earth Ratio Value	Abee e.c. Ratio Value
Lower Mantle Mass to Total Core Mass	1.49	1.43
Inner Core Mass to Total Core Mass	0.052	theoretical 0.052 if Ni_3Si 0.057 if Ni_2Si
Inner Core Mass to Lower Mantle + Total Core Mass	0.021	0.021
D'' CaS + MgS Mass to Total Core Mass	0.09	.011
ULVZ of D'' CaS Mass to Total Core Mass	0.012	0.012

Figure 4: Schematic representation of the parts of the endo-Earth (lower mantle plus core) derived from the mass ratio relations shown in Table 1 at right. For details and references, see [33].

Connecting the interior of Earth to an enstatite chondrite (Table 1) [33-36] and the highly-reduced composition of that enstatite chondrite to its parent matter having condensed from solar matter at high pressures, 1 to 1,000 atmospheres [37], connects Earth to similar high-pressure protoplanetary origin [38-40].

For more than four decades, the geoscience community has systematically ignored the consequences that began and logically followed from my nickel silicide inner core concept [29], and instead has been stuck in an intellectual cul-de-sac, unable to make sense of the plethora of species extinction data.

CRUCIAL BACKGROUND

Earth formed by raining out from within a giant gaseous protoplanet [38, 39]. Molten iron, along with elements dissolved in it, first condensed to form Earth's core. Next, the lower mantle constituents condensed, followed by protoplanetary remains that included 300 Earth-masses of ices and gases. In the final stages a component of more-or-less undifferentiated planetesimal matter in-fell. At the end of this process Earth resembled Jupiter [40].

When the sun ignited, its violent T-tauri solar winds stripped-away the gases and ices, leaving behind a rocky planet about two-thirds the diameter of present-day Earth that was entirely covered by a continental rock shell, but contained two powerful energy sources. The stored energy of protoplanetary compression, by more than a factor of 10, is the greater energy source. The other energy source is a nuclear fission reactor at Earth's center called the georeactor. Virtually all geophysical and geological activity on Earth, including surface geology, production of the geomagnetic field, and the connection between the two, is driven by these two energy sources [18, 33, 41-62].

After being stripped of its gases and ices by the violent solar wind produced during thermonuclear ignition of the sun, over time Earth began to decompress. My new paradigm, *Whole-Earth Decompression Dynamics*, describes the geological and geophysical consequences of Earth's decompression [39, 44, 45, 50, 58].

The stored energy of protoplanetary compression is the primary energy source for decompression. However, for decompression to progress without cooling and impeding decompression, the lost heat of compression must be supplied by georeactor nuclear fission and radioactive decay energy. In addition to doing work against gravity by increasing Earth's radius, the stored energy of protoplanetary compression heats the base of the crust by a process known as *mantle decompression thermal tsunami* [47]. Decompression beginning within Earth's mantle propagates outward like a wave through silicates of decreasing density until it reaches the rigid crust where compression and compression heating takes place. That compression heating is the heat source for the geothermal gradient as well as for other surface phenomena including shallow-source volcanoes.

In addition to replacing the lost heat of protoplanetary compression and powering the geomagnetic field, georeactor fission-produced heat is channeled to the surface along with its signature helium isotopes, forming deep-source volcanoes. Examples of these include the Hawaiian Islands and Iceland [63], Deccan traps [64] and Siberian traps [65].

During Earth's decompression its surface area must increase and its surface curvature must adjust. As described by *Whole-Earth Decompression Dynamics*, during decompression Earth's surface area increases by the formation of decompression cracks, *primary* decompression cracks are underlain by heat sources that extrude basalt which eventually falls into and fills *secondary* decompression cracks that are devoid of underlying heat sources. This process is responsible for the topography of the ocean floors. Indeed, all ocean-floor evidence arrayed to support plate tectonics supports *Whole-Earth Decompression Dynamics*, which does not require physically-impossible mantle convection.

Mid-oceanic ridges are examples of the primary decompression cracks. Circum-Pacific trenches are examples of secondary decompression cracks. Oceanic troughs, inexplicable in plate tectonics, are partially in-filled secondary decompression cracks.

The mechanism responsible for changes in Earth's surface curvature during whole-Earth decompression, illustrated in Figure 5, primarily results in the formation of mountain ranges characterized by folding [50, 60] and secondarily results in the formation of fjords and submarine canyons [53].

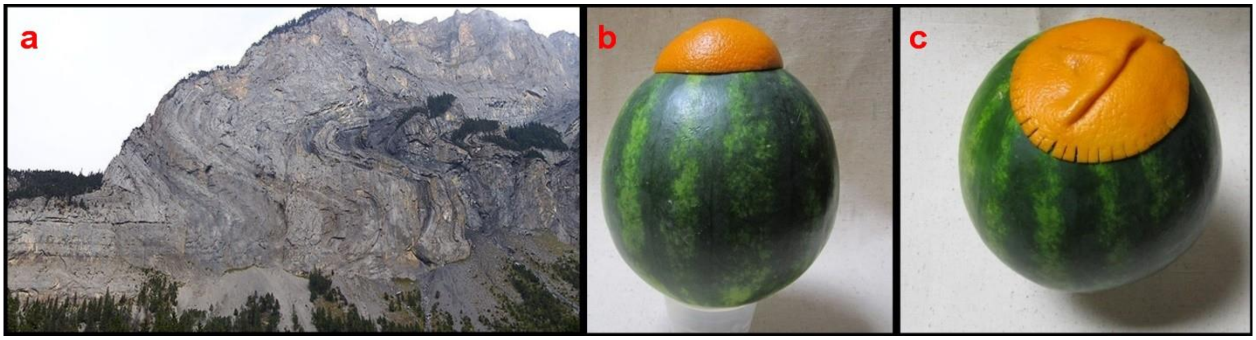


Figure 5: (a) Example of mountain folding; (b) The necessity for surface curvature changes during whole-Earth decompression. The un-decompressed Earth is represented by the orange; the larger, decompressed Earth, is represented by the melon. Note the curvatures do not match; (c) Two causally-related curvature-change mechanisms naturally result in surface curvature change, namely, major curvature adjustment by folded-over tucks, minor curvature adjustment by continental-perimeter tears. From [60].

When Earth's core rained out first from its giant gaseous protoplanet as a liquid, it contained some incompatible dissolved elements. Upon subsequent cooling, dissolved calcium and magnesium combined with sulfur and floated to the top of the core, nickel combined with silicon and precipitated to become the inner core. The densest element or compound, uranium, precipitated and settled by gravity to Earth's center forming the nuclear fission georeactor [41-44, 46, 48, 52, 54-56, 62].

In that micro-gravity environment, the uranium formed a two-component nuclear reactor. Nuclear fission in the central reactor sub-core produces convection in the charged particle rich nuclear waste sub-shell. Sub-shell convection coupled with rotation acts as a magnetic amplifier (dynamo) that amplifies to a grand magnitude an ambient magnetic field generated by the motion of charged particles from radioactive decay.

The two-component structure of the georeactor provides a natural means of self-regulation. The georeactor sub-shell consists of uranium and radioactive waste, namely, fission fragments and nuclear decay products which are reactor poisons. Hypothetically, if, in the microgravity region near Earth's center, the sub-shell components were of uniform density, the reactor poisons would consume a sufficient quantity of neutrons to prevent sustained nuclear fission. Uranium, the densest substance settles out and engages in nuclear fission, which disrupts the georeactor assembly. Eventually a steady state is reached wherein the amount of fission energy produced balances the uranium precipitation and the energy transferred to the inner core by convection [59], illustrated in Figure 6.

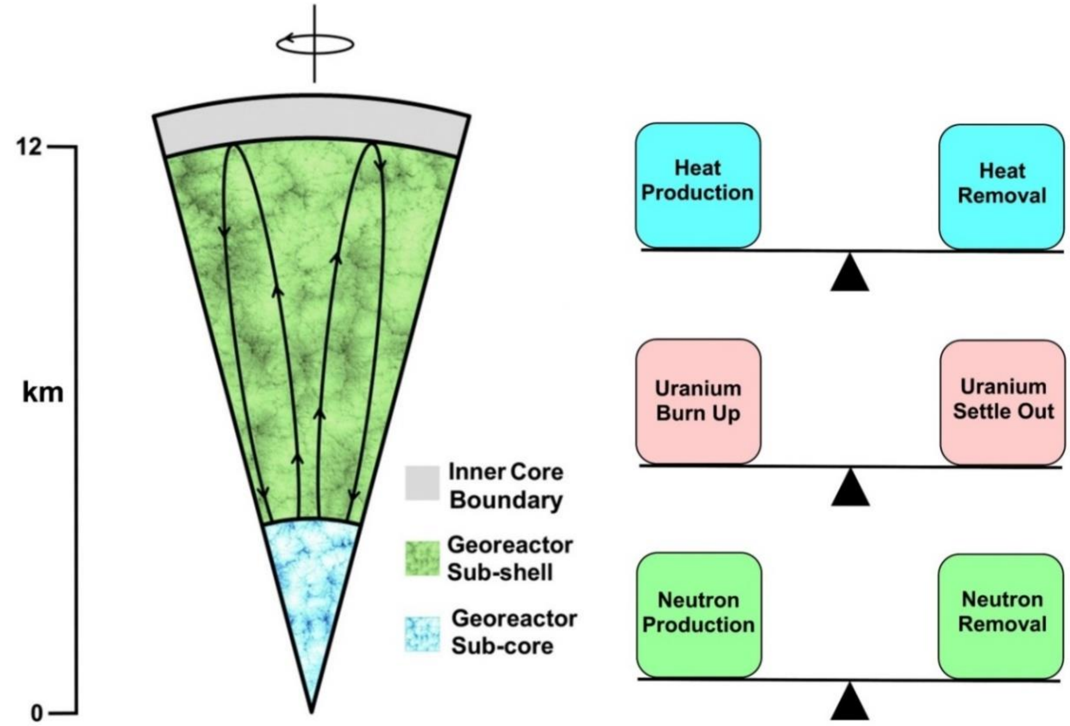


Figure 6: Right: Schematic representation of Earth's georeactor, not to scale, with non-resultant planetary and fluid motions indicated separately. Left: Representations of the balances that must be maintained for stable georeactor operation. From [59].

After being stripped of its protoplanetary component of ices and gases, Earth was about two-thirds its present diameter and completely enclosed in a contiguous shell of continental rock. As pressures began to build, Earth began to decompress by progressively fracturing its continental rock shell and in-filling the cracks with basalt, which progressively became ocean basins [45]. This is the fundamental basis for continental displacement. Concomitantly, Earth's surface curvature progressively adjusts to its greater diameter by forming tucks, which fall over forming mountain ranges characterized by folding, and to a lesser extent by forming peri-continental tears that become fjords and submarine canyons [50].

Heat-production by nuclear fission chain reactions in the uranium sub-core causes thermal convection in the sub-shell. This convection is not only responsible for generating the geomagnetic field by dynamo action involving Earth's rotation, but is the key to maintaining balances necessary for stable georeactor operation.

Convection efficiently transfers sub-core produced heat to Earth's inner core, a massive heat-sink that is surrounded by an even more massive heat-sink, its fluid core, which removes the georeactor produced heat and maintains the adverse temperature gradient (top cooler than bottom) necessary for stable sub-shell convection [66]. Sub-shell stirring by convection in this microgravity region is the principal mechanism for maintaining georeactor stable operation.

Sub-core heat produced by nuclear fission keeps most of the uranium repository mixed with neutron absorbers, preventing fission in the sub-shell. Uranium settles out from the converting neutron-absorbing mixture in the sub-shell to form the sub-core where nuclear fission takes place. Reduction in sub-core generated heat, caused by uranium burn-up, decreases convective stirring which allows additional uranium to settle downward from the sub-shell. This is a self-regulating mechanism. The less dense fission products, which are reactor poisons, settle upward to the sub-shell.

Georeactor produced heat, not only produces the geomagnetic field, but along with radioactive decay energy: (1) Replaces lost heat of protoplanetary compression which allows Earth's decompression to progress and (2) emplaces heat at the base of the crust [45, 47].

GEOPHYSICAL BASIS OF SPECIES EXTINCTION EVENTS

Figure 1 displays several geophysical events, except asteroid impacts, that appear to be coincidental with major species extinction events. In the following I explain a basis for understanding the connection between geophysical events and periods of mass extinction.

The geomagnetic field has been stable, without reversals, for periods longer than 20 million years [67, 68]. More frequent polarity reversals and excursions do occur and are indicative of external events that disrupt convection in the georeactor sub-shell.

The georeactor mass is about one ten-millionth that of Earth's fluid core. Consequently, major trauma at Earth's surface, such as an asteroid impact, can disrupt sub-shell convection in the georeactor. Sub-shell convection can also be disrupted by energy from changes in the solar wind transferred via the geomagnetic field into the georeactor by Faraday's law of electromagnetic induction [69] as I have described [59].

Although long suspected, recently published evidence points to activities on the sun provoking earthquakes [70-77] and volcanic eruptions [78, 79]. The mechanism, I posited [61], is a change in the charged particle flux impinging the Earth's magnetic field induces electric current into the georeactor, which causes ohmic heating, which disrupts sub-shell convection, which results in extra uranium settling-out, which causes a burst of nuclear fission energy, which replaces some of the lost heat of protoplanetary compression, which causes a burst in whole-Earth decompression, which results in a burst of heat emplaced at the base of the crust and/or Earth's surface experiencing a bit of decompression-driven movement, the extent of which is a function of the degree of sub-shell convection disruption.

The cause of the coincidences, shown in Figure 1, related to major extinction events, I posit, is of similar, but more intense, origin. Major trauma to Earth's surface, such as by asteroid impact, or major change in space weather causes major disruption of georeactor sub-shell convection with concomitant release of abnormally large amounts of nuclear fission energy, which releases great quantities of stored protoplanetary energy, which results in a burst of planetary decompression, which splits the continental crust and opens new ocean basins. Other geodynamic activity also may occur, such as massive basalt floods, and inevitably geomagnetic reversals or excursions.

Splitting the continental crust and opening new ocean basins lowers global sea levels and exposes the ocean water to the reduced minerals, such as arsenopyrites, that lie beneath the oxidized surface regions. Presumably, these substances alter ocean chemistry and contribute to the extinction of marine species.

Although the five major extinction events correlate with other geological data, such as with major basalt floods, as shown in Figure 1, other data are lacking. For example, the Deccan traps and the Siberian traps, appear to be related to the extinction events at 65.5 and 250 MYA respectfully, not only temporally, but by being connected by magnetic reversals and georeactor-produced occluded helium. However, somewhere else continental crust was being split and new ocean basins were opening. By extension, one might conclude that several environmental catastrophes may be involved in any given extinction event, but all are driven by the mechanism disclosed here.

CONCLUSIONS

When navigating to a series of addresses in London, members of the geoscience community should have been trained to correctly read and use a London city map.

Present understanding of Earth science by the geoscience community is badly flawed. Since 1940, geoscience has been built upon a flawed foundation. I have set forth a more correct foundation that makes it possible to understand the processes that have contributed to the geological development of our planet. It is helpful to use geomagnetic reversals as global reference points, for example [80].

In this work I have not attempted a detailed recitation of the various factors engaged in major species extinction events. Rather, I have disclosed the underlying mechanism that is the foundation for essentially all major species extinction events, except the ongoing anthropogenic-caused species extinction [81]. Understanding this mechanism may be helpful in preparing for the next geomagnetic reversal or excursion, which may have devastating consequences for our technology-based civilization [54].

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