The Biblical Chronologist

WHAT HAS BEEN IS REMOTE AND EXCEEDINGLY MYSTERIOUS. WHO CAN DISCOVER IT?
(Ecclesiastes 7:24)

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I wrote the first draft of the following article over two years ago. The urgency, dictated by ethics, of research into human aging prevented its completion. The recent discovery that human aging is a two-phase syndrome of three diseases[1] *has only intensified the urgency of further aging research. The pressing need now is to understand Aging 2 disease. My preliminary forays into this new area have so far suggested that gaining the needed understanding of Aging 2 will not be a trivial exercise. So, finding a brief lull in my workload, I have opted to quickly finish this article now and bring it to publication before it becomes permanently neglected.*

The article presents a unified solution to four origins problems in geophysics: the origin of plate tectonics, the origin of antipodal hotspots, the origin of earth's (reversing) magnetic field, and the origin of the moon. To me, this unification displays a pleasing esthetic quality which I am hopeful others may similarly perceive and enjoy.

My research into Noah's Flood is the inspiration for the present article. The article draws freely from my book, Noah's Flood Happened 3520 B.C.,[2] *in its discussion of plate tectonics, antipodal hotspots, and earth's magnetic field. Discussion of the origin of the moon and of evidence from Venus is here presented for the first time. In contrast to the book, which majors on the fact that Noah's Flood happened in real history, the present article concerns itself principally with matters of virtual history in proleptic time.*[3]

Inner Core Instability and the Origin of Plate Tectonics, Antipodal Hotspots, Earth's Magnetic Field, and the Moon

The idea that earth's inner core resides stably at the center of the earth seems generally to be taken for granted, but several longstanding problems in geophysics find natural solutions when instability is assumed.

The cause of plate tectonics is an example. The slow movement of plates over the surface of the globe is a fact of modern earth science, but the root physical cause of this motion—the driving force behind plate tectonics—continues to be wondered at and debated.

Preference seems to rest at present with the idea that the weight of a subducted plate edge drags a plate across the surface. But it is recognized that even if this is true, some other mechanism is needed to get plate motion started to form subduction zones in the first place.

Why should the earth have plates rather than just a continuous solid shell? Why should these plates be actively moving about? The purpose of the present article is to show that the idea that the inner core may not reside altogether stably on center provides simple, natural answers to these, and other, longstanding geophysical questions.

Inner Core Instability

Initial Displacement From Center

How might earth's inner core be displaced from its usual central position, and what might its mo-

[1] Gerald E. Aardsma, "Human Aging is a Two-Phase Disease," *The Biblical Chronologist* 10.8 (May 13, 2020): 1–10. www.BiblicalChronologist.org.

[2] Gerald E. Aardsma, *Noah's Flood Happened 3520 B.C.* (Loda, IL: Aardsma Research and Publishing, 2015). www.BiblicalChronologist.org.

[3] Virtual history and proleptic time are introduced here: Gerald E. Aardsma, "A Unification of Pre-Flood Chronology," *The Biblical Chronologist* 5.2 (March/April 1999): 1–18. www.BiblicalChronologist.org.

tion be once displaced? Seeking answers to these questions, I investigated the motion of outer core fluid resulting from imposition of a small, uniform acceleration applied to the crust and mantle.[4]

To make headway in a reasonable allotment of time, the problem had to be simplified.

First, the geometry of the problem was simplified by treating the surface of the core-mantle boundary as a perfect sphere. This permitted use of spherical coordinates, greatly simplifying mathematical definition of boundaries and boundary conditions.

Next, earth's rotation was excluded from the problem. This neglects the Coriolis and centrifugal fictitious forces. These should be unimportant in the present instance because the initial displacement of the inner core from its usual position on center (i.e., at the origin) is the only interest at this stage. This simplification allowed the problem to be tackled in two dimensions rather than three.

Third, the solid inner core was replaced with outer core fluid, enabling the entire core to be treated as a homogeneous fluid. The initial density of the fluid was set everywhere equal to the total core mass divided by the total core volume. This simplification allowed fluid motion to be explored apart from gravitational effects.

Even though the density of the fluid had been set everywhere to the average core density, I chose to solve the compressible fluid problem rather than the incompressible fluid problem. This approach was attractive because a simple equation of state for the fluid could easily be derived from Preliminary Reference Earth Model (PREM) data.[5] The motion of the fluid should be insensitive to whether the fluid is treated as compressible or incompressible according to dimensionless variable analysis.[6]

Setting Up the Simplified Problem

The earth was pushed northward by a force applied at the South Pole in the numerical simulation. Thus the earth was propelled to the north.

At time zero, the acceleration was turned on.

Keeping things as simple as possible, the acceleration was assumed to be constant with respect to time, yielding a constant acceleration of earth's mantle and crust.

The acceleration of the mantle-crust was, using Einstein's equivalence principle, treated as a reverse acceleration (a g field) acting on the core fluid with the mantle and crust stationary.

Finite difference (Navier-Stokes) equations were derived and implemented on a 10 by 21 polar grid in Fortran on a Windows DOS Pentium IV platform using gfortran via MinGW32 (specifically, tdm-gcc-4.7.1-2).

Viscosity and Acceleration

I chose a viscosity of 1×10^{10} Pa-s for the core fluid, and an acceleration of 1×10^{-10} m/s^2 for the mantle/crust. These specific values were chosen only to keep the calculation within the realm of the physically possible—more realistic values of viscosity and acceleration were impossible to specify at this point. The viscosity of outer core fluid, for example, seems at present to be among the most unknown of scientifically measured quantities. Summarizing 39 studies and four different measurement methods, Secco reported that, "Estimates of outer core viscosity span 14 orders of magnitude."[7] Values ranged from a minimum of 10^{-3} Pa-s to a maximum of 8.6×10^{11} Pa-s. The chosen values of viscosity and acceleration used in the present computer calculation were deemed relatively unimportant. The effect of these parameters is to control the rapidity with which motion of the core fluid develops, while interest was focussed solely on the form of the motion.

Result

Figure 1 shows the result of the computer calculation following ten days of constant acceleration at 1×10^{-10} m/s^2. A core-wide, toroidal circulation developed.

This motion of the fluid is transient. In steady state, for a constant applied acceleration, the fluid

[4]Gerald E. Aardsma, *Noah's Flood Happened 3520 B.C.* (Loda, IL: Aardsma Research and Publishing, 2015), 245–252. www.BiblicalChronologist.org.

[5]Stacey, Frank D., *Physics of the Earth* (Australia: Brookfield Press, 1992), 454–455.

[6]The Mach number, in this instance, is expected to be less than 10^{-3}.

[7]Secco, R. A. (1995) Viscosity of the Outer Core, in Mineral Physics & Crystallography: A Handbook of Physical Constants (ed T. J. Ahrens), American Geophysical Union, Washington, DC. doi: 10.1029/RF002p0218.

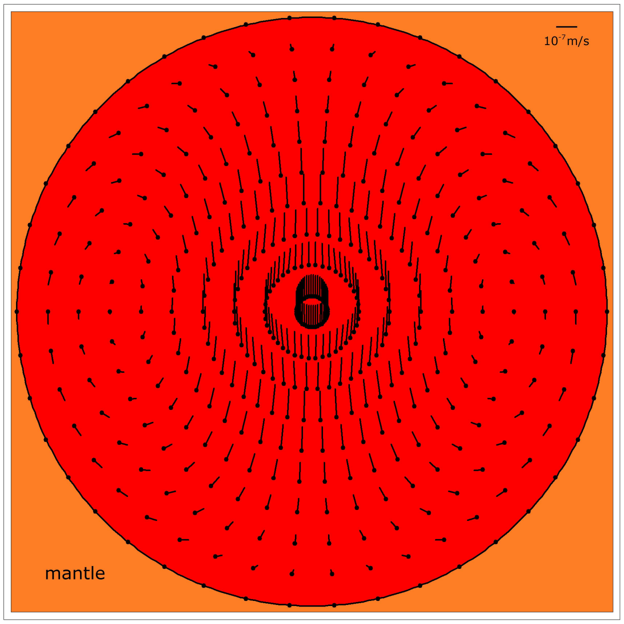

Figure 1: Computer simulation of outer core fluid motion resulting from acceleration of earth's mantle toward the north (i.e., upward). The toroidal flow apparent here is pictured in a stationary earth reference frame. Dots mark the grid points used in the finite difference calculation. Lines extending from the grid points show the directions and magnitudes of velocities of the fluid.

will obviously simply stratify horizontally, increasing in density from north to south. But to get to that steady state configuration, the fluid must first undergo the toroidal motion shown in Figure 1 when the acceleration is first applied.

This result showed that displacement of the inner core from center may be accomplished by viscous drag of outer core fluid resulting from a modest acceleration of the mantle and crust.

Interestingly, the inner core was not displaced toward the source of the acceleration, as naive considerations of the inner core's inertia alone might lead one to expect. Rather, it was accelerated in the same direction as the mantle was being accelerated, but with a larger acceleration even than the mantle.

Inner Core Motion

To solve the motion of the inner core subsequent to its initial displacement from center requires solution of the Navier-Stokes equations for a viscous, compressible fluid with moving boundaries. This is a difficult computational exercise which seems unlikely to be solvable in a reasonable length of time on a PC, but a tentative solution can be "seen" without explicitly calculating the motion.

Turn off the applied acceleration and follow the motion of the solid inner core in the stationary earth reference frame for a PREM earth. For ease of description, take the motion of the inner core to be vertically upward, as in Figure 1.

Because the restoring force acting on the inner core is zero when the inner core is on center, the viscous drag force will move the inner core upward, off center. Outer core fluid immediately above the inner core will then have moved into a region of lower pressure. As a result, it will expand. Meanwhile, outer core fluid immediately below the inner core will have moved into a region of higher pressure. As a result, it will compress.

A Positive Feedback Loop

If, for any reason, the rate of compression exceeds the rate of expansion, a runaway process seems likely to develop. Net compression of outer core fluid releases enormous gravitational potential energy. The outer core holds the mantle up against gravity. If the volume of outer core fluid reduces, then the mantle will fall inward. If the mantle falls inward, the inertia of this infalling matter will increase the pressure in the core. The increased pressure in the core will cause more outer core fluid to compress, further reducing the volume of outer core fluid. This will allow the mantle to fall farther inward. This is a positive feedback loop, fueled by gravitational potential energy, which will not stop until the outer core refuses to be compressed any further.

A possible reason why the rate of compression below the inner core may exceed the rate of expansion above the inner core, for a PREM earth, having initially homogeneous outer core fluid, is that pressure-induced precipitation of iron, yielding a relatively rapid reduction in fluid volume, is possible throughout the volume of liquid immediately beneath the inner core, while the reverse process is not possible for the liquid immediately above the inner core.

A Second Positive Feedback Loop

This first positive feedback loop fuels a second positive feedback loop. This second positive feedback loop forcibly ejects the inner core from center. Specifically, compression of outer core fluid beneath the inner core will accelerate the inner core away from center.

Pressure-induced precipitation of iron in the fluid volume beneath the inner core will cause the volume vacated by the inner core, as the inner core moves upward, to act as a sink for outer core fluid. There appear likely to be two consequences of flow into this sink, contributing to a runaway ejection of the inner core from center.

First, fluid falling into this sink will collide with the inner core, transferring momentum to it and driving it farther from center.

Second, flow of fluid into this sink will promote a core-wide fluid circulation. Symmetry says that this core-wide circulation will be predominantly toroidal. Thus the initial, acceleration-induced toroidal flow will be augmented and amplified by the flow of fluid into this sink. Since the inner core will be at the center of this torus, its displacement from center will be assisted by viscous drag due to this amplified circulation.

As the inner core moves farther off center, more volume will be vacated beneath the inner core, further enlarging the sink. More fluid will flow in to fill this vacancy, further amplifying the core-wide toroidal circulation and further driving the inner core from center. This runaway process will continue all the while the region normally occupied by the inner core is filling with outer core fluid.

Gravitational Collapse

The overall process may be thought of as a slight (but very real) gravitational collapse of the planet due to the loss from center of the usual inner core "foundation stone."

This collapse will necessarily be accompanied by rising pressures in the entire core, as mentioned above. As matter collapses (or falls) inward, it gains momentum. This momentum will be halted only by core pressures in excess of those pressures which are normally present maintaining hydrostatic equilibrium. These enhanced core pressures will exacerbate compression of outer core fluid, further accelerating the runaway process.

Ultimately, the inner core will be halted by collision with the mantle, core collapse will be subsequently halted by elevated core pressures, and a ponderous rebound of earth's diameter will begin.

Plate Tectonics

An explanation of plate tectonics now naturally emerges. To see how this works, imagine a stainless steel ball bashing about inside a spherical ceramic shell. What will this do? Fracturing of the ceramic shell is the most obvious expectation. For a strong enough collision, or for multiple weaker collisions, it is possible to fracture the ceramic shell into numerous pieces. Call these pieces "plates" and you have a basic answer to why it is that the earth should have plates to begin with.

Next, add in the inevitable squeezing together of these plates during the compression phase of a core collapse event. As earth's radius shrinks, its circumference must also shrink, and this provides both the energy and the opportunity needed for some plates to begin to be driven beneath other plates. Thus, core collapse events provide an initiation mechanism for plate subduction.

Finally, add in rebound of the earth. During the decompression phase of a core collapse event, the globe expands back to roughly its previous size. Plates now have a reason to pull apart from one another. But if one edge of a plate has been driven beneath a neighboring plate, it is likely to be somewhat stuck there. The plate's opposite edge is then likely to pull away from its neighboring plate. Thus core collapse events provide a simple explanation of divergent plate boundaries (i.e., mid-ocean ridges).

Said simply, plate tectonics is the expected outcome, in the broken, upper, solid shell of the earth, of repeated cycles of contraction and re-expansion of the whole earth resulting from core collapse events.

Antipodal Hotspots

To trigger core collapse, a modest acceleration of the crust and mantle is needed. In principle, either an asteroid impact or a large enough volcanic event might supply the needed acceleration. In either case, in a core collapse event, the inner core will impact the mantle on the opposite side of the globe from the trigger event (Figure 2). Thus, core collapse theory predicts the existence of antipodal hotspots.

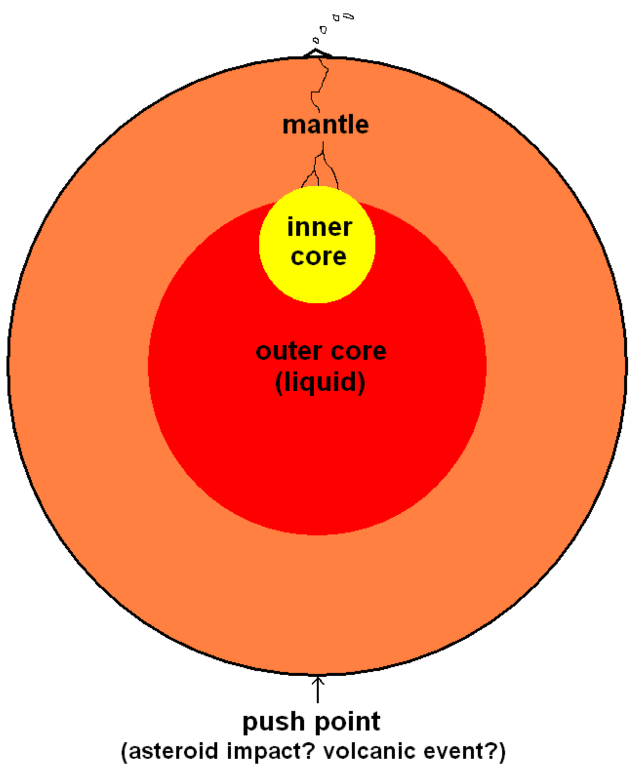

Figure 2: Conceptual diagram illustrating the expectation of antipodal surface features. Not to scale.

Instances of high-energy, antipodal surface features have been identified. Hagstrum has compiled a list of antipodal hotspot pairs.[8] He reports:

> Of 45 'primary' hotspots found in most hotspot compilations 22 (49%) form antipodal pairs within observed hotspot drift limits ($\leq$ 20 mm/yr). ...All hotspot pairs include at least one oceanic hotspot, and these are consistently opposite those hotspots related to large igneous provinces (LIPs) and continental volcanism.

[8]Hagstrum, Jonathan T., "Antipodal hotspots and bipolar catastrophes: Were oceanic large-body impacts the cause?," *Earth and Planetary Science Letters* 236 (2005): 13–27.

An example of a hotspot pair is Iceland – Balleny Islands. Iceland is one of the most volcanically active spots on earth today. Directly across the globe, off the shore of Antarctica, is Balleny Islands.

In each instance, the oceanic hotspot would be the push point. The antipodal LIP hotspot is a site where there has been a very large volume of lava poured out onto the surface. It would be due to energetic collision of the inner core with the underside of the mantle.

Apart from core collapse, a cogent explanation of the antipodal hotspot phenomenon is lacking.

Geomagnetism

The cause of earth's magnetic field has long been researched, but it is still not understood.

The electric currents responsible for earth's magnetic field are presently hypothesized to be sourced by fluid motions in the outer core. Outer core fluid is believed to be principally molten iron, which is electrically conductive. Interaction between this moving, electrically conducting fluid and existing magnetic field lines in the core is hypothesized to generate electric currents which produce the magnetic field. This hypothesis attributes the earth's magnetic field to a natural electric generator operating in earth's core. This natural generator is called the "geodynamo."

According to present scientific consensus, the geodynamo is due to convective outer core fluid motions. Convection is believed to be fueled in part by gravitational potential energy which is released by precipitation of iron from outer core fluid onto the solid inner core as the core slowly cools.

Core collapse events point in another direction entirely. They imply that, instead of a continuously operating geodynamo fueled by continuous convection of fluid within the core, earth's magnetic field is generated episodically by contraction and re-expansion of the core during a core collapse event. In the case of core collapse events, a simple Faraday induction machine generates the electric currents which give rise to the magnetic field.

Faraday's law of induction states that the electric current induced in a loop of wire by a magnetic field is proportional to the rate of change of total magnetic flux threading the loop.

Think of the core as made up of a large number of conducting loops or rings. These rings are all aligned perpendicular to and concentric with the north–south geomagnetic axis. They are all threaded by magnetic field lines from earth's magnetic dipole field. When the core contracts during a core collapse event, these rings all become smaller. Focus on one ring, say the equatorial ring. Magnetic field lines which had been inside this ring but out near its radius before contraction will, after contraction, be outside the ring.

Thus it is seen that the total magnetic flux inside each of these conducting loops will change with time during a core collapse event. This change of flux with time induces new electric currents in all the rings in accordance with Faraday's law of induction. These new electric currents generate new magnetic field.

A simple explanation of magnetic field reversals emerges. These result naturally from the fact that the net magnetic field will be the vector sum of the magnetic field induced in one direction by the compression phase, and the roughly equal magnetic field induced in the opposite direction by the decompression phase of the core collapse event. Which of these two fields is larger will appear to fluctuate randomly from one core collapse event to another, depending on details of the initial conditions and of the unfolding of the event. Thus, the polarity of the net magnetic field will appear to fluctuate randomly from event to event.

Core collapse appears to be to the geodynamo what relativity was to the luminiferous aether.

The Moon

Many summaries of now-defunct origin-of-the-moon theories can be found on the Internet. The long-favored Giant Impact Hypothesis seems also to be in trouble, leaving the origin of the moon without a cogent explanation at present.[9]

For many years prior to the advent of the Giant Impact Hypothesis, the Fission Hypothesis was popular. It was advanced by astronomer and mathematician George Darwin (son of Charles Darwin). Darwin's specialty was tidal phenomena, making it is easy to see how his Fission Hypothesis for the origin of the moon came about.

The moon raises tides in the oceans of the earth. The earth spins more rapidly than the moon revolves about the earth in its orbit. As a result, the oceanic tidal bulges pull on the moon, speeding up its orbit and slowing down the spin of the earth at the same time. This causes the moon slowly to recede from the earth, and it causes days to become longer on the earth.

Projecting this process back in time, one arrives at a point where the moon and earth are a single body, spinning much more rapidly than at present. Hence the idea that the moon was spun out of the earth, which is the essence of the Fission Hypothesis.

The Fission Hypothesis possesses a number of strengths. It displays an elegant theoretical simplicity, and it successfully predicts the measured similarity of earth and moon rocks, both chemically and isotopically. But it has one major problem. It violates conservation of angular momentum.

For a mass moving in a circle about a fixed center, centripetal acceleration is given by the equation

$$a_c = \frac{v_t^2}{R} \tag{1}$$

where v_t is the tangential velocity of the mass, and R is the radius of the circle.

For the earth–moon system under consideration, this centripetal acceleration is supplied by gravity. The acceleration due to gravity is $g = 9.8\ \mathrm{m/s^2}$ at earth's surface (i.e., at $R = R_e$, the radius of the earth). Thus, for a mass to leave the surface of the earth against gravity, v_t must exceed ($\sqrt{g \times R_e}$=) 7.9×10^3 m/s.

This tangential velocity corresponds to a day length of just 1.4 hours. Thus, for the moon to have been spun out of the earth, earth would have needed to have been spinning on its axis one complete turn every 1.4 hours.

According to the law of conservation of angular momentum, the angular momentum of the earth–moon system today should be the same as the an-

[9]Clery, Daniel, "Impact Theory Gets Whacked," *Science* 342 (11 October 2013): 183–185.

gular momentum of the earth–moon system at the moment of fission. But application of this law yields a minimum day length back when fission (hypothetically) happened of 4.2 hours, not 1.4 hours. This says that the earth was not spinning fast enough to spin off the moon back when the earth and moon (hypothetically) separated from each other.

To overcome this difficulty, it has been proposed that a nuclear fission explosion of a natural georeactor at earth's core-mantle boundary, early in earth's history, blew out the side of the earth, ejecting fragments of crust and mantle material.[10] In one illustrative hydrodynamic simulation of this process, the authors of this proposal show ejection into orbit about the earth of a moon-size fragment of mantle.

A core collapse event provides an alternative theoretical means of accomplishing this same end. It is possible that a core collapse event, rather than a georeactor, produced the explosion which resulted in formation of the moon. Call this the Core Collapse Hypothesis for the origin of the moon. It is experimentally distinguishable from the Georeactor Hypothesis in that it predicts the absence of georeactor nuclear fission products in lunar material.

The temperature of the inner core today is believed to be in excess of 5000 K. The boiling point of iron at atmospheric pressure is 3135 K. Thus, deep enough penetration of the mantle by the inner core will bring about explosive vaporization of the inner core as a result of reduced pressure. Heat of vaporization of an inner core the size of earth's present inner core would release enormous explosive energy—9×10^{28} Joules. Vaporization of outer core fluid and mantle material would contribute additional explosive energy. This works out well energetically. Reuver et al. have shown that 1.45×10^{29} Joules is sufficient for moon formation via a terrestrial explosion model.[11]

The Core Collapse Hypothesis for the origin of the moon postulates that the moon was formed as a result of a very early (possibly earth's first) core collapse event. At the early time in the formation of the earth when this core collapse event took place, the inner core was likely smaller, the mantle was hotter (and consequently weaker), and proto-Earth was spinning much faster than it is at present, producing a more oblate earth and weakening g at the equator. These conditions made deep penetration of the mantle by the inner core possible at that time. Deep penetration resulted in vaporization of the inner core and consequent explosion. Ejecta from this explosion, rather than a georeactor explosion, produced the moon.

Venus

The core collapse theory outlined above finds, for earth-like planets, a causal connection between plate tectonics, antipodal hotspots, planetary magnetism, and the existence of a moon. All four are caused by core collapse events, according to the theory. The simultaneous absence of all four of these manifestations of core collapse events in the case of Venus supports their connectedness.

This, in turn, supports the core collapse theory while raising the question of why Venus should lack core collapse events. Venus and Earth are similar in size and in composition, and Venus is expected to have a core which is similar to Earth's core.

A major difference between Venus and Earth is that Venus has no ocean. As mentioned above, all antipodal hotspots in Hagstrum's list have an oceanic hotspot, and these oceanic hotspots function as the push point, triggering inner core instability and core collapse. Because Venus has no ocean, oceanic hotspots are not possible on Venus. Without a push point, inner core instability will not be triggered and core collapse will not happen.

This suggests the further possibility that push points, such as Balleny Islands, may be episodic vents for deeply buried gas, such as primordial helium or helium from radioactive decay, these vents occurring in the ocean because of the thinness of oceanic relative to continental crust. Helium vented from the core-mantle boundary over a protracted period of time (many months) seems ideally suited to provide the sort of acceleration of the whole earth needed to trigger inner core instability and core collapse.

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[10] de Meijer, R.J., V.F. Anisichkin, W. van Westrenen, "Forming the Moon from terrestrial silicate-rich material" *Chemical Geology* 345 (January 4, 2013): 40–49.

[11] M. Reuver, R.J. de Meijer, I.L. ten Kate, and W. van Westrenen, "Boundary conditions for the formation of the Moon," *Netherlands Journal of Geosciences — Geologie en Mijnbouw* (December 2015): 1–9.

Conclusion

Core collapse events provide simple answers to several of geophysics' most difficult and longstanding questions. They explain the origin of plate tectonics, the origin of antipodal hotspots, the origin of earth's reversing magnetic field, and the origin of the moon. Core collapse theory finds the simultaneous absence of plate tectonics, antipodal hotspots, an earth-like magnetic field, and a moon in the case of Venus to be non-coincidental. It predicts that Venus' core will ultimately be found to be incapable of giving rise to core collapse events, possibly because of Venus' lack of an ocean.

Core collapse events on Earth are highly energetic and manifest globally in multiple energy-dissipating channels. They seem likely to be by far the planet's most deadly recurring natural hazard. I have previously shown that the biblically recorded Noah's Flood catastrophe resulted from a historical core collapse event, and I have named this category of natural disaster "Noahic Events" in honor of Noah, who was the first to have recorded eye-witness observations of a core collapse event.[12] ◇

The Biblical Chronologist is written and edited by Gerald E. Aardsma, a Ph.D. scientist (nuclear physics) with special background in radioisotopic dating methods such as radiocarbon. *The Biblical Chronologist* has a fourfold purpose:

1. to encourage, enrich, and strengthen the faith of conservative Christians through instruction in biblical chronology and its many implications,
2. to foster informed, up-to-date, scholarly research in this vital field,
3. to communicate current developments and discoveries stemming from biblical chronology in an easily understood manner, and
4. to advance the growth of knowledge via a proper integration of ancient biblical and modern scientific data and ideas.

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[12]Gerald E. Aardsma, *Noah's Flood Happened 3520 B.C.* (Loda, IL: Aardsma Research and Publishing, 2015), page 289. www.BiblicalChronologist.org.