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RESEARCH ARTICLE

HIGH CORRELATION BETWEEN MAJOR SURFACE EVENTS AND EARTH'S DISCONTINUITIES

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ABSTRACT

By the conventional theories on planetary formation, major discontinuities in the interior of a planet should mainly be the result of compositional differentiation or phase change of material correlated with pressure/temperature gradients. Once the planet is formed and events impacting the planet are of significantly lower energy than its own mass, no significant changes in mantle layers are expected. Exchange and recycling of material between the interior and surface of a terrestrial planet like Earth is assumed to occur through mantle plumes and processes associated with plate tectonics. Although life on surface can certainly be affected by these processes, any correlation between mass extinctions of life on surface and mantle discontinuities is conventionally unexpected and would be hard to explain. Here it is argued that correlation between temporal distribution of major surface events and spatial distribution of internal discontinuities may not be surprising, and evidence is provided that such correlation indeed does exist.

KEYWORDS

Extinction, Asteroid impact, Mantle, Discontinuity, Evolution.

1. Introduction

How much is known about the composition, structure and evolution of Earth? The average density of Earth, inferred from planetary motion and laws of gravity, is known to very good precision. Rough distribution of energy has been inferred from the moment of inertia, revealing a stronger concentration of energy about the centre. Astronomy (tidal interactions) also revealed that the mantle must be, on average, rigid. Seismic profiling revealed discontinuities, layering the Earth's interior. Details, however, are inferred from models and experiments based on certain assumptions in conventional theories on planetary formation - which are flawed, and inherently limited seismic observations prone to interpretation bias (Nayakshin, 2010). In other words, what is known for certain is very rough and of poor resolution. The models and established theories on planetary formation are relatively simple and distribution of events impacting a planet is considered relatively random, but what if the story is a bit more complex?

2. Background and Aim

Biotic and abiotic terrestrial systems both tend to contain layers. Discontinuities between layers are often associated with changes in the environment. This is as true for layers in sedimentary rocks as it is true for tree rings. Discontinuities in space are correlated with discontinuities in time and can thus be used to date events. Sometimes, however, internal discontinuities are not correlated with changes in the environment. In example, mixing soil in a glass of water will eventually result in layering, as heavier particles sink to the bottom and lighter ones concentrate on top. This is also assumed to be true in case of planetary formation. All ingredients are assumed to be already present early in the beginning and well mixed before differentiation. Over time, differences in mass and phase/chemistry with changing pressure/temperature result in layering.

Planets are thus modelled as simple abiotic systems. Development of biological systems (including tissue layering) is genetically coded to large degree, however, this coding is still correlated with environmental changes, albeit more with environmental changes experienced by past generations. If environmental changes are cyclic, this would allow for predictability of certain external events, which are then effectively locally genetically coded as well. On the scale of planetary systems, most changes are cyclic. Common extreme events which can affect a planet are asteroid impacts and, during formation, collisions with other massive bodies. What if seismic discontinuities in a planet, among other things, represent effectively genetically coded impactful events? If that is so, temporal distribution of major events impacting the surface could be correlated with spatial distribution of discontinuities in the planet's interior.

Note that this does not rule out the conventional interpretation of discontinuities, but it does allow for discontinuities not to have a conventionally assumed interpretation. Multiple valid interpretationsare also possible, and common, in nature. After all, different layers of biological tissue in organisms usually differ in composition and can be interpreted as a result of cell differentiation but it is also obvious that the density of layers is effectively coded or predictable (the specific density may be the result of some event in the evolutionary past that affected cell multiplication/differentiation). The effective genetic coding of a phase discontinuity would require effective genetic coding of the mass distribution of elements. Such coding is present in stars, where elements are locally synthesized from the lightest base (hydrogen) - mass distribution over time depends simply on the initial star mass. Effective coding of mass distribution in planets could be correlated with such coding in stars.

If one would model evolution of planets similarly to evolution of organisms, correlation between asteroid impacts and interior discontinuities may even be interpreted as natural selection. Earth, of course, is not a conventional organism and this wouldn't be a conventional natural selection. However, substantial evidence exists that Earth's

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surface discontinuity represents a complex self-regulating system in many ways analogous to self-regulating systems of complex organisms inhabiting that discontinuity. Does that similarity end at surface? The aim here is to present correlation between large surface impacting events and Earth's major internal discontinuities, showing that Earth as a whole is also probably more similar to an organism than assumed. After all, limits between biotic and abiotic systems cannot be well defined without bias, and ubiquitous self-similarity across different scales in a universe may not respect human distinction between abiotic and biotic phenomena.

It often does not. And this self-similarity doesn't show any limits, even the whole observable universe looks like a snapshot of something infinitesimally smaller - a human brain (Vazza and Feletti, 2020). In any case, various interpretations and mechanisms involved are possible for any correlation, including this one (some may even dismiss it as coincidence), however, although some possibilities will be briefly discussed, that is out of the scope of this paper (for the author's prediction and interpretation of correlations, see Appendix A).

3. Correlation and Discussion

To quantify the correlation, periods between major extinction events and thickness of Earth's mantle layers have been normalized:

$$T_n(i) = \frac{T(i)}{\sum_{j=1}^{N} T(j)}$$

$$D_n(i) = \frac{D(i)}{\sum_{j=1}^{N} D(j)}$$

where T(i) is the period between extinctions *i* and *i-1*, and $T_n(i)$ is the normalized period T(i). Similarly, D(i) is the thickness of a mantle layer between discontinuities *i* and *i-1*, and Dn(i) is the normalized thickness D(i). Results are shown in Table 1.

Table 1: Correlation between major mass extinctions (geologic periods) and mantle discontinuities (layers)

i	Geologic period T (My)	Normalized period T_n	Corresponding mantle layer thickness D (km)	Normalized thickness D_n
5	444 – 372 = 72.0	0.162	780 – 670 = 110	0.162
4	372 – 260.5 = 111.5	0.251	670 – 500 = 170	0.250
3	260.5 – 201.6 = 58.9	0.133	500 – 410 = 90	0.132
2	201.6 – 66.0 = 135.6	0.305	410 – 200 = 210	0.309
1	66.0 – 0 = 66.0	0.149	200 – 100 = 100	0.147

Mass extinctions are not instantaneous events, and, usually two years are associated with a particular extinction. In such cases, the average of the two is used in Table 1. The Late Ordovician mass extinction is considered to have occurred ~445-443 Ma, thus 444 Ma is used as the date (Harper, 2023). The Late Devonian extinction occurred about 372 Ma (Smart et al., 2023). The Permian-Triassic and the Capitanian (also known as end-Guadalupian) extinctions are both extreme events and are very close together on the geological timeline. Thus, instead of using both, only the date of one was used (Capitanian). The Capitanian extinction occurred 262-259 Ma, thus, 260.5 Ma was used for the date (Kaiho, 2022). The end-Triassic extinction occurred 201.6 Ma, while the Cretaceous–Paleogene extinction occurred 66 Ma (Kaiho, 2022).

These were then mapped to the following major mantle discontinuities: 670 km (average of 650-690 km, generally correlated with conventionally assumed phase boundary at 660 km), 500 km (conventionally assumed to be a result of splitting of the 520 km discontinuity representing a phase boundary), 410 km (assumed to represent a phase boundary), 200 km (possibly correlated with Lehmann Discontinuity, which globally varies between 200 and 250 km, but is reported at 200 km beneath North America and northwest Pacific, 100 km (Thybo and Perchuc, 1997) (8° Discontinuity, average oceanic lithosphere thickness, maximum subduction of continental lithosphere) (Rost and Weber, 2001; Vinnik et al., 2005; Vinnik et al., 2005; Schmerr, 2015; Deuss and Woodhouse, 2001; Niu and Kawakatsu, 1998). Based on correlation with these, a 780 km discontinuity was also hypothesized to exist.

A global discontinuity at that depth has not been detected, however, a small-scale regional reflector has (it will be discussed later whether this should have been left out) (Niu and Kawakatsu, 1998). As shown in the table, in all cases $D_n(i)$ is either equal or almost equal to $T_n(i)$, indicating very high correlation. Note, however, that using 445.2 Ma here instead of 444 Ma gives better or equal results for all periods except for *i=5*, as follows: 0.164, 0.250, 0.132, 0.305, 0.148. In any case, small deviation in correlation probably should be attributed to mantle instabilities, or oscillation/fluctuation of discontinuities over time. Small adjustment (by 1-3 km) of the two uppermost layers (discontinuities at 200 and 100 km) gives perfect correlation between all periods and associated mantle layers, as shown in Table 2.

Table 2: Correlation between major mass extinctions (geologic periods) and mantle discontinuities (layers), with slightly adjusted uppermost discontinuities

i	Geologic period T (My)	Normalized period T_n	Corresponding mantle layer thickness D (km)	Normalized thickness D_n
5	444 – 372 = 72.0	0.162	780 – 670 = 110	0.162
4	372 – 260.5 = 111.5	0.251	670 – 500 = 170	0.251
3	260.5 – 201.6 = 58.9	0.133	500 – 410 = 90	0.133
2	201.6 – 66.0 = 135.6	0.305	410 – 203 = 207	0.305
1	66.0 – 0 = 66.0	0.149	203 – 102 = 101	0.149

The above includes well established discontinuities in the mantle and major mass extinctions of the Phanerozoic, however, correlation doesn't end there. For example, thickness of layer 6 can be calculated assuming it is associated with the period between the start of the Phanerozoic ~538.8 Ma and the Late Ordovician boundary at ~445.2 Ma (Cohen et al., 2022):

$$\frac{T_6}{T_5} = \frac{D_6}{D_5}$$

$$D_6 = \frac{T_6}{T_5} D_5 = \frac{538.8 - 445.2}{445.2 - 372} 110 = 140.7\ km$$

In that case, assuming there was an impact 538.8 Ma, a discontinuity should exist at a depth of 780 + 140.7 = 920.7 km. Apparently, this discontinuity has been detected at 920 km, although it may not be global (Kawakatsu and Niu, 1994). Using 444 Ma instead of 445.2 Ma for the boundary yields a similar result (924.8 km). Some discontinuities show high global variation (eg. the 670 km discontinuity ranges from 650 to 690 km). In case of discontinuities assumed to represent phase boundaries, the variation is assumed to be a consequence of temperature variation, according to the Clapeyron slope.

However, the additional perturbation after initial boundary establishment can also be interpreted as mantle tissue gyrification, resulting in the increase in surface area of the layer (relatively equivalent to the gyrification of the brain mantle in mammals on Earth). As noted before, even if the conventional assumption is correct, multiple valid interpretations are common in nature. The whole Phanerozoic seems to be linearly mapped to the mantle, but to what depth is this time-space correlation valid? Assuming it is valid all the way down to the centre of Earth, using Earth's volumetric mean radius (6371 km), this would give for the age of Earth:

$$k \times (6371\ km - 102\ km) = \frac{538.8\ My}{920.7\ km - 102\ km} \times (6371\ km - 102\ km) = 4126\ My$$

where *k* (~2/3) is the factor of time/space proportionality. Although relatively close, this is a bit lower than conventional estimates of Earth's age. However, linear extrapolation (constant *k*) may be valid down to the inner core. Inner/outer core discontinuity, assuming inner core size of 1216 km, would then correspond to 3.33 Ga. Interestingly, this is equal to the current estimate on the rise of Earth's continents, and apart from extensive magmatism, can be associated with a large impactor 3.33 Ga (Choy and Cormier, 1983; Chowdhury et al., 2021; Gourier et al., 2019). The core/mantle discontinuity, assuming core size of 3486 km, corresponds to 1.83 Ga, which seems to be one boundary of the "Boring Billion" and could also be correlated with a large impactor - Sudbury crater, dated to 1.85 Ga (Hide and Malin, 1981; Peng et al., 2019; Davis, 2008).

Extreme events at 3.33 Ga and 1.8 Ga have also been recorded on the Moon (Giguere et al., 2020). Apart from Sudbury, the Vredefort crater may also be correlated with the outer core, although not the core-mantle boundary (CMB). Vredefort impact occurred about 2023 Ma, which would translate to a possible discontinuity at 3176 km. This is 291 km deeper than the CMB at 2885 km, however, it may be correlated with the recently detected toroidal region in the outer core (Ma and Tkalcic, 2024). Interestingly, while the above calculated age does not represent Earth's current age, that age can be obtained if one applies the temporal correlation to the lithosphere and atmosphere (up to the exosphere) as well. With atmosphere/exosphere discontinuity (thermopause) at 500 km, one obtains the age (Solomon and Roble, 2015):

$$k \times (6371\ km + 500\ km) = 4522\ My$$

This is within the uncertainty of Earth's estimated age of 4.54±0.05 Gy (Dalrymple, 1992). Considering that exosphere probably should not be considered as part of atmosphere, or, as intrinsic part of a planet (some smaller bodies in the Solar System, for example, have exospheres, but no dense atmosphere beneath), this may not be a coincidence either (although it is questionable whether the atmosphere itself should be considered intrinsic). Note, however, that the thermopause height varies, depending on energy input. Intense solar radiation can extend it far beyond the base of 500 km, up to 1000 km (UCAR, 2023). The value of k factor is also interesting, if fixed to 2/3, one obtains the age of 4.58 Gy.

3.1 Resolving Potential Issues

While the high correlation is apparent in presented matches, there are potential arguments against the used values. Why using Capitanian instead of Permian-Triassic, or both? In other words, why is Capitanian correlated with a discontinuity, while Permian-Triassic is not? The reason behind this is simply the very small temporal period between the events, making it unlikely that both were synchronized with a large impactor, and since impacts are probably required for a correlation with a discontinuity, it is assumed that only Capitanian was synchronized with a large asteroid impact event. One could then argue that a discontinuity at 520 km, rather than 500 km, should have been used in the comparison because it is present in more regions globally than the one chosen. In some regions, this discontinuity is present at 560 km, so the two (500 km and 560 km) discontinuities can be interpreted as "splitting" of the 520 km discontinuity (Deuss and Woodhouse, 2001).

However, that is just one interpretation. It is possible that for any large impactor an associated discontinuity should exist, and that major mass extinctions sufficiently far apart should be synchronized with such impactors. This does not rule out the existence of discontinuities uncorrelated with large impacts. One could ask why do grouped discontinuities exist? For example, why are there discontinuities at 500 and 560 km, instead of one global 520 km discontinuity? The reason for this may very well be impactors, in this case the Capitanian impactor, causing regional disruption of the 520 km discontinuity, or, perhaps global disruption of the 500 km discontinuity. Other discontinuity variations could be explained similarly. One could argue that, so far, only the Cretaceous–Paleogene has a confirmed impactor associated with the extinction. However, extensive volcanism – which is commonly interpreted as having a big role, could be associated with antipodal impacts (Hagstrum, 2005).

For example, the subglacial topographic depression in Antarctica known as Wilkes land anomaly (assumed to be a 510 km wide impact crater, which would make it the largest impact crater found on Earth, although a promising candidate for a bigger one exists was directly antipodal to Siberian Traps (largest known volcanic event in the last 500 million years) ~260 Ma, what is also the age of the Capitanian extinction. Siberian Traps are considered to be the primary cause for the Permian-Triassic extinction, largest mass extinction on Earth (Klokocník et al., 2018; Glikson and Yeates, 2022; von Frese et al., 2009). It is possible that the impact responsible for the Wilkes land anomaly occurred at the time of Capitanian extinction - evidence for that age exists, which resulted in the emergence of Siberian Traps (von Frese et al., 2009). The period of time between Capitanian and Permian-Triassic of ~8 My seems plausible for the emergence time considering the expected depth of melt associated with the seismically focused impact energy.

Here, volcanism likely results from induced lithospheric cracking and focusing of asthenospheric melt, as magma is less dense then the overlying mantle and crust. In any case, if impactors are correlated with discontinuities (or, disturbance of discontinuities), this can be experimentally verified, as regions of disturbance should be correlated with the impact site. Note that this antipodal relationship between impacts and volcanism is not limited to Earth, it is also common, for example, on the Moon and Mars (von Frese et al., 2009). Obviously, correlation becomes less striking by choosing different values for discontinuities that vary in depth, but overall remains significant - variations are concentrated near the values giving high correlation. Another potential issue is the inclusion of the 780 km discontinuity. All other values used can be correlated with well established global discontinuities, but this one represents a local reflector that may not have global presence (certainly not as a global discontinuity), and it is possible that many such local reflectors exist at various depths.

However, this depth has been predicted once other matches for major extinctions were established. Why is this discontinuity not global and should it be? This may require further research, but if correlation requires impactors one possibility is that during the Late Ordovician (~444 Ma) there were no large impactors involved in the extinction, although potential large impactors do exist - Deniliquin, Ishim (Glikson and Yeates, 2022; Zeylik and Seytmuratova, 1974). Another possibility is that impactor energy was low, as some correlation is likely to exist between impactor energy and the size of the discontinuity and/or the size of its disturbance (which does not imply, however, that discontinuities are formed at time of impacts). Also, it cannot be ruled out that the 780 km reflector represents remains of once larger discontinuity. In that case, the impactor energy may have been high but discontinuity may have been relatively unstable (as noted, potential large impactors that can be associated with this discontinuity do exist).

Late Ordovician didn't lack impactors, however. In fact, a pulse of elevated bombardment seems to have occurred in Ordovician. Evidence exists that this was a consequence of formation and subsequent destabilization of rings of debris about Earth. It has been hypothesized that these rings have been formed through the breakup of a large impactor, >10 km in diameter (Tomkins et al., 2024). Therefore, it seems that a large impactor was involved after all. Lack of the associated global discontinuity then could be correlated with its breakup and spreading of energy over space and time. Multiple ring-associated impacts have indeed occurred at or near the 444 Ma boundary (Tomkins et al., 2024). Note that the 780 km reflector has been detected under Mudanjiang, Heilongjiang Province in China, which has been at, or very close to, the equator in Late Ordovician. Impacts at the time were also concentrated at the equator (correlated with rings), any many were found at the opposite side of the world, near the antipodal location to Mudanjiang (Tomkins et al., 2024).

This seems to suggest that the reflector at 780 km depth has moved with tectonic plates, however, other explanations are possible. In any case, this should be further investigated by studying other such correlations. Why do correlations start at the 100 km discontinuity, not at Conrad, MOHO, surface, or some atmospheric discontinuity? Again, this can be explained by the proposed genetic coding, resulting in development qualitatively relatively similar to development and growth of living organisms on Earth. For example, tree rings are highly correlated with changes in external conditions (seasons) and their duration, however, this correlation starts below the crust (bark). In a tree, the bark contains the oldest tissue, the youngest is below it. Still, based on fossil records, one could argue that what's happening today is not even close to the destruction that occurred in the last 5 major mass extinctions. That is certainly true and it is possible that a 100 km discontinuity is inappropriate, however the current trends and rates of global changes strongly suggest we are on a path to a major global catastrophe. One could only question whether the tipping point has been reached or not, and if not, how likely it is that it won't be reached?

Furthermore, the lithosphere is a rigid layer of material and could be interpreted as the equivalent of a bone layer under the crust ectoderm (skin) enveloping the brain (or the equivalent of a bark layer in trees). Mantle below the lithosphere is not as rigid. Thus, in that sense, the chosen discontinuity seems appropriate. Similarities do not end there. Human neocortex has 6 layers and periods between 6 major extinctions here correlate with 6 layers in the Earth's upper mantle (the Phanerozoic aeon may thus be interpreted as a neocortex aeon). Human skull is composed out of multiple plates that have been stitched together during development. This can be compared to the lithospheric plates, which will eventually become stitched and fixed as well (like it probably has happened on Mars).

In any case, further research could verify some of the proposed explanations and the work could prove to be of scientific value even if the proposed hypotheses are rejected. The author, however, has found additional evidence for organismal-like development of Earth. Consider, for example, the Kleiber's law, which states that an animal's metabolic rate scales to the 3/4 power of its mass (Kleiber, 1932). This was found to be valid for most plants as well. The value may vary somewhat across species, but it is very accurate for mammals in general (Savage et al., 2004). Ingestion and growth rates in organisms also scale as the 3/4 power of mass (Kiørboe and Hirst, 2014). Treating terrestrial planets as organisms, the rate of evolution of life (or habitability) on them should be inversely proportional to planet's mass. Assuming the same exponent (3/4), 4.54 billion years of evolution on Earth would, on Mars, last:

$$T_M = \frac{(M_M)^{\frac{3}{4}}}{(M_E)^{\frac{3}{4}}} T_E = 852\ My$$

where M_M is Mars' mass of 0.642 × 10^{24} kg, M_E is Earth's mass of 5.972 × 10^{24} kg, and T_E is estimated Earth's age of 4.54 × 10^9 years (Konopliv et al., 2011; JPL, 2019; Dalrymple, 1992). Assuming Mars was formed roughly at the same time as Earth (reasonable assumption), present time on Earth corresponds then to 3.69 billion years ago on Mars. This is a very interesting result as studies show that Martian climate shifted from habitable to uninhabitable - when its atmosphere was lost and liquid water disappeared from surface, roughly 3.6 billion years ago (Kite et al., 2022). The same equation gives evolution period of 3.9 billion years for Venus, suggesting Venus lost habitability some 640 million years ago. Again, this is in good agreement with studies, which show that Venus lost habitability roughly 700 million years ago (Way et al., 2016; Europlanet, 2019).

Early habitability of Mercury cannot be ruled out either. For Mercury, the equation gives a period of 517 My, with its end corresponding to about 4.0 billion years ago. Interestingly, this is also the estimated age of the most heavily cratered terrain on Mercury and the end of the Pre-Tolstojan period (Denevi et al., 2018). If obtained ages are correct, this then suggests that Earth is about to lose its habitability as well. The topmost discontinuity in correlation (~100 km) then represents the end of habitability in the time dimension, or the end of evolution of life on surface. Why would that be the case? Well, again, it makes sense if Earth is interpreted as an organism. More precisely, it seems that evolution of life on surface (or, Earth's ectoderm) can be well explained and correlated with mantle layers if one treats it as a relative equivalent of [proto?] embryonic neurogenesis of organisms. Here, lifeforms on Earth's surface would represent the large scale equivalents of [precursor, or perhaps proto] neural cells/proteins, and possibly microbes.

3.2 Possible Requirements

The case of correlation of Capitanian (~260.5 Ma) and Permian-Triassic (~252 Ma) extinctions with discontinuities suggests that larger asteroid impacts should be directly correlated with discontinuities, while major mass extinctions could be correlated indirectly. However, asteroid impacts may be associated with all major mass extinctions sufficiently far apart. Capitanian and Permian-Triassic are very close on the geological timeline and two large impactors within such short period are unlikely. The above analysis suggests that the impact should be associated with the Capitanian extinction, while Permian-Triassic is a result of antipodal volcanism associated with the Capitanian impact. Large impactor and extensive volcanism are both confirmed for the Cretaceous-Paleogene extinction (66 Ma) (Ernst and Youbi, 2017). Evidence exists for the extensive volcanism in the Late Ordovician (~444 Ma) extinction and potential large impactors - Deniliquin, Ishim (Qiu et al., 2022; Glikson and Yeates, 2022; Zeylik and Seytmuratova, 1974).

Evidence for extensive volcanism correlated with the Late Devonian (372 Ma) extinction exists as well. Interestingly, flood basalt events are estimated at ~360 Ma, about 12 My later, which is consistent with the impactor at Late Devonian boundary considering expectable emergence time (Kravchinsky et al., 2002). Potential associated impactor or even multiple impactors, exist (Reimold et al., 2010; Morrow and Sandberg, 2005). Massive volcanic eruptions are considered as the main cause for the End-Triassic (201.6 Ma) extinction (Ernst and Youbi, 2017). Candidate impactors exist again, with the largest impactor (Manicouagan) reported some 12 My earlier, at ~214 Ma, which, however was not antipodal to the End-Triassic volcanism at the time, rather occurred at the same site (Hodych and Dunning, 1992). However, antipodal relation is not required for the impact to be associated with melts and large igneous provinces occurring on surface 8-12 My later.

Emergence at or near the site of impact should be possible as well, which may then be interpreted as a consequence of a reflection of the melt trigger (Jones, 2005). In case 214 Ma should then be used in the analysis (instead of 201.6 Ma), a discontinuity at 429 km instead of 410 km gives perfect correlation in Table 2, which is within the range of variation of ~405-440 km (Glasgow et al., 2024). Interestingly, a peak at 430 km has been detected below the Korean Peninsula and southwestern Japan, it is also the depth of the discontinuity beneath northeastern China, but it is unclear whether this could be correlated with the Manicouagan impactor (Lee et al., 2014; He, 2021). Large igneous provinces (LIPs) may commonly occur about 10±2 My after large impacts. Indeed, this seems to be the case for the Cretaceous-Paleogene (66 Ma) extinction as well, where LIPs associated with the birth of the Atlantic ocean (separation of Europe and America) occurred 10 My after the impactor, ~56 Ma. These were some of the most powerful volcanic eruptions in Earth's history.

This was also the age of the Palaeocene–Eocene Thermal Maximum (Berndt et al., 2023). However, unless there is no direct or antipodal relationship, or possible correlation in energy, LIPs may be hard to correlate with impacts, as they seem to occur relatively frequently, every 20-30 My (Ernst, 2021). Although most energy is focused on the site of impact and its antipodal location, large impactors will create strong earthquakes globally and may increase effective permeability of the existing deep magmatic systems. In other words, they can trigger or significantly accelerate volcanism at various locations where magma chambers and mantle plume "heads" already exist. Thus, even strong volcanism that is not at the antipodal location of the impact site of a particular impactor may still be correlated with it, and here the emergence time is probably likely to be much lower (100,000 years or less).

Indeed, this seems to be the case with the Cretaceous-Paleogene extinction, where the Chicxulub impactor provided a boost of energy responsible for at least 70% of the Deccan Traps, the Wai subgroup (Richards et al., 2015). A very interesting case is the discontinuity at ~100 km. If we are amidst a major mass extinction, and if such extinctions are correlated with discontinuities (directly or indirectly), a discontinuity about 100 km should exist (with other correlations being correct). This discontinuity does exist, however, there were no recent large asteroid impacts, although a potential candidate exists - Bowers, ~3 Ma, which, curiously, seems to have an antipodal hotspot, Jan Mayen island (Mikheeva, 2024). This, combined with the assumption of genetic coding, may suggest the impacts (or at least flood basalts) are about to come in relatively near future.

3.3 Significance

All sub-surface (or, sub-lithospheric) major seismic discontinuities have been correlated here with major events on surface, and this correlation seems to imply large impactors (asteroids and/or comets), although this may not be the sole requirement. Even if one considers alternative values for discontinuities exhibiting depth variation, significant correlation remains, even if not striking. And implied large impactors are rare. The Earth Impact Database lists only 6 confirmed impact craters with transient diameter ≥85 km (PASSC, 2023). Thus, the odds for this correlation to be a coincidence are low.

4. Conclusion

Apparently, high correlation can be found between major discontinuities in Earth and major events on its surface. Interpretations may vary, but this could have big implications for the understanding of Earth's nature and development, as the correlation is conventionally unexpected. Conventional interpretation of at least some discontinuities, composition and conditions of interior could be wrong. Analysis suggests that correlation probably requires impactors, in which case the study predicts impactors during the current mass extinction as it does seem to represent a major event. Further research could strengthen or weaken this hypothesis. Per the theory of the author (not presented here), such correlation should apply to terrestrial planets in general, although the space/time ratio in correlation should differ between planets of different mass. Follow-up works could then not only further validate it for Earth but also for other planets, such as Mars, once these are sufficiently explored (even if one rejects the hypothesis on mass extinctions on Mars, large impacts could be correlated with discontinuities).

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