

Empirical data support seafloor spreading and catastrophic plate tectonics

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Recent creationist literature has been filled with papers critical of catastrophic plate tectonics, even suggesting that a schism has divided Flood geology. Creation scientists who accept the validity of plate motion have been accused of 'naturalism' and have been labelled as 'remodellers'. However, creationist acceptance of plate tectonics does not entail any sort of acquiescence to naturalism. Six types of empirical data are presented which imply significant horizontal movement of coherent lithospheric plates during the Flood. Much of these data are independent of the secular geologic timescale, including heat flow in the ocean crust and seismic tomography data which illustrate the presence of subducted oceanic lithosphere within the mantle. Unfortunately, most of these data supporting catastrophic plate tectonics are rarely discussed by critics. In contrast, this paper suggests that the best explanation of all available geologic data supports rapid horizontal plate movement during the Flood. The catastrophic plate tectonics model further offers a mechanism for the flooding of the continents, the subsequent lowering and draining of the floodwaters, and a cause for the post-Flood Ice Age. The only 'schism' in Flood geology is one perceived by the scientists who fail to acknowledge all of the empirical data.

Several recent articles have been published in the creation literature that have been critical of plate tectonics (PT), and specifically catastrophic plate tectonics (CPT).¹⁻³ There has even been the suggestion of a 'schism' developing in Flood geology between the geologists who accept CPT and those who do not.⁴ Advocates of CPT have been labelled as 'remodellers' and have been accused of merely speeding up naturalistic processes like plate motion and nuclear decay.⁴ But as Ross has pointed out: "Labelling some creation geologists as holding a 'remodelled naturalistic approach', while wrapping themselves in the mantle of 'reconstructed biblical geology', is inaccurate and self-serving."⁵

For those that do not accept CPT as a mechanism, a different approach to creating a biblical geologic framework has been suggested. These creation scientists claim to be able to 'reconstruct' geologic history based solely "on an outline derived from the Bible",⁴ thereby liberating biblical history from geologic history, including the secular timescale and biostratigraphy. But, to date, only a generalized timescale has been developed within this 'reconstructed' biblical framework, and details from the vast majority of site-specific locations are still largely lacking.⁴

Part of the reason for the paucity of published, site-specific details on the part of the 'reconstructed' camp may involve their rejection of long-distance correlation methods. As Ross has stated:

"Moreover, the geological approach advocated by Froede and Akridge ['reconstructors'] applies models that seek to synthesize a global record of earth history while at the same time *necessarily* rejecting geologic correlation methods that could connect disparate geologic systems. How could such methods possibly succeed, when they discard necessary tools?"⁵

Furthermore, the 'reconstructed' camp has accused the 'remodellers' (advocates of CPT as a Flood mechanism) of accepting concepts and ideas derived from naturalism.⁴ But they have offered no clear evidence to back up this claim. To openly accuse other creation scientists of basing their scientific views on naturalism is completely unsubstantiated. Again, as Ross has pointed out: "Are we to assume that all of the descriptive geology published in the past three centuries is so deeply flawed that only fresh eyes of certain young-earth creationists can properly document these rocks?"⁵ How do these authors determine what constitutes empirical science based on naturalism from science not based on naturalism? Are we to ignore all scientific papers put forth by non-Christians and only accept research by scientists holding our own worldview? Science can be done by both secular scientists and by creation scientists.

Both camps claim miracles were necessary

Some members of the 'reconstructed' camp have also accused the remodellers of needing to invoke a series of miracles to explain CPT.^{4,6} They see such miracles as 'unshrunk cloth sewn onto an old garment' (Mark 2:21) and compare these miracles to an ill-conceived patch for a reluctant anti-biblical philosophy of history. Ironically, these same authors invoke their own set of miracles for geologic events when it serves their purposes and do not provide clear definitions or a clear explanation.^{4,6} Froede and Akridge (so-called reconstructors) have themselves admitted: "The application of miracles is a necessary part of defining biblical history. There are many geological events mentioned in the Bible that cannot be explained outside of 'miracles'."⁶

Froede and Akridge also call on miracles to initiate the Flood and to provide the source of the rain and as a reason for uplift of the continents at the close of the Flood.⁶ Why are these miracles justified yet others are not? Who is to judge whether a miracle is needed? Their claims that the rapid horizontal movement of the plates across the earth requires a miracle, that accelerated nuclear decay requires another miracle, and that global deposits require yet another miracle, are no different than calling on miracles to initiate the Flood as they themselves have done.⁶ Just because there are aspects of geology and CPT theory that are presently not understood is no reason to suggest miracles must be necessary to fill the gaps in our knowledge base.

There is no doubt miracles occurred during the Flood event as described in the Bible, but advocates of CPT do not simply invoke miracles at every ‘gap’ as suggested by Froede and Akridge.⁶ Many of the accusations of ‘miracles’ merely reflect our present lack of understanding and our incomplete scientific models and technology limitations. Plate tectonics, and in particular CPT, is a well-documented, working model that provides a Flood mechanism independent of a patchwork of repeated miracles. It serves as a framework to explain much of the geological data that has been collected for hundreds of years.

Does CPT explain every geological feature? Of course it does not. Does it rely on a strict adherence to the secular chronostratigraphic column so much so that it cannot be separated from it? I argue no, because there are many aspects of CPT that stand independent of biostratigraphy, radioisotope dating methods, and the timescale itself, some of which will be discussed below. Do all advocates for CPT agree on the same Flood/post-Flood boundary? Unlikely, but all agree that the observed geological data can be best explained by some type of rapid plate movement during the Flood year that separated the present continents. Exactly which days and how many days during the Flood this movement was in operation is unknown at this time.

Throughout this paper, I will assume naturalism is a godless philosophy that can be separated from true science. Science is a process that includes observation, empirical data collection, classification, and experimentation. Rocks can be identified based on mineralogy and texture. Thicknesses of rocks can be measured and the fossils in those rocks can be identified and recorded. Interpretation and worldview come into play when we postulate how and when those rocks arrived at that specific location. But the rocks and fossils are themselves factual data points. Admittedly, most of the historical earth sciences study non-repeatable events that happened only once in the past.

A short history of plate tectonics theory

Contrary to the claims of some of its critics,⁴ the theory of plate tectonics is not derived solely from naturalism but from empirical data collected over many decades by geologists and geophysicists. In the early 20th Century, Alfred Wegener used the fit of the continents and the match of fossils and mountain ranges across vast oceans to suggest that the continents had split in the past. These ideas were not accepted by the geological community at the time. Instead, his ideas were ridiculed and ignored. It was not until the 1960s, after immense quantities of oceanographic data were collected, and the publication of Harry Hess’s hypothesis of seafloor spreading⁷ and J. Tuzo Wilson’s early work on plate tectonics,⁸ that these ideas slowly became accepted. Nearly 50 years after Wegener first proposed the concept of continental drift, the secular community reluctantly acknowledged plate motion because they were overwhelmed with empirical data.

Throw out the baby with the bathwater?

Recent papers critical of PT and CPT¹⁻³ concentrate on rather insignificant and minor unresolved issues, such as small inconsistencies in plate boundaries and movement directions³ and/or reflect on misunderstandings of current research undertaken by those who support CPT.⁹ In the process, these authors have disregarded the bulk of the data that support PT and CPT. For example, Oard has been openly critical of using the results from over 2000 GPS receiver stations worldwide.¹⁰ He has claimed that these measurements cannot be extrapolated to plate movement directions.¹⁰ However, Baumgardner has shown (his figure 1) that these GPS stations have recorded uplift/subsidence and horizontal displacement details consistent with modern and past plate motions.⁹ In his response, Baumgardner explained: “Oard’s statement contradicts the clear conclusion these GPS

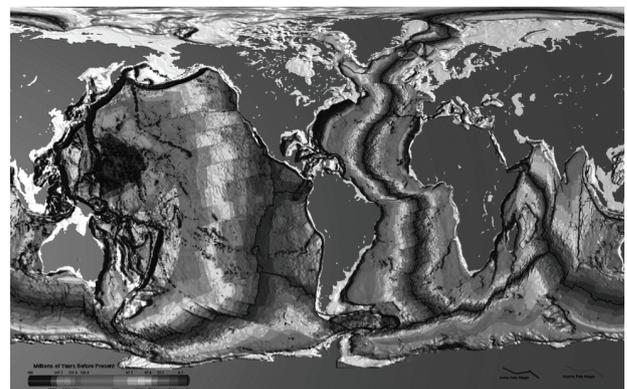


Figure 1. Map showing the age of the ocean crust from ‘Earth seafloor crust age 1996-2’

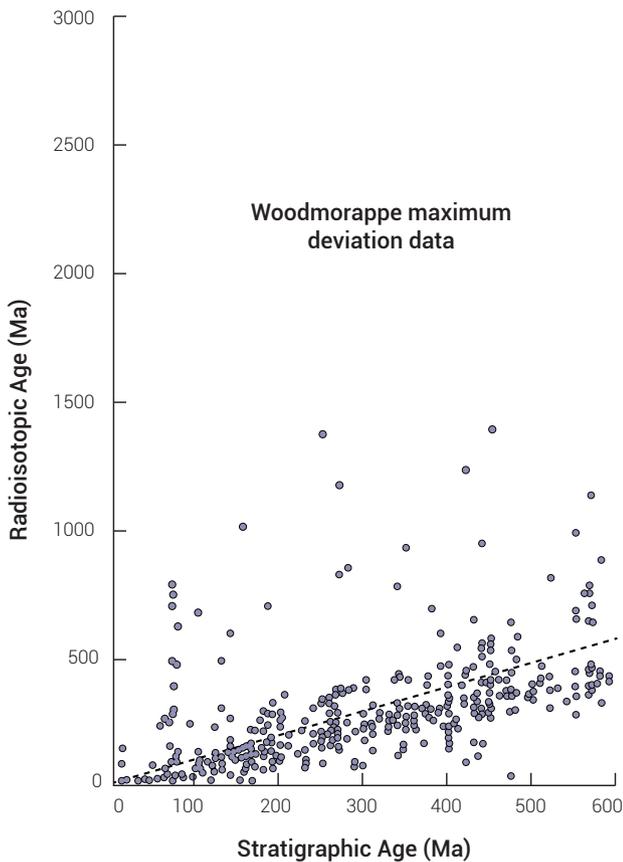


Figure 2. There is a fairly well-defined general agreement of absolute radioisotope ages and stratigraphic ages.

measurements so powerfully convey: that the plates indeed are moving in a coherent plate-like manner.”⁹

It was the information gathered from the study of the oceans in the 1950s, 1960s, and 1970s that unlocked the mystery of PT and eventually CPT. Oceanographic data clearly demonstrate a systematic increase in the age of the ocean crust (figure 1) with distance from the ocean ridges that cannot be disregarded merely because it involves absolute dating methods. As creation scientists we must not be found guilty of throwing out ‘the baby with the bathwater’ in this regard. In most cases, absolute dates have been shown to provide reasonable relative dates (figure 2),^{11–13} strengthening the argument that the ocean crust and lithosphere did indeed originate and spread from the ocean ridges in a systematic manner.

Although some have been critical of the relationship between absolute dates and biostratigraphic age,¹⁴ Baumgardner countered by writing:

“One of the important implications of the RATE research is that, while the dates which radioisotope methods give under the assumption of constant transmutation rates obviously cannot be correct, the relative dates from a large fraction of these

determinations nevertheless might well be valid.”¹¹

And he concluded with: “It is a tool we simply cannot afford to ignore.”

Oard’s criticism of the scatter in the data shown in figure 2 also was addressed by Humphreys.¹⁴ He explained that some of the scatter would be expected if accelerated radioactive decay had occurred.¹³ He postulated that rapid cooling of lava may occasionally lead to similar dates at vastly different stratigraphic horizons due to non-equilibrium conditions.

Empirical data that are independent of age dates

In addition to the age pattern observed for the ocean crust (figure 1), there is also a tremendous amount of supporting data that affirms seafloor spreading. Many of these data sets are independent of absolute dating methods. Consider for example:

- a. The temperatures recorded in the ocean crust and the heat flow measured near the ocean ridges show a systematic pattern of cooling with distance away from the ridges in both directions. Sclater and Francheteau originally defined a relationship between heat flow and distance from the ocean ridge back in 1970 that still holds today.¹⁵ This empirical data set is not dependent on any dating methods, absolute or relative.
- b. The ocean topography also reflects the age distribution and the heat flow pattern of the crust beneath. The elevation of the seafloor is highest near the ridges (where it has the highest heat flow) and drops off systematically with distance in both directions. Sclater and Francheteau, again back in 1970, initially demonstrated this relationship by simply plotting bathymetry data against distance from the ridge, not against age of the crust.¹⁵ This data set is again independent of any age dates.

The magnetic reversal ‘stripe’ pattern shows symmetry on each side of the ocean ridges, supporting simultaneous seafloor spreading outward in both directions from the



Figure 3. Bathymetric map of the seafloor showing clearly defined ocean ridges in every ocean. The ridges circle the globe twice and are the source of new ocean crust.

ridges. Critics have pointed out inconsistencies in this data set³ but the overall pattern is still readily observed in the magnetic profiles recorded on either side of the ocean ridges. The overall symmetry to this data cannot merely be dismissed. The patterns initially observed by Heirtzler et al. for the ridge south-west of Iceland show a near-perfect symmetry for 200 km in both directions about the ridge.¹⁶ Vine remarked: “This finding, together with the symmetry and linearity of the magnetic anomalies about the Juan de Fuca and Gorda ridges, recently described by Wilson, provides convincing confirmation of the two most obvious corollaries of a literal interpretation of the Vine-Matthews hypothesis: (i) linear magnetic anomalies should parallel or subparallel ridge crests, and (ii) for many latitudes and orientations the anomalies should be symmetric about the ridge.”¹⁷ The raw magnetic anomalies are based only on distance from the ridges and not on age dating of the rocks themselves.

- c. The very presence of the ocean ridges suggests a common origin by seafloor spreading. Ocean ridges are found in every ocean of the world (figure 3). The ridge system extends 70,000 km from ocean to ocean, connecting across all of the seas. They consist of huge, linear mountain chains rising 3,000 m above the abyssal plains with a rift valley at the centre, actively spewing out basaltic magma yet today. There is no ocean today that exists without a ridge system.
- d. The correlation of oils from Brazil and West Africa show demonstrable similarities when the continents are reunited (figure 4).¹⁸ The unique geochemical signature in the oil families found on opposite sides of the Atlantic, when reunited, show an unmistakable match that can only be explained by later plate movement. The geochemical differences found in the oils from north to south along the coasts depend on the uniqueness of the source rocks themselves and not the perceived age of the rocks. These data indicate similar source rocks were deposited at different locations up and down the coasts of both continents that were later separated by plate motion.
- e. The internal images of the mantle (tomography) show visible lithospheric slabs of oceanic crust going down

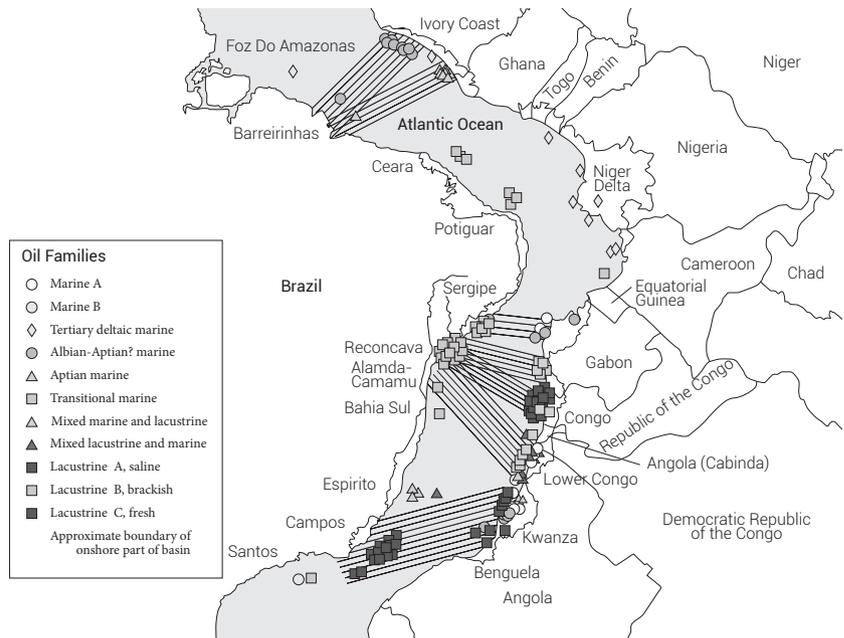


Figure 4. Map of the South Atlantic showing the correlation of families of oils and their similarities between Brazil and West Africa. The intervening Atlantic Ocean is reduced to illustrate the correlations. Although some ‘geologic time’ and ‘environmental interpretation’ is implied in the naming of the various oil families, the matching of geochemical signatures at each site from north to south, and across the Atlantic, is undeniable. Oil chemical signatures are independent of perceived geologic ‘age’ as they are based on chemical differences in liquid content regardless of rock unit. These data strongly support plate movement has occurred to separate these source rocks and these oils. (After Brownfield and Charpentier¹⁸.)

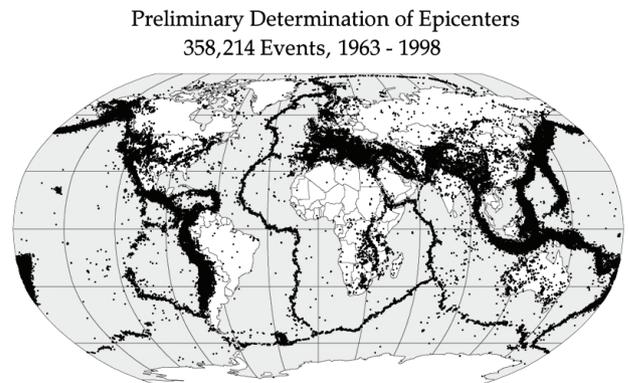


Figure 5. Map of earthquake epicenters from 1963–1998 showing the linear patterns that define the tectonic plates

hundreds of kilometres beneath ocean trenches and into subduction zones.¹⁹ These are not merely faults as some have proposed,²⁰ but 100-km-thick slabs of brittle, dense rock descending into the mantle.¹⁹ The cooler temperatures exhibited by these subducted slabs of rock create a thermal dilemma for the secular and old-earth geologists (traditional PT) who have to demonstrate how these slabs

have remained cold for millions of years. Colder, subducted slabs are best explained by runaway subduction just thousands of years ago during the great Flood.²¹

There is no other viable way to explain the ubiquitous presence of ocean ridges, the ocean heat flow pattern observed, the bathymetry pattern of the seafloor, the symmetry of the magnetic signals in the rocks surrounding the ridges, the match of the oil chemistry between Africa and South America, the seismic tomography showing the presence of subducted lithosphere, and the pattern of age of the crust other than seafloor spreading and plate movement. These data cannot be denied, ignored, or explained away as dependent on the chronostratigraphic timescale. Empirical data, independent of the chronostratigraphic timescale, demonstrate that the modern ocean lithosphere was completely created anew in conveyor belt fashion at the ridges, causing systematic spreading in both directions.

Catastrophic plate tectonics is not a naturalistic theory, it is a scientific interpretation of a plethora of factual data that conform to biblical history! There is nothing in the Bible

that precludes horizontal plate motion and seafloor spreading. Suggesting that creation scientists should merely dismiss the data as ‘naturalism’ is completely unjustified.

Scientists cannot pick and choose

How do the critics of CPT explain these data? In most cases, they do not address these data in their papers and in doing so either deny these data exist or dismiss the majority of these data as based on wholly naturalistic interpretations. Creation scientists cannot pick and choose the empirical data sets they want to use but should include all appropriate data sets in any Flood explanation.

CPT explains plate boundaries

The majority of the plates are well defined by maps of current earthquake activity (figure 5). Admittedly, there are still a few, small, unresolved micro-plates,³ and some of the modern plate movement directions may not be exactly as predicted.³ However, earthquake epicentres still clearly trace the boundaries of discernable and coherent lithospheric plates even today, nearly 4,500 years after most of the plate movement ceased. Further support for these plate boundaries is shown by the linear chains of volcanoes found along the edge of the Pacific plate, associated with the Pacific Ocean’s ‘ring of fire’. In addition, many of the major mountain ranges of the world also follow the edges of active plate boundaries, such as the Andes and Himalayas. These long linear chains of mountains run parallel, and in close proximity, to many of the convergent-style plate boundaries, explaining the reason for many of the world’s largest and deepest earthquakes.

Secular geologists admit they do not have all the answers to explain every aspect of PT. Likewise, many creation geologists who advocate CPT do not claim to understand all aspects of the theory either but accept it as a sound working model steeped in empirical data. Secular scientists and creation scientists alike debate how subduction is initiated²² and how the major continents originated,²³ but most

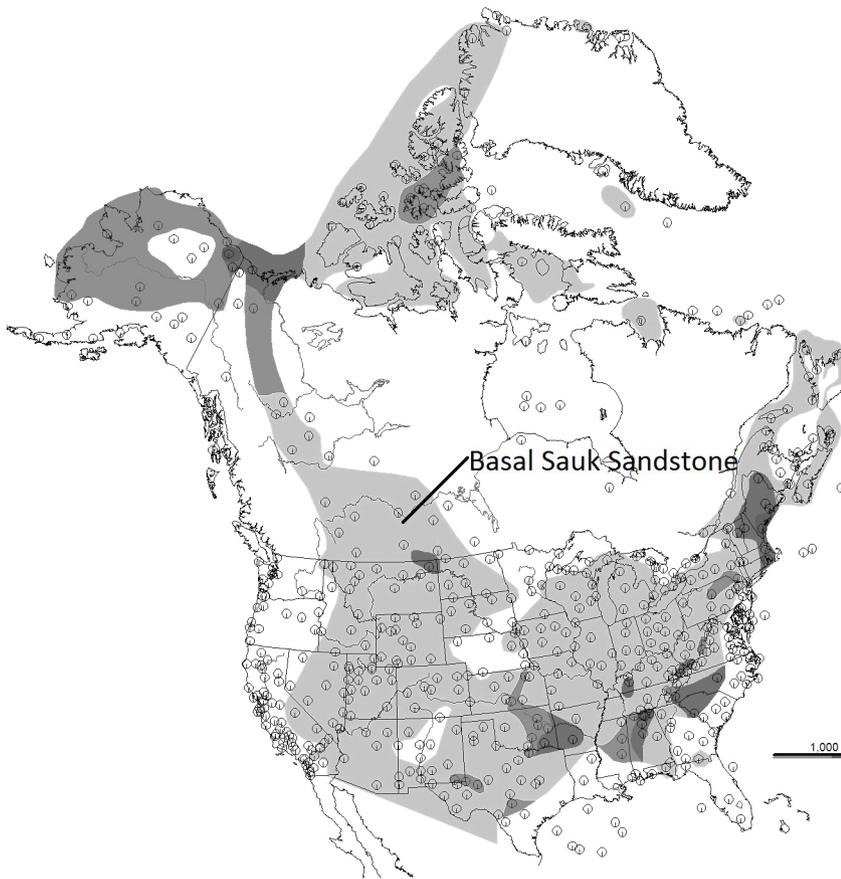


Figure 6. Map of the basal lithology of the Sauk Megasequence across North America. The extent of the one, continual sandstone layer is identified in light grey. (Image courtesy of Davis J. Werner.)

do not use this lack of understanding to question the overall validity of the PT and/or CPT model, respectively.

CPT explains the flooding of the continents

The Bible states plainly that the “fountains of the great deep were broken up, and the windows of heaven were opened” during the initiation of the Flood (Genesis 7:11). In terms of CPT, the fountains of the great deep may be a description of the rifting that took place at the ocean ridges and even within continents.²⁴ Obviously, the rainfall described as the “windows of heaven opening” must have contributed to the Flood in some capacity. But, in addition, because newly created oceanic lithosphere is relatively hot, less dense and more buoyant, the CPT model provides an additional source for the water to completely flood the continents. After its formation at the ridges, the freshly-formed, lower-density oceanic lithosphere simply pushed the top of the seafloor up from below, displacing ocean water and forcing it on to the land. Snelling has calculated that this elevated seafloor could have raised global sea level by as much as 1.6 km, greatly helping to flood the continents.²⁵

Rapid movement of the plates during runaway subduction further supplied tsunami-like waves to wash across the land surfaces, helping to deposit blanket-type sediments across continents (figure 6). Recent numerical modelling by Baumgardner has found that repetitive tsunami waves, caused by rapid plate movement, could result in water accumulation several kilometres deep on the continents, contributing to the flooding.²⁶ The runaway subduction model also provides a mechanism to lower the continental crust in the proximity of the subduction zones, causing more extensive flooding of the land and creating room for several kilometres of sediment.^{21,27} Numerical models show that friction against the subducting oceanic lithosphere as it descends will likewise drag down the edges of the continents about 3 km.^{21,27}

The floodwaters began their recession when God stopped the “fountains of the great deep and the windows of heaven” and “the rain from heaven was restrained” (Genesis 8:2). Subsequent cooling of the newly created ocean lithosphere later in the Flood year (after Day 150) offers an additional explanation for the lowering of the floodwaters. As the 100-km-thick ocean lithosphere cooled, it sank, lowering the bottom of the oceans and drawing the water back off the continents and into the ocean basins.

How do CPT critics raise the water level to Flood the continents? Rainfall alone seems insufficient. What is their definition of the ‘fountains of the great deep’, if not some type of plate boundary? What is their mechanism for raising sea level to flood the tops of the pre-Flood hills? How do the CPT critics explain the continent-scale sedimentation patterns? Creation scientists who are critical of CPT provide

only vague and generalized answers to these questions or do not discuss their views on these issues in their most recent papers.¹⁻³

CPT explains the Ice Age

Finally, CPT provides a mechanism for the Ice Age that occurred at the end of the Flood. A hot, newly formed ocean crust would have provided tremendous amounts of heat to the ocean waters above. This would have raised the overall temperature of the ocean and caused a much greater amount of evaporation, resulting in staggering amounts of precipitation.²⁸ In addition, the increased volcanic activity from the subduction zone volcanoes within the ‘ring of fire’ and elsewhere late in the Flood would have placed huge volumes of ash and aerosols into the atmosphere, cooling the climate most noticeably in the higher latitudes.²⁸ The unique magmas generated by the partial melt of subducted ocean lithosphere provides the perfect recipe for explosive, ash-rich eruptions. These types of volcanoes (stratovolcanoes) are highest in silica, making them thicker, and water-rich and more explosive.²⁹ The net result of hotter oceans and tremendous silica-rich, volcanic activity brought on from plate motion would have provided the impetus for the subsequent Ice Age.²⁸ Basalt-rich magmatic volcanoes (shield volcanoes), as commonly observed across the bulk of the ocean basins, do not produce the necessary ash-rich explosions to generate sun-blocking aerosols.²⁹ Finally, as the ocean lithosphere slowly cooled and volcanic activity diminished over the next centuries after the Flood, the Ice Age would also have ended as abruptly as it began.²⁸

Critics of CPT have more difficulty explaining the origins of the stratovolcanoes and their unique silica-rich magmas as they do not accept subduction, partial melting, and its resultant mantle disruption during the Flood year.^{20,30} They have problems justifying the observed differences in volcanic magmas in general. They also have a greater difficulty explaining the necessary heating of the ocean water to provide the precipitation for the Ice Age without the rapid creation of a completely new seafloor to heat the ocean from below during the Flood.^{10,28,30}

No schism in Flood geology

The empirical data that support CPT are not steeped in naturalism as some have claimed.⁴ It is not true that all data that support CPT are tied exclusively to interpretations of biostratigraphy and/or the secular timescale.² And not all creation scientists who subscribe to CPT agree on every issue. There is still considerable debate on the Flood/post-Flood boundary even among CPT advocates.^{9,31} Catastrophic plate tectonics simply presents a mechanism that explains much of the geology that is observed and measured,

particularly in terms of the oceanographic and tomographic data so often ignored in recent publications. The overwhelming geological evidence supports catastrophic horizontal plate movement. In addition, CPT allows for ample vertical uplift, mountain-building and down-drop of portions of the continental crust late in the Flood year.³² Vertical movements are the result of isostatic adjustments caused by crustal thickening and disruptions in the upper mantle during subduction.^{21,32}

The only schism in Flood geology is one perceived by the scientists who refuse to acknowledge the plethora of empirical data indicating horizontal plate movement during the Flood year. There are many issues still unresolved in Flood geology, such as determining an agreed upon Flood/post-Flood boundary, but plate movement should not be one of them. The empirical data are sufficient to put much of this criticism to rest!

Creation scientists should be critical of theories and hypotheses, but we also need to immerse ourselves in the latest data and the most recent scientific findings, secular or otherwise. “Iron sharpens iron”, but we have to be careful to not become so critical that our science is hampered and divided and fails to advance.

References

- Oard, M.J., Difficulties with plate tectonics—Pacific Ocean bottom features, *J. Creation* 29(2):86–91, 2015.
- Froede, C.R., Jr, Akridge, A.J. and Reed, J.K., Phanerozoic animal tracks: A challenge for catastrophic plate tectonics, *Creation Res. Soc. Quart.* 51(2): 96–103, 2014.
- McGuire, M., Plate tectonics—inconsistencies in the model, *J. Creation* 28(2): 104–115, 2014.
- Froede, C.R., Jr and Akridge, A.J., A developing schism in Flood geology, *J. Creation* 27(2):49–54, 2013.
- Ross, M.R., A developing schism in Flood geology, Letters to the Editor, *J. Creation* 27(3):46–47, 2013.
- Froede, C.R., Jr and Akridge, A.J., A developing schism in Flood geology, Letters to the Editor, *J. Creation* 27(3):48, 2013.
- Hess, H.H., History of Ocean Basins; in: Engel, A.E.J., James, H.L. and Leonard, B.F. (Eds.), *Petrologic studies: a volume in honor of A.F. Buddington*, Geological Society of America, Boulder, CO, pp. 599–620, 1962.
- Wilson, J.T., A Revolution in Earth Science, *Geotimes* (Washington DC) 13 (10): 10–16, 1968.
- Baumgardner, J.R., Global tectonics—clarity, not confusion, *J. Creation* 27(1): 99–106, 2013.
- Oard, M.J., Is plate tectonics really occurring today? *J. Creation* 26(3): 120–127, 2012.
- Baumgardner, J.R., Do radioisotope methods yield trustworthy relative ages for the earth’s rocks? *J. Creation* 26(3):68–75, 2012.
- Snelling, A.A., Radiometric dating: Making sense of the patterns, *Answers Magazine*, 1 January, 2010, answersingenesis.org/geology/radiometric-dating/radiometric-dating-making-sense-of-the-patterns/, accessed 24 June 2015.
- Humphreys, D.R., Accelerated nuclear decay: a viable hypothesis?; in: Vardiman, L., Snelling, A.A. and Chaffin, E.F. (Eds.), *Radioisotopes and the Age of the Earth: A Young-Earth Creationist Research Initiative*, Institute for Creation Research, Dallas, TX, and Creation Research Society, Chino Valley, AZ, pp. 333–379, 2000.
- Oard, M.J., Can the relative timing of radioisotope dates be applied to biblical geology? *J. Creation* 27(2):112–119, 2013.
- Slater, J.G. and Francheteau, J., The implications of terrestrial heat flow observations on current tectonic and geochemical models of the crust and upper mantle of the Earth, *Geophysical Journal of the Royal Astronomical Society* 20:509–542, 1970.
- Heirtzler, J.R., Le Pichon, X. and Baron, J.G., Magnetic anomalies over the Reykjanes Ridge, *Deep Sea Research* 13:427–433, 1966.
- Vine, F.J., Spreading of the ocean floor: New evidence, *Science* 154: 1405–1415, 1966.
- Brownfield, M.E. and Charpentier, R.R., Geology and total petroleum systems of the West-Central Coastal Province (7203), West Africa, *U.S. Geological Survey Bulletin 2207-B*, Reston, VA, pp. 1–52, 2006.
- Schmandt, B. and Lin, F.-C., P and S wave tomography of the mantle beneath the United States, *Geophysical Research Letters* 41:6342–6349, 2014.
- Brown, W.T., Jr, *In the Beginning: Compelling Evidence for Creation and the Flood, 9th Ed.*, Center for Scientific Creation, Phoenix, AZ, in press.
- Baumgardner, J.R., Runaway Subduction as the Driving Mechanism for the Genesis Flood; in: Walsh, R. E. (Ed.), *Proceedings of the Third International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 63–75, 1994.
- Marques, F.O., Cabral, F.R., Gerya, T.V., Zhu, G. and May, D.A., Subduction initiates at straight passive margins, *Geology* 42(4):331–334, 2014.
- Hecht, J., Rise of the upper crust, *New Scientist* 226 (3017): 36–39, 2015.
- Reed, J.K., *The North American Midcontinent Rift System: An Interpretation Within the Biblical Worldview*, Creation Research Society Monograph Series 9, Creation Research Society Books, St Joseph, MO, 2000.
- Snelling, A.A., Geophysical issues: understanding the origin of the continents, their rock layers and mountains. In: Boyd, S.W. and Snelling, A.A. (Eds.), *Grappling with the Chronology of the Genesis Flood*, Master Books, Green Forest, AR, pp. 111–143, 2014.
- Baumgardner, J.R., Numerical Modeling of the Large-Scale Erosion, Sediment Transport, and Deposition Processes of the Genesis Flood, *Answers Research J.*, in press.
- Baumgardner, J.R., Recent rapid uplift of today’s mountains, *Acts & Facts* 34(3), 2005.
- Oard, M.J., *Frozen in Time: The Woolly Mammoth, the Ice Age and the Bible*, Master Books, Green Forest, Arkansas, USA, 2004.
- Raymond, L.A., *Petrology: The Study of Igneous, Sedimentary, and Metamorphic Rocks*, Wm. C. Brown Communications., Dubuque, IA, 1995.
- Oard, M.J., Is the K/T the post-Flood boundary?—part 3: volcanism and plate tectonics, *J. Creation* 25(1):57–62, 2011.
- Ross, M.R., Evaluating potential post-Flood boundaries with biostratigraphy—the Pliocene/Pleistocene boundary, *J. Creation* 26(2):82–87, 2012.
- Austin, S.A., Baumgardner, J.R., Humphreys, D.R., Snelling, A.A. and Vardiman, L., Catastrophic plate tectonics: a global flood model of earth history; in: Walsh, R.E. (Ed.), *Proceedings of the Third International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 609–621, 1994.

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