

Ophiolites: oceanic lithosphere mixed with continental lithosphere during the Genesis Flood

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The nature and origin of ophiolites and oceanic crust and lithosphere are discussed as they relate to the Catastrophic Plate Tectonics (CPT) Genesis Flood geologic model and to Michael Oard's suggestions that current ocean crust may be pre-Flood ocean crust and upper mantle and that ophiolites are pre-Flood ocean crust thrust onto continental rocks by meteorite impacts. The most fundamental tenet of the CPT model, the claim by the model's proponents that the gravitational potential energy of pre-Flood oceanic lithosphere was the energy source for rapid plate tectonic processes during the Genesis Flood, contains ambiguities and contradictions; this claim is also unsupported by documented evidence, and is based on unsupported inferences and assumptions regarding the nature of pre-Flood oceanic crust and lithosphere. There is no warrant either from Scripture or from geology to speculate regarding the nature of pre-Flood oceanic lithosphere. As an alternative to Oard's model for ophiolite emplacement I suggest that ophiolites are oceanic lithosphere that was mixed with continental lithosphere during rapid differentiation of both from deep in the mantle due to gravitational decompression during the earliest stage of the Flood.

Michael Oard¹ discusses ophiolites, noting that they have a similar morphology to current ocean crust and upper mantle and occur mainly in continental margin mountain belts and near ocean margins in forearcs, island arcs and back-arc basins. He notes there are no modern analogues or credible mechanisms for ophiolite emplacement, and suggests that ophiolites represent pre-Flood ocean crust which was forced up onto continental rocks by meteorite impacts during the Genesis Flood; he asks, "is it possible that the current ocean crust is really pre-Flood ocean crust and upper mantle?"¹

In response to Oard's encouragement of those who disagree with his creationist model for ophiolite emplacement to express their thoughts, I offer the following regarding the nature and origin of ophiolites and oceanic crust and lithosphere; in particular, as each relates to the CPT Catastrophic Plate Tectonic (CPT) Genesis Flood geologic model,² regarding which Oard has expressed a need to "see more evidence that the model accurately represents the lower crust and mantle" and to "see the justification of various assumptions to the model".³ Indeed, one might ask, is there any justification, either scriptural or geological, for any specific assumptions regarding the nature of pre-Flood oceanic crust, lithosphere and mantle?

The pre-Flood seas

I suggest we can reasonably infer from Scripture that the pre-Flood "Seas" (Gen. 1:9–10), regarding which Oard has noted "It is seas (plural) that are gathered into one place",³ were much less extensive than the present oceans and ocean crust, which are essentially unbroken entities covering some 71% of the Earth's surface.⁴ Oard's suggestion that current

ocean crust and ophiolites may be "pre-Flood ocean crust and upper mantle" would require the pre-Flood seas to have covered more than 71% of the earth's surface.

Catastrophic Plate Tectonics

Apart from the speed of the subduction process, the main feature of the CPT model that distinguishes it from uniformitarian Plate Tectonic (PT) theory is the postulated energy source that drives sea-floor spreading and subduction of oceanic lithosphere. In PT theory the energy source is supposedly mantle convection,⁵ and in CPT theory the energy source is supposedly the gravitational potential energy of "cold, dense pre-Flood ocean plates" and "hot, buoyant rock ... at the base of the mantle."⁶

In addition to problems that are unique to CPT theory,^{7,8} and the many problems that the model inherited from its uniformitarian parent^{9–15} (all of which in my opinion are not a strawman as claimed by Dickens and Snelling,¹⁶ few if any having been adequately addressed by the CPT's proponents) CPT seemingly has a major problem with ambiguities, contradictions, inferences and assumptions regarding the nature of pre-Flood oceanic crust and lithosphere; in particular its density and thickness. The viability of pre-Flood oceanic lithosphere as the source of "the huge amount of energy required to accomplish ... a vast amount of geological work so quickly"¹⁷ during the Flood is thus questionable.

In response to John Baumgardner's interpretation of this aspect of the CPT model, Oard wrote in 2002:

"Baumgardner's model starts with an initial condition of gravitational instability ... The whole model of runaway plate tectonics depends on this initial condition."¹⁸

Indeed, it might reasonably be argued that the CPT model should stand or fall on the viability of this, its most fundamental tenet, which in turn relies on the tenuous assumptions that ophiolites are analogous to pre-Flood oceanic crust and lithosphere,^{19,20} and that ophiolites, and by analogy, pre-Flood oceanic crust and lithosphere, are significantly denser than the underlying pre-Flood mantle and present day, post-Flood, “new, less-dense, less-subductable, oceanic crust”²¹ which CPT proponents assume replaced the pre-Flood oceanic lithosphere during the Flood.

Given the fundamental role in CPT of the pre-Flood oceanic lithosphere as the energy source for the vast amount of geological work of the Flood catastrophe, the analogy to ophiolites, the similarity of ophiolites to present day oceanic crust and lithosphere, and the assumption that after the Flood the new oceanic lithosphere sank due to an increase in density upon cooling to form the ocean basins,²¹ one might reasonably expect, as Oard does,³ that oceanic crust and lithosphere, ophiolites, and the relationship of oceanic lithosphere density to temperature would have been discussed in some detail by CPT proponents. An exhaustive search of the CPT literature reveals that proponents of the model have not cited even one reference addressing these most fundamental issues.

Prior to the formal presentation of the CPT “global Flood model of earth history” by Austin *et al.* in 1994, at the Third International Conference on Creationism (ICC), Baumgardner, when discussing the role of pre-Flood oceanic

lithosphere as the source of gravitational potential energy for the Flood, nowhere distinguished between pre-Flood and post-Flood oceanic lithosphere, but instead tacitly inferred that the two are analogous.

In 1990 for instance, Baumgardner wrote:

“... oceanic lithosphere, which has an average chemical composition similar to the warmer rock beneath it, has a natural tendency to sink because of its lower temperature and higher density relative to the rock below. Hence it is the oceanic lithosphere that subducts.”¹⁹

And, perhaps more tellingly:

“... why, since subduction of oceanic lithosphere is presumably occurring now and the gravitational potential energy of the oceanic lithosphere is approximately equal to that just calculated, we are not undergoing a major catastrophe at this present moment? ... what was different about the earth at the time of the Flood compared with today ... answer ... the mantle’s rheology.”²²

Note that, according to Baumgardner, it was not the oceanic lithosphere that was different at the time of the Flood, but the mantle’s rheology.

Figure 1a shows a lithological profile through typical present day oceanic crust. Figure 1b shows a seismic velocity profile through typical oceanic crust and lithosphere. Table 1 shows the density distribution through the earth’s crust, lithosphere, outer mantle and transition zone down to the 660-km discontinuity according to Model ak135 of Kennett,

Engdahl and Buland.²³ From figure 1 and table 1, assuming a linear relationship between seismic velocity and density, we see that present oceanic crust and lithosphere, though cooler than the underlying mantle (Figure 2),²⁴ are considerably less dense. Thus, unless the density of the pre-Flood mantle was significantly less than it is today, Baumgardner’s tacit inference that pre-Flood and present day post-Flood oceanic lithosphere are analogous would invalidate the gravitational potential energy of pre-Flood oceanic lithosphere as a viable energy source for the Genesis Flood catastrophe. CPT proponents have not documented any evidence that oceanic lithosphere *per se* has a “natural tendency to sink”.

Baumgardner assumed that pre-Flood oceanic lithosphere covered 60% of the earth’s surface, was 80 km thick, and analogous to ophiolites,²⁹ and was, because of its lower temperature, denser

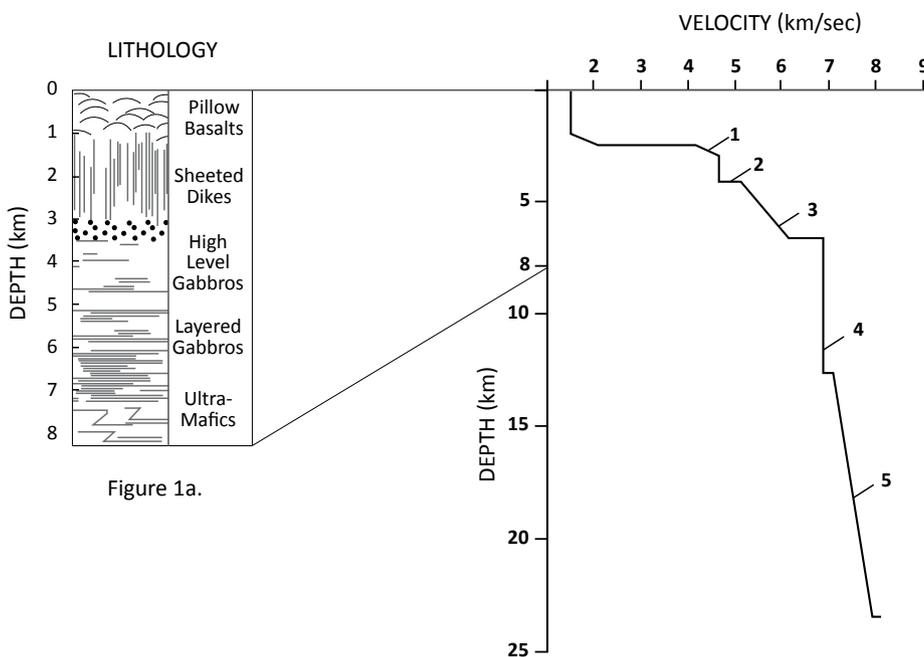


Figure 1. a) Lithological profile through typical oceanic crust (after Weper and Christenson²⁵); **b)** Seismic velocity profile through typical oceanic crust and lithosphere (after Mutter and Mutter²⁶).

than underlying pre-Flood mantle. He used a density of $3,400 \text{ kg/m}^3$ for his pre-Flood oceanic lithosphere,³⁰ which is some 3–10% higher than estimates of the density of ophiolites of $3.1\text{--}3.3 \text{ g/cm}^3$.³¹ As far as I am aware, apart from the vague notions that “pre-Flood basaltic ocean crust is suggested by ophiolites” and “buoyancy forces would make a mafic pre-Flood ocean crust into a natural basin for ocean water”²⁰ CPT proponents have offered no evidence to support any of these inferences and assumptions regarding pre-Flood oceanic lithosphere, all of which are seemingly rendered irrelevant by Baumgardner’s conclusion that “the entire pre-Flood ocean floor ... vanished from the Earth’s surface”.³² Ophiolites, described by Baumgardner as “rare ophiolite formations”,¹⁹ cover only a very small portion of the earth’s surface and thus should not be considered representative of a pre-Flood oceanic lithosphere covering 60% of the earth’s surface.

In 1994, at the Third ICC, in their formal presentation of the CPT model, CPT proponents, including Baumgardner, mistakenly equated *oceanic lithosphere* (previously discussed by Baumgardner) with *oceanic crust*, taking these two entities to be the same thing, and thereby contradicting Baumgardner’s previous discussions. Further, with little or no supporting evidence, CPT proponents assumed that pre-Flood oceanic crust was analogous to ophiolites and denser than present oceanic crust, writing:

“Pre-Flood basaltic ocean crust is suggested by ophiolites ... which are thought to represent pieces of ocean floor and [sic] obducted onto the continents early in the Flood.”²⁰

“When virtually all the pre-Flood oceanic floor had been replaced with new, less dense, less subductable, oceanic crust, catastrophic plate motion stopped. Subsequent cooling increased the density of the new ocean floor, producing deeper ocean basins and a reservoir for post-Flood oceans.”²¹

The variation of density with temperature of crystallising alkali and tholeiitic basaltic magmas over the temperature range $1,500\text{--}800^\circ\text{C}$ is illustrated in McBirney.³³ Over this temperature range, the density of alkaline basalt increases by only 0.13 g/cm^3 from 2.69 to 2.82 g/cm^3 (about 5%) and the density of tholeiitic basalt increases by only 0.16 g/cm^3 from 2.59 to 2.75 g/cm^3 (about 6%). It is difficult to envision that a sudden downwarping of oceanic lithosphere to form the ocean basins and a consequent sudden abatement of the floodwaters on Day 150 (Gen. 9:3) would result from such small gradual density increases due to gradual cooling of basaltic oceanic lithosphere.

Also at the Third ICC in 1994, at which Austin *et al.* proposed subduction of Pre-Flood basaltic ocean crust of unspecified thickness, Baumgardner proposed a different Flood scenario, involving “catastrophic overturning of the mantle driven by gravitational potential energy in large volumes of cold rock at the earth’s surface and/or in the

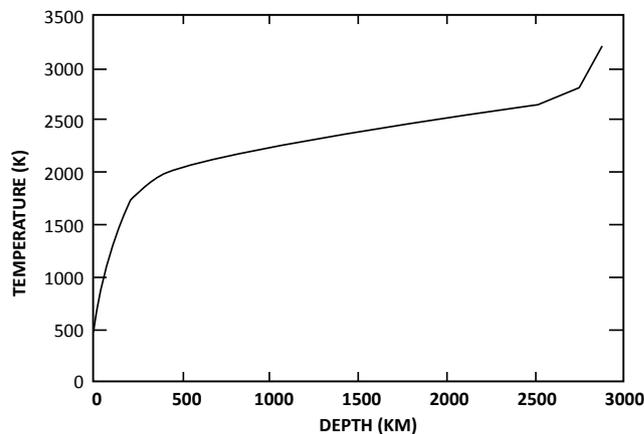


Figure 2. Temperature distribution through the earth’s lithosphere and mantle (after Baumgardner¹⁷).

upper mantle” or in “the earth’s upper thermal boundary layer”.³⁴ Not clearly defined was “the earth’s upper thermal boundary layer”, which appears to have comprised the pre-Flood oceanic crust, lithosphere and sub-crustal outer mantle from the earth’s surface to the 410-km discontinuity, which was assigned a density of $3,425 \text{ kg/m}^3$ and a thickness of 410 km.^{35,36}

Then, in 2002, in a forum exchange between Baumgardner and Oard, Baumgardner suggested that the present ocean basement, which is no older than Mesozoic, “requires ... the entire pre-Flood ocean floor ... to have vanished from the Earth’s surface”,³⁷ and noted that modelling of the earliest portion of the Flood catastrophe is difficult because “the ocean floor from this period is no longer available and clues from the continental rocks are few” and that “recovering even approximate initial conditions for this earlier state appears extremely problematic for anyone’s framework.”³⁸

In 2003, in an exchange with Carl Froede, Baumgardner wrote “without an accurate initial state, a computer model that reproduces even the basic tectonic features of earth history is impossible” and “In other words, a good guess for the initial conditions is a non-negotiable necessity if the resulting computer model is to yield any resemblance to today’s world.”³⁹

CPT proponents have thus variously considered pre-Flood oceanic crust, “pre-Flood oceanic lithosphere”, or “the earth’s upper thermal boundary layer” (with thicknesses of approximately 6km, 80 km and 410 km respectively) “an accurate initial state” or a “good guess”, and subduction of “Pre-Flood basaltic ocean crust” or “catastrophic overturning of the mantle”. Thus, the most fundamental tenet of the CPT model, that pre-Flood oceanic lithosphere was the source of gravitational potential energy for the Flood catastrophe, is seen to be loaded with ambiguities and contradictions and based on tenuous and unsupported inferences and assumptions regarding the nature of pre-Flood oceanic crust,

Table 1. Density distribution through the earth's crust, lithosphere, outer mantle and transition zone. Model ak135 (after Kennett, Engdahl and Buland²³).

Depth (km)	ρ Mg/m ³	
0.0	2.720	
20.0	2.720	
20.0	2.920	
35.0	2.920	
35.0	3.320	
77.5	3.345	~ base oceanic lithosphere
120.0	3.371	
165.0	3.398	
210.0	3.426	
210.0	3.426	
260.0	3.456	
310.0	3.486	
360.0	3.517	
410.0	3.547	410km discontinuity
410.0	3.756	
460.0	3.818	
510.0	3.879	
560.0	3.941	
610.0	4.003	
660.0	4.065	660km discontinuity
660.0	4.371	

lithosphere and mantle. Given Baumgardner's belief that "the entire pre-Flood ocean floor ... vanished from the Earth's surface" and that "Recovering even approximate initial conditions ... appears extremely problematic", it is not surprising that, with little or no supporting evidence, CPT proponents have had to use present oceanic crust, lithosphere, and ophiolites as their "models" for pre-Flood oceanic lithosphere. If "the entire pre-Flood ocean floor vanished from the Earth's surface" and if ophiolites cannot be representative of a pre-Flood oceanic lithosphere covering 60% of the earth's surface, we might legitimately ask CPT proponents what is the basis for: (i) the inference that pre-Flood oceanic lithosphere was analogous to present (post-Flood) oceanic lithosphere, and (ii) the assumptions that it was 80 km thick and analogous to ophiolites, and that ophiolites are denser than current oceanic crust, and that present oceanic crust is "less dense, less subductable" than pre-Flood oceanic lithosphere?

Pre-Flood oceanic lithosphere

I believe we have no warrant, either from Scripture or from geology, to speculate regarding the nature, or even the existence, of pre-Flood oceanic lithosphere, and certainly no warrant to assume that it was analogous to ophiolites, or to current oceanic lithosphere or more dense than the

pre-Flood mantle, or 80 km thick. We do however have some warrant from Scripture to infer, as Oard concluded in 2002, that there were multiple pre-Flood "Seas"³³ (Gen. 1:10). These seas and whatever underlaid them, being components of the newly created Earth, might have been significantly different to, and certainly less extensive than, the present oceans and oceanic crust and lithosphere, which cover some 71% of the earth's surface. We might also reasonably infer, as Baumgardner has,³⁷ that whatever underlaid the pre-Flood seas was completely destroyed in the Flood catastrophe.

If, as we read in the Scriptures, before the Flood "a mist went up from the earth and watered the whole face of the ground" (Gen. 2:6), there may have been no requirement for today's global evaporation/rain cycle that distributes water over the globe via today's rivers, large oceans, and atmosphere. During the Flood a significant quantity water was added to the earth's surface from above (the "windows of heaven"; Gen. 7:11) and from below (the "fountains of the great deep"; Gen. 7:11), such that the total volume of water at the Flood peak was sufficient to cover the whole globe to a depth of at least 3 km. Presumably the present oceans are much larger than the pre-Flood seas to accommodate this extra water.

Origin of ophiolites

As noted by Oard, one of the most characteristic features of ophiolites is their content of high pressure (HP) and ultra high pressure (UHP) minerals, including microdiamonds, coesite and stishovite, which require minimum pressures for their formation of up to 9 GPa, indicating an origin in the earth's mantle at depths of up to 250 km below the surface. Oard notes that "These minerals require very rapid exhumation from depths greater than 100 km" and rightly rejects uniformitarian subduction/exhumation models for their origin too slow, suggesting instead that because these minerals are associated with known meteorite impact craters, their presence in ophiolites may be evidence that ophiolites are "pre-Flood ocean crust ... forced up and onto ... continental rocks"³¹ by meteorite impacts.

In 1990, Baumgardner suggested that reduced mantle viscosity was necessary to allow rapid "large-scale tectonic change" in the short time frame of the Flood year, and suggested "the physical laws were somehow altered by God to cause the catastrophe to unfold within the time frame of the Biblical record",⁴⁰ noting that "one conceivable way to have the mantle deform more readily—namely to make its temperature closer to its melting temperature."⁴¹

In 2004, I proposed a revised Genesis Flood geologic model in which the earth's hot, created mantle was brought to its melting temperature, and its viscosity was thereby greatly reduced (as a result of gravitational decompression effected by an increase by God) the magnitude of the exponent of the separation distance parameter in Newton's Universal Gravitational Law.^{42,43} This gravitational decompression,

I postulated, provided both the energy to rapidly differentiate and lift continental and oceanic crustal material to the earth's surface, and reduced acceleration due to gravity (g), to facilitate the distribution of volcanics and sediments across the globe. The oceanic lithosphere differentiated as a kind of "scum" on top of the oceanic mantle, with the characteristic layered "stratigraphy" of typical oceanic crust (figure 1a). Radial expansion of the earth of about 95–100 km, due to density reduction in the transition zone and outer mantle during differentiation, caused horizontal stretching of the oceanic lithosphere resulting in transform faults and a thinning of the lithosphere. The sudden subsidence of oceanic lithosphere to form the ocean basins on Day 150 of the Flood was due to the sudden complete restoration of the gravitational force, not to density increase due to cooling.

The similarity of ophiolites to oceanic crust and lithosphere, their geographical distribution near the interface between oceanic lithosphere and continental lithosphere ("near 'subduction zones'"⁴⁴), and their HP and UHP mineral content are, I suggest, better explained by this gravitational decompression model in which oceanic and continental lithosphere are brought rapidly to the earth's surface from deep in the mantle, in close proximity to each other, by gravitational decompression-induced melting and mantle differentiation during the earliest stage of the Genesis Flood. Lithological and geochemical variations in ophiolites, and the fact that "ophiolites can be dismembered and deformed and mixed with a wide variety of other rocks"⁴⁵ in my opinion are better explained by this model. Ophiolites, in other words, may simply be slivers of oceanic lithosphere that got mixed up with continental lithosphere when both were differentiating from deep within the mantle during the early Flood.

Conclusion

It is somewhat ironic, and perhaps strangely reminiscent of an earlier period in the history of diluvialism,^{46,47} that, almost half a century after publication of *The Genesis Flood* by Whitcomb and Morris in 1961,⁴⁸ the geologic record attributed to the Genesis Flood is currently being assailed on all fronts by diluvialists. Most diluvialists relegate most or all of the Precambrian to either Creation Week or the antediluvian period.^{2,35,49–53} Some creationists propose *ex-nihilo* creation of Precambrian strata^{54,55} and creation of unfossiliferous Precambrian sediments,⁵⁶ and some even consider the creation of fossils.⁵⁷ The "Recolonizers" consider the Phanerozoic and Proterozoic to be post-Flood,⁵⁸ and now that Oard has confirmed the suspicion expressed by Baumgardner in 2002 that he (Oard) "holds that all the basaltic ocean crust is of pre-Flood age"³⁸ there remains not one square kilometre of rocks at the Earth's surface that is indisputably Flood deposited.

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