# The pre-Flood/ Flood boundary at the base of the earth's transition zone

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**The earth was created instantaneously *ex nihilo* by God, with a molten core, and a cool crust overlying a high-temperature sub-solidus mantle. The mantle was maintained at a 'critical' equilibrium pressure by gravity, the strength of which was determined by the magnitude of the created universal gravitational constant (G). The critical pressure was such that mantle melting and differentiation was inhibited.**

**A water vapour canopy probably surrounded the antediluvian atmosphere, which must have been essentially the same as today's atmosphere.**

**As first proposed by John Woodward in 1695, God initiated the Genesis Flood by suddenly and temporarily lowering the magnitude of the gravitational constant, causing thereby an instantaneous decompression of the earth which disturbed the equilibrium of the created mantle-atmosphere-canopy system.**

**The decompression initiated canopy condensation and collapse (*'the windows of heaven'*) and mantle melting and differentiation, including magma generation, mineralogical phase changes, crust formation and exsolution of volatiles, including copious volumes of water (*'the fountains of the great deep'*). This mantle differentiation resulted in the present geophysical and geological structure and composition of the earth's transition zone, outer mantle and lithosphere. The pre-Flood/Flood boundary is thus considered to be at the base of the transition zone, at the 660-km discontinuity.**

## Introduction

When young-earth creationists ascribe a pre-Flood/ Flood boundary to a particular location in the geologic record, they generally use three *a priori* assumptions:

1. There **is** an identifiable pre-Flood/Flood boundary in the observable geologic record.
2. The **first appearance of abundant fossils** is one of the main characteristics marking the beginning of Flood deposited strata.
3. The **absence of fossils** in lower, older strata identifies them as pre-Flood strata.

The sudden appearance of abundant fossils, and a world-wide unconformity, at the base of the Cambrian strata, or in the upper Proterozoic, Vendian strata has, in the minds of many creationist writers, identified this position as the pre-Flood/Flood boundary. They have on this basis assigned the formation of the older Precambrian strata (Archean and Proterozoic) to Creation week, usually assigning the formation of the Archean strata to Day 1 creative activity, and the Proterozoic to geological activity associated with uplift of the land on Day 3.

Few, if any, creationists seem to have considered that **different** criteria to those generally postulated might characterise early Flood strata. A few have proposed **additional** criteria, [1–3] and a few have suggested a lower, earlier, location for the boundary within the stratigraphic record. [1,3–7]

In 1996 I summarised the trend,[7] begun by Woodmorappe,[4] towards consideration by creationist writers of the Precambrian as Flood rocks. I postulated that the Archean *'basement granites'* and volcano-sedimentary strata, the Proterozoic sedimentary strata, and the waters of *'the fountains of the great deep'* were derived by catastrophic differentiation of the earth's mantle during the initiation and early stages of the Flood. I thus speculated that the pre-Flood/Flood boundary should lie below the base of the Archean strata, in the earth's mantle, where these differentiation processes were thought to have initiated.

In this paper I propose that the present geophysical/ geological structure of the earth's mantle is the result of a sudden decompression of the created earth, due to a sudden, temporary reduction of the magnitude of the gravitational constant (G). I intend to document what I consider to be the evidence for a temporary reduction of G in a future article.

The outlines of the model as presented in this paper may form the basis of a comprehensive Flood geologic model.

## Origin theories

> Genesis 1:1. *'In the beginning God created the heaven[s]* ***and the Earth****.'*
>
> Psalm 33:6, 9. *'By the word of the Lord were the heavens made; and all the host of them by the breath of his mouth. ... For* ***he spake, and it was done****; he commanded, and* ***it stood fast*** *[emphasis added].'*

One's conclusions regarding the structure and geological history of the earth will be strongly biased according to beliefs regarding its origin. Accordingly, a brief review of contemporary secular and creationist origin theories (cosmogenies) follows.

Regarding the origin of the Universe, Mehlert[8] notes; *'there are **two primary logical foundations** from which to begin [emphasis added].'* Either:

1. *'The universe has always existed and always will,'* (e.g. **eternal** or **steady-state** theory, as propounded by Hoyle, Gold and Bondi, in the late 1940s.) or;
2. ***'**The universe came into being at a definite point in the past, with or without a creator being involved.'* (e.g. **big-bang** or **standard** model, first postulated by Gamow in the 1940s.)

## Secular cosmogenies

Spencer[9] summarises, from a creationist perspective, current views on the origin of the universe,[10–17] including the solar system, and notes that the big-bang model for the origin of the universe is presently in favour with the scientific community. Spencer also notes that a Modified Nebular Hypothesis, much like the Nebular Hypothesis proposed by Pièrre Simon Laplace in 1796, is the currently accepted model for the origin of the solar system.

In the Nebular Hypothesis of solar system origin, the sun, planets, and all other solar-system bodies condense, by natural processes such as gravity, magnetic effects, and collisions, from an interstellar nebula forming first a *'protosun'* with a surrounding disc of solid mineral grains, dust and gases. Within the disc, turbulence and random motions, it is postulated, lead to clustering so that *'gravity begins to pull matter together by its own weight'*, and over long periods of time this matter accretes as planets and moons, **without layered interiors**, as gravitational accretion would not produce layered objects.

Radioactive decay, and bombardment of the accreted planets and planetary satellites by meteorites, supposedly caused the newly formed planets to heat. This heating was supposedly sufficient to cause the dense material to sink toward the centre and the less dense material to move closer to the surface forming the present layered structures in the planets and moons.

## Traditional creationist cosmogeny

Isaiah, 45:18. *'For thus saith the Lord that created the heavens; God himself that formed the earth and made it; he hath established it, he created it not in vain, **he formed it to be inhabited** ...[emphasis added].'*

Psalm102:25. *'Of old, thou hast laid the foundation of the earth: and the heavens are the work of thy hands.'*

Whitcomb[18] summarises the **Traditional View** involving instantaneous *ex nihilo* creation of the earth and the heavens about 6,000 years ago as follows:

*'The earth, like the heavens, was created without the use of pre-existent materials ... which clearly implies that it was created instantaneously as a dynamic, highly complex entity. ... spinning on its axis ... it had a cool crust, for it was covered with water. ... it did contain all of the basic elements and the **foundational rocks** of our present earth.*

*... it [the earth] is ...**absolutely unique in God's eternal purposes.** It was on this planet that God placed man, created in His image, to exercise dominion and to worship Him. ... Because of its positional superiority in the spiritual order of things, therefore, the earth was formed first ...[emphasis added].'*

In this paper the traditional creationist cosmogeny, involving instantaneous *ex nihilo* creation (Psalm 33:9, '**he spake, and it was done**') as outlined by Whitcomb and Morris, is assumed. The spatial relationships and relative motions of all bodies in the universe were, I believe, created fixed and functioning according to the subsequently discovered 'Newtonian' laws of motion[19] (Psalm 33:9, '**it stood fast**'). Except for subsequent minor departures from created order, these spatial relationships and relative motions are essentially the same today as they were at creation.

## Created *'antediluvian'* earth structure

**(Genesis 1:1–2, Genesis 1:6–10, Isaiah 45:18)**

Figure 1 illustrates my conception of the created antediluvian earth structure, compared to the present postdiluvian differentiated, expanded earth. The size, total mass and density distribution of the created earth were, I believe, probably designed to impart the particular orbital and rotational dynamic characteristics required for a habitable earth (Isaiah 45:18).

## Solid earth

Austin *et al.*[20] proposed that the created pre-Flood earth was differentiated into a core, mantle, and crust and precluded a post-creation origin for this differentiation. Their conclusions would seem to be confirmed by the smoothness of the density profile through the inner and outer core and the inner mantle of today's earth (Figure 2), the sharpness of the outer core/mantle boundary, and the magnitude of the density jump across this boundary. All these features indicate that these subdivisions of the earth's structure may have been created that way, and did not differentiate naturally due to heating by meteorite bombardment and radioactive decay as proposed in the current modified nebular model of earth origin.

The model of Austin *et al.* for the created earth (Figure 1A) is used in this paper. In detail, this assumes a hot, subsolidus mantle maintained at a critical pressure, such that a sudden significant reduction of pressure would have initi-

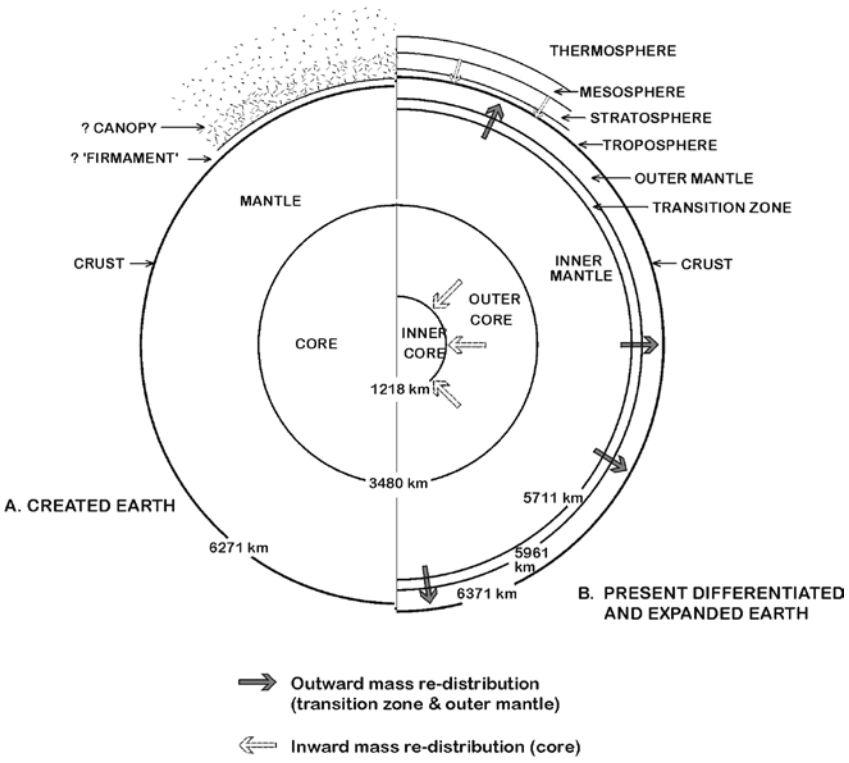


***Figure 1***. *A) Postulated structure of the created antediluvian earth. B) The present structure of the postdiluvian differentiated and expanded earth.*

ated melting and mantle differentiation, and in particular, reactions involving the formation and exsolution of water (*'the fountains of the great deep'*).

## Hydrosphere

Genesis 1:9,10. *'And God said, Let* ***the waters under the heaven*** *be gathered together unto one place ...and the gathering together of the waters called he* ***Seas*** *...[emphasis added].'*

Genesis 2:5–6. *'... for the Lord God had not caused it to rain upon the earth ... But there went up a mist from the earth, and watered the whole face of the ground.'*

The antediluvian hydrologic cycle may have been much different to that of today. The *'mist'* which watered the earth (Genesis 2:6) may have resulted from slow exsolution of water from the created mantle through the cool crust. Scripture indicates that rivers existed, but due to a probable lack of storm activity, and because their source was from the *'mist'*, flow rates in these rivers would have been extremely regular. The river waters probably carried no sediment, thereby resulting in no sedimentation in the pre-Flood oceans. They may have contained dissolved salts which were derived from the mantle and were nutritional to man and beast.

I have suggested,[7] based on the amount of water estimated to have been exsolved from the mantle during the Flood, that the volume of pre-Flood free water may have been about 10% of today's free water. This amount of water would have been enough to provide suitable depth environments for all pre-Flood fish and sea creatures. Refinement of this figure awaits more accurate estimates of the water content of the present mantle, and calculation of the amount of water exsolved from the differentiating mantle during the Flood. Such estimates will help provide some preliminary concepts of pre-Flood geography.

## Atmosphere

Many secular researchers have postulated that the earth's atmosphere[21,22] has resulted from exsolution of volatiles from the mantle early in the earth's history,[23–30] some even suggesting ***catastrophic*** differentiation.[31]

Today's atmosphere comprises 78.08 % nitrogen, 20.94 % oxygen, 0.93 % argon, and 0.03 % carbon dioxide.[32] If we assume that the physiology of today's air-breathing animals and mankind is similar to those of pre-Flood times, then the pre-Flood atmosphere could not have been much different compositionally from today's.

Exsolution of significant quantities of volatiles into the earth's atmosphere, during the Flood, or at any time during earth history, would probably have increased its toxicity, possibly to levels similar to that of the atmospheres of the gaseous planets. Thus, if significant exsolution of volatiles from the mantle did occur during the Flood, as seems likely, the volatiles most probably were precipitated and preserved in the stratigraphic record in rocks such as carbonates, nitrates, phosphates, and sulphates. The atmosphere was thus probably protected from the exsolution of volatiles from the mantle by the Flood waters, and the present atmosphere may thus be essentially the same as the antediluvian atmosphere.

## Water vapour *'canopy'*

Scripture (Genesis 7 and 8) clearly records that a significant amount of rain fell, from above, to the earth, during the first forty days and nights of the Flood. Genesis 7:11–12 indicates that the water had previously been held above the earth's surface, and was allowed to fall to the earth through ***'windows'*** (KJV) or ***'floodgates'*** (NIV) during the first forty days and nights of the Flood.

Prior to 1978, several creationist authors had speculated regarding the existence of a pre-Flood water vapour canopy.[33–36] Dillow in 1978,[37–38] modelled the canopy with its base maintained in the earth's gravitational field at an altitude of about 9 km by a temperature inversion and Taylor stability, as the source of the Flood rain. Dillow assumed

that precipitation from the canopy occurred at a global average rate of about 0.5 inches (12 mm) per hour for forty days and nights, resulting in about 40 feet (12 m) depth of precipitated water.

Dillow's canopy model has been supported,[39–44] challenged,[45–48] revised and defended[49] in the creationist literature. Opinion currently seems to be divided as to the validity of the canopy model. The main problems perceived with the canopy theory are the theorized high earth surface temperature under the canopy[50,51] and dissipation of the latent heat of condensation during canopy collapse.[52]

## Development of earth models

> Psalm 95:4. *'In his hand are **the deep places of the earth**: the strength of the hills is his also [emphasis added].'*

Contrary to belief among some creationists, the structure and composition of the inner earth is inferred with a large degree of confidence.[53–68] Progress in the study of seismology (Figure 3) and high-pressure mineral physics now allows soundly based conclusions regarding the earth's internal structure and composition and, to a certain extent, by inference, also its geological history (Figures 2 and 4).

All useful models of the density distribution inside the earth have had to satisfy estimated values for the earth's radius, mass and moment of inertia and only became available after these parameters had been estimated to fair precision.

Bullen[69] notes that the first steps toward determination of the distribution of density and other parameters within the earth were investigations by the early Greeks and Chinese (ca. 600–194 BC) concerning the earth's shape and size. By the early 1500s, the earth had been circumnavigated and, by 1669, the dimensions of the earth were sufficiently accurately known to permit an estimation of its mean density, should evidence on its mass become available.

Newton, in 1687,[70] used geophysical and planetary observations to arrive at his laws of motion, and applied these laws to investigating the earth's shape and physical properties, laying the foundations for dynamical study of the shape and structure of the earth.

According to Newton's *Universal Theory of Gravitation* the force F, between two bodies of masses $m_1$ and $m_2$, separated by a distance r, is given by $F = Gm_1m_2/r^2$ (Newton's *'Inverse Square Law'* where G is the *'universal gravitational constant'*). Thus for points on the earth's surface where r = a (earth radius), $F/m(=g)=GM/a^2$ (where g = acceleration due to gravity, amd M is the mass of the earth).

Hence, when observational values of a (earth radius) and g (acceleration due to gravity at the earth's surface) became available, a useful estimation of GM could be made. Once this was known, separate values of G and M could be determined by any experiment which determined either G or M alone.

Towards the close of the 18th century, Michell constructed a torsion balance to measure directly the gravitational at-

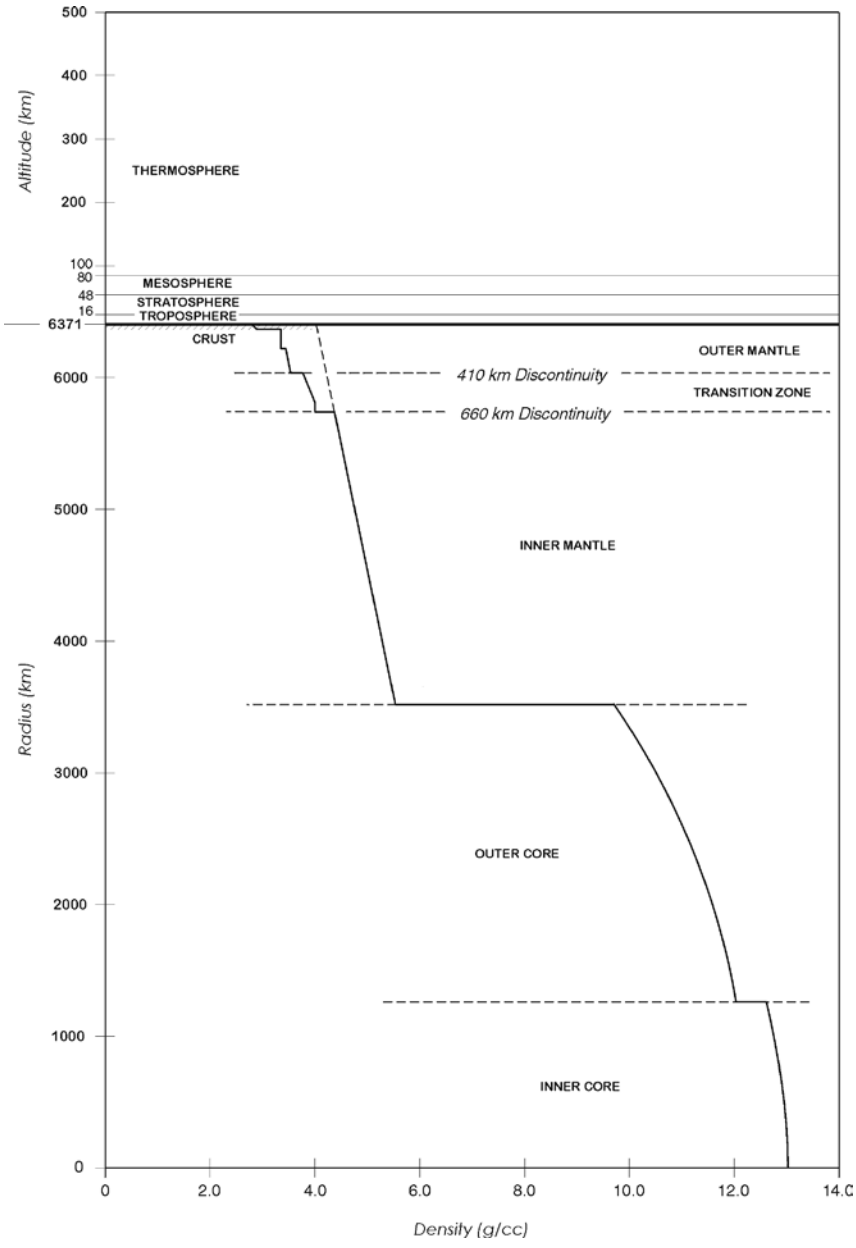


***Figure 2.*** *The density distribution within the earth according to the Preliminary Reference Earth Model (PREM) of Dziewonski and Anderson.[103] Note that a different distance scale applies to the atmosphere than applies for the solid earth.*

traction between spherical masses $m_1$ and $m_2$ in the laboratory,[71] as suggested by Newton. This enabled the constant of gravitation G, to be determined from measurements of F, $m_1$, $m_2$, and d, using the relationship $F = Gm_1m_2/d^2$. Cavendish[71] modified Michell's apparatus and in 1798 calculated the earth's mean density at 5.448 g/cm$^3$. By the early 19th century, the mean density of the earth was known to an accuracy of about 1 %.

Thompson and Tait (1879)[72] proposed the first multilayered models of the earth, with a core and an outer shell. Radau (1885)[73] and Weichert (1897)[74] worked out numerical details for the Thompson-Tait models using the density of surface rocks as 2.7 g/cm$^3$, a core density of 7.47 g/cm$^3$, and core radius of 0.844 earth radii. From Weichert's time until about 1914 several earth models with different core densities were contemplated and in 1915 Klussmann[75] constructed several models, each with three layers of constant densities and assigned thicknesses.

Haalck (1925)[76] sought to allow for variation of density within layers and postulated a linear variation down to 1200 km and a different variation from there to the core boundary at 2900 km depth.

Williamson and Adams, in 1923,[77] showed that compressibility alone could not raise the density in the deeper interior enough to account for the known mass of the earth. They concluded that there must be substantial changes in density, and/or chemical composition (phase changes) in the earth's deeper interior.

Bullen (1936)[78] confirmed the conclusion of Williamson and Adams (1923)[77] that density increased with depth more rapidly through the transition zone than could be explained by self-compression of homogeneous material within the earth's gravitational field. They concluded that chemical and/or phase changes must occur in this region. Birch (1958)[79] inferred that phase changes in mantle mineral structure were primarily responsible for the inhomogeneity between 350 and 900 km, and that chemical changes were also possible (Figures 2 and 4). Birch's hypothesis was verified in principle by direct laboratory experiments at very high pressures, mainly by Ringwood *et al.* (Canberra, Australia),[80–87] and Akimoto (Tokyo, Japan).[88] These phase changes have now been studied in detail, in both seismic modelling and in high pressure laboratory experiments.[89–92]

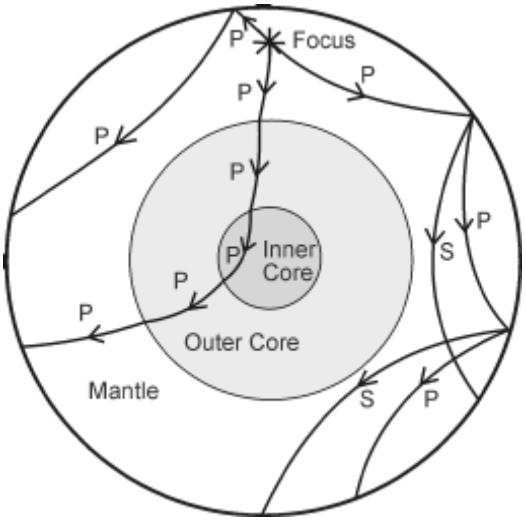


***Figure 3.*** *Examples of raypaths through the earth following a deep focus earthquake. (P) indicates compressional waves, (S) indicates shear waves. The internal structure of the earth is inferred from earthquake recordings on a global network of seismometers, and seismogram interpretation relies on theoretical models of the earth's interior. The predicted raypaths can be compared with what is actually recorded to provide further understanding of the internal structure of the earth.*

During the early 1900s, the development of seismic theory enabled the distributions of compressional (P) wave and shear (S) wave velocities inside much of the earth to be estimated. In 1964, Birch[93,94] determined relationships between seismic wave velocity, density, and several other parameters, including the elastic moduli, compressibility, Poisson's Ratio and the Seismic Parameter.[95] Thus, the approximate distributions of these parameters within the earth became available.

Bullen and Haddon in 1967[96] produced a series of earth models, including distributions of the earth's incompressibility, rigidity, pressure, gravitational intensity and several derived variables, including Young's Modulus and Poisson's Ratio. Thus, a useful first approximation of the main internal physical structure of the earth was provided.

Continued refinement of seismic techniques and laboratory mineral physics studies has allowed more accurate models of the earth's interior to be developed,[77,97–104] including Model ak 135 of Kennett, Engdahl and Buland,[105] used in this paper (Figure 5).

## Present *'post-Flood' earth structure*

The six main sub-divisions of the earth's structure, from the centre out, (Figures 1 and 2) are outlined here.

### *Core (Depth: 2886–6371 km)*

Jacobs[106] noted that as early as the nineteenth century it had been suggested that the earth had a core of higher density than the surrounding mantle, and in 1906 Oldham established its existence. Birch was the first to suggest the existence of a solid inner core.

**INNER CORE (Depth: 5156–6371 km):** The inner core is thought to consist of solid iron-nickel, at a temperature of up to 7,000 °C. The prevailing secular theory regarding the inner core's origin is that it formed by gradual solidification of the liquid core as the earth cooled.[107]

**OUTER CORE (Depth: 2886–5156 km):** The outer core is thought to be comprised of molten iron and nickel, with some FeO, at a temperature ranging from 4,400 °C in the uppermost parts to about 6,100 °C in the deepest parts.[108] The earth's magnetic field is thought to originate in the outer core.

### *Inner mantle (Depth: 660–2886 km)*

The inner mantle (Figure 5) extends from the outer core/inner mantle boundary, at depth 2,886 km to the 660-km seismic discontinuity at the base of the transition zone. It is considered to consist of 70 % λ-olivine ($(Mg\ Fe\ Al)\ (Al\ Si)\ O_3$) with a perovskite structure, and 20 % magnesiowustite ($(Mg\ Fe)\ O$).[109–113]

The 660-km discontinuity, at the top of the inner mantle, is the most pronounced seismic discontinuity in the mantle,[114,115] and is considered to be due mainly to mineral phase changes. Moving downward through the transition the γ-olivine with spinel structure transforms to λ-olivine + magnesiowustite and the garnet in the pyroxene-garnet system transforms to ilmenite, with an associated density increase of approximately 9.5 %.

Small seismic discontinuities in the outer part of the inner mantle may indicate further transitions to slightly denser states in this area.[116] The minor seismic discontinuity at about 800 km for instance, may be due to the phase transition from aluminous ilmenite solid solution to orthorhombic perovskite.

### *Transition zone (Depth: 410–660 km)*

The transition zone (Figure 5) extends from the 660-km discontinuity at its base to the 410-km discontinuity at its top.[117–120] At the top of the transition zone above the discontinuity, γ-olivine ($(Mg\ Fe)_2\ SiO_4$) is considered to transform to the higher pressure phase β-spinel ($\beta$–$(MgFe)_2SiO_4$) below the discontinuity with a 4.6 % increase in density. Aluminous pyroxene also transforms to garnet, with a 2 % increase in density.

At about 520 km, β–phase spinel is considered to transform to γ-olivine (spinel structure), and garnet to Ca-perovskite.

### *Outer mantle (Depth: 80–410 km)*

The outer mantle (Figure 5) extends above the 410-km discontinuity.[85,121–124] In the currently accepted *'pyrolite'* mantle model, first proposed by Ringwood,[80] the outer mantle consists of a pyroxene-olivine rock (peridotite) which is capable of producing basaltic magmas on partial melting. Ringwood[109] proposed a detailed mineralogy for the outer mantle peridotite: 57 % olivine ($(Fo_{89})\ (Mg\ Fe)_2\ SiO_4$), 17 % orthopyroxene ($(En_{89})\ (MgFe)\ SiO_3$), 12 % omphacitic pyroxene ($(Ca\ Mg\ Fe)_2\ Si_2O_6 NaAlSi_2O_6$), 14 % pyrope garnet ($(MgFeCa)_3\ (Al\ Cr)_2Si_3O_{12}$), and minor minerals; diopside ($Ca(MgFe)\ Si_2O_6$) and jadeite ($NaAlSi_2O_6$).

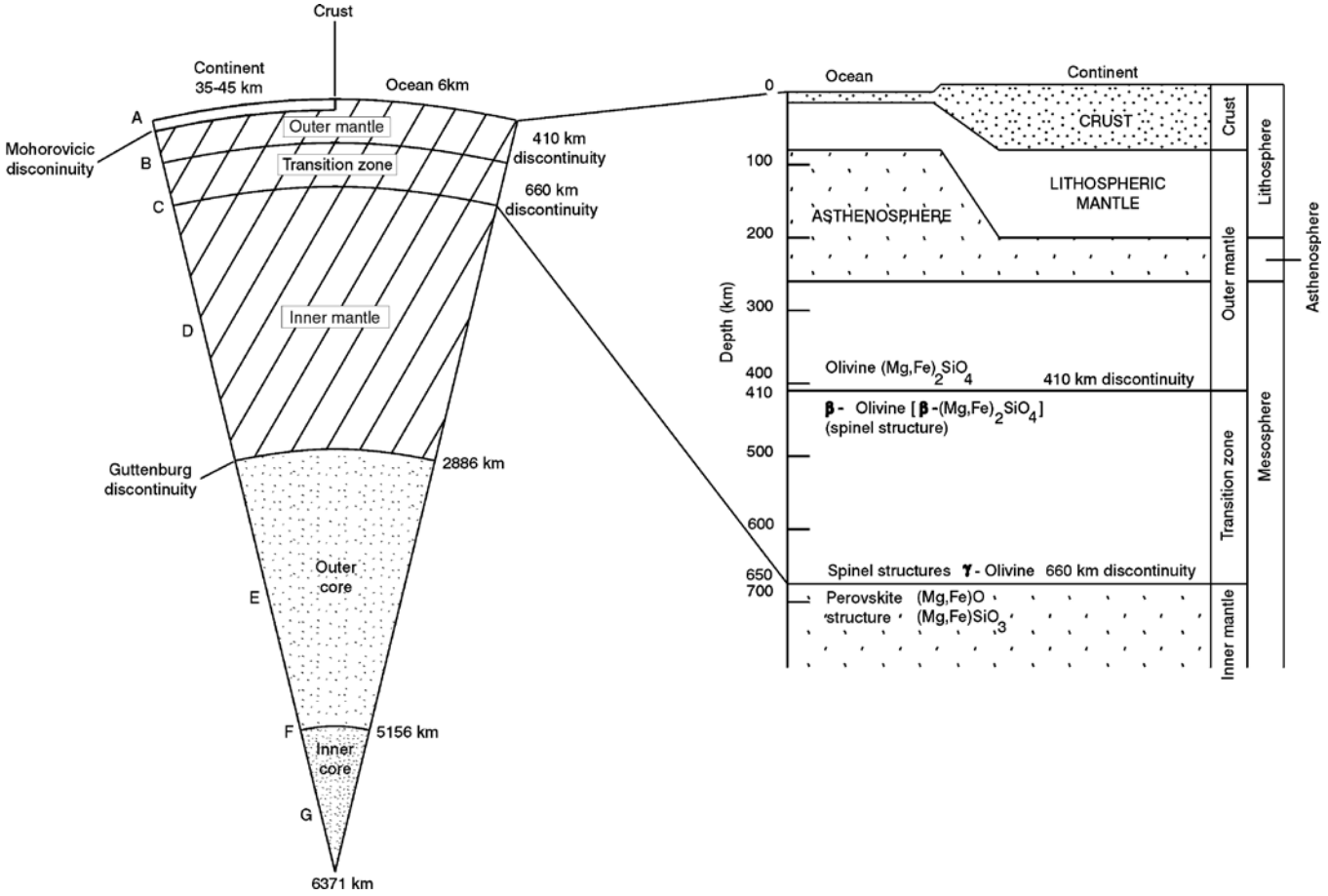


***Figure 4**. The internal layered structure of the present earth (after Bott[115]).*

Most researchers in high-pressure mineral physics and the seismic structure of the earth have ascribed the phase transitions in mantle minerals, including the main seismic velocity discontinuities at 410 km and 660 km depth, as occurring **from the lower pressure phases to the higher pressure phases**, due to increasing pressure with increasing depth. This assumption seems to be implicit in all current high-pressure mineral physics research.

Holmes,[125] for instance, notes regarding phase-changes and mantle structure:

> *'In the mantle continuous rise of density with depth depends on the effect of pressure in compressing the lattice structures of crystalline minerals. At certain critical depths a discontinuous jump to a higher density may occur either because the lattice has been modified into a different and tighter pattern, or because the minerals have absorbed sufficient energy to break down into their constituents ... which recrystallise in denser forms.'*

More recently, Jeanloz[126] stated:

> *'... the rapid increases in seismic wave velocities that define the* 'transition zone' *in the mantle at depths of 410–660 km ... are classically interpreted as being due to pressure-induced phase transitions in olivine. Just as graphite transforms to diamond at high pressures, olivine is known to transform to spinel and perovskite-type crystal structures at the pressures of the transition zone.'*

Dearnley[127] however notes that:

> *'Egyed*[128–130] *has previously suggested Earth expansion resulting from high to low pressure phase changes accompanying the inward movement of the isobars with decrease of G.'*

It is postulated here that these phase changes occurred due to the **release of pressure** consequent upon the postulated reduction in the magnitude of G. This caused the mantle minerals to convert to their present low-pressure structures, with consequent decrease in density and increase in volume.

The conversion of the transition zone minerals to the lower pressure, lower density phases resulted in a radial expansion of the earth of about 95–100 km. These outward redistributions of mass probably caused a decrease in the earth's rotational velocity, which may have been partly compensated for by inward redistribution of mass involved in the differentiation of the solid inner core from a single created liquid core (Figure 1), and due to collapse of the vapour canopy.

### *Crust (Depth: 0–80 km)*

The earth's crust (Figure 4) is comprised of continental crust and oceanic crust.[131–133] Continental crust is generally andesitic in composition, and varies in thickness from about 20 to 100 km (average 39 km). Oceanic crust is generally basaltic in composition and varies in thickness from 3 to 10 km. It is considered that the different natures of the continental and oceanic crusts reflect their different modes of origin.

**CONTINENTAL CRUST:** The continental crust mass is approximately 71 % of the total crust mass and 2.1 % of the mass of the mantle.

It is generally agreed among secular researchers that the earth's present continental crust has resulted from differentiation from the mantle, mostly during the Archean, and models for this differentiation have been constructed.[134–136] Patchett[134] for instance describes a plume-driven mantle differentiation model of continental crust formation, commencing in the Archean, which fits the Flood differentiation model presented here:

> *'... the main advantage of a plume-driven crustal genesis model, ... mantle plumes are a straightforward product of the Earth's heat ... and should have been most common in the Archaean, becoming steadily less so with time. ... The intense crustal growth in the late Archaean and early Proterozoic was followed by generally smaller-scale pulses extending to the present day.'*

In the Flood differentiation model presented here, the pre-Flood crust was completely destroyed and the present continental crust was formed by mantle differentiation, probably during the first forty days of the Flood.

Wedepohl[137] developed a *'standard [continental] crustal profile'* with symbolized compositions and processes, from the European Geotraverse. Wedepohl's model comprises, from the surface down; sedimentary rocks, granite and tonalite plutons, mica schists, gneisses, amphibolites, felsic granulites, mafic granulites to the Moho, below which occur the spinel lherzolites and spinel harzburgites of the outer mantle.

Rudnick[138] summarises current ideas regarding the origin of the continental crust as follows:

> *'... there is considerable debate regarding how and when [the continents] formed and the processes responsible for their unique composition. Did the present mass of continents form very early in Earth's history [supposedly 4.0 Gyr ago], with past and present growth counterbalanced by recycling of crust into the mantle? If so, what were the main processes that formed the early crust and how do they compare with those operating today?'*

Maaloe and Steel[131] suggest that the continental crust was formed by differentiation from the *'primitive mantle'* and that a model composition of the primitive mantle before continent formation may be approximated by adding the composition of the crust to the average composition of the present mantle. In the creationist model this would equate to working out the composition of the created mantle.

**OCEANIC CRUST:** The oceanic crust mass is approximately 29 % of the total crust mass.[139]

In contrast to the continental crust, the structure of the oceanic crust is fairly consistent, comprising four layers:

Layer 1; approximately 300 m of semi-consolidated to unconsolidated deep-sea sediments. Layer 2; 1,000–1,500 m of basaltic pillow lavas. Layer 3; 3,000–6,500 m of sheeted dyke complex overlying a gabbroic magma chamber. Layer 4; layered peridotite overlying the Moho, below which is the peridotite and dunite of the outer mantle.[140,141]

It is postulated here that the basaltic oceanic crust formed due to decompression melting of peridotitic mantle material during stretching of the oceanic lithosphere due to earth expansion.

### *Hydrosphere*

The total volume of free water at the earth's surface[142] is $1.384 \times 10^9$ km$^3$. In an earlier paper, I postulated that 89 % of the present free water at the earth's surface was exsolved from the mantle during the Flood as *'the fountains of the great deep'* and 1 % was precipitated from the pre-Flood canopy.[7]

### *Atmosphere*

The troposphere, the lower part of the present atmosphere, must be essentially the same composition as the antediluvian atmosphere beneath the canopy, as it supports the same air-breathing creatures, plants and mankind. The upper present atmosphere probably differentiated into the stratosphere, mesosphere and thermosphere after dissipation of the canopy, probably during the first forty days of the Flood.[143–146] As previously discussed, any volatiles exsolved from the mantle during the Flood must have precipitated in sediments in the Floodwaters, otherwise they would have toxified the present atmosphere.

## The Genesis Flood

Genesis 6:13. *'And God said unto Noah, The end of all flesh is come before me; for the earth is filled with violence through them; and, behold, I will destroy them* ***with the earth*** *[emphasis added].'*

Genesis 6:17. *'And, behold, I, even I, do bring a flood of waters upon the earth,* ***to destroy all flesh****, wherein is the breath of life, from under heaven; and* ***every thing that is in the earth shall die*** *[emphasis added].'*

Genesis 7:4. *'For yet seven days and ... every living substance that I have made will I destroy from off the face of the earth.'*

Genesis 7:21–23. *'And all flesh died that moved upon the earth, both of fowl, and of cattle, and of beast, and of every creeping thing that creepeth upon the earth, and every man:* ***All in whose nostrils was the breath of life,*** *of all that was in the dry land, died. And every living substance was destroyed which was upon the face of the ground, both man, and cattle, and the creeping things, and the fowl of the heaven; and they were destroyed from the earth ... [emphasis added].'*

The huge scale differentiation of the earth's mantle from 660-km depth, and destruction of the antediluvian crust, as proposed in the Flood model presented here, would appear to be much more catastrophic than necessary to destroy mankind and air-breathing creatures.

Genesis 6:13 indicates that the destruction of ***'the earth'*** was part of God's intention for the Flood. In the process of destroying and re-making the earth, God was, in effect, setting up the geography of the earth's surface for the next millennia, until Christ's return and the *'new heaven and a new earth.'* (Matthew 24:35, 2 Peter 3:13, Revelation 21:1)

The post-Flood geography, including the distribution of continents, oceans, islands, mountain ranges, rivers and lakes, and of natural resources such as fertile soils, fossil fuels, and minerals, would, by strongly influencing trade, migration and wars, etc., to a large degree influence the geo-political history of the post-Flood world.

### *Initiation of the Flood*

Genesis 6:5–7. *'And God saw that the wickedness of man was great in the earth, and that every imagination of the thoughts of his heart was only evil continually. And* ***it repented the Lord that he had made man on the earth,*** *and it grieved him at his heart. And the Lord said,* ***I will*** *destroy man whom I have created from the face of the earth ... for it repenteth me that I have made them [emphasis added].'*

Genesis 6:13. *'And God said ...The end of all flesh is come before me ... behold,* ***I will destroy them with the earth*** *[emphasis added].'*

Genesis 6:17. *'And behold, I, even I, do bring a flood of waters upon the earth ...'*

Genesis 7:4. *'For yet seven days, and I will cause it to rain upon the earth forty days and forty nights ...'*

Genesis 7:10–11. *'And it came to pass after seven days, that the waters of the flood were upon the earth. In the six hundredth year of Noah's life, in the second month, the seventeenth day of the month,* ***the same day*** *were all the fountains of the great deep broken up, and the windows of heaven were opened [emphasis added].'*

Creationist descriptions of the Flood event must, it is suggested, explain its sudden initiation (Genesis 7:11, '**the same day**').

Austin *et al.*[20] have summarised the events postulated to have initiated the Flood as constituting one or a combination of the following:

a. The ***'direct hand of God'.***
b. The ***'impact or near-miss'*** of an astronomical object or objects.
c. Some ***'purely terrestrial event or events.'***

It is here suggested that any creationist explanation of the

initiation of the Flood must, ultimately, resort to the ***'direct hand of God'.***

Whitcomb and Morris[147] speculate concerning the initiation of the Flood as follows:

> *'Great volcanic explosions and eruptions are clearly implied in the statement that "all the fountains of the great deep (were) broken up" ... great quantities of liquids, perhaps liquid rocks or magmas, as well as water (probably steam) had been **confined under great pressure** below the surface rock structure of the earth since the time of its formation and that this mass now burst forth through great fountains ... [emphasis added].'*

Many creationist writers have recognised the requirement for an extremely large amount of energy to initiate the Flood process. Brown[148] for instance, suggests a build-up of subterranean water pressure, culminating in the explosive failure of the crust, Baumgardner[149] suggests gravitational potential energy, perhaps triggered by meteorite impact, and Auldaney,[150] Fischer,[151] Spencer[152] and others, have suggested meteorite/asteroid impacts, and/or a close fly-by of a large planetary body.

John Woodward, a contemporary of Sir Isaac Newton, proposed in 1695[153] that *'the action and suspension of the Newtonian force of gravity'* caused the Genesis Flood. I postulate, similarly to Woodward, that the energy required to initiate the Flood constituted ***'negative gravitational potential energy'*** resulting from a sudden, temporary reduction of the magnitude of the gravitational constant resulting in a sudden decompression of the earth. The duration of such a reduction of the universal gravitational constant (G) may be difficult to determine, however only a few hours may have been sufficient to initiate mantle melting and irreversible differentiation.

The Flood was thus, I postulate, and as speculated by Whitcomb and Morris, initiated by a sudden significant **reduction of pressure** within the interior of the earth. This initiated canopy condensation and collapse (*'the windows of heaven'*) and mantle melting and differentiation, in particular, reactions involving the formation and exsolution of water (*'the fountains of the great deep'*).

### *Canopy collapse (*'the windows of heaven'*)*

> Genesis 7:4. *'For yet seven days, and I will cause it to **rain upon the earth forty days and forty nights** ...'* [emphasis added].
>
> Genesis 7:11–12. *'In the six hundredth year of Noah's life ... the same day were all the fountains of the great deep broken up, and **the windows of heaven were opened. And the rain was upon the earth forty days and forty nights**'* [emphasis added].
>
> Genesis 8:2. *'The fountains ...and the windows of heaven were [had been] stopped, and **the rain from heaven was restrained**'* [emphasis added].

An immediate effect of a sudden decompression of the earth would have been a reduction of atmospheric pressure, which would have promoted condensation of the postulated superheated steam canopy as proposed by some creationists.

One of the main objections to the canopy model, apart from the antediluvian earth surface temperature problem,[154] has been the predicted large atmospheric and ocean temperature rises resulting from latent heat of condensation during canopy condensation and collapse.[155, 156] Morton[157] recognised the heat dissipation problem and suggested that the Flood may have been initiated by a reduction of the permittivity of free space, suggesting that:

> *'The permittivity hypothesis is the only creationist theory which can account for the absorption of enough heat at a rapid enough rate to allow for 40 days and nights of rain.'*

Walters[156] suggested that the *'energy load'* on the atmosphere resulting primarily from *'the energy released by the canopy when it condenses; would have caused atmospheric temperature rises much too high to **sustain** life'* [emphasis added].

As the Flood was specifically engineered to destroy terrestrial life on Earth, even extremely high atmospheric and oceanic temperatures, in specific areas, during canopy collapse should not have been a problem regarding the sustaining of life.

Significantly, Walters speculated that the Flood rainfall may not have covered the whole earth, but may have been *' concentrated near the equatorial belt, with lighter rains in the more extreme latitudes?'*

In 1996 I postulated a canopy collapse scenario involving destabilisation of the canopy base by pressure perturbations caused by large Archean caldera collapse structures and associated volcanic eruptions on the earth's surface at the initiation of the Flood.[7] Depressurisation of the canopy may, I suggest, also have promoted condensation.

Some secular authors have speculated that ocean temperatures in Archean times may have been very high. Costa, *et al.*,[158,159] for instance, note that there is evidence that; *' ocean temperatures may have been **near the boiling point** in the Archaean'* [emphasis added].

Such evidence would suggest that the high temperature Flood *'rain'* may have been concentrated, not in the equatorial areas, but in the Archean portions of the Precambrian Shields. Here canopy collapse may have been initiated by caldera collapse structures and volcanic activity associated with the rise of large *'mantled gneiss domes'* and *'gneiss fold ovals,'* the major tectonic structures of the Archean. The latent heat of condensation of the canopy would have been dissipated into the 'oceanic' Flood waters. In areas distant from the Precambrian Shields, the Flood waters, and the atmosphere, would have been cooler, allowing sea creatures, and the inhabitants of the Ark to survive. This may provide further tentative clues regarding pre-Flood geography as to the location of the construction of the Ark and its journey upon the waters.

### *Mantle melting and differentiation*

The physico-chemical processes of mantle melting and differentiation are extremely complex.[160–168] Consequently, the development of a comprehensive model of mantle melting and differentiation due to a sudden reduction in pressure is beyond the scope of this paper. Thus, only a brief outline of the envisaged scenario can be attempted.

It is proposed that the key to understanding Flood mantle melting and differentiation processes lies in determining the effect of a sudden decompression on a reconstituted pre-Flood mantle-crust-hydrosphere.[131]

I propose that the created mantle was maintained at a critical pressure and sub-solidus temperature by pressure determined by the magnitude of the created gravitational constant. The postulated de-compression of the earth would lower the solidus temperature causing melting of mantle minerals and initiating mantle differentiation.

Several secular authors have postulated that melting of mantle material is initiated by depressurisation. Nielson and Wilshire[169] for instance suggest:

> *'Melts form when a portion of the mantle exceeds the solidus temperature by progressive heating or **depressurization** ... [emphasis added].'*

McKenzie and Bickle[170] note that magma is generated by decompression melting beneath mid-ocean ridges due to lithospheric extension and Asimow *et al.*[171] discuss pressure-release melting of the earth's mantle.

Wyllie[172] examines the effect of water on the conditions for melting in the mantle, and suggests a model for magma generation involving diapiric uprise of mantle material. He proposes that uprise of magma may have begun at the base of the low velocity zone, at depths of the order of 300 km, being triggered by the outward migration of water from within the deep mantle. Interestingly Wyllie cites ***'gravitational instability'*** as initiating the outward migration of water and mantle material.

Secular researchers thus recognise that depressurisation plays a vital role in mantle differentiation and melt generation.

### *Water exsolution (***'the fountains of the great deep'***)*

Genesis 7:11. *'In the six hundredth year of Noah's life, in the second month, the seventeenth day of the month, **the same day** were **all the fountains of the great deep** broken up ...[emphasis added].'*

The water of the *'fountains of the great deep'* is considered to have been derived by exsolution of water from the differentiating transition zone and outer mantle.

The significant role of water in the generation of mag-

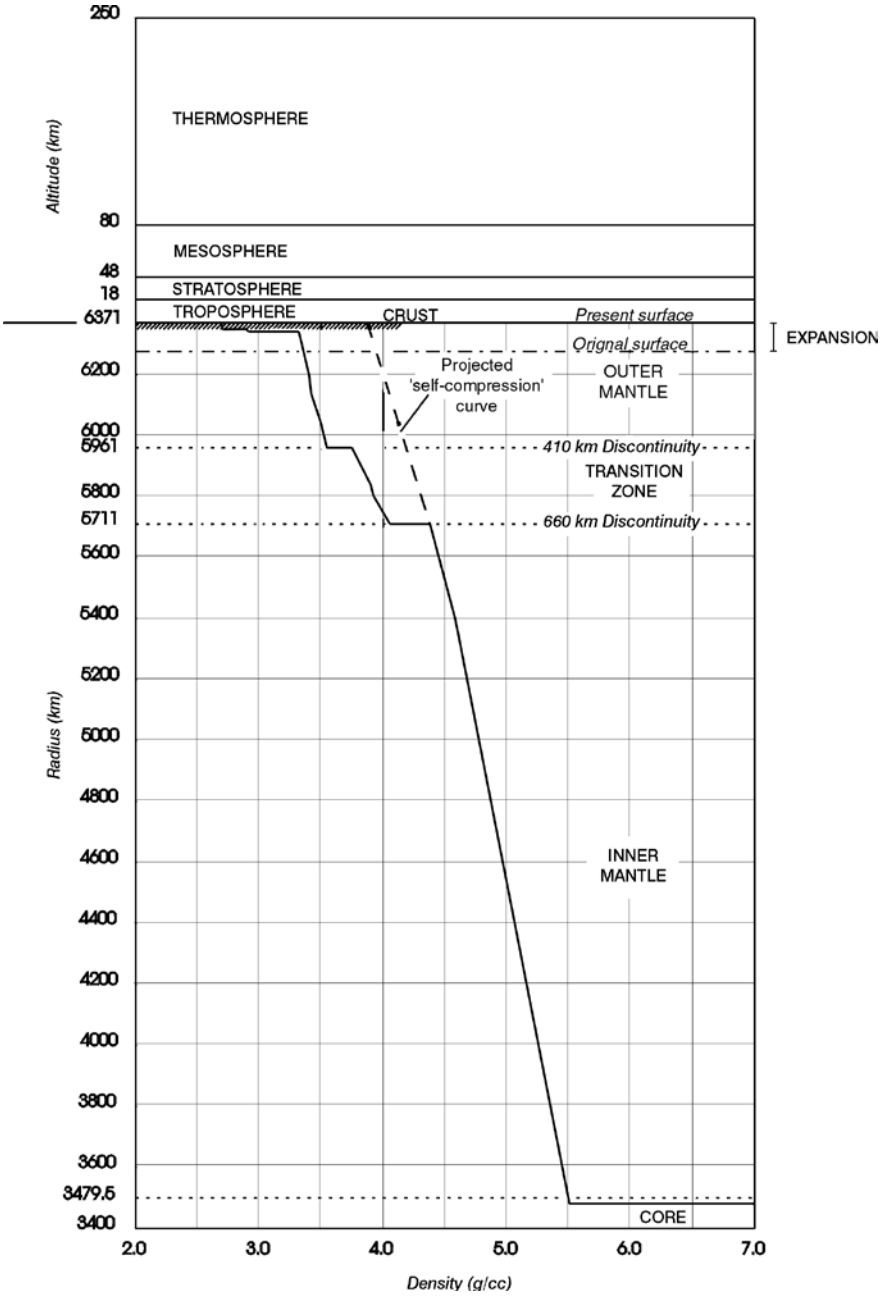


***Figure 5.*** *Density profile through earth's inner mantle, transition zone and outer mantle (Model ak 135 of Kennett* et al.*[105]). The expansion of the earth's surface due to differentiation during the Flood is indicated. Note that a different distance scale applies to the atmosphere than applies for the solid earth.*

mas and the initiation of diapiric uprise of mantle material had been recognised by mantle researchers for many years prior to the mid 1970s.[172–182] Researchers had speculated regarding the origin of the earth's oceans and atmosphere by (catastrophic) *'de-gassing'* of the mantle.[183–185] Bell and Rossman[186] note:

> *'Determination of Earth's water budget and the identification of suitable repositories for H [colloquially "water"] in the mantle are long-standing problems in geology with important implications for the evolution of the planet as a whole.'*

Wyllie[172] wrote, regarding the role of water in magma generation and initiation of diapiric uprise in the mantle:

> *'... the most reasonable model for magma generation involves the diapiric uprise of mantle material ...'*

and proposed that:

> *'... uprise may begin at the base of the low velocity zone, at depths of the order of 300 km, and ... uprise may be triggered by the outward migration of water from within the deep mantle.'*

In the mid to late 1970's, researchers began to identify specific minerals as possible hosts for water in the mantle. In 1980 Akimoto *et al.*[187] suggested hydrous magnesian silicates as hosts for water in the transition zone, and in 1985 Kato *et al.*[188] studied the stability of phase β, a hydrous magnesium silicate, to 2300 °C at 20 GPa.

Smyth, in 1987[189] cited β-$Mg_2SiO_4$ as a host for water in the mantle, and in 1994[190] proposed a hypothetical ordered model for **hydrous wadsleyite** ($Mg_7Si_4O_{14}(OH)_2$). He predicted a maximum $H_2O$ content for the hypothetical phase of 3.3 wt%, implying that the transition zone of the mantle might contain several oceans of $H_2O$ if fully hydrated.

Finger *et al.*[191] describe the crystal structure and crystal chemistry of phase B ($Mg_{12}Si_4O_{19}(OH)_2$) and suggest that the reaction B + spinel -AnhB + $H_2O$ or B + stishovite - AnhB + $H_2O$ could be a mechanism for storage and release of large volumes of water.

Thompson,[192] Bell and Rossman,[186] and Bai and Kohlstedt[193] have reviewed the stability of various phases of hydrous magnesian silicates, and note that:

> *'... of the nominally hydrous phases believed to make up the upper mantle and transition zone, none has been reported with a greater H content than wadsleyite (β-$Mg_2SiO_4$). ... If the Earth's mantle between 400 and 525 km were 60% fully hydrated wadsleyite with a density of 3.5 g/cm$^3$, the amount of $H_2O$ incorporated in this phase would be equal to a worldwide ocean more than 8 km deep or more than four times the amount of $H_2O$ currently in the Earth's hydrosphere.'*

Thompson[192] notes:

> *'Since it was first reported that DHMS [Dense Hydrous Magnesian Silicates] were found when the simple system MgO–$SiO_2$–$H_2O$ was subjected to high pressure and temperature there have been repeated suggestions that such minerals might be able to store water deep in the mantle. ... most of the nominally anhydrous minerals (NAMS) in the mantle contain structurally bound OH. Pyroxenes contain 200–500 ppm water, and β-$Mg_2SiO_4$ has been found to contain up to 4,000 ppm (0.4 wt%) water.'*

These findings may be highly significant for a catastrophic Flood mantle differentiation model.

## The pre-Flood/Flood boundary

In the Flood geological model presented in this paper, the only *'rocks'* which can be considered to retain their pre-flood characteristics are those of the inner mantle, and the core, below the 660-km discontinuity. Seismic evidence suggests that even the rocks of the inner mantle may have changed their characteristics slightly due to the reduction of hydrostatic pressure throughout the earth due to the postulated decompression although the effects of the pressure reduction should diminish with depth.

The pre-Flood/Flood boundary is thus considered to occur at the base of the earth's transition zone, at the 660-km discontinuity.

Above the 660-km discontinuity, the rocks of the transition zone and outer mantle would have suffered progressively more complete disintegration of their created perfection towards the earth's surface. The reduction of confining pressure towards the earth' surface would have allowed progressively more magma differentiation, mixing of mineral components, and disintegration of the mantle structure.

This decompression model explains the progressive change in the composition of rocks from deep in the mantle towards the surface. The deeper rocks such as dunites, peridotites, pyroxenites are almost monomineralic (90+% olivine) while the shallower rocks such as granites are polymineralic. This variation perhaps reflects progressively more mixing of components in the shallower, lower-pressure outer mantle during the Flood catastrophe.

The mineralogical phase changes principally at the 660 and 410-km discontinuities, resulted from a sudden decrease of confining pressure. This is contrary to the general conception of cause by increase of confining pressure with depth.

The consistent reduction in the density of the crustal sedimentary pile towards the earth's surface probably reflects the progressive reduction with time, of the energy, and thus the load-carrying capacity, of the Flood waters as they waned toward the end of the Flood. This is contrary to the common interpretation, that density increases downward due to the weight of overlying sediment.

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