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USING T. C. CHAMBERLIN'S APPROACH FOR DETERMINING THE FORCES THAT MOVE THE EARTH'S TECTONIC PLATES

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USING T. C. CHAMBERLIN'S APPROACH FOR DETERMINING THE FORCES THAT MOVE THE EARTH'S PLATES

By Jon Thoreau Scott

Life is frittered away by detail…Simplify, simplify.
Henry David Thoreau, (Walden)

ABSTRACT

The approach in this paper stems primarily from the application of principles of the philosophy of science to determine if the current ideas on the forces of plate tectonics are plausible. The philosophic principles used are (1) Bacon's scientific method using T.C. Chamberlin's idea of examining multiple hypotheses; and (2) the characteristics of a valid theory. The driving forces of plate tectonics are not well understood. In particular, it is shown herein that the mantle convection and mantle plume models are suspect primarily because these models cannot explain the very important anomaly that oceanic ridges between continental plates migrate away from the continents. These two convective models also have difficulty explaining many other anomalies and are termed "geomyths." Using Occam's razor, a comparison of the ridge push forces of the plate model and a "far above" mechanism, suggested by the author, leads to a preference for the latter.

INTRODUCTION

It took fifty years for the concept of continental drift to be recognized by many geoscientists, because most did not utilize simple philosophical ideas including Chamberlin's (1890, 1897) concept of examining multiple hypotheses, Bacon's (1620) scientific method that Platt (1964) calls *Strong Inference,* Popper's (1963) ideas on falsification and Kuhn's (1962) arguments on scientific revolutions. Instead of examining the evidence that Alfred Wegener (1912, 1929, 1966) presented to show that the continents must move most geoscientists adhered to a shrinking Earth concept that did not explain all of the observed geological features on Earth such as the preferred locations of mountain ranges, volcanoes and earthquakes. This hypothesis of continents fixed in place, a corollary of the shrinking Earth concept, was wrong but was kept alive for fifty years. In their mantleplumes.org (hereafter mp. o) entry Anderson and Hamilton (2008) suggest that this paradigm of continental fixity became "zombie science" and a scientific myth which is quite common in science (see also Armstrong, 1991; Fanchi, 1996; Anderson, 2002, 2013; Dickenson, 2003; Charlton, 2008; and Scudellari, 2015). These authors state or imply that it is the peer review system that keeps incorrect paradigms alive by preferential rejection of research proposals and technical papers that differ from the conventional wisdom adhered to by peer reviewers.

The characteristics of a good theory are used in this paper as a method of examining plate motion hypotheses. The most important characteristic is that a theory (paradigm, hypothesis, mechanism or model) must be consistent with all observations. If a theory cannot explain how any one of the most simply observed features of the Earth is formed, that theory should probably be excluded. *Ad hoc* additions and complicated mathematical theory allow wrong ideas to become myths. Geosciences would progress much faster than is usual if the scientific method and these characteristics of theories were applied in the testing of multiple hypotheses. Unfortunately, this has not been the case in the search for the forces that cause of the movement of the Earth's tectonic plates.

SIMPLE PHILOSOPHIC CONCEPTS

No amount of experimentation can ever prove me right;
a single experiment can prove me wrong.
From: "The Quotable Einstein" by Alice Calaprice (2005), Princeton Univ. Press.

There are an impressive number of papers, textbooks and internet diagrams attempting to explain why mantle convection and plumes cause plate motion. The researchers use tools such as tomography, sophisticated mathematics, computer models and isotopic analysis, with many assumptions, to prove that convection (Hess, 1962) and plumes (Morgan, 1971) produce plate motion. Why are efforts to prove that hypotheses are correct so rampant in the geosciences?

It is argued here that simple concepts should be applied when dealing with the testing of scientific hypotheses of plate motion well before complicated models and sophisticated data analysis are attempted. A good theory must be consistent with all of the pertinent observations and these explanations of consistency should be as parsimonious as is possible, according to Occam's razor, but no simpler than needed. Many observations that are needed for examining the forces of plate motion are indeed quite easy to understand.

T.C. Chamberlin (1890), who wrote the first version of *Studies for Students* when he was President of the University of Wisconsin, and the second after he organized the Journal of Geology (1897), asked why many scientists use their "Ruling Theory" in research instead of examining multiple hypotheses that are treated as equally as possible.

Instead of taking the advice of Chamberlin on the evaluation of multiple hypotheses and that of Francis Bacon (1620), (see Platt, 1964) on the scientific method, most scientists who support the convection (or bottom-up) mechanisms of plate tectonics fall into the trap of the "Ruling Theory" that Chamberlin warned against. He argued that scientists should avoid the temptation of considering an idea which a scientist has developed, or has studied, as that scientist's "intellectual child." All of the possible hypotheses should be treated as a scientist's own "child."

In *Strong Inference* John R. Platt (1964) discusses how he thinks science could proceed rapidly by using the scientific method of Francis Bacon (1620). He states that strong inference is based upon the systematic application of:

(1) Devising alternative hypotheses.
(2) Devising a crucial experiment (or observation program), or several of them, with alternative possible outcomes, each of which will, as nearly as possible, exclude one or more of the hypotheses.
(3) Carrying out the experiment (observations) to get a clean result.
(4) Recycling the procedure, making sub-hypotheses to refine the possibilities that remain, and so on.

The procedure is called "Baconian exclusion." Platt quotes Bacon:

> *"My way of discovering sciences goes far to level men's wit and leaves little to individual excellence because it performs everything by the surest rules and demonstration…Truth will sooner come from error than from confusion."*

Platt goes on to write:

> "*The difficulty is that disproof is a hard doctrine. If you have one hypothesis and I have another, evidently one of them must be eliminated…Perhaps this is why so many scientists are disputatious."*

Perhaps this is also why Thomas Kuhn (1962) suggested that "normal science" is what changes paradigms by the accumulation of anomalies to the existing conventional wisdom. A scientific revolution takes place when the anomalies overwhelm the central theme of the existing paradigm. The scientific method, or strong inference of Platt, described above, is rarely employed in evaluating multiple hypotheses (Platt, 1964, Armstrong, 1991, Dickenson, 2003, Anderson, 2013). Dickenson (2003) also discusses the use of multiple hypotheses and contends that strong inference suggested by Platt (1964) can prevent scientists from lapsing into the mythical mode of an idea. Platt states that conscious use of Bacon's method causes rapid progress in some sciences.

While the idea of strong inference (SI) of Platt (1964) has been quoted widely in the science and social science literature, there has been some criticism on its application to many problems including problems in most of the geosciences and astronomy where experimentation is not possible. O'Donohue and Buchanan (2001) discuss the application of SI, as suggested in the list above, and point to many problems that exist when only one scientific method is used (see also Feyerband, 1975). Much of their criticism attacks the letter of the procedure as stated in the four steps mentioned above, but not its spirit. The spirit, not the exact procedure, is that hypotheses should be compared on how well they stand up to empirical fact whether it be experimental or observational. A great chef does not follow a recipe in its detail. Instead chefs use their judgement after many tests of what makes a great dish. Thus, to prescribe that SI uses only the "recipe" given above is misleading. O'Donohue and Buchanan (2001) discuss the approach of several great scientists (Galileo, Darwin, Lyell and Newton) who they claim did not use *the* scientific method (SI), but when one allows that deviation from the four statements of Platt's SI is within the spirit of the method and not just the letter one can realize that inductive reasoning was used by those scientists. For example, Galileo had in mind the two competing systems (hypotheses) on how the planets and Earth moved in his dialogue on the Earth and Sun-centered possibilities. Measurements were made in accordance with excluding one of these proposals (moons of Jupiter, craters on the moon, phases of Venus etc.). A similar statement can be made for Darwin's observations concerning the examination of the creation hypotheses versus his own emerging ideas on natural selection. It is believed here that the spirit of the scientific method, especially the examination of alternative hypotheses, is a common theme is science even though it is not always stated by scientists. It is the view of this author that the comparison of multiple hypotheses (Chamberlin, 1897) can be accomplished by use of observations, not just the results of actual laboratory experiments and not only those hypotheses generated by an individual scientist. This is the sense of the Einstein quote given above.

It is, no doubt, correct that background knowledge and such things as serendipity (Blanchard, 1979, 1996; Schaefer, 2013) play a role in scientific progress. Schaefer (pers. Comm. 1994) states that serendipity "happens to those who have a sagacious mind." Or as Blanchard puts it Pasteur is reported to have said: "In the field of observation, chance favors the prepared mind." To say that such scientists as Galileo, Pasteur, Darwin and others did not consider alternate ideas (hypotheses) with the intent of ruling out one or more is not within the *spiri*t of Bacon's scientific method and is misleading. This is why this author broadens the concept of the scientific method to include the idea that a hypothesis (model, paradigm, etc.) should be examined using the characteristics of a good theory. One version of this idea comes from comments by Aaron Ihde (pers. comm,1962) when the author was a graduate assistant in his course "The Physical Universe." The course was part of an integrated liberal studies program, at the University of Wisconsin, Madison, that discussed the history and philosophy of science, in this case astronomy, physics and chemistry. Ihde suggests that good theories should:

(1) Explain all observations of phenomena or results of experiments.
(2) Be understandable, at least in a general way, to the interested layperson.
(3) Be reasonable so that they are testable (falsifiable or disprovable).
(4) Be economical or parsimonious (Occam's razor).
(5) Be predictive, or fruitful, leading to new observations or hypotheses.

The most important characteristic is that any theory, or hypothesis, must be consistent with all relevant observations. As Einstein says in the quote above it only takes one experiment (observation) that cannot be explained by a theory to prove it to be wrong. Some disagree with the concept that a theory can be proven to be wrong and Kuhn (1962) posits that concepts are right or wrong only within a given paradigm. In this paper the concept of exclusion is emphasized rather than whether a concept is right or wrong. However, in some cases such as continental drift versus fixed continents there can be only one possibility. The continents move or they don't. The same is true, of course, for the concept of a geocentric vs. a heliocentric planetary system. Either the Earth or the sun is at the "center" of the solar system. To say that there are other possibilities is very much like "arm waving" and does not consider all of the facts.

Many might disagree with the second characteristic mentioned in the list above, because some ideas, such as quantum physics, are not well understood even by many scientists. The third characteristic is designed to eliminate "all encompassing" theories that can be changed with the addition of *ad hoc* devices that allow the theory to explain some observations that it otherwise could not.

The fourth characteristic (Occam's razor) is a powerful tool for examining hypotheses and is best used when comparing two different paradigms (Anderson, 2002). The most parsimonious should be accepted and those with complicated assumptions and *ad hoc* additions should most likely be excluded.

OBSERVATIONS TO BE EXPLAINED

The Complex Earth is Simpler than You Think.
Don Anderson (2006)

This paper deals with several widely accepted observations of the Earth's crust and upper mantle. Mechanisms that are proposed to cause plate motion need to be consistent with these observations. They include:

(1) The ocean ridges are elevated some 1 to 2.5 Km above the abyssal plains on either side.

(2) The ridges between continental plates migrate from 1 to 2 cm/y away from their original locations next to the continents of the supercontinent Pangaea (*i.e.* westward, eastward and southward from Africa, or away from Antarctica on nearly all sides).

(3) The ridges between continental plates are approximately mid-way between the continents.

(4) The East Pacific Rise is the fastest spreading ridge.

(5) Ridges in the Eastern Pacific are being covered over by continents and thus seem to be nearly stationary with respect to the mantle.

(6 Seafloor spreading varies geographically.

Many scientists would consider other observations that should be included in an analysis of mechanisms, and some possibilities will be mentioned later, but it is suggested here that those above are enough to start with and are probably recognized by most geologists as being likely. If a hypothesis is inconsistent with any one of these it should probably be suspect if not excluded.

THE MULTIPLE HYPOTHESES

Dust and chaff are mingled with the grain in what should be a winnowing process.

T. C. Chamberlin

In the discussion of Platt's SI above the hypotheses generated in Bacon's scientific method are to be provided by the investigator (scientist) who is to do the experimentation. However, in many problems such as the determination of the forces of plate tectonics there are already a variety of hypotheses to consider that are already found in the geoscience literature. These are not necessarily all of those hypotheses that have been proposed, but they are those that are considered in this study.

After the discovery of sea floor spreading and the formulation of the plate tectonics concept there were several mechanisms developed to explain why the Earth's plates move. The following mechanisms will be compared:

(1) Mantle convection.
(2) Mantle plumes.
(3) The plate model.
(4) Trench rollback.
(5) The supercontinental cycle.
(6) The far above model.
(7) Polarized plate tectonics.
(8) Luna-tectonics.

Left out is the idea of an expanding Earth to explain continental drift that is shown by precise measurement not to be true. Also left out is Wegener's explanation that the continents "plowed" through a weaker oceanic crust forced by a "pole-fleeing" force that is shown to be untenable. Note that if any one of these proposed models cannot explain one of the simple observations listed earlier it should probably be excluded or at least suspect.

Mantle Convection. The idea of fixed continents with mountains formed by a shrinking Earth was finally set aside in the 1960s, when sea-floor spreading was discovered and the plate tectonics model was introduced. New ideas emerged that either mantle convection or mantle plumes produced plate motion. These convection mechanisms were supported by several highly-respected scientists; mantle convection was proposed by Arthur Holmes (1933, 1965), and plumes by Wilson (1963). The Holmes idea of convection currents was re-introduced by Hess (1962) to explain seafloor spreading.

The convection current mechanism was considered to be questionable soon after it was proposed in the early 1960s. For example, Menard (1986, pp. 183-84) writes about the confusion regarding the spreading ridge around most of Antarctica. The question was about how the ridge moved (the term used herein is "ridge migration"). Menard writes:

> *"The spreading rift merely drifted away from Antarctica. This may not have been easy to accept because, in the model of Dietz and Hess, the giant convection cells in the mantle would have to drift with the rift. I was among the majority who believed at the time that this was a major weakness in the convection-driven hypotheses... If the spreading was a fact, the spreading center <u>had</u> to drift, and the problem shifted to how the convection cells went with it, or a startling thought, whether the cells actually existed."*

If one follows a line on the Earth from west to east in the southern latitudes, that line crosses three ridges. These are the East Pacific Rise, the Mid Atlantic Ridge and the Carlsberg Ridge. Thus, there must be six rolls of convection producing seafloor spreading due to upward flow between the rolls. The rolls would have to be on either side of the ridges and would have to get larger so that the upwelling remains under the ridges. A parcel in one of the convection cells would take about 100 million years to complete one cycle. Thus, by the time a parcel goes around the ridge that started out at the edge of a continent (say Africa) the ridge has moved some tens of thousands of km to be about half way between Africa and the continents of the western hemisphere (South and North America).

The analogy to produce the upward flow often used is that of boiling water in a pot on a stove. This is completely inadequate as the upward plume of boiling water stays in place. On the Earth the upward motion would have to move. Note that the rolls on either side of the MAR would be oriented in the N-S direction while those between Africa and Antarctica would have to be oriented in the E-W direction. What would cause such a change in the direction of convection?

This ridge migration problem, as suggested by Menard, was never resolved. The problem is explained in Figure 1. Holmes original diagram shows the ridge to be stationary as shown in many diagrams in textbooks and the internet with subducting oceanic plates on either side. This is approximately the case for the East Pacific Rise, but that ridge is not in the center of the Pacific Ocean. Thus, such diagrams do not explain why the ridges surrounding the continental plates migrate. The East Pacific Rise may be the only ridge on Earth that is nearly stationary. No matter how many papers and textbooks one reads about the nature of the convection model there has not been any that show that the convection cells can change size and direction so that the upward flow between the cells is always *directly* under the ridges that migrate away from the continental plates such as Antarctica and Africa (as examples see the texts by Schubert, et al, 2001 and Kearey, et al, 2009). As it stands now, even if a model can produce convection that could show that the cells can change size with some fairly complex assumptions, it is suggested here that the convection model should be removed by Occam's razor because the assumptions would be too complex and probably not possible.

Perhaps another reason that the convection and plume models were introduced and have hung on for so long (about fifty years) is that they seem logical to the casual observers who are told that hot lava comes from volcanoes and islands such as Hawaii, and possibly, from deep in the mantle. The idea of an Earth-centered planetary system, another long-lasting geomyth, was believed for centuries because it seems obvious to casual observers that the sun goes around the Earth. It rises in the morning and sets in the evening. Copernicus had to look at another possibility (heliocentricity) to explain some of the obvious observations of planets and the Earth-centered system that used epicycles and other such devices to explain planetary motions, could be removed by Occam's razor as being too complicated.

Mantle Plumes. The plume mechanism was proposed by Morgan (1971, 1972). Both Hess and Morgan were at Princeton University and were highly respected in the geosciences and no doubt that encouraged many geologists to believe in these models for explaining plate motion. They are incomplete or incorrect, because they have difficulty explaining some of the well-known observations of the Earth's crust as is discussed later on, but they persist despite this problem. Dickenson (1963) calls the plume hypothesis a geomyth as does Anderson (2013). For a more complete review of the plume model see Anderson and Natland (2005) and Foulger (2010). It is possible that Morgan suggested plumes as a mechanism to explain plate motions to replace the convection current model because of the difficulties explained above by Menard (1986). He omits discussion of ridge migration in his original paper (Morgan 1971) but does discuss the problem in Morgan (1972).

The problem of ridge migration in the plume model is the same for plumes as it is for mantle convection (see Figure 1). Courtillot, et al (2003) show that some of the proposed mantle plumes, or hot spots as they are often called, are near ocean ridges, as Morgan (1971) proposed, but only in a few places. For example, there are no plumes around Antarctica and many plumes are in the mid Pacific and not near ridges. If plumes are always stationary and near mid-ocean ridges it is more likely that the manifestation of the plumes (igneous provinces, ocean island basalts etc.) are caused by what causes the ridges in the first place than by heated mantle that starts at the core mantle boundary (Anderson and Natland, 2005, Foulger, 2010). Morgan (1971) proposes that plumes are fixed with respect to the mantle and that they drive plate tectonics. Morgan (1972, p.208), however, does consider the problem of ridge migration. He states:

> *"Why are the mid-ocean rises "mid-ocean" and why is the magnetic pattern symmetrical about the rise crest? It would be easy to imagine that a rise creates new sea floor on one side only, analogous to the one-sided consumption of crust in the trench system."*

And here he explains the crux of the issue:

> *"As a consequence, rise crests cannot be fixed with respect to the mantle; they must migrate over the mantle to maintain their position midway between continents. An example of such ridge migration is seen for the rise boundaries that enclose Africa on three sides. As the Mid-Atlantic Rise spreads symmetrically, there is ever more sea floor between the rise crest and the African coastline. With a similar increase in the distance from Africa to the crest of the Mid-Indian Rise, the distance from the crest of the Mid-Atlantic Rise to the Mid-Indian Rise must be increasing."*

Refer to Figure 1 or any globe or map of ridges on the Earth, to see how this would work. And then Morgan (1972) changes the idea of fixed mantle plumes that was proposed in Morgan (1971). He suggests that only the plumes beneath the Mid Atlantic Ridge (MAR) are stationary. This is where Morgan is trapped by his Ruling Theory (Chamberlin, 1890, 1897) and has not taken Chamberlin's warning seriously. All the ridges associated with continental plates must move As Chamberlin puts it:

> *"The moment one has offered an original explanation for a phenomenon which seems satisfactory, that moment affection for his intellectual child springs into existence; and as the explanation grows into a definite theory his parental affections cluster about his intellectual offspring, and it grows more and more dear to him, so that, while he holds it seemingly tentative, it is still lovingly tentative, and not partially tentative."*

And later:

> *"Instinctively, there is a special searching out of phenomena that support it, for the mind is led by its desires. There springs up, also, an unconscious pressing of the theory to make it fit the facts, and a pressing of the facts to make them fit the theory*."

Still later:

> *"The theory then rapidly rises to the ruling position and investigation, observation and interpretation are controlled and directed by it. From an unduly favored child, it readily becomes the master, and leads its author withersoever it will."*

This is what happened to Morgan. His plume idea became his master, and this idea also became the master of many geoscientists who search for measurements, usually through tomography and use mathematical models that attempt to show that deep mantle plumes, or convection currents, exist. Morgan should have asked why the rises (ridges) east of Africa undergo seafloor spreading even if they are moving (rapidly) to the east. If plumes cause the ridges they would have to move eastward very fast to stay underneath the ridges for them to produce seafloor spreading. They cannot be stationary. He should also have asked how the "plumes" in the MAR cause Africa, and Eurasia to move rapidly to the east? The Eurasian continent is the largest and should be the hardest to move.

The peer review system helps to maintain the dominance of a paradigm whether it is a geomyth or not and this peer review process slows down the progress in science by squelching contradictory ideas even if some of them might be plausible. As Anderson (2002) states, the best way to compare conflicting paradigms is to use Occam's razor.

On a plaque near the Lincoln statue in front of Bascom Hall at the University of Wisconsin (one of the original buildings) there is a declaration that states the core of the University's mission. It reads:

> *"Whatever may be the limitations which trammel inquiry elsewhere, we believe that the great state University of Wisconsin should ever encourage that continual and fearless sifting and winnowing by which alone the truth can be found."*

Chamberlin (1890) who was President of the University of Wisconsin at the time refers to this plaque (see an earlier quote). Morgan and other enthusiasts of plume mechanisms also should have adhered to this advice.

The Plate Model. There are a growing number of geoscientists who question the current dogma of bottom-up models (convection and plumes). Most do not use the simple idea that convection and plumes cannot explain ridge migration, but there is plentiful other evidence against these models. There are two main alternatives that will now be discussed that Anderson (2001) terms "topside tectonics." The first is the plate model discussed in many papers including several in Foulger, et al (2005), Anderson (2006), Foulger (2010) and the second is the trench rollback (or trench suction) model discussed by Hamilton (2007). The plate model is most completely described by Anderson (2006, 2007, 2013) and Anderson and Natland (2005). Anderson's (2006) statement is that plate tectonics is:

> *"A far from equilibrium dissipative and self-organizing system that takes matter and energy from the mantle and converts it to mechanical forces (ridge push, slab pull) which drive the plates."*

The plate model assumes that the plates are part of a gravity-forced mechanism analogous to Marangoni (or Benard-Marangoni) convection (Anderson (2006). The plates drive themselves and become the self-organizing system. Thus, in this model, the mantle is cooled from above and not heated from below as is the case in the bottom-up (convection and plume) mechanisms. In essence Anderson (2006, 2007, 2013) rejects the convection mechanisms and states that the shallow mantle convection is driven at the top by the plates due to subduction at trenches and the sliding away from ridges and not from heating deep in the mantle near the Earth's core. In this view, the upper mantle is not homogeneous as would be expected if heating from below causes mixing as in the convection models. The plates are not rigid bodies but are held together by compression and gravity and have coherency of motion "as in a flock of birds or a billowing cloud." The plates are strong in compression like cathedrals or igloos but weak in tension (Anderson, 2005). They are not "rigid" as in many of the conventional arguments.

This "plate model" is elegant and simple in concept, as is the concept of self-organization, but this model does not explain how some of the observations mentioned earlier are produced. For example, although the model requires ridge migration, ridge elevation and the need for ridges between continental plates to be about mid-way between continents, it does not explain how these features are produced and none of the papers that describe the plate model discuss these problems. The ridge push force is mentioned as part of forces driven from above but is not described (see Anderson's definition above). Unless there is a physical explanation for producing these Earth features the plate model must be suspect. Self-organizing does not produce these features in some automatic way. It takes a specific set of forces to do the job.

Trench Rollback. This gravity mechanism requires that the subducting slabs roll back away from the continent or back-arc basins under which they sink at the trenches. Originally, Forsyth and Uyeda (1975) and Cox and Hart (1986) label this the "trench suction" force and the mechanism is discussed more completely in Hamilton (2007). Hamilton states that the subducting slabs do not "slide" under the continents at the trenches, but "roll back" (sink downwards) causing the advancing continents, or back-arc basins, to be pulled over the ocean plates as in the case of South America moving over the Nazca plate or the Australian plate moving over the Pacific plate. It is proposed herein that the South American and Australian plates would be pulled apart if the trench rollback mechanism were to be correct. Plates are not rigid in extension (Anderson, 2005). It is also very difficult to explain why the mid ocean ridges are elevated and why they must be mid-way between the continents (Africa and South America in the case of the Mid Atlantic Ridge). Why would the pulling of South America to the west cause the ridges around

Antarctica to be elevated? Hamilton (2007) states that the mid ocean ridges are "required" to be midway between continents, but he gives no reason for this requirement. For these reasons, it is posited that the trench rollback model is also excluded.

The Supercontinental Cycle. Evidence that the Earth has gone through several cycles of continent amalgamation and dispersion, possibly for most of Earth's existence, has been surmised for a long time by many authors, including Umbrove (1947) and Wilson (1966). It was not until a group led by Worseley, Nance and Moody (1982, 1991) summarized a data set on climate, sea level and fossils that showed that such a cycle is realistic. They called the process the supercontinental cycle. Nance and Murphy (2013) and Murphy and Nance (2013) provide extensive literature on this cycle of aggregation and break-up of supercontinents and speculate on the possible mechanisms of how the process takes place. This large set of papers will not be reviewed here, but it is evident from the literature that this important process is very real.

The break-up of continental aggregates such as Pangaea is based on the idea of Anderson (1984) that insulation of the mantle by the supercontinent creates a heat build-up and causes an aggregate of continents to rise. For example, the heat may cause the stagnant supercontinent to rise about 400m. Eventually, the force of gravity causes the continents to flow away from the geoid high that is caused by the heating.

Murphy and Nance (2013) speculate on how the cycle works involving two processes they call extroversion and introversion. The former is similar to the situation that exists today where the African, Atlantic, Indian, Eurasian and Antarctic plates are growing while the Pacific plate is shrinking due to subduction in the "ring of fire" that surrounds the Pacific. Introversion is a process where the internal ocean lithosphere forms subduction on the passive margins of the continental plates and the process causes the internal lithosphere to shrink and collide to form the next supercontinent. Note that the introversion process implies that the extroversion process must stop and so the cycle goes into reverse to reassemble the next aggregate of continents. Murphy and Nance (2013) propose that Pangaea was formed by the introversion process as suggested by the position of the continents of Pangaea. In this reversal the subduction on the passive margins of the expanding plates must overcome the force of subduction of the trenches of the exterior margins (such as the present trenches west of the Americas and the trenches along the western Pacific). In this reversal process Murphy and Nance (2013) suggest that a plume in the exterior ocean (for example the present Pacific Ocean) forms to produce a geoid high that drives the continents in a reverse direction.

Although the arguments of Murphy and Nance (2013) are convincing some questions remain about the forces involved. The process is similar to the plate model described above where most of the forces to move the continents are gravitational based upon ideas of Anderson (1984, 2001, 2006). What is the role of the present mid-Pacific rise in this process? Could the Pacific rise (ridge) have been involved in pushing the continents together to form Pangaea? How does the reversal of the direction of movement of continents cause the ridges of the interior ocean, for example, the present Atlantic and Indian Ocean ridges, to subside so that the continents flow toward what is formally higher elevation? Why does an extensive plume or geoid high form right at the time it is needed to push the continents back together? An alternative explanation is given by the mechanism of this author that is described below in which a ridge push force is the main driving force and the continents are pushed together to form the next supercontinent (see the paper "On the

Forces of Plate Tectonics" in the website www.tectonicforces.org). This mechanism involves only extroversion and that must be defended.

Far Above Tectonics (Expansion and Contraction of Ocean Crust at Ridges). The term "far above tectonics" is used herein for this mechanism based on the suggestion by Anderson (2006) at the end of that paper that the bottom-up models be termed "plutonics" and the plate models "platonics." This is because the driving forces of climatic variation in this mechanism originate at the top of the ocean, far above the ocean crust. Because this model has not been published in the standard literature (only on a website and in an unpublished book) it will be discussed here in more detail than the other hypotheses of plate motion.

This hypothesis of plate motion is analogous to the manner in which the area of ice on lakes in cold climates increases due to diurnal air temperature variations above the ice. The manner in which the lake ice expands and pushes against the lake shores is discussed by Scott (1926) and Zumberge and Wilson (1953).

For a more complete discussion of the far above mechanism as applied to the Earth see the paper *On the Forces of Plate Tectonics* that can be found on the website tectonicforces.org. Also, a book *Top-down Tectonics: The Role of Oceanus and Gaia* can be obtained from this author by contacting him by e-mail at jscott34@nycap.rr.com. The far above mechanism is most completely described in the book. In the paper *On the Forces of Plate Tectonics* several pictures of ridges and ramparts are shown. These can be very impressive and the force of compression that is produced on ice can be very powerful. Because the physics of ice and ocean crust are not very different, then the far above model should be considered to be an alternative to the existing models of plate motion.

On frozen lakes on a cold night with low snow cover on the ice it cracks near the top so that the distance perpendicular to the crack at the top of the ice is less than that at the bottom where the ice does not contract because the water temperature is 0^{o}C. The water freezes in the crack that is formed. If the next day is sunny or warm the ice at the top expands and so the area of ice on the lake must increase producing compression against the shores of the lake. Ice ramparts are formed on the shores and ridges may buckle up across the lake, often in similar locations each year.

As applied to the Earth the trigger for temperature variations comes from the long-term changes in climate such as those due to the Milankovitch periodicities (about 22, 41 and 96 Ky) as shown in Figure 2. The relatively small changes in climate due to the Milankovitch periodicities, produced by the astronomical variations in the Earth's orbit around the sun, are amplified by positive feedbacks. Much of the amplification is produced by the feedbacks probably due to the changes in greenhouse gases caused by the Earth's biota (Lovelock, 1979, 1988, 2009). For a discussion of the powerful manner in which greenhouse gasses can change climate refer to Ruddiman (2005) on how humans converted the Earth's climate from a probable ice age to the present warming of the planet.

The heat flow at the top of the crust at ocean ridges comes both from the mixing of heat downward from the ocean and from the steady conduction of heat from below through the crust that is about 6-10 Km thick and is illustrated in Figure 3. The downward heat flow in the ocean above a ridge is due to both deepening of the thermocline during warm periods vs. its rising during cold times, and also by changes in advection due to deep ocean circulation processes. For example, during warm climates the North Atlantic Deep Water and other such deep-water currents may be strengthened (Broeker, 1966)). Downward heat flux (or advection) can be as high or higher than the conduction through the crust.

This is because the eddy diffusivity of the ocean water is at least 180 to 300 times its molecular conductivity (Sverdrup et al, 1942; Broeker, 1966; Garrett, 1979; Wunch and Ferrari, 2004). Thus, when the ocean is warm, and the thermocline moves downward, the heat coming from above (D in Figure 3) can be much greater than that conducted from below (C in Figure 3). This may be surprising to many geologists because the heat from below is usually considered to be more important than the downward heat in the water (D). The fact that it may be the other way around justifies the term "far above tectonics" as is used in this paper.

During a time of cold seawater at the top of the crust it contracts as illustrated in Figure 4a. At this time MORB may flow up into the crack that is formed producing new crust when it solidifies. During warm climates (warm ocean seawater), as illustrated in Figure 4b, the crust expands at the ridges and causes seafloor spreading. This produces compression in the crust on either side of the ridges that push against the continents on either side. This expansion at the ridges causes the plates on either side of the ridges to get larger and thus a ridge, such as the Mid Atlantic Ridge (MAR) is forced to move to the west, with respect to Africa and Eurasia, and all other ridges associated with continental plates must move (migrate). The continents, such as North America, must also move, relatively, to the west.

The far above mechanism as applied to the Earth, when combined with the plate model, is illustrated in Figure 5. The result satisfies Anderson's definition of plate tectonics in that both slab pull and ridge push are needed to produce plate motion. Shown in Figure 5 is that seafloor spreading takes place at two ridges the MAR and the East Pacific rise (EPR). This spreading is driven primarily by the far-above mechanism ridge push force. The slab pull to the east of the Nazca plate adds to the ridge push in the EPR so that ridge has a very high spreading rate compared to the ridges associated with continental plates like the MAR.

Minerals such as eclogite are formed in the subduction process and by delamination and sink to levels according to their density (Anderson, 2007). They are passed over by South America which is moving, relatively, to the west and they rise passively beneath in the MAR to form new crust. It appears that the EPR does not move much because it is being passed over by the South American and other continental plates as they move.

Occam's Razor. Ridge migration is required of the far above mechanism because the new crust at the ridges must move as the continental plates get larger. For example, if the African and Eurasian plates do not move very much (at least relatively) the MAR will move to the west at half the spreading rate and the continents to the west (North and South America) will move westward at the spreading rate. The mechanism also requires that the ridges between continental plates be about half way between the continents because the distance from the continents to a ridge must increase and it is likely that new crust is formed about equally on each side. It also explains that the ridges are elevated similar to the manner in which pressure ridges buckle up on lake ice due to compression against continents on either side. The mechanism also explains why seafloor spreading varies geographically due to variation in the depth of sediments which insulate the crust from the temperature changes that come from above. Deep sediments insulate the ridges from the temperature variations and that would slow down the spreading rate where sedimentation is high. The ridge push force of the far above mechanism adds to the gravity force of subduction in the trenches and that helps to explain that the EPR spreads faster than ridges between continental plates. Thus, the observations mentioned earlier in this paper are explained parsimoniously so as to satisfy Occam's razor. No extra assumptions are needed (except those considered in the next section). When gravity and other forces of the plate model are added to the far-above model Anderson's definition of plate tectonics is satisfied.

Possible problems with the far above model. There are at least three possible problems with the far above mechanism. The first of these was suggested by a marine geologist when our seminar group (see Acknowledgements) sent an early version of our manuscript to 40 scientists for review. The marine geologist (at Lamont Geophysical Laboratory) thought that the crust at the top of ridges may not be strong enough to allow the thermal expansion, especially for short climatic variations, to push the plates away from a ridge. Would the crust at the top of the ridge be crushed rather than move the plates? There is no good answer to this possibility except to point out that oceanic crust is quite strong and the top of the asthenosphere is slippery with little friction. Figure 6 illustrates that the thermal pulses due to fairly long term climatic periodicities extend downward a few kilometers. Can this be enough to keep the ocean crust from being crushed?

A second difficulty is that the analogy to ridges on ice-covered lakes is not exact. On lakes the area of ice increases in all directions, but for ocean ridges it is proposed that the movement is *primarily* perpendicular and away from the ridges. What would prevent the mechanism from producing new crust along a ridge? The only reply to this is that the lithosphere grows rather fast on each side of a ridge preventing a large number of cracks from forming perpendicular to a ridge. See Figures 4a and 4b to see how the lithosphere thickness increases rapidly away from the ridge center. Although this is a cartoon diagram there are many such as these in the literature that show rapid growth in thickness of the lithosphere away from the ridge center.

A few scientists suggested that the temperature variation in the ocean above ridges is too small on geological time scales to cause the expansion and contraction of the crust at the top of ridges. The discussion regarding Figure 3 relates to this possible problem. The mixing of the ocean produces heat flow that is as high or higher than the conduction of heat through the crust, because the eddy diffusivity of ocean water is highly variable. Thus, the downward heat flow in the ocean is as large, or larger at times, than the conduction through the crust. Ocean water heating and the downward displacement of the thermocline over periods of thousands of years or longer is possible. Conduction through the crust of around 70 to 100 mW/m^2 is very small compared to typical fluxes in the atmosphere and upper ocean that is measured in W/m^2 not mW/m^2. Thus, it is heat flux and not the actual ocean temperature that governs the temperature change at the top of the crust at the ridges. The temperature change at the top of the crust (Figure 3) needs only to be a degree or two to explain the high downward heat flow at the ridges.

No doubt there may be more possible weaknesses pointed out if this paper gets a reasonable review so that it can be read by many geoscientists. Whether some of these possible weaknesses may be significant remains to be seen, but a reviewer who is susceptible to new ideas should allow ideas such as this to be available to the science community so that a fair discussion is produced (Fanchi, 1996). The present peer review system does not allow this to happen when a new idea is proposed that suggests changes to the current paradigm.

Polarized Plate Tectonics. A mechanism of plate motion caused by the forces of the moon and sun on the Earth has very recently been reviewed by Dogliani and Panza (2015) and Dogliani and Anderson (2017). The mechanism is also discussed in Dogliani et al (2005). The basic idea is that there is a westward drift of the lithosphere caused by gravitational attractive forces of the moon and sun. The mechanism involves tidal friction due to the force of attraction on the ocean together with decoupling of the lithosphere from the mantle due to low friction in the low velocity zone (LVZ). It is assumed that the LVZ is superadiabatic while the mantle below the LVZ is subadiabatic. This is the reverse of the assumptions of many of the models of mantle convection. It is postulated that the westward drift of the lithosphere causes the subduction total in the westward directed slabs in the Pacific trenches (Tonga, Marianna etc.) to be three times the subduction in the Eastern Pacific such as west of South America where there is eastward or northeastward subduction (Doglioni and Anderson, 2017). The estimate is that the westward subduction is about 232 Km^3/y compared with the eastward subduction of about 74 Km^3/y. To balance the downflow in the subduction zones there is a passive upward flow in the rest of the mantle of the same total magnitude. This passive upward flow provides the MORB that feeds the increase of crust in the ridges. This model postulates a "Tectonic Equator" in the tropical and equatorial regions where there is a maximum of the westward drift of the lithosphere. Earthquakes are maximum in this region and there are fewer major earthquakes in the high latitudes.

While the asymmetry in subduction seems to be very reasonable it is still circumstantial evidence that it is caused only by the westward drift of the lithosphere. The asymmetry in subduction could be caused by the fact that the western part of the Pacific plate is much larger in area and much older and thicker than the Eastern parts of the Pacific (Nazca and Cocos Plates etc.) and, therefore, more dense. Dogliani and Panza (2015) provide arguments against the latter.

Because the polarized plate tectonics model shows that most of the action is in the equatorial regions there seems to be no explanation of what causes the seafloor spreading in the ridges of the Atlantic and Indian Plates and those ridges surrounding most of Antarctica. There is no obvious explanation as to why these ridges are elevated, why they are midway between continents and why they migrate away from the continents (as opposed to only the movement, or drift, to the west).

Luna Tectonics. Another model that proposes that forces from the moon and sun produce plate motion is termed "Luna Tectonics" by Peter Haney (pers. comm., 2016). Haney's statement is: "Every day Lunar and Solar gravitational forces lift the Earth's surface and mantle beneath. As the tide passes through the divergent zones or faults of the Earth, that divergent fault is expanded by one meter for each kilometer of width of the fault. With this expansion molten mantle material intrudes into the gap and some of it cools enough to change phase and solidify. As the Earth tide passes the surface displacement returns to normal and then even negatively six hours later, compressing what was molten before. The previously intruded molten mantle is now part of the lithosphere. As this process repeats day after day a pressure gradient is built up."

This is a one-way process like a winch (or toothpaste coming out of a tube and not going back as Haney puts it). If the increase in crust at the ridges is possible by this mechanism then compression will be built up on either side of the ridge. This one-way process is similar to the far above mechanism described earlier although the timing of the seafloor spreading mechanism is much shorter.

Thus, if luna-tectonics is a realistic mechanism it provides a parsimonious explanation of the observations that are considered in this paper similar to that of the far above mechanism. Ridge elevation, ridge migration, ridge location between continents, etc. are all explained. Geographical variation in the spreading rate is not. The main question is whether or not the MORB will actually solidify rapidly enough in half a day and, as with the far above tectonics model, if the crust is strong enough.

Haney endorses the concept of Dogliani and Panza (2015) that the lithosphere is driven to the west by tidal friction (etc.) and his proposal that Earth tides can cause seafloor spreading adds to this concept. Thus, Polarized Plate Tectonics and Luna-Tectonics might be considered as one mechanism.

DISCUSSION

Ridge push in the plate and far-above mechanisms. In the above analysis of multiple hypotheses, the bottom-up mechanisms (convection and plumes) are excluded as a cause of plate motion because they are not consistent with the important observation of ridge migration. Also, the plate model is suspect because it does not have explanations as to why the ridges are elevated, why they are midway between continental plates, why they migrate and why seafloor spreading varies geographically. However, if the ridge push force mentioned (but not explained) concerning the plate model is strong enough to produce plate motion this ridge elevation process must also be explained. There is an extensive literature on the cause of the ridge push force in the standard models (convection and plumes). The force is actually not a "push" force but is the flowing away from a ridge that is elevated from heat by a proposed upward plume of the convection mechanisms. As the crust moves away from the ridge lithosphere forms, thickens, and is cooled as it sinks. Sclater (1972) and Parsons and Sclater (1977) model the height of the ocean ridges away from the ridge top and find that the slope varies as the square root of time. The assumptions in all of this early work is that ridge elevation is caused by upward heat from a convection plume. Much of the early work is discussed by Forsyth and Uyeda (1975), Cox and Hart (1986), Schubert, et. al. (2001) and Kearey, et. al. (2009).

Anderson (2013) and Anderson and King (2014) disagree with those who believe that the temperature under ridges is higher than under the lithosphere or continents farther away from the ridge. They point out that insulation of the mantle by the thick lithosphere and continental crust produces a higher temperature underneath and away from the ridges (Anderson, 1984). If the geological community agrees with the conclusion of this paper that the convection and plume mechanisms are excluded then the ridges would not be elevated by heat from below. If the upward heat flow from the asthenosphere to the ocean through the thin crust near ridges is high then the asthenosphere (LVZ) under ridges should be cooler than underneath thick lithosphere. This is analogous to the observation that it is colder near a window of a house in winter than near a wall because the glass is not as good an insulator as is a wall. The thin crust near ridges allows more heat to escape and if it is not replaced by thermal upwelling of a convection process it must be cooler there than under the lithosphere. Thus, there would be no elevation given by the standard explanation for a ridge push force to work.

Ridge Migration. In 1989 the author, together group of students in a seminar, attempted to publish a paper that was disputed and rejected by two reviewers (see Acknowledgements). The reviewers did not respond to the conclusion in that paper that the convection model should be excluded because it could not explain ridge migration as discussed herein regarding Figure 1. Both reviewers did not disprove the far above mechanism (our group called it the expansion-contraction or EC mechanism at that time) that had been proposed in the paper, but both reviewers stated that we would have rejected our own mechanism had we quoted and understood the papers that had been written on the subject. One reviewer mentioned several "critical contributors" that we did not quote. These were "McKenzie, Richter, Sclater, Parsons and others." Do not the peer reviewers have to show why the papers we did not quote disproves the far above model? They did not. Stating that something is wrong without proof is disputation and not disproof! This is the basis of Dickenson's (2003) and Anderson's (2013) arguments that myths and "zombie" paradigms hang on long after they are shown to be suspect.

Although this author, and others in the seminar group, did read many papers by the authors mentioned that was some time ago (late 1980s) so in the past several months the current author read or re-read many papers and books on mantle convection and plumes to see if the convection models proposed so far did, in fact, explain ridge migration. This included all of the 69 papers in Bird (1980) and many in other journals that dealt with convection. All of those in Bird (1980) were published by the American Geophysical Union. Papers were searched for the mechanism of seafloor spreading that was assumed by the authors and whether or not migration of ridges was shown to be a result in their modeling.

As mentioned above, Sclater (1972) and later Parsons and Sclater (1977) discuss the elevation changes away from mid ocean ridges in papers that are widely quoted. In both cases the convection current mechanism is assumed to produce the elevation of ridges with heat coming from below but no mention is made of ridge migration. Richter (1973), models the cause of ridge elevation and finds small scale convection in the upper mantle, but these bear no resemblance to the pattern of ridges on Earth. These have been called "Richter rolls." He makes no mention of ridge migration. Richter does conclude that it is the "…preeminence of the subducted lithosphere among the driving mechanisms considered…" in agreement with many authors on the importance of slab pull. He gives no discussion of how the convection rolls would cause the plates to move away from ridges. Parsons and McKenzie (1978) develop a model that shows small-scale convection in the upper mantle and conclude that it is driven largely by cooling from above. They provide no discussion of how ridge migration is explained in the model. A search for other papers in which ridge migration is discussed was unsuccessful except for Menard (1986) and Morgan (1972), both of which are discussed above.

This search included several books on the problems of convection and plate motion to see if there have been discussions of how and why the ridges migrate. This included Davies (1999), Schubert, et al (2001) and Kearey, et al (2009). All three of these books start out with the assumption that mantle convection or plumes (hot spots) of some kind cause plate tectonics. All provide models of how convection might work both from deep in the mantle and forced by subduction at trenches. In all three there is no explanation of ridge migration. It seems that few of the advocates of convection (or plumes) consider this important anomaly.

The Schubert et al book (2001) has the title *Mantle Convection in the Earth and Planets* and they start out in the first sentence with the concept that mantle convection is an obvious phenomenon in the Earth's mantle. It is therefore difficult to see why they neglect to solve the problem of why the ridges between continents move. They provide exhaustive mathematical presentations to show that convection exists without explaining how the models produce most of the simple features of the Earth's crust discussed above. Shouldn't this be done first before developing the complicated models? They present arguments of models in two dimensions (Chapter 9) and three dimensions (Chapter 10) and show many diagrams of convection. In all of these kinds of diagrams in the literature there does not seem to be a resemblance to the pattern of ridges and trenches on the real Earth. Since many diagrams, using different assumptions, are often shown the question is: Which one do we pick?

Some form of mantle convection may exist, but the model results should have a closer fit to the pattern of ridges and trenches than those in the countless number of tomographic results, simulations and mathematical treatments that appear in the literature. Forced, and probably shallow, convection of the kind that Anderson (2007) discusses is a form of "convection" driven from the top and not from deep in the mantle, or even in the upper layers of the mantle, by thermal instability. It is a product, not a cause, of plate motion. The upward component of such mantle movement is passive, not active.

Tomography. Many studies of seismic waves using tomography imply or conclude that convection or plumes exist in the mantle (c.f. Kerr,2013 and Hand,2015). Anderson (2007b) discusses the fact that the speed of seismic waves, as shown by colors in tomographic studies, results from (a) phase differences, (b) anisotropy as well as (c) temperature so that to conclude that the red and blue colors always indicate hot or cold parts of the mantle may lead to some confusion. Anderson (2007b), Karason and van der Hilst (2000), Dziewonski (2005), several papers in Foulger et al (2005) and Anderson (2013) suggest that there are often inconsistencies in the tomographic studies.

For more than three decades this author has examined papers and figures in books that conclude that the results of tomography studies show that convection and plumes exist. Some of these the patterns of red and blue that are deemed to indicate hot and cold regions of the mantle seem reasonable enough, but on closer inspection there are many difficulties with the notion that convection and plumes produce the movement of plates. It seems that there are too many other interpretations of the data and this author concluded that, at least in some cases, the researcher(s) did some selection of the data in their discussions. It seems to this observer that the blue ("cold") patterns extending down from subduction zones are reasonable in many tomography studies, but when an attempt is made to see that deep plumes or deep convection of hot (red) regions rise to the top of the mantle it is not at all obvious that they show up beneath ocean ridges. There is a continual search for deep plumes, but the results of this search are unconvincing that deep plumes produce seafloor spreading. As discussed earlier, the scientific method casts serious doubts about the bottom-up mechanisms. Because studies such as tomography (and modeling of convection) are expensive should not the simple approaches be used first?

Earthquake Frequency. Dogliani and Panza (2015) show that earthquake frequency is highest in the low latitudes where they propose that a "Tectonic Equator," caused by the westward drift of the lithosphere, produces a faster westward drift in low latitudes. They also show a plot that shows that earthquakes have increased in the past few decades. This might be caused the global warming and melting of continental ice in polar regions that increases the depth of the ocean, giving it more mass. Thus, tidal friction effects on the oceans is increased possibly producing more lithospheric movement and more earthquakes. There are, of course, some other reasons why earthquakes might be increasing in recent times including rebound from melting of ice caps, in places like Greenland, effects of mining processes and the like.

Earthquakes should also be increased due to the far above mechanism by global warming. With an increase in the depth of the thermocline or increase in advection due to warmer water masses (such as the NADW) the higher ocean temperatures causes increased warming at the top of the ridges producing greater crustal expansion at ocean ridges (see Figure 4b). This increases the rate of seafloor spreading and this increases the compression against continents to produce a faster westward movement of ridges like the MAR and of plates such as the North American and South American continental plates. This faster movement would produce more earthquakes in the pacific plates. This is highly speculative, of course, and the increase in earthquakes might be a random process.

Multidisciplinary Research. One of the reasons that dominant paradigms (conventional wisdom of a given period of time) last so long and become scientific myths is that most scientists do not consider working in fields with which they are unaccustomed. As a consequence, they miss some important ideas. For example, many geologists did not believe that the climatic, biological and geographical studies that Alfred Wegener included in the idea that the continents moved were relevant. It was only after the concept of seafloor spreading showed that there was a way to prove that drift occurred that they agreed with Wegener's concept. The seafloor evidence came from their own discipline and so it was accepted by the geological community. But it took many decades for this to happen. The same is true when geologists and geophysicists attempt to show what forces move the Earth's tectonic plates. The bottom-up mechanisms (convection and plumes) and the plate and trench suction mechanisms deal only with forces that are derived from data and concepts that are mainly geological or geophysical. The far above mechanism involves concepts from climatology, oceanography and biology as well as ideas that are geological or geophysical. The two ideas that involve motions of the moon and sun are also not strictly speaking geological or geophysical. This lack of dealing with ideas outside of one's field of study is a problem concerning the advancement of ideas on the forces of plate tectonics. The new ideas are rejected without being shown to be wrong. As Kuhn (1962) posits, most of the leading scientists will take their wrong ideas to their graves. Thus, if any of the last three of the models, considered in this current paper, actually do produce plate motion they may not be published because those in geology or geophysics will not consider the importance of ideas that come from other fields of study. The only answer comes from suggestions like that of Fanchi (1996) that gatekeepers of conventional wisdom find a way to allow new concepts to be published. For more on this subject please check the website tectonicforces.org.

CONCLUSIONS

Sit down before fact as a little child. Be prepared to give up every preconceived notion, follow humbly wherever nature leads you or you shall learn nothing.

Thomas Henry Huxley

It has now been 103 years since Wegener published his first book on continental drift in 1915 and an additional fifty-five years, or more, since the arguments that favor the bottom-up models (convection and plumes) of plate motion were introduced. It was shown early on that the forces Wegener proposed for the continents to move were inadequate. But that does not mean that the concept was wrong. Obviously, he was correct that the continents do move. After these 103 years the geosciences still have no convincing mechanism on what causes plate motion. These forces will be revealed in the future, but it may take some time.

As Anderson (2007c) points out*:*

> *"The scientific method does not apply when conventional wisdom starts to fall apart. Defenders of an existing paradigm use their own ground rules and assumptions to attack the new models."*

But the scientific method, using the comparison of multiple hypotheses, works to test hypotheses and if used properly it can make science move rapidly as Platt (1964) states. Only this approach will remove the zombie science of the plutonic (bottom-up) mechanisms.

The bottom-up models should be excluded by the sifting and winnowing processes advocated by those who support the plate models that are quoted above. In the case of the top-down (or plate models) of Anderson (2001, 2006) and Hamilton (2007) it is easy to add a mechanism driven by the far above (or expansion and contraction of the crust) to the top-down gravity ideas to give a complete and parsimonious explanation of the observations that are listed near the beginning of this paper.

The main conclusion to be drawn from this essay is that the peer review system keeps conventional wisdom alive even if the premise of that wisdom is not logical. The peer review system works when papers within a given paradigm are reviewed, because small corrections, wording and the like help the author and it works when a paper can be shown to be completely wrong or poorly written. But it doesn't work when the peer reviewer is confronted with a new concept that contradicts the opinion of that scientist. This argument goes against Kuhn's (1962) main point that it is mainly lack of communication (incommensurability) that causes the new ideas to be rejected. It is suggested here that it is also the politics of science (Charlton, 2008), that keeps a person at the top of the field that a scientist represents, that causes the rejection of ideas that conflict with that scientist's own ideas. This is a major factor that causes science to make such slow progress, that is, to allow geomyths to exist.

The main purpose of this paper is to present to the scientific community models such as the last three discussed (far above tectonics, polarized plate tectonics and luna-tectonics). The polarized plate tectonics model has been well published, but not the other two. If any of these cannot be disproved they may help explain plate motion because they are more parsimonious than the other mechanisms discussed herein. It is the hope that someone young or new to the field (Kuhn, 1962) takes an interest in these mechanisms and publishes ideas that either support or disprove them.

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In my unpublished book (Scott, 2015) I give a lengthy section on acknowledging those who helped in the thinking process that led to an alternative mechanism of plate motion and why the existing conventional wisdom may be wrong. That will not be repeated here. See the book mentioned below (*) for more on these contributions.

Many of the ideas in this essay originated in discussions of a seminar group that met for two years, every other Saturday in 1988 and 1989, after which the group wrote a paper in1989 entitled *Crustal Expansion and Contraction in Response to Climatic Change as a Mechanism for Driving the Earth's Tectonic Plates.* The participants were G. Hakim, C, Memrick-Hawks, A. Mainolfi, N.E. Rosenbach and A. Rutherford. That paper was sent to the journal *Global and Planetary Change,* but was disputed and rejected by two peer reviewers.

The reviewers did not show that our mechanism (now called far above tectonics) was wrong, but instead stated that if we had read many papers we did not quote we would have rejected our own model. They did not specify which papers we should have read. I note that this is disputation and not disproof as is often the case in peer reviewing.

I especially acknowledge those colleagues who helped me to discover the many anomalies to the convection and plume hypothesis and who led me and my students to develop an alternative mechanism of plate motion. These include former professors at the University of Wisconsin, Robert A Ragotzkie and Reid Bryson, my colleagues and friends at the University at Albany, especially Duncan Blanchard, Ulrich Czapski, Eugene McLaren, Dave Fitzjarrald, Bernard Vonnegut, Chris Walcek and to Peter Haney for correspondence on the Polarized Plate Tectonics and Luna-tectonics mechanisms.

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*For a free, postage paid, copy of Scott (2015) *Top-down Tectonics: The Role of Oceanus and Gaia* contact jscott34@nycap.rr.com.

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FIGURES

Figure 1: (a) Position of proposed convection currents (rolls) at the time of the break-up of Pangaea and (b) showing that the rolls must get larger sometime after the break-up so that the ridges between continental plates must migrate.

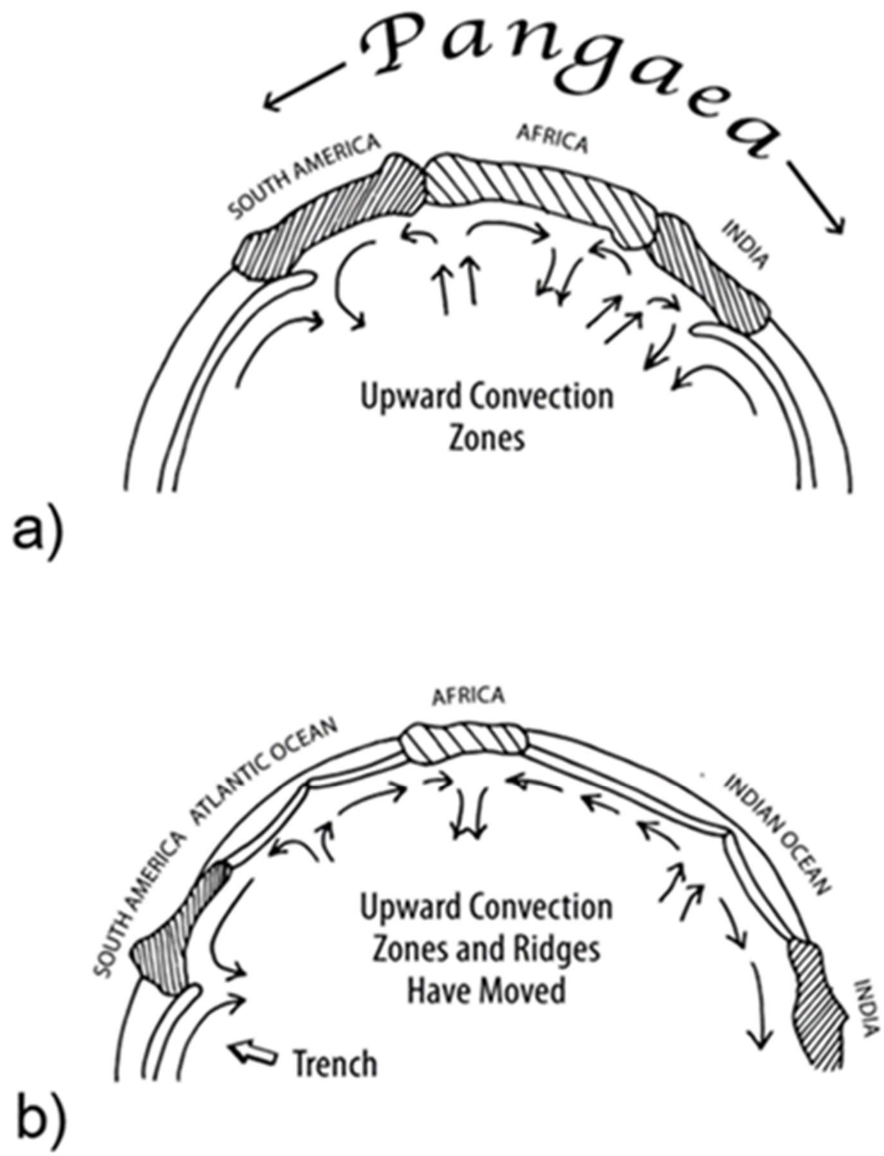
Figure 2: Plots of temperature, concentrations of carbon dioxide and methane over time from the Vostok ice core data (redrawn from Wikipedia Argu 1 Vostok 20K).

Figure 3: Schematic of how the temperature might vary in and above the crust near an ocean ridge. (D) is downward convection (eddy diffusion) in the ocean water, (A) is advection in the water and (C) is conduction through the crust from the upper mantle.

Figure 4: (a) Crust at a ridge during a cold period of climatic variation (contraction at ridge) and (b) crust at a ridge during a warm period (expansion phase).

Figure 5: How the combination of gravity and far above (EC) forces may cause plate motion in the region of South America.

Figure 6: Thermal pulses in oceanic crust for periods of 100 Ky, 20 Ky, 2.5 Ky, 1.0 Ky and 0.2 Ky



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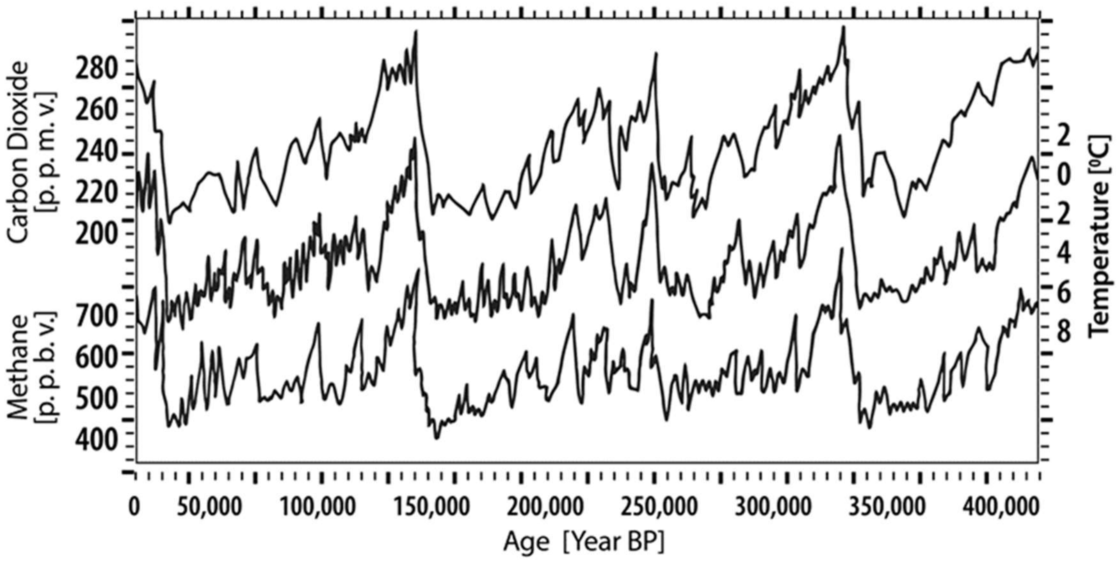

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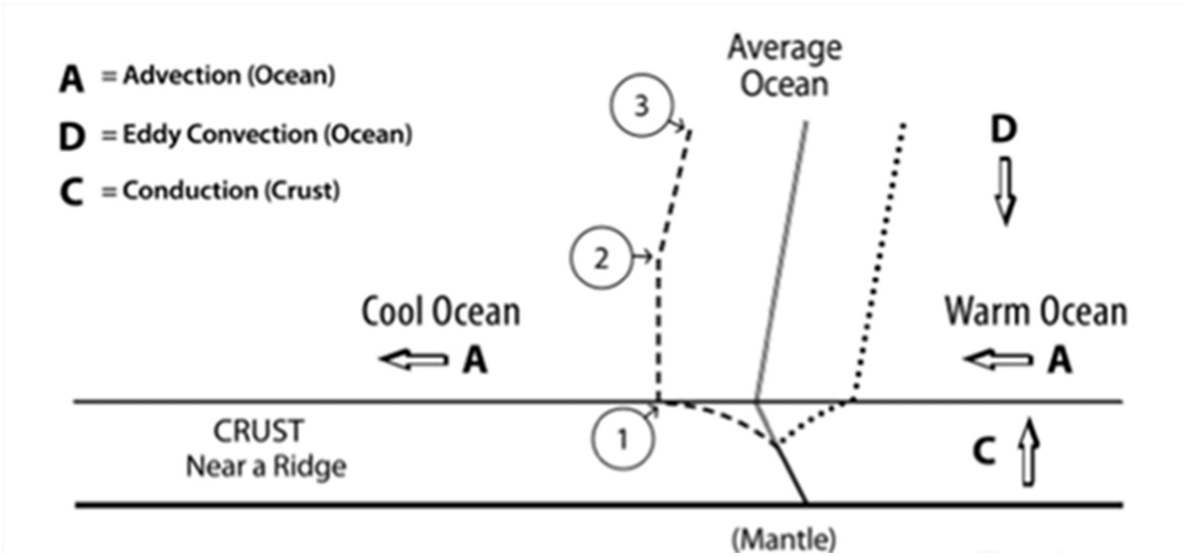

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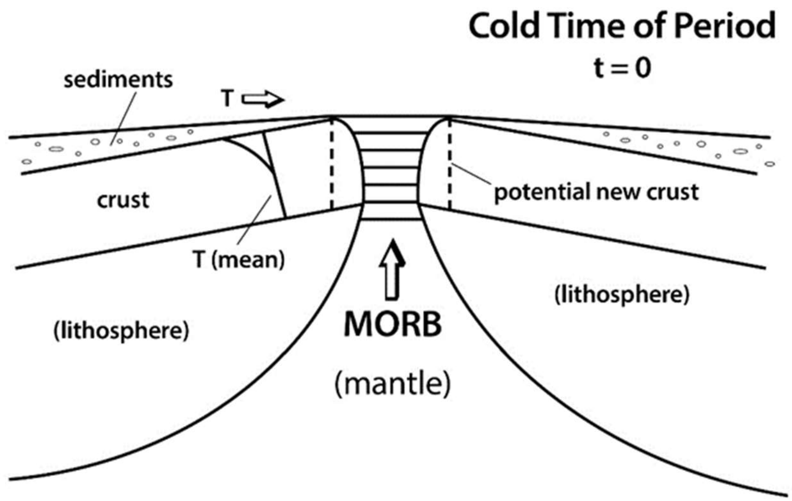
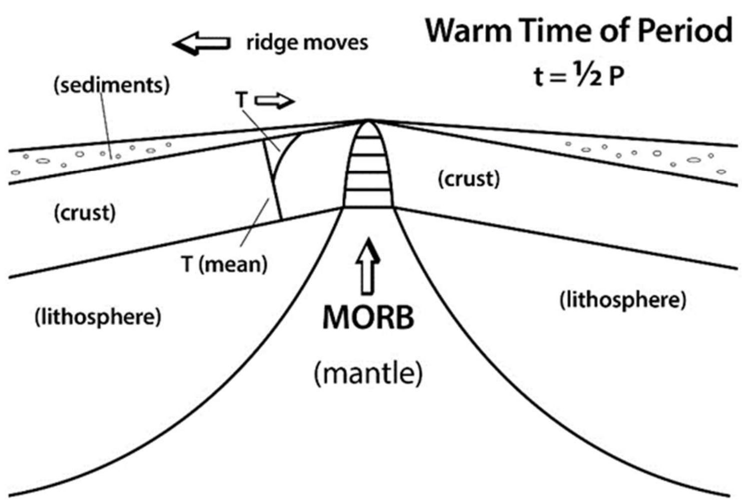
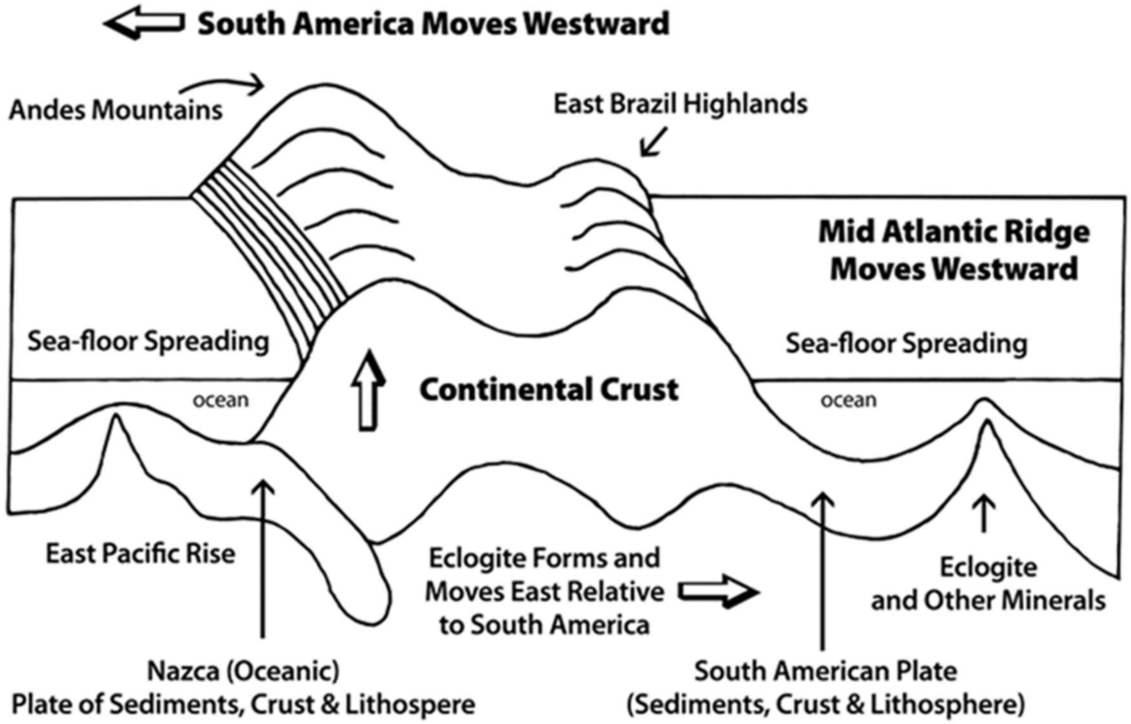


4a



4b

Figure 4: (a) Crust at a ridge during a cold period of climatic variation (contraction at a ridge) and (b) Crust at a ridge during a warm period (expansion phase).



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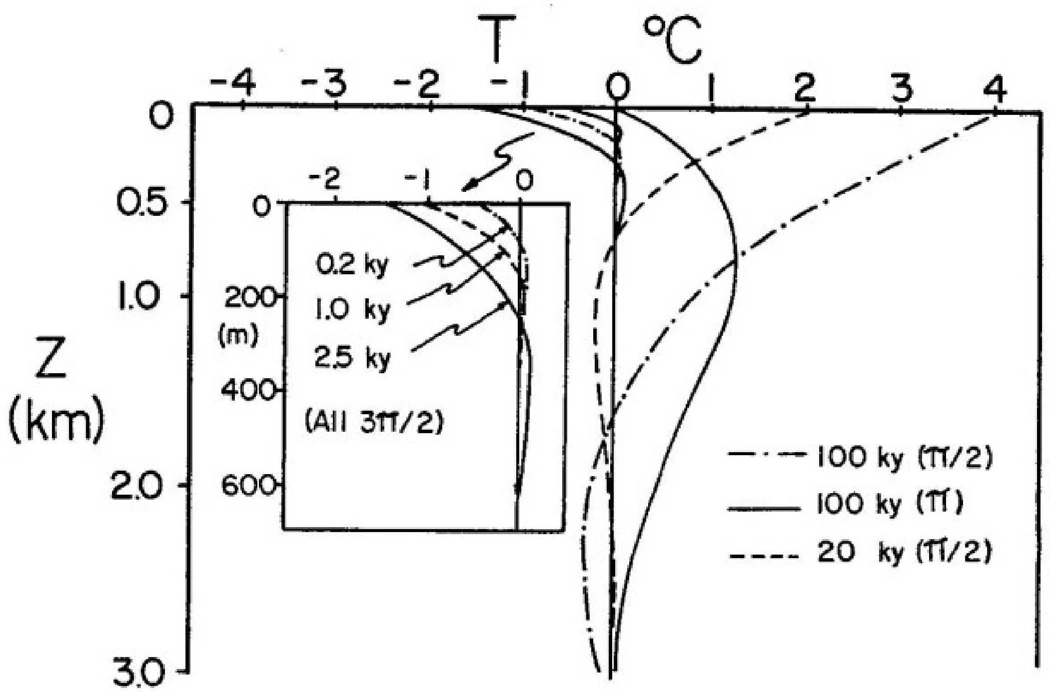

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