AN INTRODUCTION TO MODERN UNIFORMITARIAN AND CATASTROPHIC PLATE TECTONIC CONCEPTS

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Abstract

Within the last 35 years, a revolution in geology has occurred through the advent, acceptance, and application of the unifying geodynamic theory of plate tectonics. Acceptance of plate tectonics followed the development of post-World War II geophysical datasets. The concept has proven popular both in and out of the geologic profession, as evidenced by its ubiquitous presence in earth science teaching at all levels, and its presentation in popular media. Plate tectonic interpretations are not restricted to uniformitarian geology. Recent publications advocate derivative catastrophist interpretations of plate tectonics.

Catastrophist and uniformitarian interpretations share many premises and conclusions. Therefore a concise analysis of more voluminous evidence for and against uniformitarian plate tectonics can be used as a shortcut to assess the credibility of catastrophic plate tectonics. Ongoing questions regarding uniformitarian plate tectonics offer reasons for skepticism of catastrophic plate tectonics until a more thorough evaluation is complete.

Introduction

A history of late twentieth century geology would undoubtedly revolve around the dramatic changes in the structure, technology and scope of the discipline, and could perceptively marvel at the flexibility of naturalistic uniformitarianism to accommodate all of these changes while maintaining its cornerstone status in the science. Although some interpret the developments of the twentieth century as the replacement of traditional geology by the new "earth sciences" (Wood, 1985), the continued dominant presence of naturalistic uniformitarianism demonstrates no fundamental philosophic change. Externally the ubiquitous presence of geology in frontiers such as marine studies and space exploration demonstrates an expanded application of geologic knowledge far beyond the bounds of the early twentieth century discipline. Internally, the shift from chronostratigraphic to environmental interpretation in stratigraphy; the advent of sequence and event stratigraphy; and the acceptance of modern plate tectonic theory have all made relatively smooth transitions from "outside" revolutions to conventional wisdom within the fundamental tenets of naturalistic uniformitarianism.

Plate tectonics (or the new global tectonics) has proven remarkably popular both in and out of the geologic profession, as is evidenced by its ubiquitous presence in earth science teaching at all levels (Lowman, 1992), and by its presentation in popular media such as *National Geographic* and *Public Broadcasting System* specials. The historical development of plate tectonics, both early and modern, has been documented and reviewed (Glen, 1982; Wood, 1985; Menard, 1986; Cone, 1991). A future contribution is being developed by the authors to review the historical development of plate tectonics, and a very brief summary is presented below.

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Development of Plate Tectonics

Early expression of plate tectonic concepts is credited as far back as Francis Bacon (1561-1626), who noticed the conformity between the mapped coastlines of South America and Africa (Faul and Faul, 1983). The nineteenth century saw proposals of historical continental separation from both uniformitarian and catastrophist perspectives, but most historians consider Alfred Wegener (1880-1930) to be the progenitor of modern plate tectonics. Wegener explored a variety of evidence to support his contention that the continents were united in the Carboniferous into a supercontinent which he named Pangea. Wegener's work was rejected by the vast majority of his contemporaries but those that did accept his views (e.g., Dutch geologist Alexander du Toit) maintained an active minority viewpoint through the mid-twentieth century.

Modern plate tectonics developments are commonly attributed to studies of remanent magnetism in rocks and post-war sea-floor studies (Ewing and Ewing, 1959; Heezen, 1962; Shepard, 1963). Studies of remanent magnetism and the Earth's magnetic field suggested that either the magnetic pole or the continents had moved historically (Wood, 1985, pp. 113-116). Sea floor mapping showed the presence of extensive submarine orogenic belts (midocean ridges) and deep linear troughs. Harry Hess (1962), of Princeton University proposed the generation of new oceanic crust at the midocean ridges which migrated laterally away from the ridges over time. The term "sea-floor spreading" was introduced by Dietz (1961), and evidence for sea-floor spreading was presented by Vine and Matthews' (1963) description of symmetric magnetic anomalies on both sides of the midocean ridge in the North Atlantic Ocean. By the late 1960's the framework of modern plate tectonics had been published, and its application to numerous geologic phenomena such as orogenesis (Dewey and Bird, 1970) was quickly established. By the late 1970s most geologists accepted and applied plate tectonics to their work. Direct application was commonly limited to academic and industry research functions, since plate tectonic concepts are seldom predictive on the ordinary scale of employee projects.

In order to understand the impact of the new global tectonics on geological thinking, it is important to consider the explanatory value of the concept and the new datasets that demanded explanation. The history of the acceptance of plate tectonics is usually traced from the early ideas of Wegener which included (1) coastline matches of continents across oceans, (2) matching orogenic belts (3) paleontological correlations across oceans. These data were not convincing to Wegener's peers. Convincing the geologic profession of the validity of continental drift required not only the identification of anomalies in existing datasets, but also the discovery of new datasets supportive of the concept. Emphasis was placed on new datasets because they stimulated interest through their novelty, and did not have a preassigned evidentiary value based on the existing paradigm (although it might be argued that the conceptual framework of continental drift itself was already present as an alternate paradigm). These included:

(1) paleomagnetic studies that gave evidence of polar wandering (or continental motion);
(2) sea floor mapping of midocean ridges, trenches, and fracture zones;
(3) definition of discernible patterns in normal and reversed magnetic anomalies in the ocean crust; and
(4) the accumulation of sufficient seismic data from earthquake distributions to demonstrate a definite three-dimensional distribution of earthquakes in the crust.

These data were sufficient to lead to the widespread acceptance of plate tectonics. Greater confidence was inspired in the idea as several longstanding geological puzzles were supplied an explanation. These included orogenesis, sediment distribution on both continental and oceanic crust, and ophiolites.

Attraction of Plate Tectonics

One of the most attractive features of plate tectonic theory is its presumed ability to upgrade the discipline of geology by serving as a "grand unifying synthesis" of how the earth works. The nineteenth-century North American tradition of extensive and exhaustive field work (e.g., King Survey, the Powell Survey, the Wheeler Survey, (Faul and Faul, 1983)) that relied primarily on first hand observation of field data (e.g., outcrop mapping) was tedious, demanding, and did not rapidly build large datasets. This situation began to change during the first half of the twentieth century with the advent of the intense search for oil and gas.

Geology underwent a transition from a field mapping emphasis to a more integrated science in the early to mid twentieth century. Several factors drove this transition. The early twentieth-century oil and gas booms generated a cascade of information that gradually became available outside of proprietary corporations. New technologies of indirect data collection (seismic, remote sensing, sonar applications) and the evolution of existing ones (e.g., well logging) augmented the basic field and subsurface data with a plethora of information that demanded more sophisticated interpretation. Contemporaneous advances in data collection, storage, analysis and communication led to greater scales of cooperative effort. Finally, the global scope of the oil and gas exploration efforts led to the formulation of new ideas for predicting their occurrence as well as an economic impetus for unified global geologic theories. All of these external factors combined with the propensity of naturalistic uniformitarianism towards system building (Reed and Froede, 1996; Reed, 1996), and the demand for a single controlling concept for the integration of data.

Plate tectonic theory has achieved all that its early advocates had hoped for, if not more. It has become the concept around which earth science education is structured, from early grade levels to post-graduate research. Few workers openly question the concept, and most published interpretation of geologic data is done explicitly or implicitly in plate tectonic terms. Public interest in geology appears to be fueled as much by plate tectonic concepts as by dinosaurs, and any regular viewer of public television or one of the nature / science cable channels could probably identify the basic concepts of midocean ridge crustal creation, lateral plate motion, and subduction.

Catastrophic Plate Tectonics

Uniformitarians are not alone in their application of plate tectonic concepts to geologic data. Creationists have also explored aspects of plate tectonic theory in the past (Strickling, 1978; Tippetts, 1979; Bluth, 1983; Hansen, 1983; Cook, 1987; Baumgardner, 1987, 1990a, 1990b, 1994a, 1994b), and many have apparently accepted its basic outline as being congenial and complementary to the Biblical account of the Genesis Flood (Wise et al., 1994).

A critical method that utilizes similarities in uniformitarian and catastrophic plate tectonic concepts to streamline thought by lumping both positive and negative evidence for both forms of plate tectonics commends itself. Distinctions between uniformitarian and catastrophic plate tectonics models (as presented by Wise et al., 1994) are essential, because those distinctions also highlight similarities in both concepts that can be jointly evaluated (Table I). Application of identical contrary evidence to uniformitarian and cata-

Table I: Comparison of Uniformitarian and Catastrophic Plate Tectonics.

Similarities	Differences
Global crustal processes dominated by lateral motion of crust and upper mantle	Geologic time available for tectonic motions is orders of magnitude less for catastrophic plate tectonics
Size of the Earth essentially stable	Plate motions are much more rapid in catastrophic plate tectonics
New oceanic crust has been created at mid-ocean ridge spreading centers	Crustal upheaval and plate motions initiated by unique historical processes for catastrophic plate tectonics
Portions of the crust are subducted into the mantle and melted: The surface expressions are ocean trenches	Catastrophists infer that plate motions are probably one-time events
Orogenesis is directly related to rifting (oceanic) and subduction or collision (continental and oceanic)	Evolutionary interpretations of paleoenvironments and successions not accepted by catastrophic plate tectonics
Historical existence of one supercontinent, separated by rifting, and subsequent generation of new oceanic crust	Relationships between tectonics and the rock record are dissimilar between uniformitarian and catastrophic plate tectonics
Most large-scale geologic features can be related directly to global tectonic processes	

strophic plate tectonics based on those similarities allows a more coherent evaluation. Catastrophic plate tectonics is distinct in several basic ways from its uniformitarian counterpart. The primary distinction is the much shorter time frame of any young-earth model. This difference has several implications. The first is the necessity for more rapid plate motions, and more abrupt acceleration and deceleration of lithospheric plates. The limited time frame also precludes the repeated cycles of tectonic activity postulated by uniformitarians (e.g., the repeated opening and closing of the Atlantic Ocean (Wilson, 1966)). The second is the absence of constraint by the uniformitarian assumption of continuity of geologic processes through time. Therefore, in a gross sense, the causal mechanism for triggering and/or changing plate motions for current catastrophic plate tectonics models is the Genesis Flood, and is thus dissimilar to any present day mechanism (some creationists posit post-Flood initiation of plate motions, but the point remains the same, since any mechanism would be dissimilar from present day geologic processes).

Distinctions should also be made in the types of evidence acceptable to creationists. Paleontological correlations between separated landmasses have been proposed as support for continental drift (Wegener, 1929; Colbert, 1985). If this evidence supports uniformitarian models of plate motions (i.e., similar geologic and biotic examples between continents) is it acceptable to creationists? Certainly not in the sense of the evolutionary basis for pigeonholing the correlations. Do these correlative flora and fauna represent continental separation of identical paleoenvironments, or do they represent the global nature of both the historical setting and the depositional processes? Recent models suggest billions of years for convective mantle flow based on mixing considerations (Davies, 1990). Are these mantle convection models acceptable as potential explanations of plate motion causes? Again, the answer must be negative, based on the biblical historical record. The stratigraphic similarities between continents relative to the uniformitarian timescale presents similar problems. For example, stratigraphic evidence suggests a Mesozoic opening of the present-day Atlantic Ocean. However, Wise et al. (1994) suggest continental separation at the onset of the Flood event. Combining these two assertions leads to the conclusion that the entire Paleozoic record was deposited prior to the Flood. Another distinction would be in the use of radiometric dating to support relative ages for magnetic anomalies which in turn provide a spreading rate at midocean ridges and across hot spots (e.g., the Hawaiian Islands and the area around Yellowstone, Wyoming). Both evolutionists and creationists accept the metaphysical concept of unidirectional, linear time, but the magnitude of this vector is disputed. Without the means to quantitatively reduce generally accepted uniformitarian timescales to Biblical magnitudes, radiometric and other means of measuring absolute time are of questionable relevance when the attempt is made to introduce them quantitatively into a young-earth model (Froede, 1995; Walker, 1994).

Reasons for Skepticism

Most uniformitarian and many catastrophist geoscientists accept plate tectonics explanations with few reservations. Although we applaud the effort of Wise et al. (1994) in attempting to address plate tectonic concepts within the context of the Genesis Flood, we believe that a certain level of skepticism is warranted for any plate tectonics approach. It is also appropriate for other global-scale models such as the Hydroplate Theory of Brown (1995). This caution is based on several factors which are detailed as follows.

No uniformitarian scientist or philosopher that the authors are aware of has offered an explanation for how to classify plate tectonics as an intellectual construct. Wise et al. (1994) do not address this issue. either. As with any other explanation of the past based on indirect evidence, plate tectonics can at least be classified as a mixed question! However, no one has defined which intellectual disciplines should contribute in what order of precedence to the concept. What are the relative contributions of geology, anthropology, biogeography, history, philosophy, and theology? Unless some answer can be supplied, the precise formulation of evidence either for or against plate tectonics becomes problematic; only geologic evidence is ac-

[1]The mixed question approach as defined by Adler (1965) recognizes that each intellectual discipline is based on its own special methods and special questions. When questions arise that cross disciplinary lines, they are addressed by a combination of disciplines (e.g., science and philosophy). and are considered mixed questions because they are not exclusively within the domain of any single discipline.

cepted and no satisfactory conclusion can be reached. We encourage the classification of plate tectonics as a system of thought by the philosophers of science within the mixed question context to facilitate the discussion regarding its application to geological datasets.

As an interim approach, we suggest that one basic principle of Earth history studies should be that models should be constrained from the top down and developed from the bottom up. In other words, the foundation of any model of earth history will be determined by philosophical and theological assumptions and the skeleton may well be provided by extrascientific information (e.g., the Biblical historical record). Field data should be used to flesh out the model, and address issues not addressed by non-geological information. For example, the Biblical record clearly tells of a global flood. Any geological concept of history that does not recognize a global flood is wrong at the outset. A true understanding of Earth history is constrained by the recognition of a global flood apart from scientific investigation. The nature of the detailed processes that occurred in the past, however, is determined from field investigation of their products in the rock record. Precision in evaluating such a model depends on the precision of the distinctions drawn between these different sources. More details of this methodology can be found in (Reed and Froede, 1996; and Reed, 1996). Until this weakness is resolved for all comprehensive geodynamic models, critical evaluation will be limited, but is still profitable within these limits.

Catastrophic plate tectonics is a derivative concept of uniformitarian plate tectonics, and thus offers a shortcut method of critical evaluation. Since it is dependent on the fortunes of uniformitarian plate tectonics, evidence both *pro* and *con* relating to uniformitarian plate tectonics is relevant to catastrophic plate tectonics. Distinctions between uniformitarian and catastrophic plate tectonics provide an opportunity for: (1) the solution of existing problems in uniformitarian plate tectonics by catastrophic plate tectonics, or (2) the introduction of additional new problems by catastrophic plate tectonics. Until advocates of catastrophic plate tectonics can demonstrate the former (so as to show that catastrophic plate tectonics is not redundant), and resolve any new problems, their model is incomplete. The accumulation of new datasets continues. If the then-new datasets of the 1950s and 1960s led to the abandonment of previous models in favor of plate tectonics, where will future discovery of additional new datasets lead? Additionally, the key data that support plate tectonics are new; as they mature, different interpretations may become preferred.

Acceptance of plate tectonics by creationists should be done cautiously. One obvious reason is the creationist tenet of a young Earth with the accompanying constraints of a several thousand year time frame for all geologic activity implied by the rock record. Also, the application of Occam's Razor would support less complex models of geologic change, and would force the question: "Is continental relocation necessary?" Catastrophists need not agree with current uniformitarian beliefs in the absence of compelling empirical evidence.

Table II: Evidence Pertinent to Plate Tectonics.

Evidence Supporting Plate Tectonics	Evidence Not Supporting Plate Tectonics
Apparent division of the crust into distinct interlocking plates based on the distribution of seismic activity, trenches, ridges, and fracture zones	Inability to define a convincing mechanism that would accommodate crustal properties, required motions including accelerations and decelerations, and in the case of catastrophic plate tectonics, the extremely limited time frame
Observed seismic and orogenic activity heavily weighted to defined plate margins	The relative importance of various datasets appears to be defined by the model, rather than more objective criteria
Crustal motion between scattered points inferred from geodetic measurement	Present day unambiguous plate motions not observed
Age-dating of oceanic crust in cross section from mid-ocean ridges landward, heat flow measurements, and the presence of symmetric magnetic anomalies at midocean ridges support sea-floor spreading	Primary datasets (i.e., magnetic anomalies, distribution of seismicity, nature and distribution of ocean floor features) questioned by more recent data and by reevaluations of earlier interpretations
Three-dimensional arrangement of earthquake foci at certain plate boundaries, the relationship of island arc and mountain chain physiography and chemistry to oceanic trenches, and seismic tomographic imaging of descending crust support subduction of lithosphere into the mantle	New datasets such as the imaging of continental "roots" at great depths are difficult to explain in the context of plate tectonics
Age distribution of crustal features such as ocean floors, orogenic belts, and sedimentary basins, geomagnetic polar wandering calculations relative to age-dated rocks, and comparison of continental outlines supports continental joining and separation	Features such as basaltic magmatism explained uniquely by plate tectonic processes on Earth are not formed by plate tectonic processes on the moon, Mars, and Venus in the past

Thus, drifting continents may be an unnecessary burden for the Creationist-Diluvialist paradigm. In fact, it may be an impossible one, since continental displacement within a very short time span requires massive heat flow from new ocean crust as well as seismic activity on a scale that is difficult to even model, much less demonstrate.

Evidence Cited in Support of Plate Tectonics

A wide variety of evidence has historically been submitted to demonstrate plate tectonics (Table II). Cronin (1992, pp. 13-14) has suggested that the evidence for plate tectonics can be summarized as follows:

> The actual cornerstone of plate tectonics is the collection of observations that unambiguously shows that, among other things, (1) Earth's outer surface is composed of an interlocking array of lithospheric plates, (2) most earthquakes and magmatic activity occurs along the margins of plates, (3) all plates are in motion relative to one another,

(4) plates diverge along the mid-ocean ridges, where new crust forms to fill the gaps, in a process known as sea-floor spreading, (5) mantle lithosphere is resorbed as it sinks into the deeper mantle in subduction zones, (6) the bathymetry of ocean basins is related to the variation in age and thermal structure of the plates, (7) the apparent offset of midocean-ridge segments is opposite to the actual sense of slip along the intervening transform fault, (8) oceanic fracture zones emanate from both ends of a given transform fault, (9) collision of continental lithosphere is a mechanism for the generation of mountain ranges, and (10) the oldest continental crust is Archean in age, whereas the oldest oceanic crust that is still in an ocean basin is Jurassic."

Additionally, evidence has been historically offered for the past existence of a unified landmass or supercontinent (Pangea). Wegener (1929) originally proposed that measured drift rates (Wegener's efforts in this area are not presently considered valid), SIAL (silica / aluminum rich continental crust) isostasy, polar wandering, transoceanic alignment of orogenic belts, and paleontological correlations between presently separated continents supported his concept of continental drift. Historically plate tectonics has provided explanations for previously problematic phenomena such as terrane accretion (both suspect and exotic), ophiolite suites, midocean fracture zones (transform faults), and hot spots. The breadth of explanatory power has always been considered one of the major strengths of plate tectonics. However, those explanations are not unique to plate tectonics, as will be discussed in detail in future papers in this series.

Wegener's concept of continental drift was rejected primarily because he could not provide an adequate mechanism to explain drift. Continental drift was tied to sea floor spreading by Hess (1962), and supported by the comparison of magnetic anomalies symmetric to the midocean ridge (Vine and Matthews, 1963; Phinney, 1968; Cox, 1973). The discovery of midocean ridge volcanoes is also considered to be evidence for sea-floor spreading (Corliss and Ballard, 1977). Recent studies in seismic tomography (3-D imaging from sources at depth) are cited to demonstrate convective flow in the mantle (Anderson and Dziewonski, 1984; Burnett, Caress and Orcutt, 1989), which is alleged to provide the mechanism for plate motions. The corollary of sea floor spreading on a non-expanding Earth is the subduction of crust into the mantle. Proposed evidence for subduction has included the spatial distribution of medium and deep-focus earthquakes at plate boundaries and volcanic chemical composition variations relative to plate boundary location. In addition to these lines of evidence, modern plate motions are asserted to be demonstrated by various geodetic calculations (Argus and Heflin, 1995).

A wide body of existing literature discusses these points and many others. The scope of this paper precludes the detailed discussion of each point either for or against the plate tectonics assertions. However, these will be discussed in future contributions by the authors.

Additional Evidence Cited for Catastrophic Plate Tectonics

An explicit metaphysical framework allows those operating within a Biblical-Christian framework to apply other evidence to the issue of plate tectonics. First and foremost, the historical record of the Scripture provides a basis for interpretation. The onset of the Genesis Flood marked the greatest single physical discontinuity in earth process recorded in the Bible. The terms used to describe the Flood are graphic and unambiguous. The exposition of terms such as ". . . all the fountains of the great deep burst open . . ." (Genesis 7:11, NASB) immediately gives rise to physical associations to those educated in geology. One possible interpretation is the one supplied in Wise et al. (1994) that the reference to the breakup of the fountains of the great deep refers to an episode of rifting, plate motion, and subduction. Although this interpretation may do no violence to the text of Genesis, the question of whether it is the only possible one has not been addressed. If other interpretations are possible for this and similar passages, then other evidence will be necessary to distinguish the truth between them. This evidence may be found both within Scripture and outside it. If all evidence within Scripture does not resolve this interpretation issue, then only physical evidence remains, with a corresponding decreased level of confidence in any interpretation.

Arguments Against Plate Tectonics

In spite of the quantity of data presented in support of plate tectonics, others have also presented information opposing plate tectonic interpretations (Table II). Advocates of other views of global tectonics often focus their criticisms on mechanisms proposed for historical plate motions. The most commonly accepted mechanism is mantle convection. However, explanation of mantle convection and its relationship to plate motions is not resolved (Frankel, 1988; VanDecar, James, and Assumpcao, 1995). Proposed mechanisms for subduction are especially criticized, and rejection of subduction combined with acceptance of sea-floor spreading support expanding Earth theories (Owen, 1992). Problems with mechanisms focus on strength of materials versus uniform acceleration over large areas and edge-deceleration during subduction of crustal material into the mantle. Catastrophic plate tectonics appears to circumvent numerous physical mechanisms proposed by uniformitarian plate tectonics, such as long-term ductility of rock material, and gravity / density sinking of oceanic crust (i.e., isostasy). This is due to the relatively high velocities and accelerations required by catastrophic plate tectonics. Although Baumgardner (1994a, 1994b) has provided numerical modeling in support of conceptual motions, additional analysis is required, if for no other reason than the incomplete physical description of plates and their motions in the Wise et al. (1994) paper.

The generational aspects of plate tectonic acceptance in the 1960s and 1970s (younger scientists accepted; older scientists rejected) has had repercussions that have not yet been fully realized. Acceptance of plate tectonics represented a corresponding paradigm shift away from traditional datasets and methods of geology to different datasets and methods, especially geophysical ones (Wood, 1985). Only continued progress in the earth sciences will show whether or not the new emphases of the younger plate tectonics advocates are more relevant than those of the older generation.

Two issues arise from this directional change in the discipline. The first is that of the relevance of popular datasets used as evidence for plate tectonics models compared to previously existing datasets, and the second is the relevance of the plate tectonics evidential datasets compared to future knowledge. The latter issue will by definition only be resolved in the future, and it highlights the uncertainty of scientific interpretations of past events. Thus, several relevant questions would include:

(1) Are the selected new datasets adequate to support tectonic theory?
(2) Are the selected new datasets consistent with previously developed datasets (do the selected datasets force conclusions contradicted by other datasets)?

The first question attempts to remove the excessive emphasis placed on newfound discovery from plate tectonic theory and reassess new knowledge. For example, the mirror image magnetic anomalies parallel to spreading centers were a primary part of the evidence for plate tectonics. Do the anomalies remain compelling evidence after they are subjected to more rigorous quantitative assessment (Agocs, Meyerhoff, and Karoly, 1992)? Again, plate tectonics predicts a fundamental difference in the crustal composition of ocean versus continental crust. How does the possible existence of continental crust underlying parts of ocean basins (e.g., the northwest Pacific Ocean basin (Choi, Vasil'yev, and Bhat, 1992)) fit with the accepted theory that all oceanic crust is basalt, formed at midocean ridge spreading centers?

The second utilizes prior knowledge to make a similar assessment. Geologic and paleontologic evidence have been in print for decades that indicate the close proximity of India to Asia since Paleozoic time. Existing plate tectonic models place the Indian subcontinent apart from Asia and close to Africa and Madagascar until relatively recently. How are these conflicting data to be evaluated, and which will take precedence (Smiley, 1992)?

Any assessment is limited by the existing limits on current knowledge of the Earth and geological processes. All proposed mechanisms for either form of plate tectonics originate in the Earth's interior. Yet how many of the properties of the Earth's interior can be directly observed or measured? Only heat flow near the surface, mass, density, surface gravity / magnetic fields, and seismic velocity through the interior are actually measurable; other properties (often confidently discussed) are inferred or assumed. Note that meteorite data are interesting but of uncertain relevance to the Earth's interior composition, since the bulk density of all but the nickel-iron types is grossly inadequate to account for the observed density of the Earth. Of course, analogies with nickel-iron meteorites may also be invalid as indicators of the Earth's interior. This follows from the fact that any putative analogy between planetary interiors and meteorites is a child of cosmic evolutionary theory, not empirical analysis. It seems as though every major new discovery about the outer planets of our solar system has generated some new challenge to these same theories. Additionally, the absence of pressure features in nickel-iron meteorites suggests that either these meteorites were never derived from planetary interiors, or that they have been so altered that they are not reliable indicators of planetary interiors.

Plate tectonics theory by its comprehensive nature makes two demands that can be difficult to reconcile. The first is that it explain all relevant datasets in some fashion (because it is a global unifying theory) and the second is that it defines which datasets are relevant and what their evidentiary priority is (for the same reason). In other words, since it must explain all data, and if some data apparently do not fit the hypothesis, then the data must be the problem, not the hypothesis. In this manner, at least, plate tectonics shows similarity to evolution, which also must explain all relevant data while simultaneously defining which data are relevant.

There are a number of specific problems that have been raised in opposition to plate tectonic theory. Many of these are ignored or dismissed because there is an apparent preponderance of evidence supporting plate tectonics. However, as noted above, any theory that purports to explain everything, must. Thus, small problems are either problematic data that will be changed with more data acquisition, or are indicators that the hypothesis is wrong at least in part. Some of the problems include:

(1) geologic evidence of extension at supposed convergent plate margins (Hamilton, 1988; Bevis et al., 1995);
(2) difficulty of explanation of continental interior tectonics and seismicity (Kahle, 1974; Molnar, 1988; Grant, 1992);
(3) the inconclusive nature of recent geodetic measurements of the Pacific basin relative to present day motions (Owen, 1992);
(4) physical features of the midocean ridges that do not appear to support orthogonal motions (Carey, 1988) and the presence of physical features suggesting ridge-parallel motions in the crust (Meyerhoff et al., 1992);
(5) zones of large-scale compressional thrust faulting on the flanks of the midocean ridge rather than the expected tensional features (Meyerhoff et al., 1992);
(6) features associated with plate tectonic processes on the moon, Mars, and Venus independent of plate tectonic processes (Lowman, 1992);
(7) seismic tomographic expression of the deep structures of continental crust that would hinder or preclude movement relative to the mantle (Lay, 1988; Shearer, 1988; Meyerhoff et al., 1992; VanDecar et al., 1995);

(8) evidence of no large-scale strike-slip faulting along the San Andreas fault (Martin, 1992; Oard, 1992);
(9) difficulty in explaining physical features of oceanic trenches (Fisher, 1974; Bloomer, 1983; Cloos, 1984; Bloomer and Fisher, 1987)
(10) heat flow measurements that do not follow predicted patterns (Meyerhoff et al., 1992); and
(11) plates surrounded by spreading features with no apparent offsetting subduction (Africa), and plates surrounded by subduction with no apparent offsetting spreading (Caribbean) (Hamilton, 1988).

Alternate Geodynamic Theories

Since catastrophic plate tectonics is derivative of uniformitarian plate tectonics, an examination of alternate geodynamic theories to uniformitarian plate tectonics can provide another means of evaluating potential challenges to catastrophic plate tectonics. A variety of geodynamic theories have come and gone during the history of geology. Historically they can be considered in terms of the size of the Earth through time. Earth contraction, Earth expansion, and stable Earth hypotheses have all been proposed. Both uniformitarian and catastrophic plate tectonics concepts appear to adhere to a stable size history of the Earth. Earth contraction theories have not been pressed since the advent of plate tectonics, since most were developed to explain crustal compression (for a major exception, see the following discussion of Surge Tectonics). However, Earth expansion ideas still compete as a minority view with plate tectonics concepts. The most recognized advocate of Earth expansion concepts is Samuel Warren Carey (l911-) of the University of Tasmania. Just as the continental fit of Africa and South America has been a standard argument for continental drift for many decades, Earth expansion is illustrated by the terrella models of Vogel (1983) which show a fit of all the continents that would completely cover the surface of the Earth at approximately 40% of its current diameter. Although disagreement remains on the rate and mechanism(s) for expansion, many geologists have been persuaded by the arguments of the expansionists that the Earth does expand through time at least to some degree.

Other concepts and variations on existing concepts can be found by careful search of the literature. Prior to his death, Arthur A. Meyerhoff (Meyerhoff et al., 1992), perhaps the most visible critic of plate tectonics in geology, published a massive critique of uniformitarian plate tectonics while simultaneously advocating a new concept of geodynamics called “Surge Tectonics.” He and his co-authors advocate the foldbelt-parallel movement of less rigid asthenospheric material in surge channels within the cooler lithosphere. The trigger for surges or pulses of magmatic migration (that would correspond to orogenesis) is episodic contraction of the lithosphere driven by uniform contraction of the strictosphere (upper mantle), and mediated by the less rigid asthenosphere. Thus the magmatic migration under the midocean ridges would be parallel to the ridge instead of at right angles to it. Consequently, sea-floor spreading would not occur, and no “conveyor belt” motion of the mantle would exist that could drive subduction. The surface crustal expression of surge channels are the continental and oceanic foldbelts of the Earth. A wide selection of international geological and geophysical data is presented in support of this concept at the expense of uniformitarian plate tectonics. The ongoing presence of minority geodynamic models demonstrates areas of weakness in conventional plate tectonics that must be overcome or shown to be irrelevant in catastrophic plate tectonics.

Conclusion

A review of the data available to geologists today could not fail to impress any researcher, especially in comparison to the state of the discipline even 50 years ago. However, it is unlikely that sufficient data exist to generate a comprehensive unifying theory of how the Earth works even at the present. The historical dimension, moreover, forces any such theory to become a mixed question, and open to criticism from information gained outside of the earth sciences. Even though very few would recognize the necessity of a mixed question approach to Earth history, it remains true that any unifying theory that relies only on geological and geophysical data is deficient.

The development of catastrophic plate tectonics implicitly accepts the mixed question approach, but does not explicitly address it. This results in a lack of coherence in the method of applying information outside of physical sciences (e.g., the Scriptural references do not appear to uniquely constrain the plate tectonics interpretations). As a derivative concept, catastrophic plate tectonics is susceptible to most criticisms of uniformitarian plate tectonics, and the distinctions between the two appear to generate additional difficulties for catastrophic plate tectonics in the one area of ongoing weakness in all plate tectonic theories—that of a credible physical mechanism for large-scale lateral plate displacement and subduction.

Creationists should certainly reject the current uniformitarian version of plate tectonics, although there may well be useful elements of truth in specific local analyses. Even a cursory reading of currently accepted plate tectonic literature is sufficient to conclude that the theory contradicts the Biblical record of Earth history. Catastrophic plate tectonics attempts a synthesis of the Scriptural account of the Genesis Flood and plate tectonics concepts. Any attempt by creationists to present concepts that incorporate existing geological and geophysical datasets is to be welcomed, and can only increase the relevance of the creationist worldview to the earth sciences. However, any present synthesis of Genesis and plate tectonics (e.g., Wise et al., 1994) is not convincing in its present form, and should be regarded with healthy skepticism until it is more fully developed. Similar skepticism should be exercised towards any current comprehensive geodynamic model such as the Hydroplate theory (Brown, 1995) for the more general reasons of imbalances between interpretation and supporting data.

Summary

(1) A variety of factors has combined to bring about the general acceptance of plate tectonic theory in geology. Plate tectonics has provided geology with a grand unifying theory of how the Earth works, and has proven to be publicly popular because of its simplicity and easy visualization.

(2) Acceptance of plate tectonics hinged on the development of new datasets rather than the reinterpretation of previously existing ones. The geological evidence submitted by Wegener (1929) was not convincing to a majority of geologists. New geophysical evidence developed in the post-World War II period was.

(3) In spite of several key differences, catastrophic plate tectonics is essentially a derivative concept of uniformitarian plate tectonics and these similarities allow the use of much evidence for and against uniformitarian plate tectonics to be used in any evaluation of catastrophic plate tectonics.

(4) Arguments against either type of plate tectonics must assess the new datasets offered by plate tectonics advocates, compare those datasets with previously existing datasets for consistency, and evaluate even newer datasets that are presently being developed.

(5) As a theory that purports to comprehensively explain how the Earth works, the validity of plate tectonics depends on its ability to explain all the evidence, not just a preponderance of evidence. "Small" problems recognized today may be the basis for a geodynamic revolution in the future (see Kuhn, 1970).

(6) Despite its widespread public and professional acceptance, there is an enduring and vocal minority of geologists that does not accept plate tectonics. Many support expanding Earth concepts, while others have generated original geodynamic theories. Comparison of data available to conclusions drawn from any existing comprehensive geodynamic theory demonstrates that skepticism of any current theory is appropriate.

(7) Skepticism is also the appropriate response to catastrophic plate tectonics, both for the reasons cited immediately above, and because the extrascientific grounds cited for the concept do not uniquely require that interpretation.

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A BIBLICAL CHRISTIAN FRAMEWORK FOR EARTH HISTORY RESEARCH PART II-FOUNDATION AND METHOD OF HISTORICAL ANALYSIS WITHIN THE BIBLICAL CHRISTIAN SYSTEM

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Abstract

Although the naturalist-uniformitarian system and its derivative view of earth history are demonstrably invalid, a biblical Christian substitute is not logically a de facto replacement. It must first succeed at the points of failure of the naturalist system. In this paper I attempt to show that the biblical Christian system is successful in passing these tests as it demonstrates internal consistency in developing a framework within which historical analysis can take place. Additionally, the epistemological framework of the system is shown to integrate geological models of earth history, separable from the system, in a comprehensive approach to historical analysis.

Introduction

In Part I of this contribution I noted two tasks involved in the development of a viable interpretation of earth history. These include: (1) the refutation of the dominant naturalist-uniformitarian system and (2) the introduction of an alternative that successfully addresses the failures of that system. Demonstrated contradictions between the fundamental axioms of the naturalist-uniformitarian system on the one hand and its methodology and conclusions on the other invalidate it. The remaining positive task is then to demonstrate the validity of a replacement. The biblical Christian system can successfully address the failings of the naturalist system by these means;

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