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Earth Geodynamic Hypotheses Updated

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Abstract—A basic understanding of the various tectonic hypotheses is necessary to understand Earth geodynamics. Tectonics is the key to unlocking the regional structural geometry, and the regional geology is the key to unlocking the geodynamic history. Much of this history is recorded on the oceanic lithosphere. Lithosphere motions determine regional structure and the geomorphology. Lithosphere motion after the principal production phase gives rise to additional stresses which may or may not change the geomorphology of an existing feature. Thus secondary and tertiary tectonics create secondary and tertiary features on the primary structure. The basic assumption is that three physical possibilities exist; Earth can maintain the status quo, expand, or contract. Using ocean floor rock ages to show the fallacy of the magnetic isochrons, expansion and status quo are refuted. Contraction driven by the surge-tectonic hypothesis seems to be the explanation for ocean floor lineaments recorded by bathymetry and structure.

Keywords: Plate tectonics — earth expansion — magnetics — surge tectonics

Plate-Tectonic Hypothesis

This study begins during the modern era, when scientists began to look more closely at their surroundings. Technology was on the verge of catching up to inquisitiveness, so that a marriage of the two could produce finite results. To that end, the derivation of a hypothesis which allows for an Earth size remaining status quo is the beginning: plate tectonics.

Alfred Wegener is given credit for deriving the continental drift hypothesis (Wegener, 1925) when he manually manipulated South America to fit Africa. While Wegener's continental drift did not catch on at first, Arthur Holmes published the idea of seafloor spreading (Holmes 1931). Africa and South America had to be separated by some means. Geophysics, or more specifically earthquake seismology, entered the picture when the Earth was predicted to be a series of plates separated by active seismic belts (Gutenberg and Richter, 1949). Large horizontal displacements on Earth's surface along great faults, or fracture zones, were noted (Hill and Dibblee, 1953). Deep earthquake zones around the Pacific were interpreted to be great thrust faults (Benioff, 1949, 1954) at the surface. The lower earthquakes were noted to be "decoupled" from the upper. Soon after this, Keith Runcorn (1956) used 180 Ma rock samples to demonstrate magnetic pole displacement. He showed that North

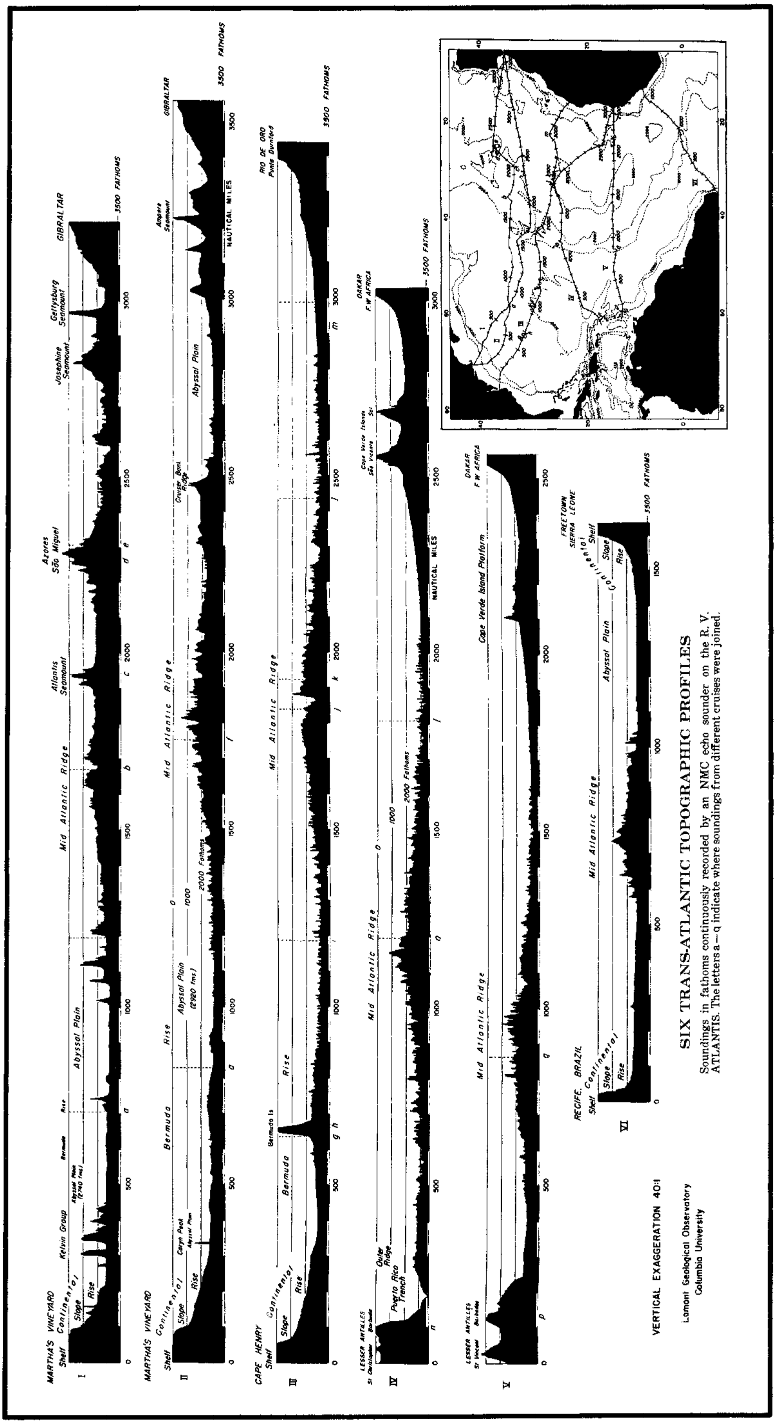

Fig. 1. Six profiles across the Atlantic basin showing location of MAR (from Heezen, 1960).

America had been displaced from Europe. Next, Bruce Heezen (1960) is given credit for delineating the great rift system of the midocean ridges (Figure 1). Extensive magnetic patterns on the seafloor which ended abruptly verified fracture zones. Harry Hess revived seafloor spreading (Hess, 1962). A paleomagnetic time scale using a mass spectrometer was developed, and Fred Vine and Drummond Matthews (1963) described magnetic anomaly patterns over oceanic ridges. Fracture zones were shown to be the indicators of the direction of seafloor spreading. Tuzo Wilson (1965) showed that the magnetic anomalies were offset on formation along transform faults after the magnetic signature had been imprinted. The transform faults were the intersections of the fracture zones with the midocean ridges. The transform faults proved to be the key, and the tectonic revolution was underway. At the 1966 Geological Society of America meeting in San Francisco, Lynn Sykes proved Wilson's hypothesis by studying earthquake motion (Sykes, 1966). Even though the shallow and deep earthquakes were known to be decoupled in every case, Benioff's great thrust faults became subduction zones. Vine tied all of the preceding together, and this point is recognized as the start of the plate-tectonic revolution (Vine, 1966).

The new hypothesis, based primarily on geophysical studies, revealed an overly simplified conveyor belt explanation. Midocean ridges, or spreading centers, are zones of shallow seismicity where magma wells up to the surface from the asthenosphere and forms new oceanic lithosphere comprised primarily of basalt. The spreading center is a divergent plate boundary, and “ridge push” is one of the three driving forces of plate tectonics. The rate of movement varies but is measured in centimeters per year. The movement direction is shown/imprinted by the fracture zones. The crust moves, cools, and ages with distance away from the midocean ridge crest. That crust eventually is subducted into the upper mantle in a region known variously as the subduction zone, the Benioff zone, the convergence zone, or the active margin. The subduction zone is characterized by deep earthquakes and is also a convergent plate boundary. The subducting slab is the second of the driving forces of plate tectonics, called “slab pull.” Continental and oceanic volcanic arcs form landward to Benioff zones and are the foci of extremely virulent volcano and earthquake activity. Transform faults and fracture zones interconnect the midocean ridges and subduction zones. They are the foci of shallow earthquakes and are sometimes thought to be plate boundaries.

Features not associated with those means of crustal production are generally attributed to hotspots, which Jason Morgan described as fixed diapirs centered in the mantle (Morgan, 1971). Linear seamount chains, sequentially aged, show the direction of plate movement. At the same time Ian McDougall (1971) felt that the linear seamount chains may have been formed by a “hot line,” which was an eastward flowing source of magma. Through time, the ridges, transforms, and trenches may move about in no organized manner producing such phenomena as plate reorganizations, changes in plate movement direction,

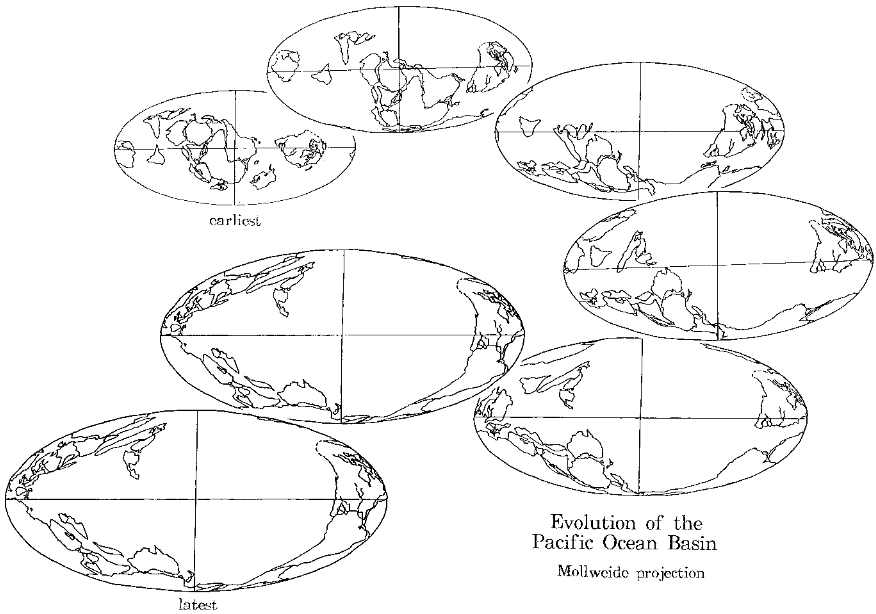

Fig. 2. Hypothetical ocean opening sequence (freely adapted from many articles by Chris Scotese). Although times have been assigned, they are based on magnetic anomaly lineations and have no foundation based in fact.

polar wandering, magnetic shifts, trench migration, and others. A third driving force of plate tectonics is the convection cell underlying the ocean basins.

Wegener's continental drift portion of the equation became the "Bullard fit," a situation in which South America and Africa were presumed to have been joined until the Jurassic (Figure 2). As the idea expanded, all of the continents were assumed to have been a part of a large land mass called Pangaea. This supercontinent split apart in an essentially E–W direction to form a northern Laurasia and a southern Gondwanaland. Further splitting of the land masses during the Jurassic, coupled with the drift provided by the seafloor spreading, resulted in the present continental configuration. The solid lithosphere was able to move around an oblate spheroid at will, riding on a cushion of magma called the asthenosphere.

Verification followed swiftly by paleobiogeography, meaning "where the critters lived a long time ago." Continental drift was proven by, among other things, the existence of a little, pig-like Triassic tetrapod fossil called *Lystrosaurus*. *Lystrosaurus* had been found in India, South Africa, and Antarctica, thus allowing the juxtaposition of all of those continents during the lifetime of *Lystrosaurus*. That cluster of continents including South America was called Gondwanaland, a supercontinent (Figure 2). *Lystrosaurus* was used to prove continental drift because these continents, while being joined during the

Triassic, are no longer joined. Within the plate-tectonic continental configuration, another supercontinent existed to the north, Laurasia. The extreme edges of Gondwanaland and Laurasia were in the cold oceans, and the interiors bordered the warm Tethyan Sea. Naturally, no *Lystrosaurus* could be found on both because it could not get across such a wide body of water or such a climate extreme as must be crossed under the constraints of that continental configuration. As proof of this phenomenon, magnetic anomalies outlined the movement north of the Indian subcontinent, showing its arrival time at Laurasia about 40 Ma.

Hailed by the ocean floor community as the universal panacea, the plate-tectonic hypothesis was adopted *in toto*. This hypothesis has been proposed to be one of the five greatest scientific paradigms ever brought forward, being listed on an equal footing with the periodic tables in chemistry, the Big Bang theory in astronomy, evolution in biology, and Einstein's theory of relativity in physics (Wynn et al., 1997). The new hypothesis answered many questions about the origins and functions of the midocean ridges, continental rifts, fracture zones, volcano production and active arcs, deep sea trenches and the attendant Benioff zones, ophiolites, accreted melanges, *etc.* that had never had a satisfactory explanation. Initially, 12 plates were included in this package: North American, Caribbean, South American, Scotia, African, Eurasian, Indian-Australian, Philippine, Pacific, Antarctic, Cocos, and Nazca. Since that time this number has increased appreciably with the addition of many micro-plates.

As we have seen, this hypothesis is based primarily on geophysical measurements; magnetic anomalies and earthquake seismology.

Earth Expansion Hypothesis

However, by 1966 not enough of the ocean floor had been surveyed or sampled to derive any meaningful explanation about how the floor formed (Figure 3). The ocean and sea floors comprise 70% of Earth's surface, so this in itself was a major problem that seems to have been overlooked. The problem of geometry should have waved a red flag before anything else was started. With new lithosphere being produced at the spreading centers, the midocean ridges, ridge push is one of the driving forces that moves the plates. Few spreading ridges exist on land; they are mostly in the ocean basins. The amount of ocean floor that is produced must be consumed somewhere if the plate-tectonics model is to have any validity. The consuming boundaries at sea are subduction zones, and slab pull by the lithosphere being consumed is a second driving force of the plate-tectonic hypothesis. The sum of the lithosphere produced must equal the sum of the lithosphere consumed.

But, the geometry of the ocean basins available at that time revealed 74,000 km of midocean ridges. In theory, spreading is happening on both sides of the ridges, so new lithosphere is produced along 148,000 km of the spreading centers. As stated, that much linear distance in convergent margins must exist to keep Mother Earth from having a middle-age spread, which could lead to an-

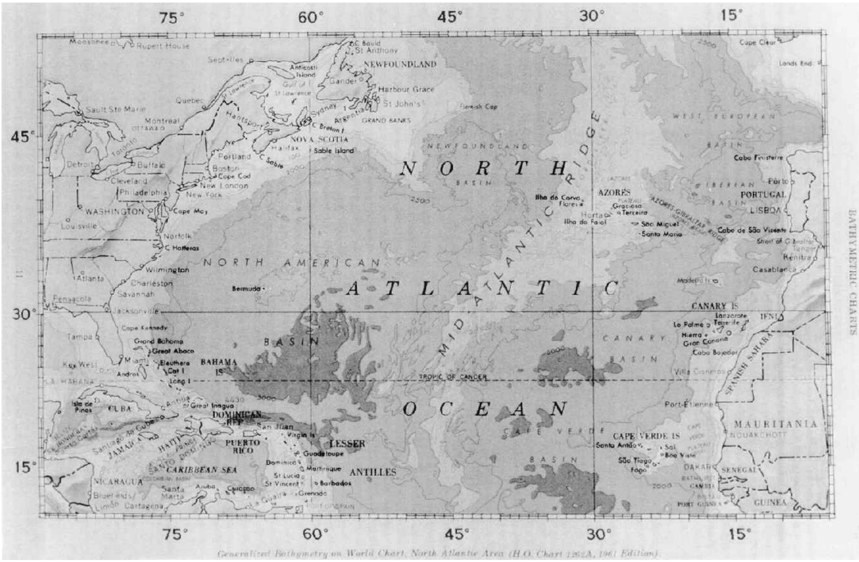

Fig. 3. The first attempt at producing a bathymetric chart for the North Atlantic Ocean basin showing the 100, 1000, 2000, 2500, and 3000 fm contour values (Navy Hydrographic Office H.O Chart 1262A, 1961). This map actually shows the Mid-Atlantic Ridge, such as it is.

other "big bang" situation. There is not; there are only 30,500 km of trenches, less than one-fourth the linear distance producing new ocean floor. The Mediterranean-Zagros-Himalayan-Indonesian collision zone to the Timor Trench adds 9000 km more to that, still only about one-fourth the amount of spreading ridges. This disparity in linear distance causes some basic problems. Unless we believe in an expanding Earth, we must find some other means of explaining the geometry.

Realizing that something was amiss, geoscientists developed a newer hypothesis which expounded upon the utility of an expanding Earth. Pannella (1972), Carey (1976), Vogel (1983), and Shields (1983) all have a fast-expanding Earth that was only 60% of its present size in the Jurassic. Carey believed the equatorial region to be in a state of sinestral torsion, which was thought to be the combined effect of gravity and rotational inertia. Strutinski (1994) changed that to mean an easterly flowing asthenosphere, and that this could also be inferred from Jupiter and Saturn. Vogel's terella models provided what some considered to be the most convincing model of Earth expansion. He had most of the Earth covered by continental crust until the Mesozoic, with the recent crustal movements all being related to radial outward pressing of the continents and the infilling by new oceanic crust from ocean floor spreading at the midocean ridges. Shields used paleobiogeography: "In Permo-Triassic times, e.g., there are terrestrial biotic links spanning the eastern Tethys and central Panthalassic oceans that don't occur across Pangaea, so explaining these seems to require an expanding Earth." (Oakley Shields, pers. comm. 1998). Kremp (1992) hypothesized that Earth was only 40% of its present size at 2.5 Ga. Owen (1992) is a little more conservative in that his Earth was already 80% of the modern size during this period of "great expansion." Owen used the same geometry exercise used herein to prove that the generation of crustal material does not equal the amount of subduction plus the amount of foreshortening (collision). Hoshino (1998) believes that it has expanded very little, but that it is expanding. His hypothesis is primarily based on glaciology and sea level changes without the agent of crustal subsidence. Several of these models use nothing more than seafloor spreading/ocean floor magnetic anomalies with no subduction (Luckert, 1998; Maxlow, 1998), so the models only explain conditions from the present back through the Jurassic.

All of these models include descriptions of the growth of the Tethys Sea and the fit of Pangaea, all based on magnetic anomalies. They also assume Earth to be a heat engine. They all include at least three phases of Earth evolution, beginning with continental crust and ending at the present with oceanic crust being produced from continental crust through basaltic magmatism in a process called oceanization. The continental shield/granite stage was during the Archaean Era. The original continental crust was created by calc-alkalic magmatism before the Mesozoic in a series of steps. These in order were geosynclinal, orogenic platform, continental rift, and block tectono-magmatic activization (Beloussov, 1992). The Proterozoic and Paleozoic Eras are called the transitional stage. The Mesozoic and Cenozoic are called the basaltic stage (Hoshino, 1998). This process is called oceanization, a taphrogenic oceanization process of tholeiitic magmatism. In an attempt to placate the plate tectonicists, the basalt is replacing the granite from the midocean ridges by ocean floor spreading.

In order for expansion to occur, the moment of inertia constraints must be overcome. An expanding Earth would necessarily rotate more slowly than a smaller diameter planet so that angular momentum would be conserved. In order for this to happen, the lunar tides would have to slow down, which would effect the length of the lunar month. Pannella (1972) studied the growth patterns of mollusc shells since the Ordovician. He derived an Earth year of 447 days at 1.9 Ga decreasing to an Earth year of 383 days at 290 Ma to 365 days at this time. However, the Devonian coral rings show that the day is increasing by 24 seconds every million years, which would allow for an expansion rate of about 0.5% for the past 4.5 Ga, all other factors being equal. According to the coral growth patterns then, 0.5% expansion of the planet is not enough to warrant a discussion, especially in terms of ocean basin opening, moving continents around, or the dispersal of Pangaea. All of these require Earth to have expanded by about 50%, or two orders of magnitude higher than the actual data show.

To give the hypothesis some validity, Earth has experienced a slow down in spin rate during the past 900 Ma according to the NASA space physicists (Internet: http://image.gsfc.nasa.gov/poetry/ask/a11765.html). Even now, this can be detected, and the rotation rate changes in milliseconds per day. This is dependent upon "how the mass distribution of Earth and its atmosphere change from earthquakes and the movement of water and air." A further explanation of the spin slow down reveals that a day was 18 hours long at 900 Ma. Because the Moon and Sun are constantly applying a tidal force to the Earth, the water moves as tides. As that water flows against the ocean floors, it applies a "braking force," essentially a slow-down mechanism, on the planet. In billions of years, this will force the lunar months to increase from the present 27.3 days to 47 days. Please notice that Earth expansion has absolutely nothing to do with this explanation.

Chandler wobble and axis tilt also change the rate of spin. If the tilt were as much as 54° instead of the current 23.5°, the polar regions would have had the regional warm climates that have produced the fossils being found there with no continental movement (Odenwald, 1999). Also, the motion of large air masses can change due to tilt by measurable amounts daily. The change in tilt affects the rate of rotation. Chandler wobble "resides in the natural resonances in the body of the spinning earth due to detailed distribution of mass in its surface, interior, oceans, and atmosphere. The entire system is teleconnected."

Primarily, though, Earth expansion is a discussion of philosophies, and this philosophy is based on math, statistics, geophysics, and theory. Real data, such as rocks and bathymetry, provide the best evidence. Words seen in researching expansion were "estimates…should be…postulated…" In simplified terms, Earth expansion in general is a watered down version of plate tectonics; seafloor spreading with minimal subduction or even without subduction.

The expanding Earth hypotheses cannot explain observed phenomena such as superposed, or cross, folding. The first set of folds is normal to the orientation of compression, in this case the Himalayas. The superposed/cross folds have fold, or hinge, lines that are also perpendicular to those at a N–S orientation. This requires E–W compression, which is not good for either plate-tectonic or expansion descriptions of this area. In an expanding Earth model, folding is explained by gravity gliding along the lines of a regurgitating geosyncline. This does not explain the cross folds. The expanding Earth model cannot explain anything from the shield, or continental, regions in relation to the sedimentary basins except for the so-called Bullard Fit. The uplift and subsidence of sedimentary basins can be explained in an easier fashion. Shield regions have not been eroded since much of the Archean. "The inferred provenance of the sediments deposited during the Late Archean or Early Proterozoic are suggested to be rocks that are still exposed and very much there, e.g. in Africa, Australia, India, Canada, and other shield regions…There is possibly no argument for expansion from shield regions" (MI Bhat, pers. comm., 1999). The expanding Earth model cannot do a good job of explaining any of the compressional regimes, pre-Mesozoic drift, subduction zones, or the lack of erosion on the large shields, such as Africa and Australia.

The common thread in both of the geodynamic hypotheses is the magnetic anomalies, and we will begin our analysis of both hypotheses by evolving the magnetic dating on the ocean floor. The time of the actual geodynamic events is of paramount importance, and no working hypothesis can be robust without a proper timeline. The timelines for both hypotheses begin essentially at about 200 Ma for the present continent/ocean configuration. So, before beginning the third hypothesis, that of contraction, we will of necessity study how magnetic anomalies are dated and how that applies to any working model.

Magnetic Anomalies vs. Rock Ages

Magnetic anomalies are based on reversals of the magnetic field at discrete, worldwide identical time intervals. This was first hypothesized by Bernard Brunhes about 90 years ago when he noticed reversed polarity in clays associated with lava. In the 1950s Seiya Uyeda and Takesi Nagata from Tokyo University demonstrated that certain rocks acquired a magnetization just the opposite of the field when they cooled. The fact that younger rocks of less than 780,000 years are all magnetized in the same direction was discovered independently by a host of studies in 1963. This work was verified by Christopher Harrison and Brian Funnell at Scripps Institute of Oceanography by sediment cores from the Pacific ocean floor. Morley, Vine, and Matthews combined the reversals with Hess's idea of seafloor spreading. Since then, this measurement has been used extensively to date the seafloor and prove both geodynamic hypotheses. The oldest age of the seafloor has been determined by magnetics to be about 200 Ma.

Field hands are not happy with an internal audit of the magnetic anomalies, most preferring to work instead with actual samples. Very early in the study of plate tectonics, some higher authority determined that the anomalies needed to be ground-truthed by rock samples collected *in situ*, certainly a viable and worthwhile undertaking which would no doubt solidify any working hypothesis. A meeting of the minds produced the Deep Sea Drilling Project (DSDP) in 1968, two years after the formulation of the plate-tectonic hypothesis. The purpose of that project was to obtain basement material at predetermined sites. The idea was that a cored sequence, or real rocks, could be used to solidify the magnetic anomalies, or geophysical data. By inference, this test would verify the plate-tectonics hypothesis. In an original study of the first 429 sites, not one off-ridge drilling attempt reached basement rock. In a continuation of the preliminary study (Meyerhoff et al., 1992), DSDP sites 430 through 625 and the Ocean Drilling Program (ODP) sites, 626 through 949, have been investigated for a total of 520 additional drill cores (Figure 4). The categories are divided by (1) on-ridge basalts (pillow, fractured, breccia, or enriched), backarc basins, and emplaced large, igneous provinces; (2) off-ridge, seafloor basalts; and (3) basalt not reached. The on-ridge, large igneous province, and backarc basin sites numbered 111. The midocean ridges, several continental borders, and the Lau Basin and the Philippine Sea were all younger than Miocene. Sites 443 and 444 are in the Shikoku Basin, and the rock ages disagree with the magnetic anomaly ages. The various rises, banks, guyots, atolls, and plateaus

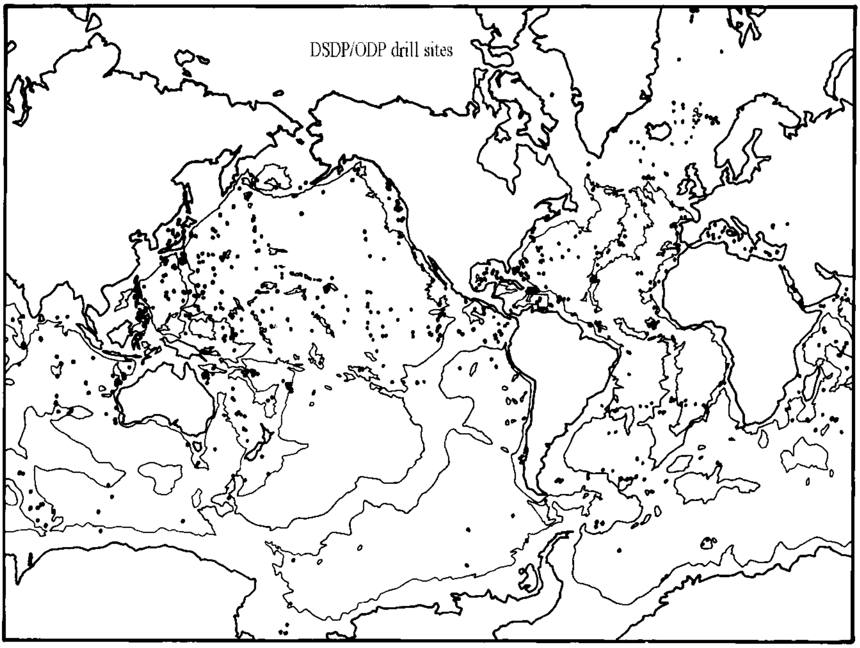

Fig. 4. Location of DSDP, IPOD, and ODP drill sites.

revealed a variety of ages that are not significant to this discussion because these features were all emplaced on older ocean floor crust by magma floods. Those were listed as fresh basalt flows, most of which fell into the Eocene-Oligocene age group. The two other categories germane to this discussion reveal a story that is not in line with the original intentions of the DSDP. Site 801 was the one off-ridge, pre-Miocene age at 157 Ma. The description reads as interbedded basalts with some pillow basalts, which is not basement. As to the other 395 cores, no basalt was recovered from them (Figure 5).

This study demonstrates that, while we now know much more about the composition of the overlying sediments on or near the large igneous provinces, we still know very little about the off-ridge ocean basement, its composition, or more specifically its age. Too many of the site descriptions include "sills or dikes, fractured basalt interfaced or interbedded with other sediments, andesitic mixed with dikes" and others (Meyerhoff et al., 1992). These descriptions do not inspire a great deal of confidence in the would-be user. Transects across the equatorial Pacific, the north and south Atlantic, south to the Antarctic margin, and across the central Indian Ocean basin have done nothing to give the basement ages. Apparently at the end of the DSDP, basement could not be reached off-ridge, and the practice, or attempts, were stopped by the ODP. The age of the ocean basement, and the dating technique for the magnetic anomalies, is not ground-truthed.

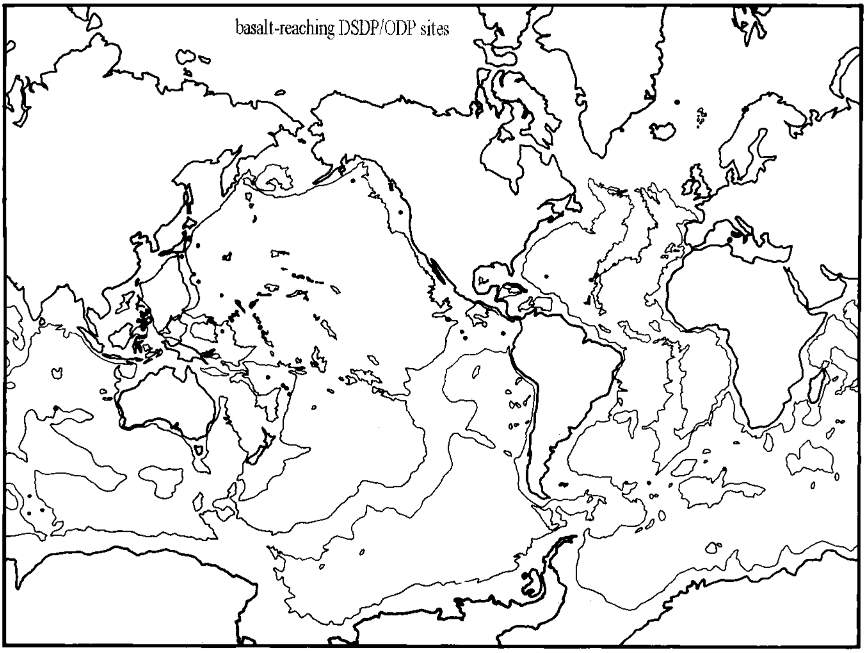

Fig. 5. Location of basement-reaching drill sites, all 18 of them.

The study was broadened to include dredge samples. Orphan Knoll, 50°23'N latitude and 46°24'W longitude, is a fairly representative sample. Magnetic anomaly 24 lies atop Orphan Knoll, giving an age of 53 Ma. Finally published (van Hinte and Ruffman, 1995), this feature began its perambulations through the hallowed halls in 1970 before being fully accepted. It had the entire barrage thrown at it by the naysayers. In essence, DSDP Site 111 established the Knoll as being continental in nature while implying the presence of Precambrian metamorphic and granitic rocks. The following year Paleozoic limestones were recovered that were interpreted to represent the nearby bedrock. The feature was dredged again in 1978 with the same results. This paper pointed out that the samples were not ice rafted, and it was rejected in 1992. Possibly the reviewers felt that, given enough sampling, there would no longer be an Orphan Knoll, and that the problem would go away. Not so, the paper was finally published in 1995 with full descriptions of all the samples.

Just as Orphan Knoll is a part of this region, so the entire North Atlantic region has been hypothesized by many investigators to have remained constant, and at times to have been a land bridge from Europe to North America. The Iceland Plateau seems to have been continental at one time, at least 700 Ma. It was part of a large North Atlantic dam that included Greenland, Iceland, the Faeroes, and Rockall Bank. Graptolites have been dredged from the King's Trough region (Barrie Rickerds, pers. comm., 1999). Graptolites are Ordovician in age, or older than 470 Ma. Magnetic anomaly 34 lies atop King's Trough, or 72 Ma. Given the ages of some of the rocks, this would necessarily preclude any deep water transport of deep faunal mixing in this region. As a result, spreading is possible only in rift zones, so no spreading occurred in this part of the Atlantic basin. New lithosphere can hardly overlay older unless there is no spreading, or later leakage occurs.

The equatorial Atlantic region of the Mid-Atlantic Ridge (MAR) has long been recognized as a region of considerable structural complexity that contains old rocks (from Washington, 1930 through Bonatti et al., 1996). It is also a region of comparatively low heat flow (<55 mW/m^2) along the midocean ridge system, where heat-flow values in the crestal zone normally are very high (>60 mW/m^2). Samples from 1992 and 1993 from many other localities in the equatorial Atlantic straddling the Mid-Atlantic Ridge (0°–5°N latitude, 25°–35°W longitude) recovered continental flood basalts, sericitic mica phyllite, quartzite, carbonaceous shale, brown coal, and many other rocks derived from continental sources, as well as midocean ridge-type and eugeosynclinal alpinotype rocks. Late Cretaceous-Eocene samples are common. West of the central rift is a 200 to 300-km-wide plateau that dips gently westward into the Guyana Basin NE of Brazil; east of the rift valley, the plateau remains elevated and merges into the Sierra Leone Rise west of Africa. The plateau is capped with sedimentary rocks 400 to 1,200-m thick, sections which do not thin away from the midocean ridge crest. The investigators concluded that seafloor spreading in this >550,000-km^2 area is not possible. The omnipresence in the equatorial Atlantic of so many shallow-water and continental rocks led investigators to propose that a major E–W structural barrier crossed the Atlantic Basin between the Ceara Rise and the Sierra Leone Rise at approximately 8°N latitude. At the intersection of the Romanche Fracture Zone and the Mid-Atlantic Ridge, 140 Ma “Maiolica”-type pelagic limestones have been found in the center of the basin (Bonatti et al., 1996). The limestones occur in a deformed region approximately 4-km thick and 200-km long. This feature, lying along the equator, also contains continent-derived quartzitic siltstones of Paleocene and Eocene age. This region is, according to the magnetic anomalies, zero-aged basalt.

A 1988–1989 Soviet study (Udintsev et al., 1992) found granitic and silicic metamorphic rocks on the western side of the MAR from the equator to 30°S latitude. These rocks have been suggested to have been formed repeatedly throughout the ridge's existence, an interpretation which explains many puzzling geochemical data. These data also indicate that the MAR is continental in origin with $^{87}Sr/^{86}Sr$ ratios of 0.704–0.723.

Summarizing the above, Precambrian protolith ages of many rocks from the Mid-Atlantic Ridge and associated ridges, from at least Iceland to 30°S latitude, are abundant. These are mainly in the 1.1 to 1.9 billion-year-old (Ga) range. Had these protoliths been found on a continental block, they would have been categorized as such without further ado. However, because these rocks occur in an oceanic environment, they are attributed to other *ad hoc* causes. What this means from a geologic standpoint is that, according to actual rock ages collected *in situ*, the ocean floor is at least an order of magnitude older than that proposed by the use of magnetic anomalies; that is, it approaches 2,000 Ma (2 Ga). Any excuses about ice rafting, ballast dumping, or evolving technology are obviously not germane. Geologically, the ages used in the plate-tectonic hypothesis do not work. Apparently, the technology needed to reach basement is not available to the parent organization of the ODP.

But, that is not all. Another inherent problem has also existed with the geology. The principal investigators have, by direction or otherwise, misrepresented the actual rock ages and types. In a summary article of the history of the DSDP/ODP (Davies, 1998), the present head of the ODP states that "…indeed we have yet to find rocks older than 200 MY in the deep oceans. These observations lead to rapid acceptance of plate tectonics."

At the risk of applying an overkill factor into the study, one last look at India is in order. We left *Lystrosaurus*, bedded in the rocks, to drift from somewhere near the south pole north to Laurasia. Paleobiogeography in action, a team of scientists (Meyerhoff et al., 1996a) plotted all of the known fossils, and they discovered yet another scientific oversight. *Lystrosaurus* has been found north of the Taurus-Zagros-Indus-Yarlung suture zone. A study mapping all of the *Lystrosaurus* remains included Antarctica, South Africa, India, the Moscow basin in Russia, Sinkiang region of western China, Mongolia, and Vietnam. The sample base increased, but to date none have been found in the Americas. In fact, four amphibian families have been found in the same bed only in Antarctica, South Africa, and Tasmania. All four are found from as far away as Asia and Svalbard, but nowhere else are they in the same bed. Speculation now has it that *Lystrosaurus* evolved in the north and migrated south during the Triassic (Figure 6).

Additionally, investigators (such as Dickins, 1994) have found that India has never been anywhere. The Wadia Institute of Himalayan Geology in Dehra Dun is specifically tasked to study the Himalayan region. The Institute has fully researched the proposed site of the Tethyan Sea, which would necessarily lie in the Himalayan Mountains between the Laurasia and India (Bhat, 2001). The findings were that India had not been anywhere since the Late Archaean based on the existence of several kilometers thick of Precambrian and Palaeozoic sediments, that this fact had been suppressed, and that the fact had been known since the 1970s. The ancestral basin is dated at 2510 Ma (2.51 Ga), and it began with a volcano-sedimentary sequence. The magnetic anomalies say 40 Ma. The concept of a "Gondwanaland" is unsubstantiated.

One last well-known bit of geology is introduced into the study: the magnetic data all show the seafloor to be accreting and aging to the west for the Gulf of Alaska and the west coast of the United States (Figure 7). No spreading center exists to produce crust in that direction from Baja California to Canada. In fact, the San Andreas Fault is postulated to be a NNW–SSE-trending transform fault

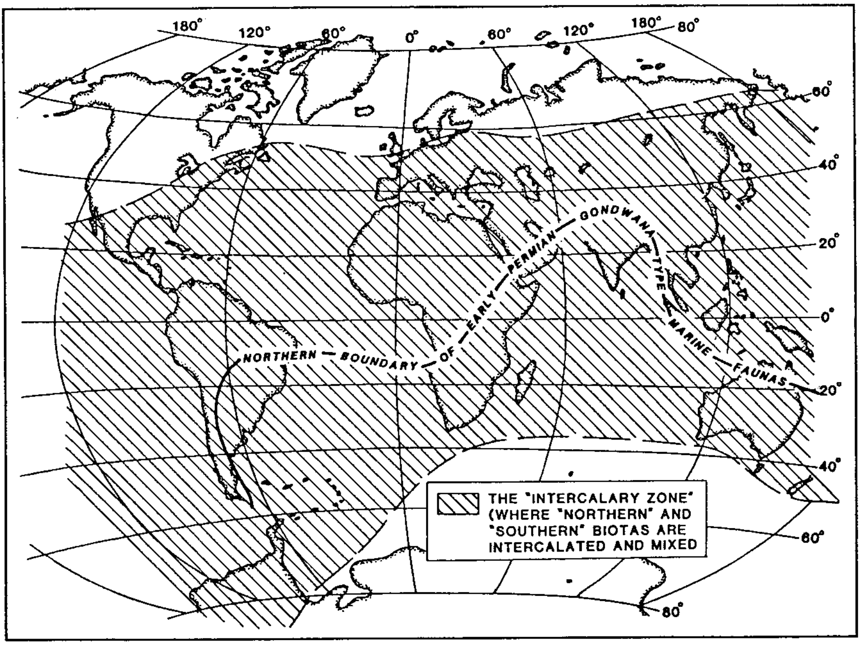

Fig. 6. World's intercalary zone showing fossil coverage that belies the continental drift/plate-tectonic hypothesis (Meyerhoff et al., 1996b)

offsetting the two spreading centers of the East Pacific Rise and the Juan de Fuca Ridge, theoretically the same midocean ridge. The San Andreas Fault is predicted to have at least 3000 km of offset based on the magnetic anomalies, and that Baja California will eventually move to British Columbia (Wynne et al., 1995). Fracture zones, being extensions of transforms, point the direction of plate flow. The fractures in this region, the Chinook, Mendocino, Pioneer, Murray, and Molokai fracture zones, all point ENE; the San Andreas Fault points to the NNW. In a landmark study of that region, actual rock samples from British Columbia, in this case zircons on both sides of the Fault, demonstrate clearly that the amount of slippage between the two sides is on the order of less than 500 km, if that, since the Archean, approximately 1500–1600 Ma (1.5–1.6 Ga; Mahoney et al., 1999). Baja California is going nowhere.

A quantitative study, rather than a qualitative study, of the magnetic anomaly pattern on the Reykjanes Ridge, south of Iceland, explains the way that isochrons have been measured. As background, the Iceland Plateau had been thought to have been formed as part of the British-Arctic plateau-basalt province, which had broken up during the initial rifting of the Atlantic Ocean and sunk below sea level. Because of Iceland's position on the Mid-Atlantic Ridge, investigators decided to have Iceland formed on the ridge crest by volcanic eruptions. In a 1976 explanation, a hot spot was felt to be the creator.

Fig. 7. Ocean floor sediment ages for the northeast Pacific Ocean basin based on magnetic anomalies.

Yet later work in 1977 theorized at least three rifts through Iceland and no extensional tectonics (read seafloor spreading) because the neovolcanic zone overlay Pliocene stratigraphy. The arguing papered the press, and William Agocs et al. (1992) disproved the magnetic lineaments used to "verify" seafloor spreading on the Reykjanes Ridge, the portion of the Mid-Atlantic Ridge south of Iceland.

In the Agocs study, 15 profiles were analyzed with a coefficient value along strike of 0.31 and across strike of 0.17. In order to compare this to any other region of the world, the data must be put onto the same denominations, such as apples with apples. In this case, the magnetic profiles were digitized, and correlation coefficients were determined both across the ridge crest and along strike. In an effort to correlate these values with other worldwide anomalies, a common magnetic datum was sought, in this case by moving them all to a pole, or common latitude with the north magnetic pole. A study could not be performed because of the fact that there were *no* quantitative studies in the literature. This means that no studies claimed in the literature have taken into ac-

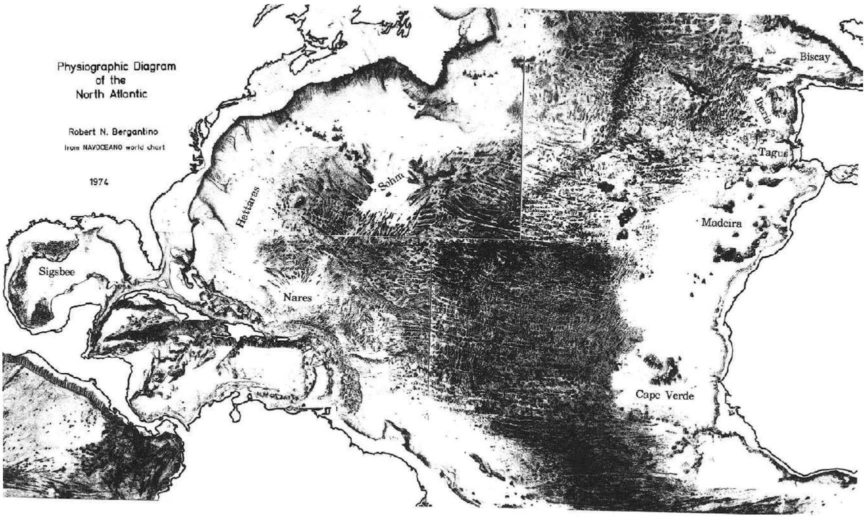

Fig. 8. Physiographic diagram of the north central Atlantic Ocean basin based on NAVOCEANO maps NA-6, NA-7, NA-9, and NA-10 (compiled by Bob Bergantino of NAVOCEANO, 1974).

count the changes in magnetic latitude, the strike and configuration of the anomaly sources, the orientation of the magnetic profiles with respect to the magnetic latitude and strike of the source bodies, or the depths of the sources. The determination was made that the linear magnetic anomalies of the Reykjanes Ridge could be caused just as easily by magnetic susceptibility as by changes in the Morley-Vine-Matthews polarity.

In a summary article (Fuller et al., 1996), the validity of the magnetic anomalies is questioned by the depth at which they were locked in, the sedimentation rates, and "the reexamination of the evidence for and against the reality of the pattern has produced intense controversy…We lack the key data to settle the argument."

Without magnetic anomalies, neither the plate-tectonic nor Earth expansion hypotheses have any basis in reality; they are both castles in the sand. Rather than provide a tool for the study of Earth geodynamics, they have provided a substantial roadblock to the furtherance of any data which may lead to the ultimate solution, a solution which has been mired down for these past 35 years. But, the collection of ocean floor data during that time has produced enough information to make corrections to that time frame and help derive a more robust hypothesis.

Bathymetry and Satellite Altimetry: Ocean Basin Lineaments

We use the bathymetry, a tool that was not available to the "founding fathers" of either of the above hypotheses, to provide an overview of ocean floor

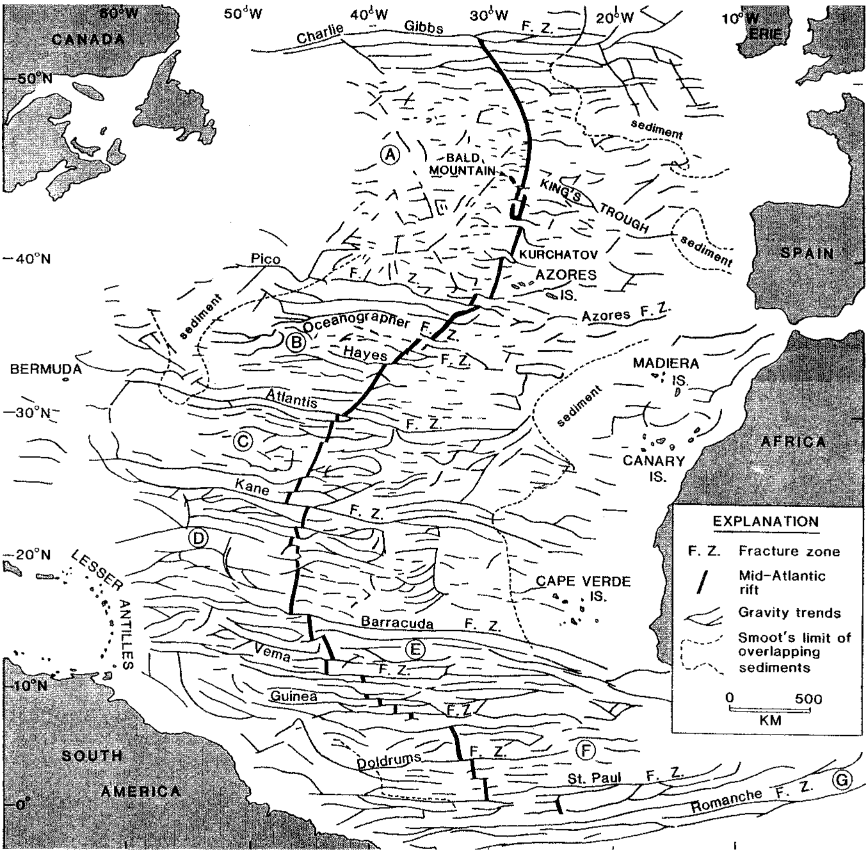

Fig. 9. Tectonic trends in the North Atlantic Ocean basin based on Haxby's 1987 *Seasat* map (Smoot and Meyerhoff, 1995). These trends are in theory the intangible, invisible gravity trends.

processes. As was shown in the introductory material, the fracture zones/ transform faults are supposed to show the direction of seafloor spreading. They were known to wander, braid, anastomose, and splay as early as 1974, which would show nothing like the pre-supposed ideas (Smoot, 1988; 1989). This bathymetry was ignored, even though the very founders of the plate concept were the advisors to the mapping efforts (Smoot and Murchison, 1998). The Digital Bathymetric Data Base five-minute grid (DBDB-5) was on the shelf by 1974. It showed fracture zone trends (Figure 8) agreeing very strongly with Haxby's (1987) *Seasat* trends (Figure 9; Smoot and Meyerhoff, 1995).

By the mid-1980s the US Naval Oceanographic Office (NAVOCEANO) had completed the total-coverage surveys for the northern Atlantic Ocean basin. The bathymetry was based on swath mapping principles using a multibeam sonar collector, called Sonar Array Surveying System (SASS). The

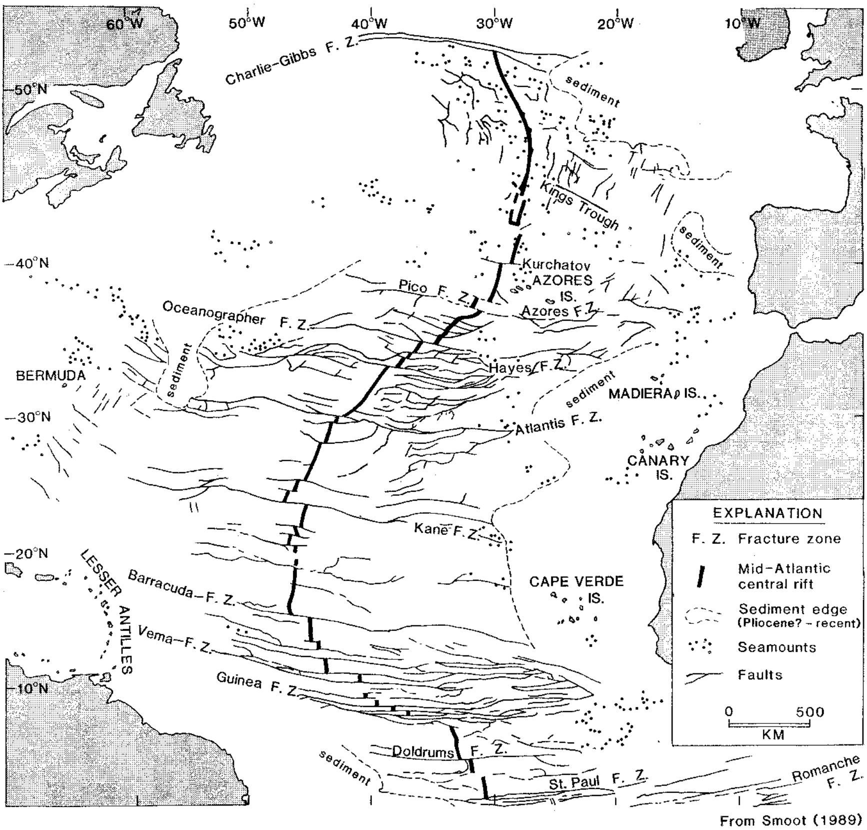

Fig. 10. SASS-based diagram of the location of the Atlantic Basin fracture valleys and seamounts (Smoot, 1989). These trends are the visible, tangible bathymetry trends. The reader will note that seamounts predominate where fractures cease, thus continuing the trends.

SASS collected depths using a constantly updated sound velocity program. This allowed for the prediction of ray bending effects on the outer beams so that corrections could be applied in the computer. The results were charted by discrete regions. The system had been in use since 1967 (Smoot, in press). Reducing the charts and pasting them on a grid produced a "superchart." From this, a seamount locator diagram was designed and published (Epp and Smoot, 1989). At the same time, a stick figure diagram all of the E–W-trending fracture valleys was drawn, presented (Smoot, 1988), and published (Smoot, 1989). Every one of the linear seamount chains was at the distal ends of the fracture valleys, giving a certain linearity to that ocean basin (Figure 10).

Another ocean basin study tool was introduced first in 1985 and again in 1989, that of satellite altimetry. In 1989, NAVOCEANO produced a classified, worldwide, 5-minute gridded *Geodetic Earth Orbiting Satellite* (*GEOSAT*) data base using approximately 8000 of the world-orbiting satellite

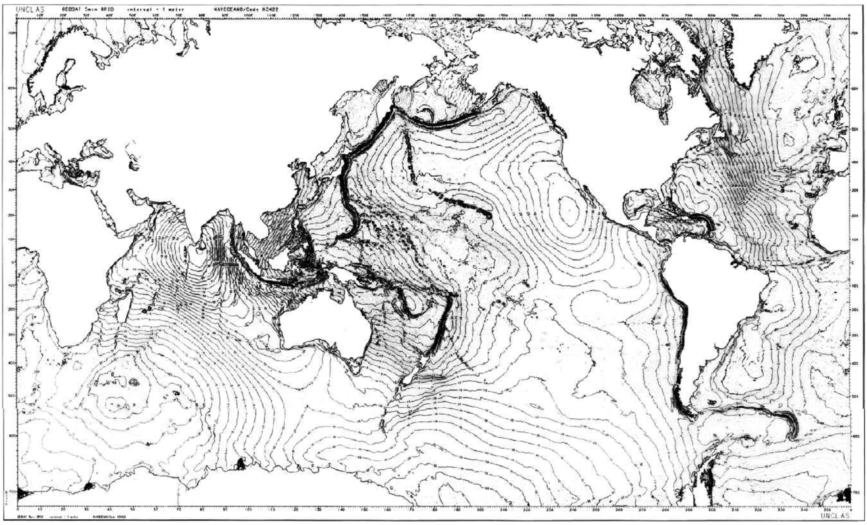

Fig. 11. *GEOSAT* geoid for the world's ocean basins.

revolutions. This collector measured the marine geoid height to determine the gravity geoid, since undulations in the geoid are caused by changes in the local gravity field (Figure 11). An algorithm was produced that applied a two-dimensional high-pass filter to the gridded *GEOSAT* data file, creating a filtered data set. The filter extremes were set to pass data at wavelengths over 125 nautical miles and less than 70 nautical miles. With certain exceptions the changes correlate well with bathymetry, and that is the value of the *GEOSAT* data for any hypothesis which includes the ocean floor. As a result, many new uncharted structures have been found. These trends have been used to help drive the contours where needed, especially on long, linear features such as ridges and valleys on the southern ocean floors where data is scarce to non-existent. The previously classified *GEOSAT* data were released in July 1995 by the Navy for public use (Figures 12, 13, & 14). The *GEOSAT* lineaments show that Earth has in fact tilted on the order of 120°.

The Atlantic SASS-based lineaments (Figure 9; Smoot, 1989) were compared to the *GEOSAT* lineaments (Figure 12), similar to that exercise performed with the Seasat earlier, with the same results. The *GEOSAT* lineaments were determined to be analogous to the actual bathymetry lineaments. The fact that the Hayes/Oceanographer fracture zone swarm, which included the attendant seamounts, spanned the region from Ontario, Canada and Massachusetts USA through the Iberian Peninsula and the Ballaeric Islands in the Mediterranean Sea was not according to the hypothesis (Figure 15). Those fractures had never been noticed to join, had never been extended onto the continents, and the Wegener/Bullard fit prescribed that Massachusetts join Morocco.

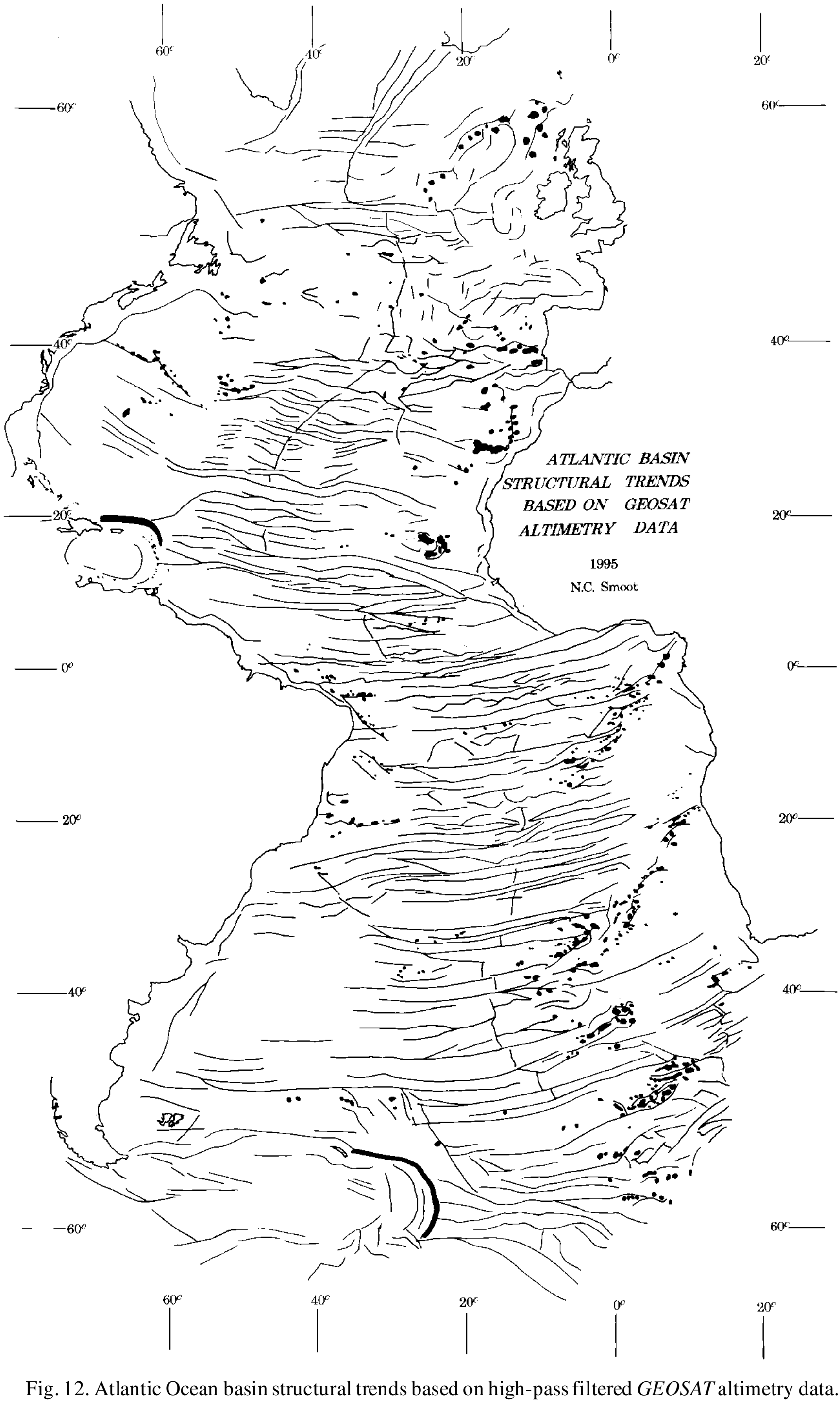

Fig. 12. Atlantic Ocean basin structural trends based on high-pass filtered *GEOSAT* altimetry data.

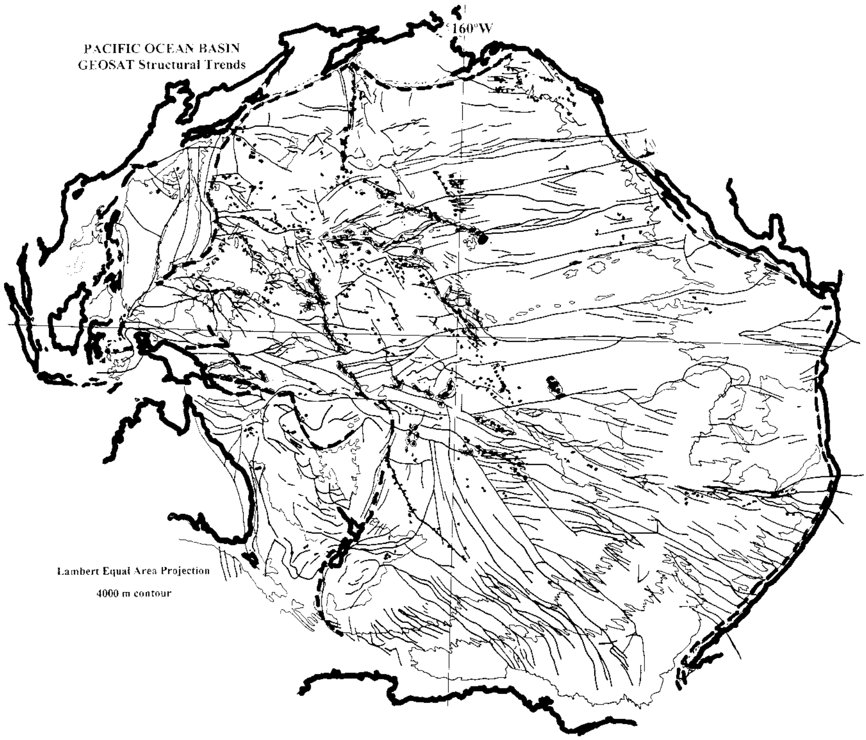

Fig. 13. Pacific Ocean basin structural trends based on a high-pass filter of *GEOSAT* altimetry data.

Next, the WSW–ENE-trending fracture zones in the North Pacific were shown to react to their environment similar to those in the North Atlantic. Many were shown to traverse the entire ocean basin, such as the Mendocino Fracture Zone (Smoot and King, 1997), Chinook Trough (Smoot, 1998a), and the Clipperton Fracture Zone. This was a novel concept in itself. Then they were shown to intersect the NNW–SSE-trending megatrends, many very well known fractures such as the Krusenstern, Mamua, Adak, Amlia, Rat Island, Kashima, Udintsev, and Emperor fracture zones. This gave a checkerboard effect of orthogonally intersecting fracture zone/megatrends in the north Pacific Ocean basin. At this point it was realized that all of the rises and plateaus lay atop the intersections. There was no need for the myriad micro-plates, such as the Magellan and Manihiki, being introduced in the literature.

With the addition of the *GEOSAT* high-pass filtered data set (Figure 13), yet another set of trends was introduced, that of trans-basin WNW–ESE-trends. This is the trend of the proposed hotspot tracks. Linear seamount chains, originally explained as hotspot tracks, may be formed in leaky fracture zones, or McDougall's hot lines. The hotspot idea received the support of the practicing tectonicists, which was another wrong turn. At any point of weakness at any

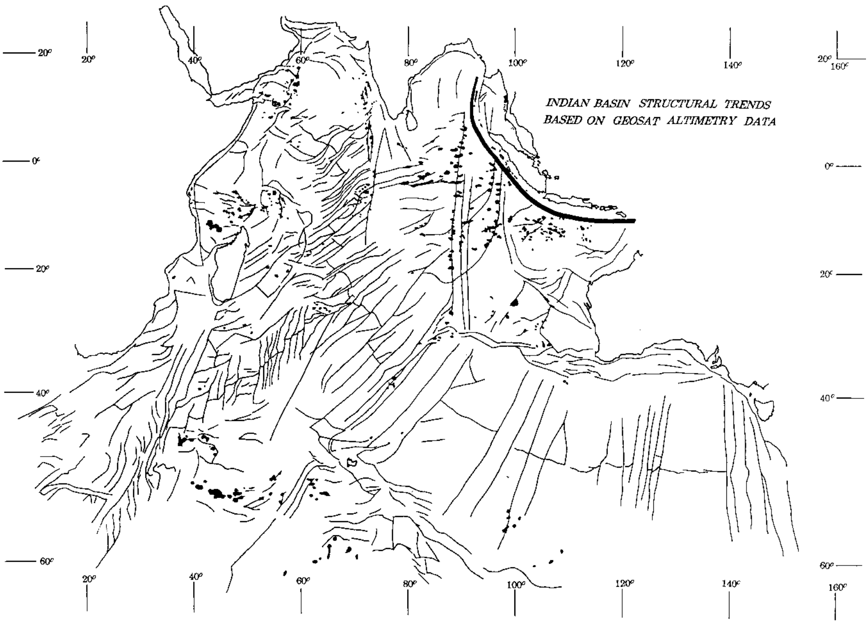

Fig. 14. Indian Ocean basin structural trends based on a high-pass filter of *GEOSAT* altimetry data.

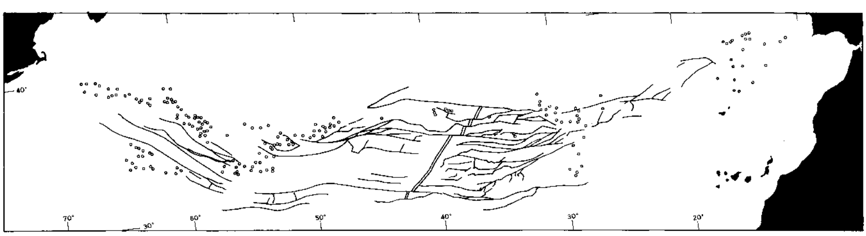

Fig. 15. The Oceanographer/Hayes fracture swarm includes the Corner Seamounts, the New England Seamounts, and the Monteregnan Hills on the west. On the eastern extreme the Horseshoe Seamounts and the Sierra Nevadas, and the Balleric Isles continue the megatrend.

time magma leakage through the fracture zone can produce seamounts or islands (Lowrie et al., 1986). While the original thoughts had the seamount chains to be age sequential, that is, to progress from younger to older, that has since been proven not to be the case (Epp, 1984; Baksi, 1999). Non-time-sequential linear seamount chains are the result of normal tectonic activity (Meyerhoff et al., 1992). In the place of a time-sequence aging outward from the hotspot, one finds all-aged seamounts and islands intermingled. Were that not the death knell of hotspots, seismotomography has already disproven the concept of mantle plumes (Anderson et al., 1992; Anderson, 1984; and others). Additionally, the fracture zones, which are supposed to show the direction of plate movement, and the hotspot/seamount chains, which also show the direction of plate movement, do not agree anywhere at any time. This has been known since the inception of both hypotheses.

The WNW–ESE trends have been previously noted, but little has been done to interpret them in a reasonable tectonic framework, primarily one can assume because they disagree with the prevailing thoughts concerning hotspot evolution and the 43 Ma elbow proposed for all of the seamount/island chains. Many basin-wide trends based on the high-pass filtered *GEOSAT* data base (Figure 13) have been published on the same azimuth as the Hawaiian Ridge (Leybourne and Smoot, 1997; in press; Meyerhoff et al., 1996b; Smoot, 1997, 1998b, 1999; Smoot and Leybourne, 1997; Smoot and Meyerhoff, 1995). Very early in the study of the *GEOSAT* altimetry data these trends were noted by other authors, with little attention paid to them other than to note that they may be the result of extensional processes.

Using the data available during the 1980s, a group tried to incorporate all of the real data into a more robust explanation as to Earth's geodynamic history (Meyerhoff et al., 1992; 1996b). They assumed that rocks exposed at the surface should cool, and that was the start. The net ever-diminishing Earth's radius and increase in rotational acceleration, along with the four cycles of geodynamics, are combined in the surge-tectonic hypothesis. Evidence exists in the lithosphere of pipe-like, tubular, or lens-like hot bodies that are interconnected. As we have seen, this has been known for the past 25 years. These hot bodies underlie foldbelts, rift zones, and strike-slip zones. The hot, lenticular bodies are called surge channels, occurring at depths of between 40 km and the top of the asthenosphere. The hot bodies move as Earth contracts in a sequence called the geotectonic cycle.

The geotectonic cycle is described as undergoing periods of alternating taphrogenesis and tectogenesis whereby the following events occur. (1) In the tectogenesis process, contraction of the lithosphere is always occurring because Earth is always cooling. (2) The overlying lithosphere is already cool, so it does not contract. Instead, Earth's basal circumference decreases in discrete pulses by large-scale thrusting along Benioff zones in the lithosphere. This process has been called subduction in the plate-tectonics hypothesis, and that term is sufficient still. (3) The discrete pulses of large-scale thrusting along the Benioff zones occur when the underlying dynamic support of the lithosphere fails. The weight of the lithosphere overcomes the combined weight of Benioff zone friction and the asthenosphere. Hence, tectogenesis is episodic. (4) During periods of lithospheric stability, or anorogenic intervals, the asthenosphere volume increases slowly as the strictosphere, or mantle, radius decreases and decompression of the asthenosphere begins. (5) Decompression is accompanied by rising temperature, increased magma generation, and lowered viscosity in the asthenosphere. The asthenosphere gradually weakens during the time intervals between collapses. (6) During lithosphere collapse into the asthenosphere, the landward sides of the Benioff zone obduct the ocean floor. The lithosphere buckles, fractures, and founders. Enormous compressive stresses are produced by this action in the lithosphere. The position of the surge channels is partially controlled by the presence of Benioff zones. (7) When the lithosphere collapses into the asthenosphere, the asthenosphere-derived magma begins to surge in the overlying surge channels intensively. Where that volume exceeds capacity, and when the compression in the lithosphere exceeds the strength of that lithosphere directly overlying the surge channel, the surge channel roofs rupture along strike in cracks that comprise the fault-fracture-fissure system generated before the rupture. Rupture is bivergent and forms continental rifts, foldbelts, strike-slip zones, and midocean rifts. These ruptures, called kobergens, are mountain ranges and midocean ridges, and the identifiers can be used interchangeably from a geomorphology standpoint through terrestrial/marine settings. (8) Once tectogenesis is complete, another geotectonic cycle sets in, usually within the same belt.

The characteristic tectonic features generated by surge channels are (1) linear to curvilinear lithosphere breaks, (2) structures directly related to lithosphere breaks, (3) structures indirectly related to lithosphere breaks, (4) morphotectonic features, and (5) geophysical phenomena.

Linear to curvilinear features are (1) long, linear zones of faults, fractures, and fissures, (2) horst-and-graben complexes, (3) strike-slip faults, sutures, *verschluckungszonen*, and tectonic lines, (4) thrust faults, (5) horsetail structures, and (6) eddy and vortex structures. Structures directly related to lithospheric breaks are (1) magmatic arcs, eugeosynclines, and alpino- and germano-type foldbelts, (2) tectonostratigraphic terranes, (3) fissure eruptions and volcanic fields, (4) aligned plutons, (5) lines of thermal springs, (6) kimberlite dikes or pipes, diatremes, ring complexes, (7) dike swarms, (8) ophiolite belts, (9) melange belts, (10) metamorphic belts, and (11) submarine aseismic ridges. Structures indirectly related to lithospheric breaks are (1) stretching lineaments and (2) mineral belts. Listed under the category of morphotectonic features are (1) linear river courses, (2) linear topographic divides, (3) linear evaporite basins, (4) plateaus, (5) midocean ridges, (6) feeder channels, or oceanic rises, and (7) breakout channels, or linear seamount chains. The geophysical characteristics of an active surge channel are (1) a negative Bouger gravity anomaly, (2) midocean ridge magnetic anomalies, (3) bands of microearthquakes, (4) bands of anomalous upper mantle P-wave velocity, and (5) transparent interior seismic reflection lens. The geophysical characteristics of an inactive surge channel are (1) positive Bouger gravity anomalies and (2) the interior of the reflection seismic lens is filled with reflectors.

Reducing all of the above to plain English, the rise-type, positive gravity anomaly features such as seamounts, plateaus and rises, aseismic ridges, volcano arcs, and midocean ridges are all products of taphrogenesis where the surge channels are filling and flowing. The region over the surge channels is expanding somewhat due to the excess heat being brought to or near the surface, but this is no way to be construed as seafloor spreading or Earth expansion. During tectogenesis, the surge channels are emptied, Earth contracts, and compressional features such as trenches, ocean floor fabric, and fracture zones are formed. The compression is a unidirectional move in a contracting Earth, as the entire body will never be that size again.

Just as no forces exist to drive the plate-tectonic hypothesis, three drive surge tectonics. That the Earth is cooling is a given, and that is the first driving force. The second is Earth's rotation coupled with drag along the outsides of the surge channels. The process involves differential lag between the already cooled lithosphere and the strictosphere. The third driving force is gravity. Gravity makes the roof collapse over the surge channel. The collapse is analogous to stepping on a tube of toothpaste. Any magma in the chamber is forced to surge.

Using the surge-tectonic hypothesis, the first analysis of this basin-wide phenomenon was outlined when the major swarm across the central Pacific basin was determined to be a part of the world-encircling geostream (Smoot and Leybourne, 1997), now called the Central Pacific Megatrend (CPM). The oceanic portion begins behind the Izu-Bonin-Mariana arc system and at the Banda Sea vortex. Passing beneath the Van Rees and Maoke Mountain in New Guinea, the CPM ridge merges with those from the Caroline Ridge to form the Ontong-Java Plateau and Solomon Islands. Continuing to the ESE, these ridges intersect the Clipperton Fracture Zone to continue to build a 4-km high ridge. At the Fiji Plateau they are joined by the SSE-trending Marshall-Gilbert Seamount chain and the WSW-trending Galapagos Fracture Zone to form the Fiji Plateau. At 4000 km from the Banda Sea, the CPM forms the Samoan Ridge. There it bifurcates. The presence of the CPM belies the Vityaz Trench system. With a constant 5400-m ocean floor depth to the north, it also belies a South Pacific Superswell.

The northern fork underlies the Tuamotu Archipelago, becomes the Easter Fracture Zone, and continues to the Easter vortex structure on the East Pacific Rise. From there the CPM becomes the Sala y Gomez Ridge, the Nazca Ridge, and continues onto the South American Precambrian Brazilian Shield (Figure 16; Choi, 1987, 1998; Choi et al., 1992). The southern fork of the CPM becomes the Austral Islands, underlies the Tubai Ridge, the south fork of the Easter Fracture Zone, and helps create the Juan Fernandez vortex structure on the East Pacific Rise. From there it proceeds as the Chile Rise, passes through the South American Precambrian shield, and continues into the Atlantic basin as the Falkland Islands. This, too, passes through rocks as old as Precambrian.

Studies around Australia reveal much the same pattern (Choi, 1997 for example), showing a marked linearity between ocean floor lineaments and continental lineaments (Figure 17). Additionally, the Mendocino Fracture Swarm has been taken ashore to the Yellowstone National Park area of the United

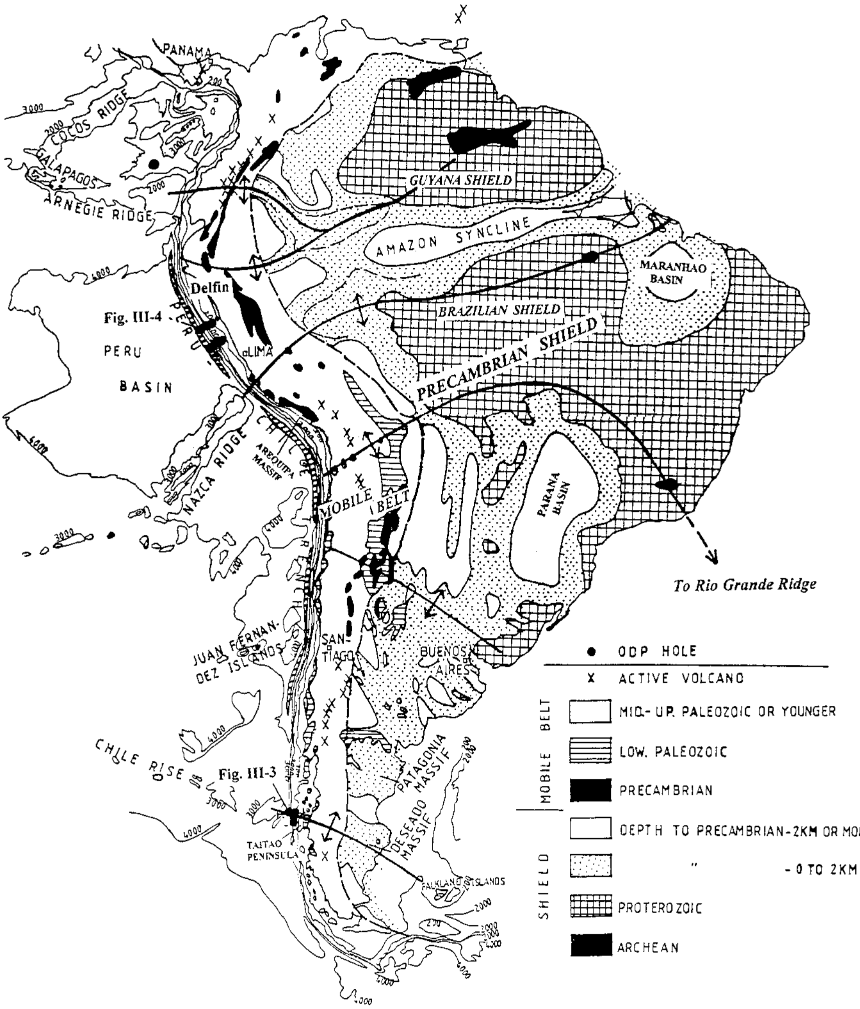

Fig. 16. Lineaments across the South American continent (Choi, 1998). All of these trends are continuations of ocean floor lineaments. All are also through Precambrian substrate.

States. The New England Seamounts continue ashore to the Monteregian Hills in Quebec. These are just a few examples, but the connections are worldwide.

An immediate benefit of this knowledge is the fact that all of the proposed micro-plates can now be deleted from the data base. All of the rises and plateaus on the ocean floor form atop these intersections; they present zones of excess weakness in the lithosphere. Also, the proposed "Darwin Rise" (Smoot and King, 1997) and South Pacific "superswell" have been proven to be figments of the geophysical imagination. Ocean science is radically simplified.

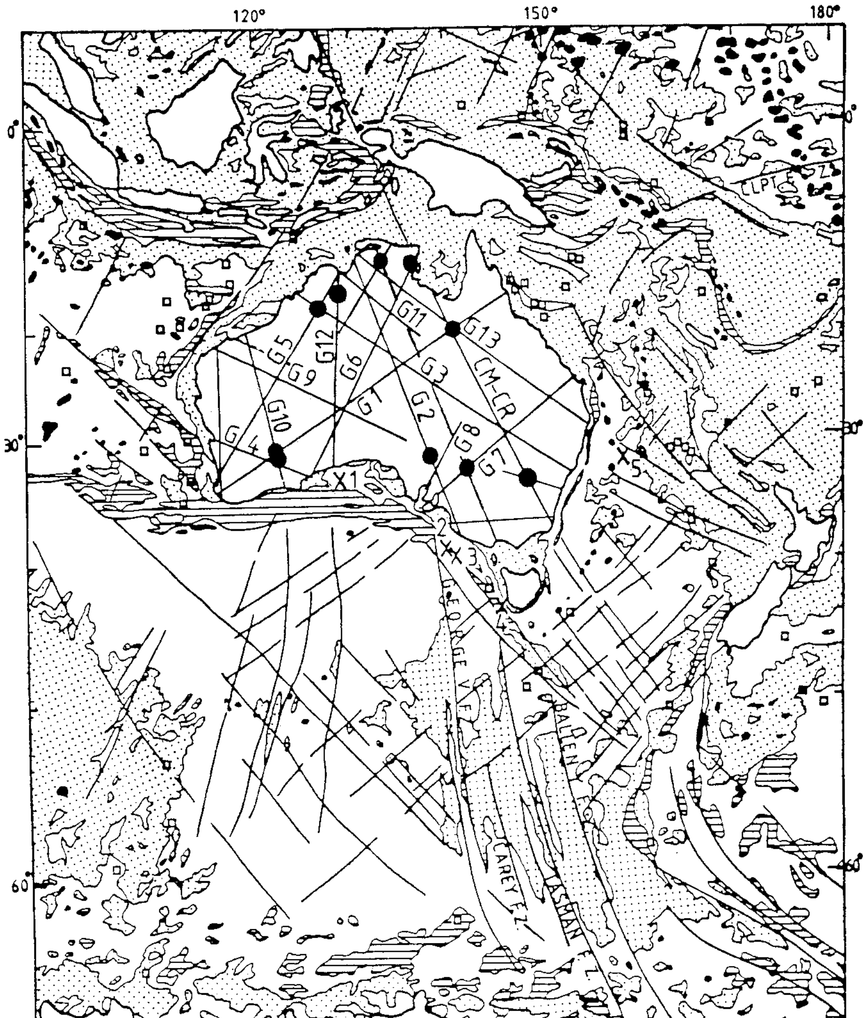

Fig. 17. Lineaments across Australia (Choi, 1997).

Seafloor spreading, by definition, cannot occur in three directions at the same time. Earth expansion or contraction would produce offsets in these lineaments, and very little offset is produced across any of the megatrends that have been studied with the possible exception of the NNW–SSE-trending megatrends in the Pacific basin. One would expect some offset if for no other reason than differential slippage across the megatrends. What these connecting lineaments show is that no movement of any of Earth's lithospheric components has occurred at any time, anywhere, in any way, shape or form since the

Paleozoic. No geodynamic explanations exist for this universal phenomenon other than vertical tectonics and a status quo movement regime. All the rest must incorporate this before any explanation can be acceptable to any but the most myopic of geodynamic students.

Conclusion

As the reader can clearly see, problems exist within and outside of the current working hypotheses that render those hypotheses more than untenable solutions to Earth geodynamics. Many other investigators have outlined the various problems. Now is the time for an adjustment in the thought processes that includes the use of the real ocean floor data, a tectonic paradigm shift as it were. This is reasonably akin to the story of the blind men describing the elephant; 70% of the Earth's surface had never been seen or mapped. The orthogonally intersecting megatrends belie any previous theories with the possible exception of the rhomboid theories advanced by Joe Gilg during the 1960s and being furthered by Karsten Storetvedt with global wrench tectonics. The surge-tectonic hypothesis explains the reasons for and formation of the lineaments. The geological, paleobiogeography, bathymetry, and *GEOSAT* data have certainly borne out these preliminary ideas.

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