

Annulling the “marriage of convenience” between Earth Expansion and Seafloor Spreading

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In an article published in the June 2012 issue of the *New Concepts in Global Tectonics* (NCGT) [newsletter](#), Stephen Foster (2012) announced that he had changed his mind concerning the expanding Earth hypothesis and now rejects it, offering a *mea culpa* for having previously advocated expansion. Dr. Foster notes that he rejected subduction long ago but until recently accepted seafloor spreading and Earth expansion. However, Dr. Foster now believes that seafloor spreading, like subduction, is a myth, and he provides a valuable review of the data that refute the seafloor spreading hypothesis, recapping several articles previously published in the NCGT newsletter that describe the widespread existence of ancient continental rocks on the floors of the world’s oceans.

Dr. Foster seems to believe that *if* seafloor spreading *and* subduction are *both* myths, then ocean widening and continental displacement, lacking a plausible mechanism, must also be myths, which renders superfluous any theory that purports to explain them, including, and perhaps especially, Earth expansion.

In my opinion, Dr. Foster has drawn the wrong conclusion. He apparently assumes that seafloor spreading is the *only* available mechanism for ocean widening on an expanding Earth. That is not so. However, it is not surprising that he has made that assumption because most expansion advocates following S. Warren Carey have done the same thing.

Carey (1976) characterized plate tectonics as a “shotgun wedding” between subduction on the one hand, dismissed by Carey as a myth that exists “only in the minds of its creators,” and seafloor spreading on the other, which Carey endorsed and incorporated into his expansion model. “Plate tectonics and expansion schools agree in respect to sea-floor spreading. They differ mainly in the interpretation of the trenches. This issue then is the crux of the debate.” In other words: subduction *bad*, seafloor spreading *good*. Unfortunately, Carey, by endorsing seafloor spreading, essentially sanctioned a “marriage of convenience” between expansion tectonics and seafloor spreading. Given the many problems now facing the seafloor spreading hypothesis, that marriage has not proved happy. But the failings of one partner should not besmirch the other. Expansion and seafloor spreading are *not* joined at the hip, so their fates are not inextricably intertwined. More to the point, and dispensing for the moment with the matrimonial metaphor, the refutation of seafloor spreading should have no bearing on Earth expansion.

Following Carey (1976), most expansion advocates have tacitly or explicitly accepted the “conveyor belt” model of seafloor spreading. Indeed, many expansion chronologies, such as those proposed by Owen (1983) and Maxlow (2005), are based on the Vine and Matthews (V-M) hypothesis (1963) and the associated polarity reversal timetables, such as Hertzler et al. (1968), which treat the marine magnetic anomalies as reliable “isochrons” that are literally *written in stone* on the ocean floor, and which purportedly reveal the history of seafloor spreading from the Early Mesozoic down to the present day. By accepting the gradualism implicit in V-M, these expansion chronologies invariably indicate continuous expansion from the Early Mesozoic onward.

There was, however, one continental-drifter and expansionist who never accepted Vine-Matthews or, for that matter, seafloor spreading (in the generally accepted sense of a convection-driven bilateral “conveyor belt”). Lester C. King, the great South African geologist and geomorphologist, was among the earliest critics of Vine-Matthews and seafloor spreading. Not

only did he dispute the emerging plate tectonic dogma, but he also insisted that continental displacement (i.e., expansion) unfolded through a series of discrete tectonic episodes that were largely restricted to the Mesozoic, as opposed to a gradual and continuous process from the Triassic onward, as the V-M-based plate tectonic and expansion theories would have it. (Erickson, 1988)

In his 1983 book *Wandering Continents and Spreading Sea Floors on an Expanding Earth* (a book rarely cited in the literature, alas), King challenged the underlying assumptions of the V-M hypothesis and seafloor spreading in general. Although it is impossible to fully describe King's vision here, which I hope to accomplish in a future article in the NCGT newsletter, a few quotations from his book should suffice:

- The Vine and Matthews (1963) hypothesis which requires that reversal patterns are frozen into the sea-floor rocks is only assumptive. But the reversal blocks, as drawn [in a figure in Vine and Matthews (1963)] convey a degree of confidence not yet warranted by the original data. (King, 1983, p. 111.)
- [W]hat the [shipborne] magnetometer has measured is a present total magnetic field. While this may have developed by migration laterally away from the zone of origin, there is no proof that the rocks through which the magnetic impulses now pass have themselves moved laterally with time. (96)
- That there is a pattern of polarity reversals is agreed; that these are “frozen” into the rocks is *assumed*, and that the pattern demonstrates the physical transportation of rock masses beneath the sea-floor is also an assumption that will be true only if the magnetism is “frozen” into the sea-floor basalts and other rocks. (96, italics in original)
- Symmetrical injection and outflow of lava from the ridge axis is assumed; but it is not likely to be so in nature. The boundaries for the claimed magnetic polarity reversals are unlikely to coincide with natural outflows of lava. (76)
- [T]he magnetic phenomena generated in relation to the mid-ocean ridges, and in particular the twinned polarity reversal stripes recorded by magnetometer traverses across the oceans, may well be only “signals” the pattern of which passes away to either side from the crestal zone of the ridge *through* the ocean floor, without any necessary displacement of, or addition to, the floor itself. On this viewpoint, sea-floor spreading is an unnecessary and perhaps wrongful assumption. (105, italics in original)
- To this author “sea-floor spreading” expresses the action admirably; but he sees no evidence of the “conveyor-belt” technology. Instead, he comprehends a general enlargement of the mantle body within the Earth. (82)

King also anticipated many articles in the NCGT newsletter in noting “the long list of Palaeozoic rocks dredged from certain ridge crests.” These are impossible to reconcile with seafloor spreading without recourse to secondary *ad hoc* hypotheses that merely “explain” the specific anomalies after-the-fact but yield no new discoveries or predictions, which is symptomatic of a “degenerative scientific research programme” (Lakatos, 1970).

King's criticism of the Vine-Matthews hypothesis and seafloor spreading both expresses and justifies his rejection of the gradualism implicit in plate tectonics. Instead of continuous post-Paleozoic seafloor spreading and continental displacement down to the present day, as envisioned by plate tectonics (and those expansion chronologies that rely on V-M), King argued that most of the global tectonic “action” in the ocean basins occurred during the Jurassic and Cretaceous periods of the Mesozoic era:

- [T]here were two phases of continental disruption and drift in the mid-Jurassic and late Cretaceous respectively, followed during most of the early Cenozoic by tectonic quiescence and widespread planation – denudational upon lands, sedimentational in the oceans. Only the India-Australia-Antarctica land mass drifted extensively during the early Cenozoic. Tectonic activity resumed on the planetary scale (with only local drift) during the late Oligocene to early Miocene, and has increased (with quiescent intervals of widespread synchronicity) until the Pleistocene at least. (120-121)
- Several authors have drawn attention to the apparent lack of disturbance in the sediments of the ocean basins, and remarked that such horizontality over such vast distances is surely not in conformity with the concept of convectional spreading. The extent of Cretaceous sediments is so vast as to indicate that most of the present oceanic area was already in existence at that time. In other words, the late Mesozoic fragmentation of Gondwanaland was followed by very rapid dispersal of the southern continents, and relatively little drift in Cenozoic time. (80)
- Argument from the study of geomagnetic reversal patterns in rocks have generally led to the conclusion of smoothly continuing, slow spreading of the ocean floors. The geological record, however, is one of “fits and starts” with short tectonic episodes followed by prolonged intermissions of relative quiescence. (79)
- [S]ea-floor spreading and plate tectonics became popular concepts immediately following the acceptance of continental drift, which was already proved by geological data. But, following du Toit [1937], geologists have been careful to relate continental drift to late Mesozoic tectonic activity, which was episodic. The neotectonicists disregarded this point and thought of plate tectonics as a general and continuous process of lateral change. They postulated average rates of horizontal movement in the several oceans – averaged over the past 100 million years. *In geology, time is long and tectonic averages mean little. Tectonic happenings (both vertical and horizontal) are episodic and not infrequently of global extent, with long quiet intermissions during which wide planations developed upon the lands and ample depositions took place in the oceanic basins.* (120) [*Emphasis added.*]

If seafloor spreading *sensu stricto* is not viable, as seems to be the case, then ocean widening must have been caused by other geological processes. King, of course, recognized this requirement, and he invoked processes that should be very familiar to readers of the NCGT newsletter.

Of great importance is the nature of the basaltic lower crust which, during the late Mesozoic when most of the continental break-up and drift occurred, must have been potentially eruptive upon a global scale, as is shown by the wide distribution of plateau basalt synchronous with the motion of the continents. This basaltic, lower crustal type is universal beneath the continents and ocean basins alike. Isotopic and trace element evidence suggests that it is derived as a product of fractional melting of the upper mantle on which it rests, sometimes with an intervening layer of gabbroic complexes and periodotitic rocks. But there is more. This upper mantle is abundantly charged with primitive volatiles at high temperature and low viscosity, which confer upon the melt an extraordinary state of mobility and vitality. (74-75).

Describing the Mesozoic breakup of Gondwanaland, upon which large depositional troughs and basins had previously formed, King wrote:

As the supercontinent subsided, tensional fissures leading upward would form at the base of the sagging crust. Advantage would be taken of these for the potent magmas of the upper mantle, with their volatiles, to begin a large scale invasion of the overlying supercontinental crust. Widespread dyking (with sill intrusion into suitable rock formations (shales)) then reversed the continental sagging and instead began domings of both the base and the surface of the supercontinent.... *The crust of Gondwanaland became engorged with levitated mantle,* and

because of the new doming was placed under a set of centrifugal forces (partly gravitational) with each sector of its periphery tilted outward (or forward) ready to fly apart....

[A]s the magmas finally reached the surface in the mid-Jurassic, they poured forth the immense floods of plateau basalts covering hundreds of square kilometers in Brazil, in South Africa, in India, and in Antarctica. This was the moment of disruption....

Henceforth the present southern continents were on their own. Each daughter continent inherited a leading edge of fold mountains that had formed part of the Gondwanaland circumvallation, each was tilted forward in the direction of travel, and each had to supply its own motive power....

Each continent rode as it were upon a cushion of levitating mantle. The power source might be expected to fail ultimately, but to begin with each continent was powered like a rocket. Later power surges are indicated by further outpourings of plateau basalt in early Cretaceous time (Brazil and southwest Africa) and late Cretaceous to Eocene (India), so that propulsion died down by the end of the Cretaceous.... But from the remaining southern land masses there is, as yet, no compelling geological evidence of Cenozoic drift, only of vertical displacements *in situ*. Certainly there is no orthodox geological evidence of Cenozoic subcrustal convection currents, or of sea-floor spreading.

The phenomena accompanying the disruption of Gondwanaland and the centrifugal dispersion of its fragments, with distinct mid-Jurassic, late Cretaceous and Miocene episodes of drift, and quiet intermissions of stability between, form the prescription which must be fulfilled by tectonicists. *It is a problem immensely grander* than the opening of the North Atlantic, which has received a disproportionate amount of attention. (89-91). [*Emphasis* added.]

King's account of the geological processes that dismembered Gondwanaland has many similarities to the "neo-fixist" tectonic models propounded in the NCGT newsletter and elsewhere by Belousov (1992), Rezanov (2003), Storetvedt (2003, 2010), and others. Expansion and the neo-fixist models agree that the Earth was once entirely enclosed by sialic (continental) crust and that the ocean basins are post-Paleozoic. They also agree that the continents are "fixed" to deep mantle roots and thus have always remained more or less *in situ*, and also that ocean basins are created by the infiltration of volatile-rich mantle material into the base of the continental crust along zones of weakness. However, expansion differs from the neo-fixist models in that the various land masses on an expanding Earth became displaced vertically on the globe (horizontally in plan view) as the mantle expanded beneath them, and thus it also differs with respect to ocean-basin development.

Like plate tectonics, the neo-fixist models assume a constant-sized Earth. But unlike plate tectonics, the neo-fixist models envision "oceanization" of the continental crust as the proximate cause of ocean basin formation (Belousov, 1992). According to these models, oceanization spreads laterally outward from ancient geosynclines (marginal seas), which eventually transforms the continental crust into oceanic basins through extensional faulting, attenuation, basaltic magmatism (basification), and sub-crustal delamination, in a progressive manner that is similar to seafloor spreading in its horizontal propagation, but also quite different because there is no crustal displacement.

In contrast, an expansion model based on King (1983) envisions that new oceanic crust was formed between the various "levitated" remnants of the ancient supercontinents as the mantle expanded and became exposed at the surface. Thus, the continental land masses for the most part were seemingly unaffected by oceanization, except on their peripheries, where narrow epicontinental seas (zones of weakness) stretched and evolved into wide global oceans. Since the primary tectonic motion of the crust – *all* of the crust – on an expanding globe is radially outward and upward on diverging radii, the "levitated" continents remained fixed to their mantle

roots. (Figure 1.) So it should come as no surprise that pieces of old continental crust, where it was torn asunder and oceanized, were also transported radially outward and upward and were therefore intermixed *in situ* with the new oceanic basalt: e.g., Madagascar and the Seychelles in the Indian Ocean, St. Peter-Paul Rocks in the mid-Atlantic (James, 1997), Jan Mayan Ridge in the North Atlantic (Yano et al., 2009), the numerous submarine plateaus worldwide, and the many continental rocks that have been dredged from all of the oceans (Vasiliev and Yano, 2007).

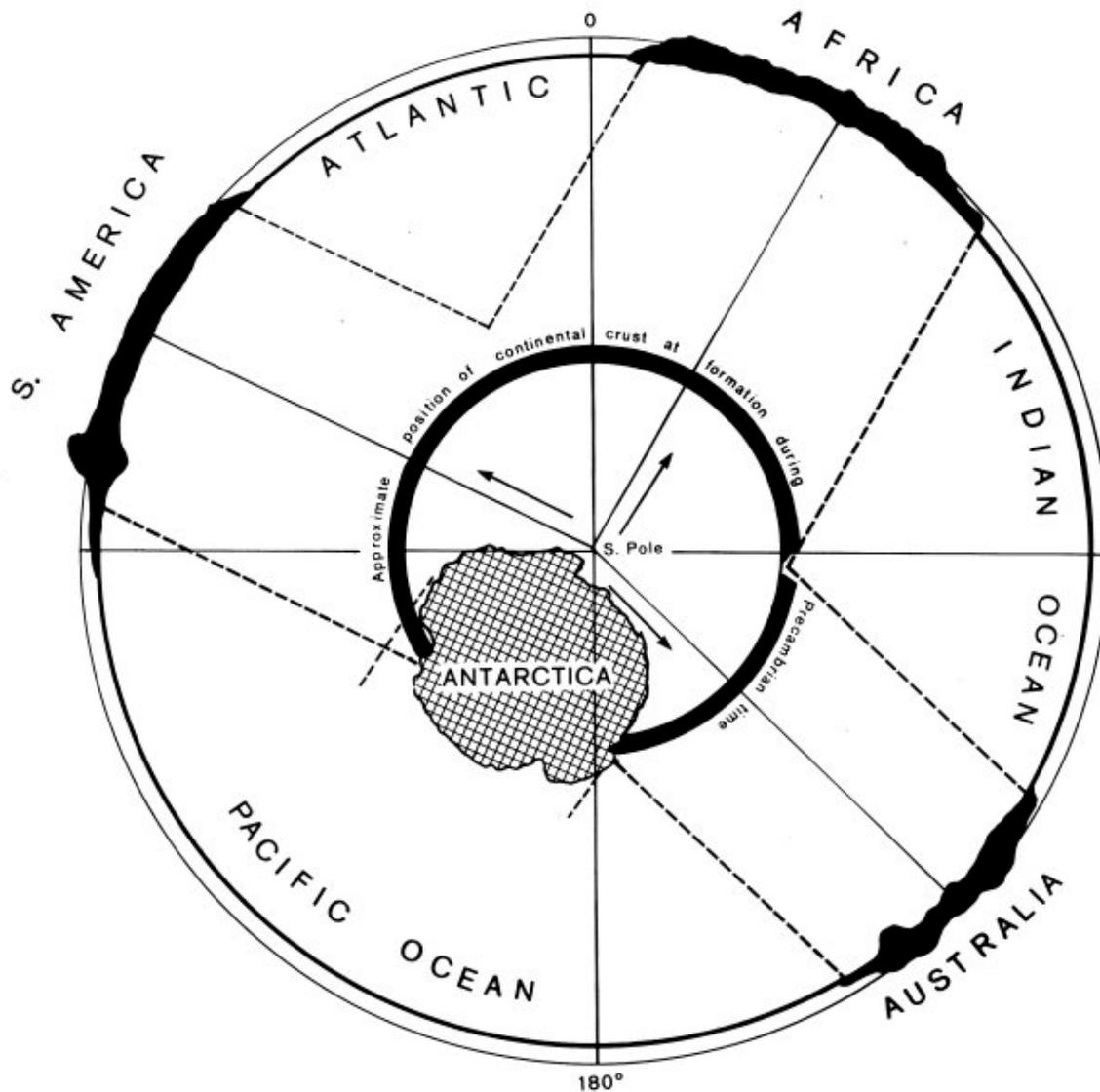


Figure 1. Present southern continents and ocean basins on an expanding Earth. Original size of continental crust in heavily-drawn inner circle. Continental drift is shown by vertical rise of the continents on diverging radii, and growing distance between them on the increasing circumference. As areas of continental crust do not enlarge during global expansion, the increase of the surface is taken up in the oceanic areas which become wedge shaped. Probable order of ocean basin formation is: (1) Pacific Ocean; (2) Indian Ocean; (3) Atlantic Ocean. South America and Africa are drawn from equatorial section, Australia at 15° S latitude. Antarctica is shown in plan near its present position. (Figure and caption from King, 1983, Fig. 31.)

In this alternate model based on King, expansion tectonics is divorced from seafloor spreading and wed to oceanization, but only on its own terms and in a much narrower sense. Indeed, this expansion model explains how and why oceanization was triggered in the first place. As the Earth expanded – which certainly must have involved mineral phase changes in the mantle on a global scale – the continental crust became attenuated, or “stretched” laterally and perpendicularly to ancient geosynclines, where the new ocean basins originated. This stretching, or lateral extension, of the continental crust initially may have taken many forms: horst-and-grabens, low-angle listric faults, and brittle deformation (fault breccias and gouge) near the surface, as well as ductile deformation (mylonites, schists and gneisses) in the deeper, hotter, and more plastic levels of the continental crust. Attenuation weakened the continental crust, and block faulting provided pathways for volatile-rich mantle materials to intrude along high-angle faults or simply through cracks and joints in the rocks (e.g., sheeted dykes, ophiolites, and basaltic magmatism generally), topped by subareal “traps” and pillow basalts in submarine environments. Eventually, widespread flood basalts buried most of the remaining continental rocks in the ocean basins whilst leaving isolated chunks, slivers, and debris of the ancient crust here and there – *in situ*.

Southwestern North America provides dramatic evidence of crustal extension, attenuation, and magmatism at what may be a nascent *pre-oceanic* stage: the Basin and Range Province (Dickinson, 2006; Figure 2), characterized by numerous extensional features, such as horst-and-grabens, listric and low-angle detachment faults, mylonites (Figures 3 & 4), and metamorphic core complexes (Coney, 1980; Figure 4); the Rio Grande Rift (Wilson et al. 2005; Figure 2), where the continent is “stretched like taffy” (Hill, 2005); the Yellowstone Caldera (Figures 2 & 5) and Snake River Plain (Figures 2 & 6) in the heart of the North American Cordillera, where the crust is highly attenuated and the upper mantle is very close to the surface (Christiansen et al., 2002; Figure 5); and the Columbia River flood basalts, which are among the largest on Earth (Bryan et al., 2010; Figure 2). The total basin-and-range extension is estimated to be between 50% and 300%. (Liu and Shen, 1998, and references therein.)

According to expansion tectonics, the primary tectonic motion is vertical and radially outward, so these Neogene extensional and magmatic features may simply be the means by which the continental crust accommodates the increased surface area of the globe and they may presage, if expansion continues (or resumes), the development of a large and largely basaltic oceanic basin, or perhaps the eastward enlargement of the Pacific basin through oceanization, with or without expansion. (Cf. Carey, 1976 and Storetvedt, 2003.).

Significantly, the Basin and Range Province falls directly on the line of the East Pacific Rise and thus may be the northward continuation of that feature beneath North America. (Figure 2.) Plate tectonic theory denies this and maintains instead that transform faults, e.g., the San Andreas, have shifted this “spreading center” westward so that it sidesteps North America and continues off the west coast as the Gorda and Juan de Fuca Ridges.

Plate tectonic theorists interpret the Cenozoic geology of southwestern North America generally in a convergent, subduction zone setting (Dickinson, 2006). The basin-and-range topography and other extensional features are thought to have resulted, at least initially, from the collapse of a thick, gravitationally unstable crustal welt that developed in the Late Cretaceous and Paleogene during the Laramide orogeny (Coney, 1987; Cf. Liu and Shen, 1998), which occurred along the entire length of the North American Cordillera. However, plate theorists, invoking subduction, have considerable difficulty explaining how or why Laramide deformation developed approximately 1000 km inland from the nearest active margin. “None of the proposed

mechanisms for driving Laramide orogenesis satisfactorily explain the geometry, timing, or extent of this inboard, continental-scale orogeny.” (English and Johnston, 2004.)

(There are striking similarities between the American Basin and Range and the Tyrrhenian Basin southwest of Italy, which is now kilometers deep beneath the Mediterranean. “The extensional basin of the Tyrrhenian formed within thickened continental crust on the former site of a collisional orogeny.” [Kastens and Mascle, 1990.]).

The Colorado Plateau (Figures 2 & 7) is surrounded by this tectonic mayhem but seems to have been largely unaffected by it and, moreover, it has risen 2-3 km above sea-level, which is also difficult to explain: “What caused the elevation gain of this previously stable cratonic region in Cenozoic time? Did the source of buoyancy for plateau uplift arise from the crust, lithospheric mantle, or asthenosphere, or through some combination of the three? Why did this low-relief plateau escape significant upper crustal strain during uplift, in contrast to the Cenozoic surface deformation that is so strikingly apparent in the high-relief landscape of the surrounding Rocky Mountain, Rio Grande Rift, and Basin and Range provinces?” (Flowers, 2010.) These problems remain unsolved. Southwestern North America has some of the most interesting, enigmatic, and important geology on Earth and therefore deserves close and careful study.

Finally, we should recall that most if not all of the neo-fixist models propounded in the NCGT newsletter and elsewhere agree that ocean basin formation was essentially a Mesozoic phenomenon (e.g., Belousov, 1992; Rezanov, 2003; Storetvedt, 2003; Choi and Vasiliev, 2008; Storetvedt and Longhinos, 2011). However, this very important *geohistorical fact* remains unexplained by those models, except in a very general way, and is therefore mere happenstance according to them. But if King is right, then the sudden and unprecedented creation of the wide ocean basins was a direct *and necessary* consequence of rapid Earth expansion during the Mesozoic, which ruptured the ancient supercontinents that had formerly covered the smaller Earth and perforce required *something* – i.e., young mantle-derived basalts intermingled with fragments of ancient continental crust – to fill in the voids between the remnant continents as the latter were displaced vertically on the 3-D globe and horizontally on 2-D maps. *Natura abhorret a vacuo.*

In rejecting Earth expansion based solely on the shortcomings of seafloor spreading, Dr. Foster has thrown out the baby with the bathwater. Accordingly, I urge him to reconsider his *mea culpa* and take a fresh look at the expansion hypothesis; i.e., an alternate version of expansion tectonics based on King (1983), a version that eschews Vine-Matthews and seafloor spreading, and one that embraces crustal attenuation and oceanization.

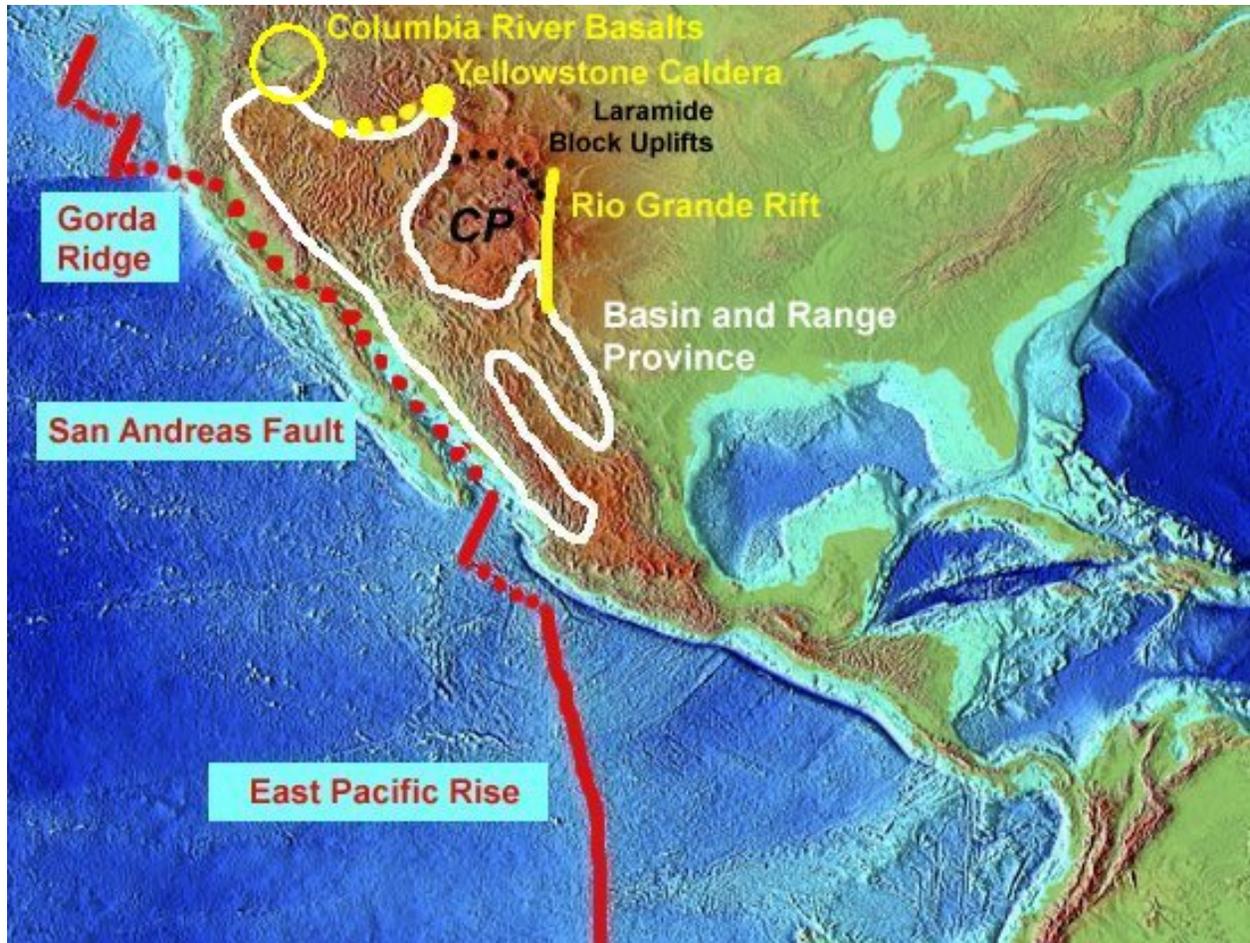


Figure 2. Geographical setting of the Basin and Range Province, outlined in white, and the other Neogene features mentioned in the text shown in yellow, in southwestern North America, north of where the East Pacific Rise approaches the continent. Note the Big Horn Mountains and the Black Hills, barely visible to the left of the word “Laramide” and beneath the letters “ll” and “s,” respectively, in the word “Yellowstone, which are reverse-fault-bounded uplifts of Precambrian crystalline basement, as are the Wind River Range and Laramie Mountains further south, along the black stippled line. These block uplifts are associated with the Laramide orogeny, “a profound compressional event” that occurred during the Late Cretaceous and Paleogene and extended from Canada to Mexico. “The entire crust was folded and broken by very deep-seated thrust faults” (Coney, 1978). In the midst of all this tectonic mayhem is the Colorado Plateau (labeled “CP”), the iconic landscape of the American West (e.g., Monument Valley, The Arches, Zion, the Grand Canyon [Figure 7], etc.), which is a veritable island of crustal stability, barely touched by the Cenozoic diastrophism that surrounds it.

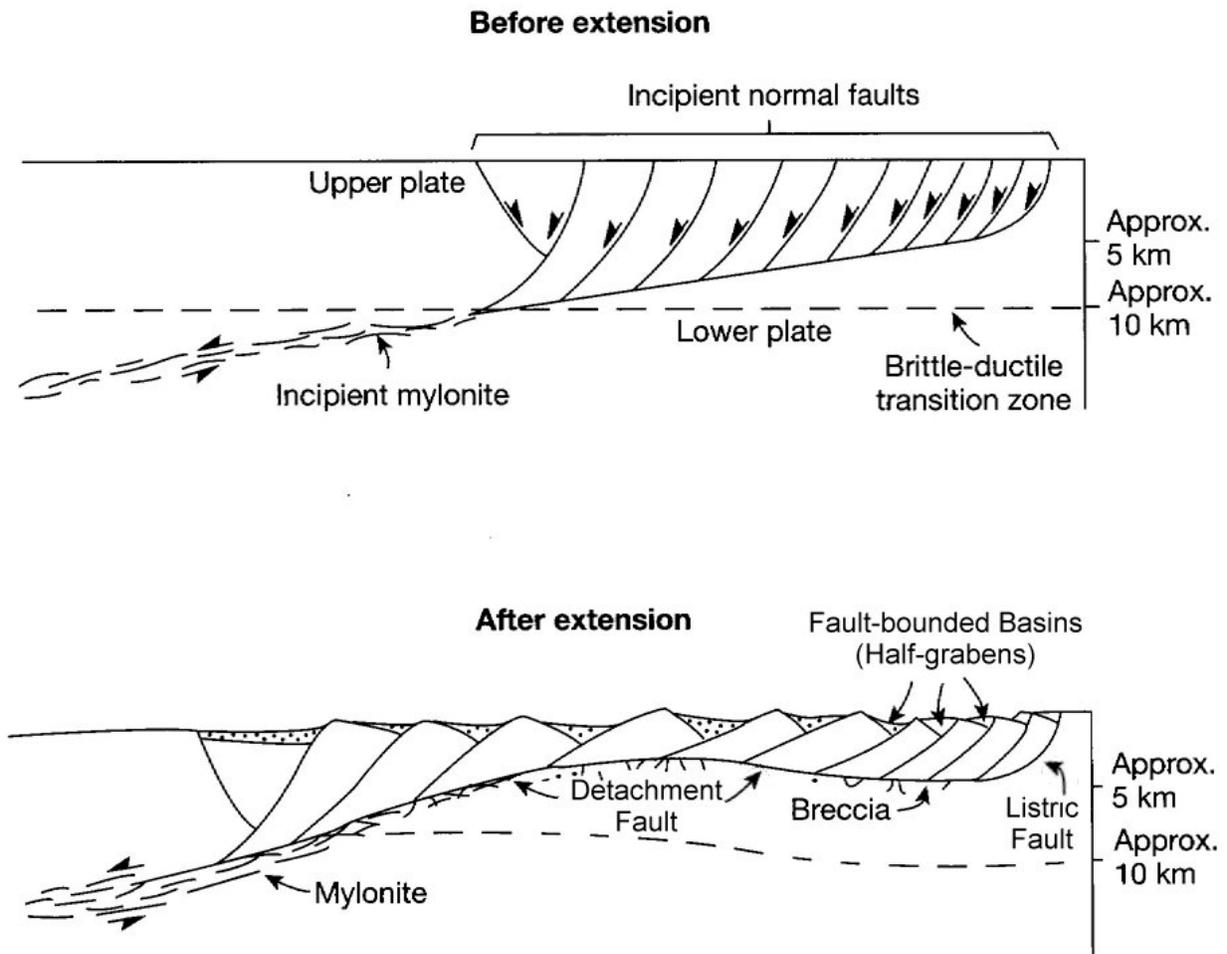


Figure 3. Schematic cross-section of basin-and-range geology before and after crustal extension: normal, listric and low-angle detachment faults, imbricate fault blocks, and mylonites near the brittle-ductile transition zone. (Modified after Michaelsen.)

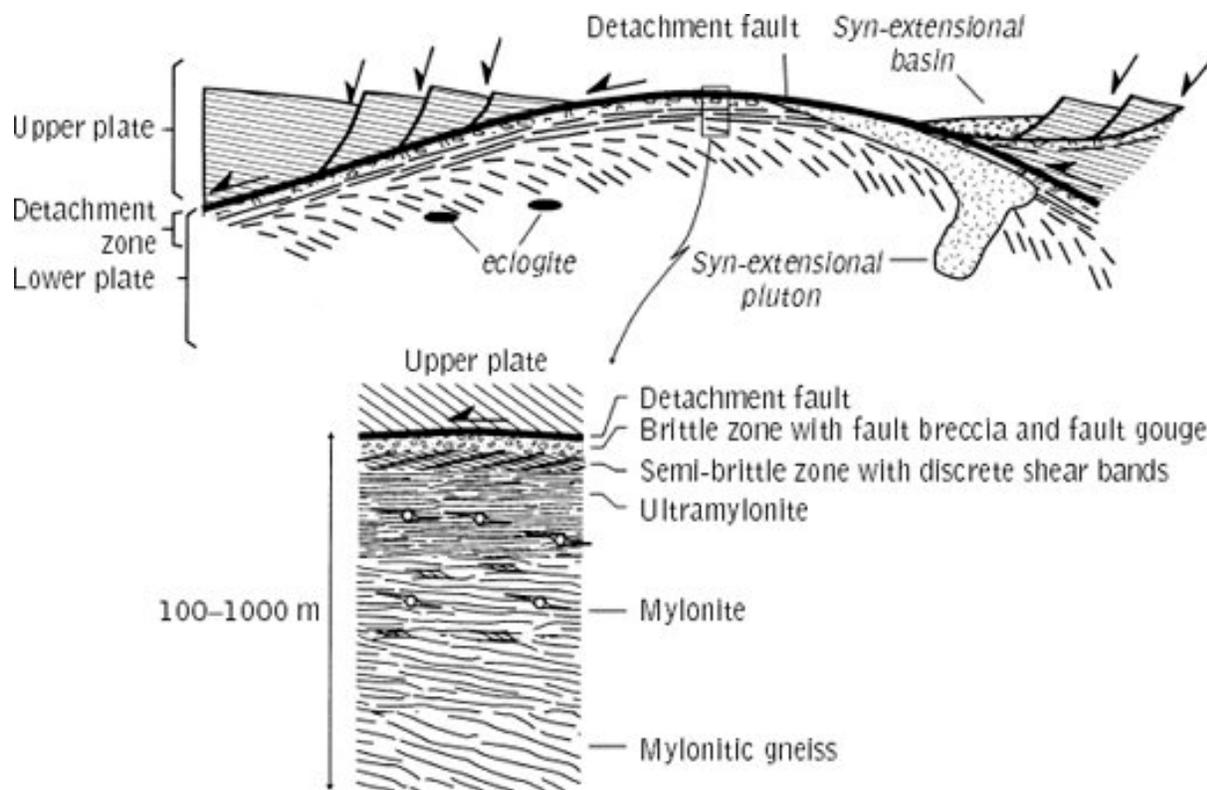


Figure 4. Schematic cross-section of a metamorphic core complex, with detachment fault and metamorphic basement exposed at the surface. This extensional mode of basement exposure differs significantly from the Laramide style, which involved reverse block-faulting indicative of compression. The development of metamorphic core complexes in many places marked the onset of post-Laramide extension. (Coney, 1987.)

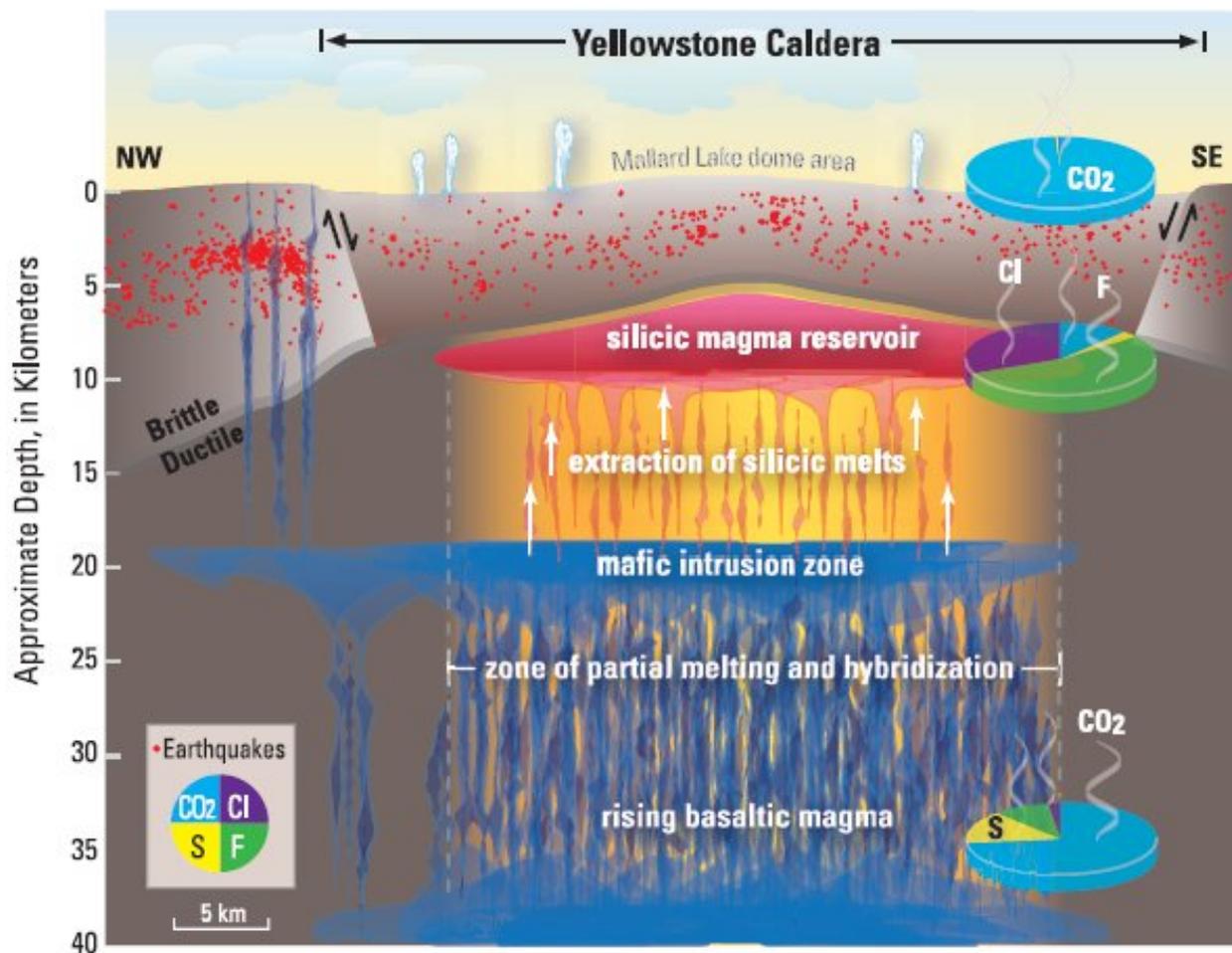


Figure 5. Schematic cross-section of the crust beneath the Yellowstone Caldera [references excluded]. Red dots represent earthquake epicenters. The silicic magma reservoir is responsible for most of the volcanism over the past 2.1 million years and overlies a middle and lower crust invaded by mantle derived basalt. The silicic magma is a hybrid of crustal melts and residual liquid formed as mafic magma cools and crystallizes. Magma rises closest to the surface (5–7 km depth) beneath the resurgent domes. Pie diagrams compare the relative abundances of volatiles emitted from the Yellowstone hydrothermal system (top) with the abundances of volatiles dissolved in Yellowstone rhyolites (middle) and hotspot basalts (bottom). The CO₂-rich hydrothermal system appears to reflect the basalt dominated crust below. (Figure and caption from Lowenstern and Herwitz, 2008.)

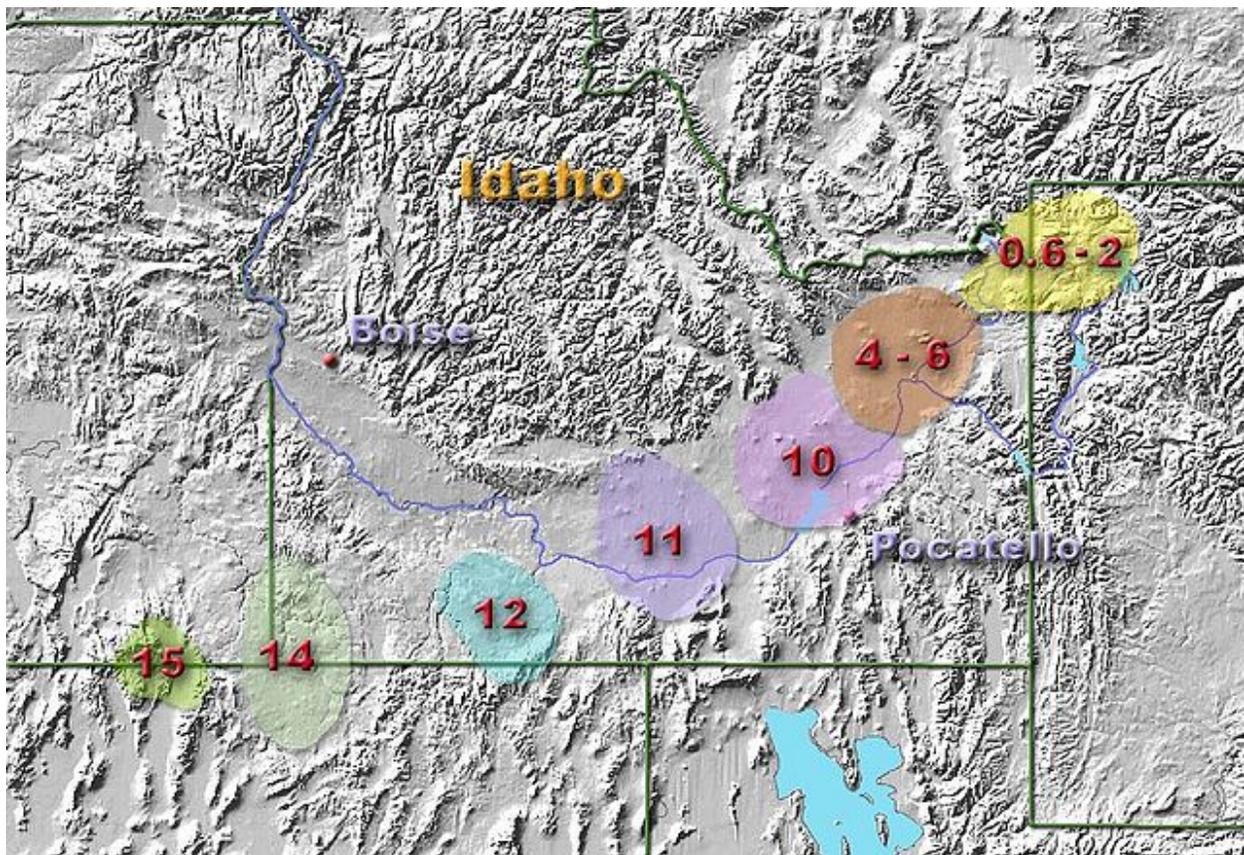


Figure 6. Path of the Yellowstone “hot spot” during the past 15 million years along the Snake River Plain at the northern edge of the Basin and Range Province (Wikipedia: *Yellowstone Caldera*). Note the basin-and-range topography south of the path, but not north of it, suggestive of a northeast trending (and advancing?) tectonic boundary.

The Grand Staircase

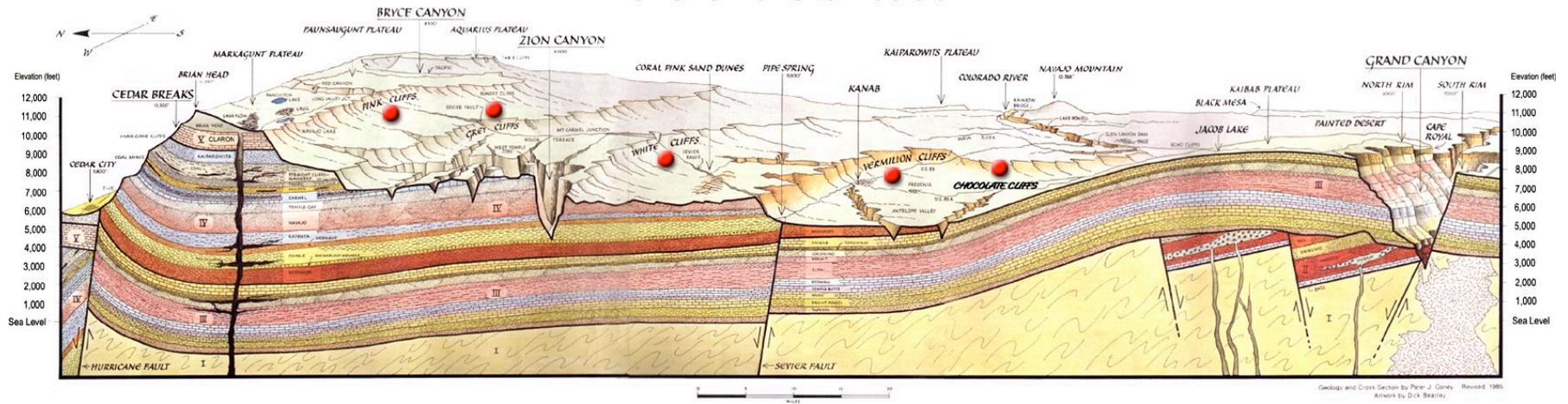


Figure 7. Stylized cross-section of “The Grand Staircase” in the southwestern region of the Colorado Plateau (Coney, 1985). From left-to-right (north-to-south) are Cedar Breaks, Bryce Canyon, Zion Canyon and the Grand Canyon. The strata are Cambrian through Eocene (discontinuous) resting unconformably on Middle Proterozoic basement. Note the almost complete absence of Phanerozoic deformation, despite the Cenozoic diastrophism (Laramide, Basin-and-Range, etc.) that surrounds the Colorado Plateau.

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