Paper 2: Modelling the Modern Oceans

"But in the end the rigorous approach has paid off. For it has revealed a discrepancy which had not been apparent. It was not my method that was at fault, but my assumption that the earth of Pangaea was the same size as the earth of today. The assembly of Pangaea is not possible on the earth of the present radius, but on a smaller globe...these difficulties vanish." Carey, 1958

Conventional Plate Tectonic studies do not use the *Geological Map of the World* (CGMW&UNESCO, 1990) (Figures 1 and 2) or similar maps to constrain plate assemblages. Heavy reliance is instead placed on palaeomagnetic apparent-polar-wander studies to locate ancient pole positions of adjacent crustal fragments. While at an advanced stage of sophistication these apparent-polar-wander studies result in a multitude of plate-fit options for the various crustal fragments and are severely constrained by a lack of longitudinal control during plate assemblage. Crustal fragmentation, dispersal, and reassemblage to form supercontinents is then portrayed as a random, non-predictable process of continental drift across the surface of a constant radius Earth.

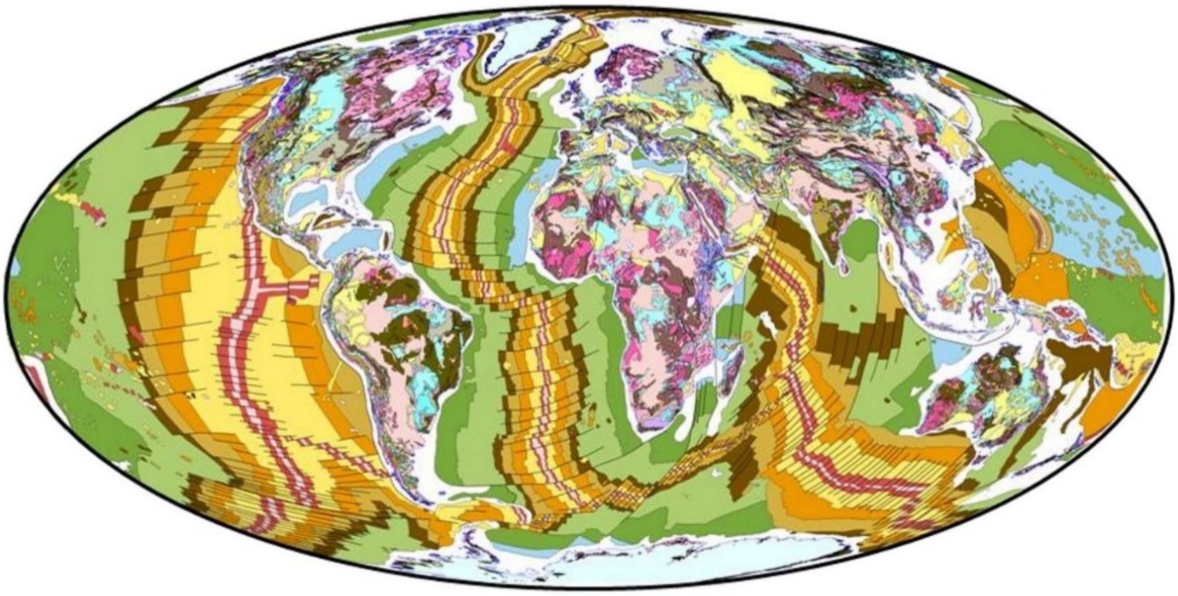

Figure 1 Geological Map of the World (CMGW & UNESCO, 1990) showing time-based bedrock geology reproduced in Mollweide projection.

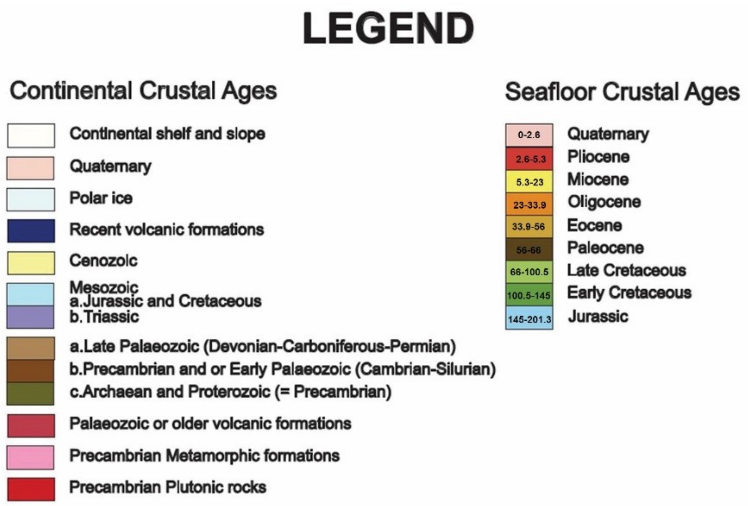

Figure 2 Geological timescale legend showing the various colours of the continental and seafloor crustal ages as shown in Figure 1. Seafloor crustal ages are in millions of years before the present-day.

In contrast, for an increasing radius Earth, in addition to providing a unique means to measure ancient Earth surface area, the coloured Geological Map of the World map provides a means to constrain the precise location of all seafloor crustal plates at any moment back in time to the early-Jurassic Period. By returning the seafloor volcanic rocks back to the mantle, from where they originally came from, the surface areas of each of the oceans must, by established protocol, be progressively reduced and each of the continents moved closer together. The uniqueness of adopting an increasing surface area model of the Earth is that there is no need to consider where, or when, pre-existing crusts occurred or, similarly, where they must go to. All that is required is to let the configuration of the coloured seafloor crustal mapping dictate the precise crustal plate assemblages on a pre-determined smaller radius Earth model.

To fully comprehend the small Earth models presented here it is important to visualise the proposed mechanism for formation of new matter within the Earth as a time-dependant process. Moving forward in time electron and proton ions enter the Earth and synthesis within the core-mantle region to form new matter. When moving back in time, as is done during construction of each small Earth model, these same ions leave the Earth and return to the Sun where they originated from. So, when I say *"removing the coloured seafloor stripes in succession and refitting the plates together on smaller radius Earth models"*, for instance, it must be understood that this also involves removal of synthesised matter from the core-mantle and returning this same material back to the Sun via the solar wind.

To test the application and validity of an increasing surface area Earth model and, in particular, the ancient Earth radii as determined from empirical seafloor mapping data, a series of spherical small Earth models (Figure 3) were initially made for the present-day and the beginning of the Pliocene, Miocene, Oligocene, Eocene, Palaeocene, Late-Cretaceous, Mid-Cretaceous, Early-Cretaceous, Late-Jurassic, and early-Jurassic Epochs and Periods.

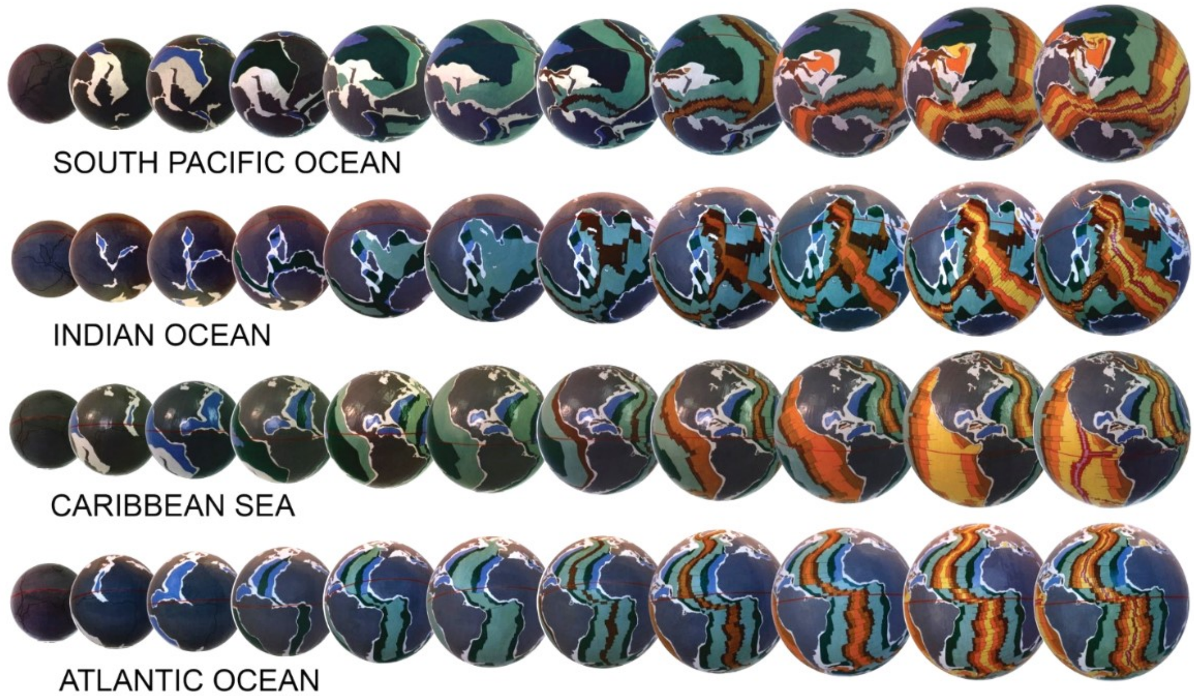

Figure 3 Spherical small Earth models of the Jurassic to present-day increasing radius Earth. Each small Earth model demonstrates that the seafloor crustal plate assemblage coincides fully with seafloor spreading and geological data and accords with the derived ancient Earth radii.

Observations

For the completed small Earth models (Figure 3), as the coloured seafloor stripes are progressively removed and the surface area reduced in turn the remaining coloured stripes are shown to neatly close together on each successive model. Each crustal plate assembles together in a unique, orderly, and predictable manner, during systematic closure of all of the oceans. By removing the coloured seafloor stripes in succession and refitting the plates together on smaller radius Earth models, each plate is then shown to reunite precisely along their respective mid-ocean-ridge spreading axes, estimated to be at better than 99 percent fit-together for each model.

The distinguishing feature of this modelling technique is that prior to the Jurassic Period—model at far left in Figure 3—all continental crusts are united as a single Pangaean supercontinent covering the entire ancient Earth. On an increasing radius Earth the Pangaean supercontinent simply wrapped itself around to enclose the entire ancient Earth with continental crust. It is the subsequent rupture and breakup of Pangaea during increase in both Earth radius and surface area—shown elsewhere to occur around 250 million years ago during the late-Permian—that then led to the formation of the modern continents and opening of the modern oceans.

On each of the small Earth models the continental shelves, marine plateaux, and remnant ancient seafloor crusts—shown as white areas around the margins of the continents—are also shown to merge during the Jurassic Period to form a global network of intracontinental marine sedimentary basins on an ancient small Earth at approximately 55 percent of the present Earth radius. This mergence suggests that pre-existing continental sedimentary basins plus primitive marine basins represent a network of ancient continental seaways. By progressively returning the eroded sediments from these continental and marine sedimentary basins back to the lands where they came from, additional continental small Earth modelling shows that each continent further re-unites with adjoining continents along their mutual margins at approximately 50 percent of the present Earth radius during the late-Permian to early-Triassic Periods.

From the model studies briefly introduced here it is important to reiterate a very important observation.

By globally removing the seafloor volcanic lava from each of the coloured stripes in succession and refitting the remaining crustal plates together on small Earth models, all plates reunite precisely with one, unique assemblage. Each crustal plate is shown to assemble with a better than ninety-nine percent fit-together, for each model constructed.

If the Earth were not increasing in surface area then this unique fit-together of all plates and continents would not occur. Similarly, if the Earth were not increasing in surface area then large gaps or overlaps in the reconstructed plates should occur and the need to fragment continental and seafloor crusts to accommodate for the seafloor crustal evidence should become increasingly apparent and necessary. Each of these gaps or overlaps in turn would also outline areas where presumed, pre-existing subducted crusts should have once been.

The fact that large gaps or overlaps do not occur, on any of the models, demonstrates the significance of the coloured seafloor mapping as a valuable tool for reconstructing plate assemblages and constraining the unique fit-together of all past plate assemblages back to at least the early-Jurassic Period.

Modern Oceans and Seas

"It is difficult to believe that chance alone can explain this fitting together of the continental margins." Barnett, 1962

On an increasing radius Earth, prior to the late-Permian—around 250 million years ago—there were no modern oceans, only ancient continental seas. The transition from ancient seas to modern oceans came about when the Pangaean supercontinent first started to breakup to form the modern continents and intervening modern oceans. Breakup then initiated draining of waters from the ancient continental seas into the newly opening modern oceans plus expulsion of new waters from along the mid-ocean-ridge spreading zones.

Fundamental to the concept of an increasing surface area Earth is the premise that ocean waters and atmospheric gases have been accumulating throughout much of geologic time in sympathy with the formation of ancient supercontinental crusts and intrusion of new seafloor volcanic crusts along the mid-ocean-ridge spreading zones.

The modern oceans initially opened during the late-Permian within ruptured areas of continental crust where supercontinental crust had failed to keep pace with increases to the Earth surface area and surface curvature. On each of the small Earth models these rupture zones were initially located within the present northwest Pacific and North Atlantic Ocean regions respectively. The rupture zones then progressively opened and rapidly extended in surface area throughout the Mesozoic and Cenozoic Eras forming what are now the modern Pacific and Atlantic Oceans.

Arctic Ocean

The Arctic Ocean originated as a very ancient marine sedimentary basin which first formed and commenced opening as the ancient Pangaea supercontinental crust started to rupture around 250 million years ago (Figure 4). This early Arctic Ocean basin was originally located in mid- to high-northern latitudes. Successive small Earth models show that over time, as the ocean continued to open, the basin and surrounding continents remained within the north polar-regions.

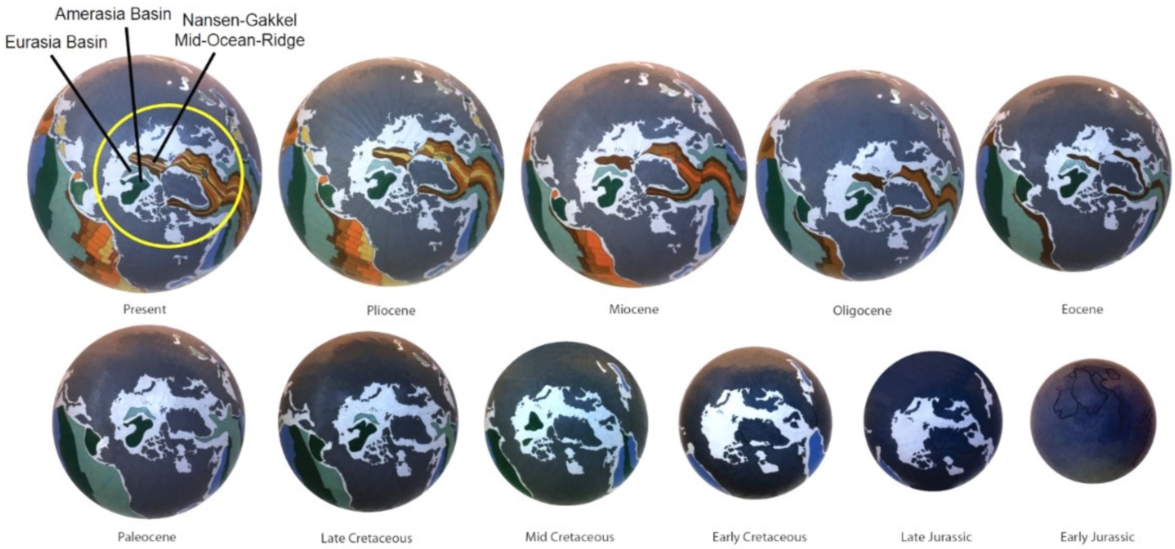

Figure 4 Arctic Ocean small Earth spreading history, extending from the present-day back to the early-Jurassic.

In Figure 4 the older Arctic Ocean shown in the lower right models is made up of a large expanse of marine sediments, shown as white areas located around the margins of the ancient continents, plus two seafloor basins shown as green colours. These green coloured seafloor basins are the Amerasia and Eurasia Basins. The basins are Cretaceous in age and are shown to crosscut and displace the extensive white areas of marine sediments which were first deposited along the newly emerging continental shelf margins prior to exposure and preservation of the volcanic seafloor crusts.

On an increasing radius Earth, opening of the Arctic Ocean occurred as a result of crustal rupture and breakup of the ancient Pangaea supercontinent and was located between the newly formed North American and Russian continents. This breakup was then followed by on-going seafloor crustal stretching and opening of the Arctic Ocean within this region. The initially small Arctic Ocean basin progressively increased in surface area and its boundaries continued to extend further to the southeast during the Mesozoic Era.

The presence of exposed coloured seafloor crustal rocks within the Amerasia and Eurasia Basins shows that there was an initial period of seafloor spreading in each of these areas during the Cretaceous Period. The lack of any further seafloor crusts suggest that spreading then effectively ceased during late-Cretaceous times. Today, there are no active spreading centres in the older Arctic Ocean regions. Spreading is now located within the adjoining Nansen-Gakkel mid-ocean-ridge, which is a northern extension of the North Atlantic Ocean mid-ocean spreading ridge.

From the late-Cretaceous to the present-day the North Atlantic mid-ocean-ridge progressively extended into the Arctic Ocean region, crosscutting pre-existing marine sedimentary basins in this area. This progression into the Arctic Ocean gave rise to further fragmentation of the ancient Canadian continental crust and opening of new seas located between Greenland, Canada, and Russia. During this opening phase, sediments eroded from the lands were initially deposited within the early Arctic Ocean basin. Deposition of sediments then progressively changed from deposition within a shallow marine basin to deposition within marine continental shelf settings which then bordered a true deep-ocean-spreading centre.

Throughout much of this time the present-day Alaskan and Siberian Peninsulas remained joined, forming an important land-bridge between the two continents and effectively isolating the Arctic Ocean from the opening Pacific Ocean. During that time continental crustal stretching between the two land masses was accompanied by translational faulting along each of the peninsulas during opening of the Arctic Ocean basins. The continental crust that now makes up Greenland and the Canadian Arctic Islands also fragmented during this time and these fragments began to gradually rift apart as the newly formed seas continued to open.

From 65 million years ago to the present-day the Arctic Ocean basin was then characterised by an on-going phase of symmetric-style seafloor and continental crustal extension and opening. This phase resulted in further separation of the Canadian Arctic Islands, opening of Hudson Bay, and further rifting between Greenland and Canada. Separation of the Alaskan and Siberian Peninsulas across the Bering Strait occurred within the past 2 million years and crustal separation, rifting, and extension is continuing to the present-day.

Atlantic Ocean

The ability to match the east coast of South America with the west coast of Africa has long been recognised by mapmakers for many centuries. This remarkable fit-together now forms the conceptual basis for both early Continental Drift and conventional Plate Tectonic studies. The closing of the Atlantic Ocean and reconstruction of these continents also forms the basis for assemblage of the Pangaea and Gondwana supercontinents. This fitting together of the South American and African continents is further substantiated by an extensive array of geological evidence dating back to the investigations of Wegener.

On conventional reconstructions of the Atlantic Ocean, the corresponding margins of northern Brazil in South America and Guinea in Africa are traditionally fitted together according to their geological matches. But, fitting these coastlines together produces a narrow triangular gap that widens south between the continental margins of South America and Africa south of the Niger Delta region. To minimise this misfit, the margin of South America may also be fitted against southern Africa south of the Niger Delta region. This then produces a narrow triangular gap between the Guinea and north Brazil coastlines, widening northwards. Unfortunately, this also produces a significantly greater area of misfit in the Florida and Central American regions.

It is significant to note that in 1958, when Carey first reassembled these continents on a spherical model representing the Earth's modern dimensions, Carey noted these very same misfits. He commented that *"...if all the continents were reassembled into a Pangaean configuration* on *a model representing the Earths modern dimensions, the fit was reasonably precise at the centre of the reassembly and along the common margins of north-west Africa and the United States east coast embayment, but became progressively imperfect away from these areas."* Carey concluded from this research that the fit of these ancient continents *"...could be made much more precise in these areas if the diameter of the Earth was smaller at the time of Pangaea."*

Opening of the North and South Atlantic Oceans on an increasing radius Earth is shown sequentially in Figure 5. Opening is shown to have commenced in the lower right models during the early- to late-Jurassic in the North Atlantic region, located between North Africa and North America. This opening North Atlantic region later extended south to merge with the opening South Atlantic Ocean, as well as west into the Gulf of Mexico and Caribbean Sea regions.

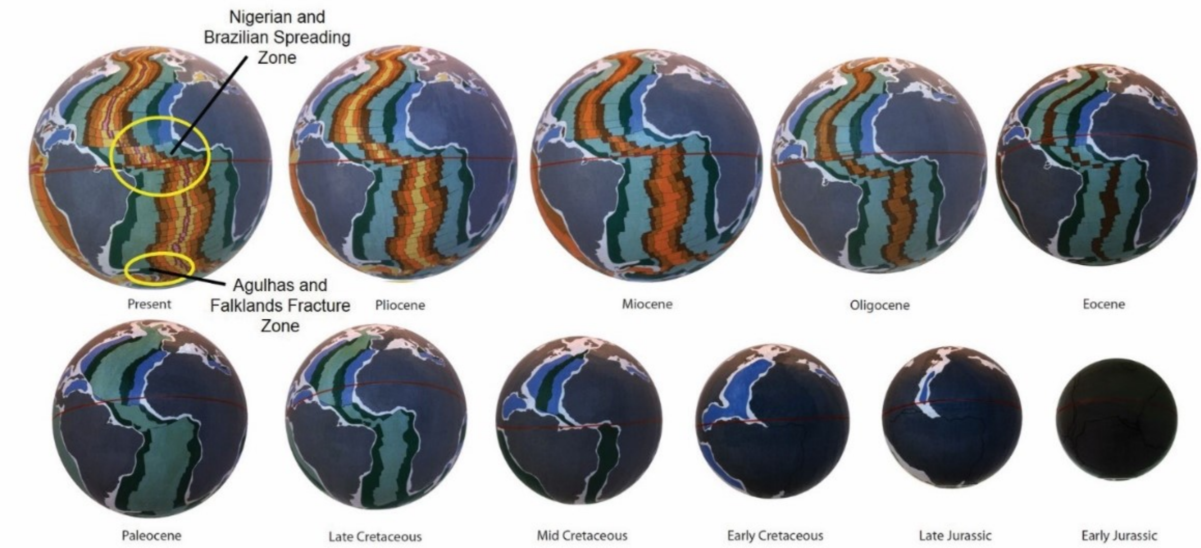

Figure 5 Atlantic Ocean small Earth sequential spreading history, extending from the present-day back to the early-Jurassic.

On small Earth models it is significant to note that, just as Carey concluded, when the North and South Atlantic Oceans are closed misfitting between the continental margins of North and South America, Europe, and Africa is entirely eliminated. Opening of these oceans during the Mesozoic and Cenozoic Eras is then shown to be progressive and symmetrical. Subsequent opening of the Atlantic Ocean is also shown to have occurred in conjunction with opening of both the Arctic and Indian Oceans.

North Atlantic Ocean

Opening of the North Atlantic Ocean on an increasing radius Earth (Figure 5) commenced as a narrow rift basin, located between the east coast of North America and west coast of Africa. Over time, this rift basin continued to open and progressively extend north into the Arctic Ocean and south into the South Atlantic Ocean. From the early-Jurassic a small counter clockwise rotation of the combined South American and African supercontinent, relative to North America, accelerated opening of the North Atlantic region and also extended the ocean west into what is now the Caribbean Sea. This rotation occurred in sympathy with opening of the Pacific Ocean as each of the adjoining continents continued to adjust for changing Earth radius and surface curvature.

During the early-Cretaceous—around 130 million years ago—the newly formed North Atlantic spreading ridge extended north into the Grand Banks continental shelf, then located between Canada and Iberia. This occurred in response to both continental plate motion and opening of the Caribbean Sea. Rifting between South America and Africa also commenced which initiated a progressive extension of the spreading ridge into the previously separated North and South Atlantic Oceans.

By the Late Cretaceous—around 80 million years ago—the North Atlantic mid-ocean spreading ridge had continued to extend further north into the Arctic Ocean. This spreading ridge then branched northwest into the Labrador Sea rift zone, located between Canada and Greenland, and northeast into the Mediterranean Sea. The extension and branching of this spreading ridge gave rise to continental breakup and rifting between Canada and Greenland, as well as rifting and rotation of Spain relative to both France and England.

From the late-Cretaceous to the present-day, the North Atlantic mid-ocean-ridge has continued to open in conjunction with both the Nansen-Gakkel spreading ridge within the Arctic Ocean and the South Atlantic spreading ridge. Spreading within each of these areas has resulted in a progressive enlargement of both the North and South Atlantic Oceans and was accompanied by symmetrical seafloor spreading.

South Atlantic Ocean

The South Atlantic Ocean (Figure 5), commenced opening between the southern South American peninsular and the South African region as a long narrow rift zone and has continued to steadily open to the present-day. The pattern of coloured seafloor stripes shows that this opening occurred in sympathy with opening of the Indian Ocean. Because of this, these two oceans can be considered as extensions of the same continental crustal rupture and opening event.

Separation between the west coast of Africa and east coast of South America commenced during the late-Jurassic—around 155 million years ago. This opening occurred along the now separated Agulhas and Falklands fracture zones, presently located in the southern South Atlantic Ocean. During late-Jurassic times, continental rifting and separation of the two continents progressively extended north. The South Atlantic spreading ridge then merged with the North Atlantic spreading ridge during the early-Cretaceous along the Nigerian and Brazilian rift zone. Since that time the North and South Atlantic Oceans have remained united as a single Atlantic Ocean.

From the late-Cretaceous—around 80 million years ago—to the present-day spreading in both the North and South Atlantic Oceans has continued along a common mid-Atlantic spreading ridge. Subsequent spreading in both regions continued to be symmetrical, with a slow clockwise rotation of South America, relative to Africa, giving a slightly greater spreading rate in the southern South Atlantic Ocean.

Caribbean Sea

Conventional Plate Tectonic reconstructions of the Atlantic Ocean traditionally fit the Brazil and Guinean coastlines of South America and Africa together. This fit helps to minimise any misfit in the Caribbean Sea region. The Caribbean region is then seen as a buffer zone between the North American plate, the South American plate, and subducting oceanic plates of the Pacific Ocean. On these reconstructions the Caribbean region is considered to be a preserved piece of the ancient Pacific Ocean, referred to as the Farallon plate, which is inferred to have originated from outside of the Caribbean region.

The Caribbean Sea is made up of the Mexico, Colombian, and Venezuelan Basins (Figure 6) separated by the Antilles Arc. On an increasing radius Earth the development and subsequent opening of the Caribbean Sea was intimately related to the continental plate motion histories of both South America and Africa, relative to North America. Bedrock geological mapping of the seafloor shows that opening of each of the Caribbean basins was most active during the Jurassic Period. This was then later reactivated along the Antilles Arc during the Paleocene—around 65 million years ago—and has continued to open as a relatively restricted basin to the present-day.

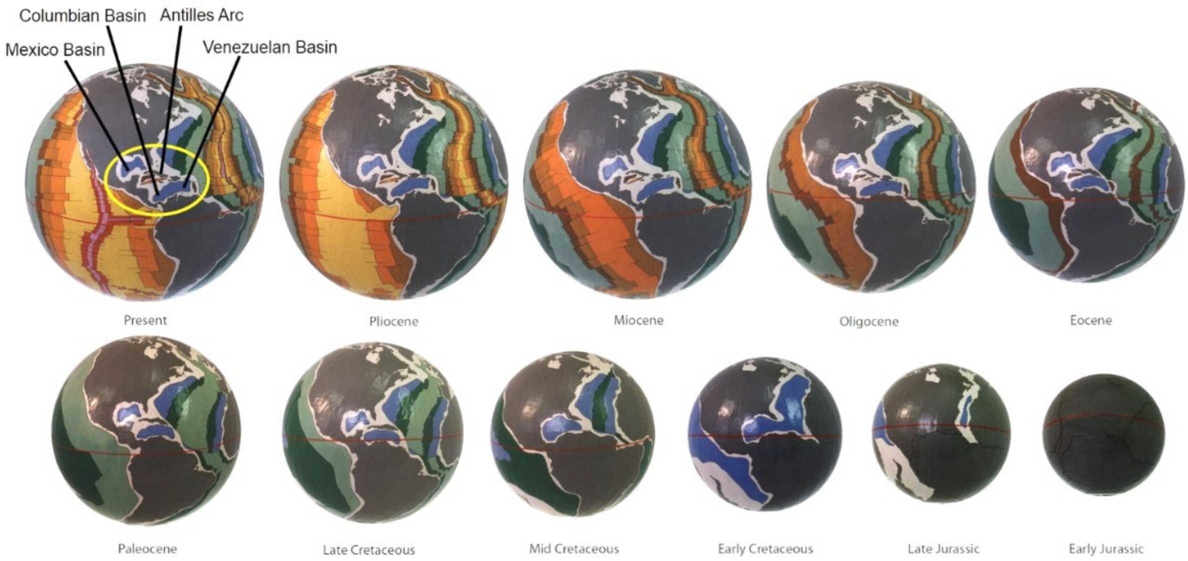

Figure 6 Caribbean Sea small Earth spreading history, extending from the present-day back to the early-Jurassic.

On an increasing radius Earth, early development of the Caribbean Sea was intimately associated with opening of the North Atlantic Ocean along with subsequent rifting of Africa away from the Americas. Opening of the Caribbean Sea commenced during the Triassic to early-Jurassic Periods as a result of north-south crustal stretching and extension between the North and South American continents. Subsequent development of the Caribbean Sea was then closely related to a northwest migration of North America, relative to the still joined South American and African supercontinent. The Colombian and Venezuelan basins opened during the Jurassic to Cretaceous Periods and were later separated by the Antilles island-arc.

This early opening phase lasted until the early-Cretaceous—around 130 million years ago—when rifting and eventual breakup between South America and Africa first began. During this phase, the Nicaraguan and Panama Peninsulas remained joined to South America. After separation of South America from Africa, South America then began to slowly rotate clockwise, relative to North America, in response to opening of the South Atlantic Ocean. This gave rise to further crustal extension and opening within the Caribbean basins, as well as isolation of the Antilles island-arc.

From the Paleocene Period to the present-day, South America has continued to slowly rotate clockwise, relative to North America, and was accompanied by fault movement along the length of the Antilles Arc. This fault movement extends along the western margin of Mexico and has continued into the Gulf of California.

On an increasing radius Earth, an external origin for the Caribbean crustal region, as proposed in conventional Plate Tectonic studies, is unnecessary. Small Earth model studies show that sourcing a fragment of crust from the Pacific region is untenable and is inconsistent with the established seafloor crustal mapping. Instead, opening of the Caribbean Sea region is shown to be intimately associated with opening of the North Atlantic Ocean as well as on-going crustal plate motion between North and South America and Africa.

Indian Ocean

Reconstructions of the Indian Ocean and assemblage of the surrounding continents is crucial in understanding the assemblage, breakup, and dispersal history of the Plate Tectonic Gondwana and Pangaea supercontinents. These conventional reconstructions place the precursor to the Indian continent within an ancient southern Gondwana supercontinent, located adjacent to Africa, Madagascar, and Antarctica. The Indian Ocean is then inferred to have formed during the subsequent breakup and dispersal of the Gondwana continental fragments during a later Pangaean supercontinental assemblage cycle.

On this conventional reconstruction an inferred ancient Tethys Ocean was located between a southern Pangaea supercontinent, made up of fragments of the Gondwana supercontinent, and a northern Laurasian supercontinent. During breakup of these supercontinents, India is then inferred to have broken away from Gondwana to drift north as an island continent during subsequent opening of the Indian Ocean. This northward migration of India during the Mesozoic to early-Cenozoic Eras requires subduction of some 5,000 lineal kilometres of inferred pre-existing seafloor crust in order to close the ancient Tethys Ocean. India is then said to have collided with the Asian continent to form the Himalaya Mountains during the Cenozoic Era, leaving behind no trace of this pre-existing ocean crust.

In contrast, on an increasing radius Earth, small Earth modelling shows that the Indian continent remained firmly attached to the Asian continent throughout the Mesozoic and Cenozoic Earth history (Figure 7). The Indian Ocean is shown to have opened during a post-Triassic phase of crustal rupture of the Pangaea supercontinent, in sympathy with opening of the adjoining Atlantic Ocean basin.

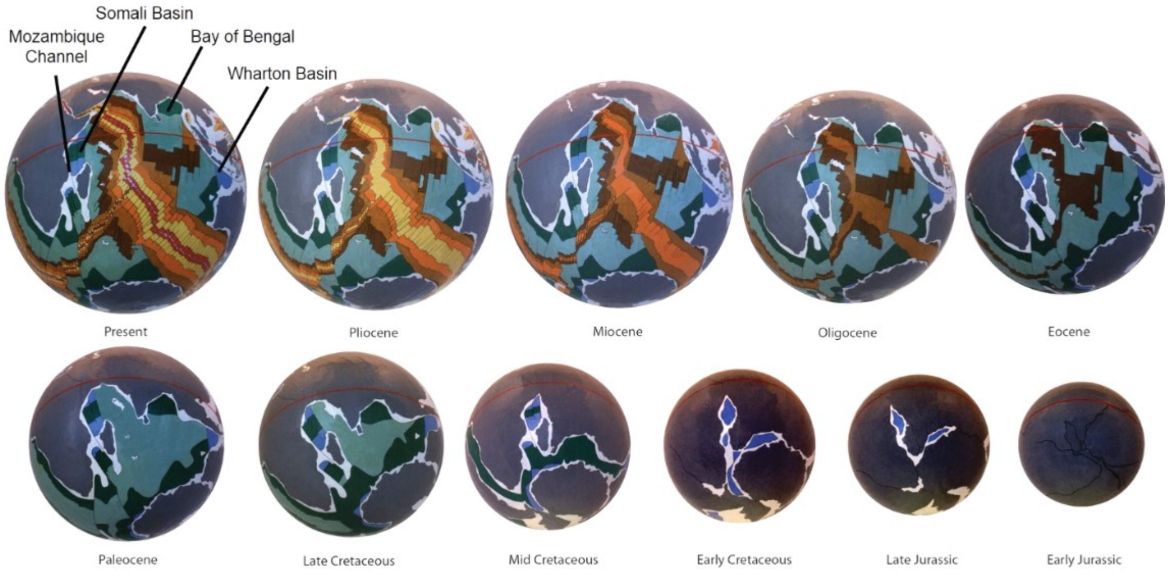

Figure 7 Indian Ocean small Earth spreading history, extending from the present-day back to the early-Jurassic.

Opening of the Indian Ocean on an increasing radius Earth (Figure 7) commenced during the early-Jurassic Period. This occurred as a result of initial crustal rupture within two separate areas, located adjacent to both India and Madagascar, in what are now the Somali Basin and the Bay of Bengal. Opening, and a southward extension of the Somali Basin continued up to the mid-Cretaceous Period which later became the Mozambique Channel located between Madagascar and Africa. During that time the Indian, Madagascan, and Sri Lankan continents and islands continued to remain firmly attached to the ancient Asian continent.

Crustal breakup and opening between Africa, Madagascar, India, and Antarctica then progressively extended south during the early- to late-Jurassic. During that time the Somali Basin and Bay of Bengal areas merged south of Madagascar. The merging of these basins formed a triple-junction—the junction of three separate spreading ridges and crustal plates—south of Madagascar and this region now represents the birthplace of the modern Indian Ocean basin.

The Mozambique Channel represents the northern limb of this early Indian Ocean triple junction. The southern limb of the triple junction extended south, around the tip of South Africa, to form an extension of the South Atlantic Ocean, which opened near the present Falkland Islands. The east limb then extended east to form the emerging Wharton Basin, which lay adjacent to West Australia.

By the mid-Cretaceous Period, the Mozambique Channel spreading ridge was abandoned and a new spreading ridge commenced opening between Madagascar and India. Once abandoned, the Somali Basin, Mozambique Channel, and Madagascar continent then remained as part of the African plate as seafloor crustal extension and opening progressively shifted to the east.

From the mid-Cretaceous to Paleocene times seafloor spreading continued between Madagascar, Africa, and India forming the Arabian Sea. During that time the Indian Ocean underwent a rapid north-south and east-west opening between Australia, Antarctica, Africa, and South East Asia, with a rapid northward opening and displacement of the Indian and Asian continents relative to Antarctica.

During the Paleocene—65 million years ago—to the present-day, symmetrical seafloor spreading radiated from a new triple junction located within the central Indian Ocean. This new spreading crosscut and displaced the older, previously established Mesozoic seafloor crust. Spreading then extended into the southern Indian Ocean, east between Australia and Antarctica and northeast into the Gulf of Aden. In the southern Indian Ocean region, the southwest limb of this spreading ridge split across older spreading patterns and now forms an extension of the South Atlantic Ocean mid-ocean-ridge system.

The north-south Ninety East spreading ridge, located within the eastern Indian Ocean, was abandoned during the Eocene. A new spreading ridge then extended southeast from the central Indian Ocean triple junction into a newly opening rift zone located between the Australian and Antarctican continental plates. This rifting initiated separation and northward migration of Australia relative to Antarctica, as well as initiation and relatively rapid opening of the Southern Ocean.

As spreading continued, the Gulf of Aden opened during the Miocene along a northwest extension of the central Indian Ocean and Carlsberg spreading ridges. A second triple junction has since formed at the western end of the Gulf of Aden during the Pliocene. This triple junction is now represented by the actively spreading Red Sea ridge and the East African Rift Valley system.

Pacific Ocean

At present the Pacific Ocean occupies nearly half the surface area of the Earth and can be arbitrarily subdivided into North Pacific, Central Pacific, and South Pacific Ocean regions. In all conventional Plate Tectonic reconstructions, the precursor to the Pacific Ocean was a much larger ancient Panthalassa Ocean. This largely hypothetical early-Mesozoic Panthalassa Ocean is inferred to have possessed an old seafloor crust, which was formed by spreading along ancient mid-ocean-ridge zones during the Palaeozoic Era extending into the Triassic Period.

The conventional Mesozoic and Cenozoic Plate Tectonic history is then depicted as an east-west and north-south contraction and reduction in surface area of the ancient Panthalassa Ocean in sympathy with opening of the Arctic, Indian, and Atlantic Oceans. This ancient ocean is thought to have eventually contracted in area to the size of the modern Pacific Ocean and is inferred to be still shrinking. During that time, all pre-Mesozoic crust is again inferred to have been subducted beneath the continents along subduction zones located around the margins of the Pacific Ocean basins. This inferred subduction must have also included a substantial amount of new Mesozoic and Cenozoic seafloor crust, which is currently being generated within the East Pacific Ocean mid-ocean-ridge zone.

On all conventional Plate Tectonic reconstructions, the North American continent progressively overrides the eastern North Pacific Ocean region. This occurs during a westward displacement of the North American continent during opening of the North Atlantic Ocean. The North Pacific Ocean spreading ridge is then inferred to have been entirely overridden and subsequently dislocated beneath the Pacific margin of the North American continent.

In contrast, on an increasing radius Earth an expansive pre-Mesozoic Panthalassa Ocean, and similarly an ancient Tethys Ocean, did not exist. Subduction of between 5,000 to 15,000 lineal kilometres of pre-existing East Pacific seafloor crust beneath the American continent is also not required. In Figure 8 the Pacific Ocean is instead shown to originate during early-Jurassic times as two separate marine sedimentary basins. A North Pacific basin was located between northwest Australia, Canada, and China, and a South Pacific basin was located between east Australia, South America, New Zealand and Antarctica.

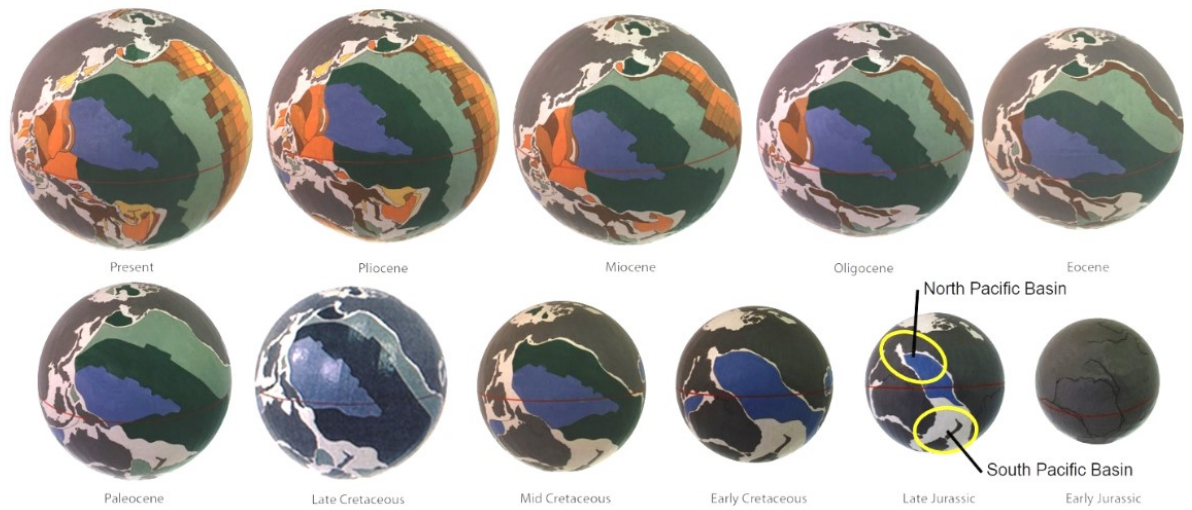

Figure 8 North Pacific Ocean small Earth spreading history, extending from the present-day back to the early-Jurassic.

Both of these marine basins progressively opened to the south and north, along the west coasts of North and South America respectively. These basins then merged to form a single Pacific Ocean basin during the mid- to late-Jurassic Period. Remnants of this early basin history are now preserved as continental margin and marine plateaux sediments within the South East Asian and Coral Sea regions—shown as white areas in Figures 8 and 9.

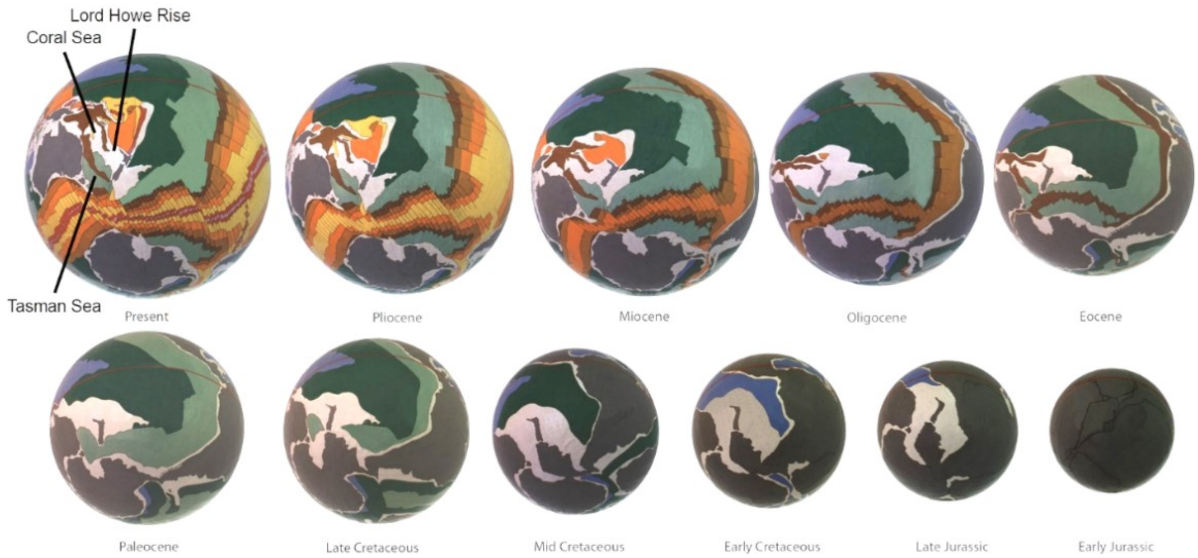

Figure 9 South Pacific Ocean small Earth spreading history, extending from the present-day back to the early-Jurassic.

On an increasing radius Earth, the subsequent evolution of the North and South Pacific Oceans involved a period of rapid northeast to southwest crustal extension and opening between North America, South America, and Australia. By the late-Jurassic, a deep ocean had extended southeast and south along the west coasts of North and South America. This coincided with the initiation, exposure, and preservation of new volcanic seafloor crust in the South Pacific Ocean.

Throughout the Mesozoic Era the North Pacific Ocean underwent a very rapid enlargement, with an asymmetric spreading axis extending southeast into the South Pacific region. This spreading and mid-ocean-ridge development curved along the west coasts of North and South America and ultimately extended west into the Coral Sea region during the Cretaceous.

During the mid- to late-Jurassic, crustal rifting and opening between New Zealand, New Caledonia, South America, Australia, and Antarctica isolated the Coral Sea plateau, as well as the Lord

Howe Rise and New Zealand. This rifting phase then left New Zealand as an island continent, which has remained isolated from surrounding continents to the present-day.

Development of the Pacific Ocean on an increasing radius Earth during the Cenozoic Era is characterised by the initiation and rapid development of symmetric-style seafloor spreading. This initially commenced within the Tasman Sea region, located southeast of Australia, during the Paleocene and it continued to extend east towards South America during the Eocene. From there, symmetric spreading continued north, forming the present East Pacific spreading ridge, and then continued to extend along the west coast of North America to its present location adjacent to California.

The opening and formation of the Pacific Ocean on an increasing radius Earth differs slightly to each of the other oceans. Because of the long period of time involved in opening the Pacific Ocean, the large area of older seafloor crust in the North Pacific region has been subject to considerable crustal stretching and distortion as a result of changing surface curvature of the Earth. This changing surface curvature was generally absorbed as extension within the thin seafloor crust, but also gave rise to complex plate interaction, island-arc volcanism, and jostling between and along adjoining plates, in particular between the various seafloor and continental plate margins.

Between the North Pacific Ocean plate and the Australian, South East Asian, and Chinese plates, complex crustal interaction formed the South East Asian island-arc-trench systems, which are now characteristic of the western Pacific region. On an increasing radius Earth, this region represents a complex interplay of plate motions that were generated during on-going adjustments to surface curvature, especially within the older North Pacific Ocean region.

This development of the Pacific Ocean on an increasing radius Earth cannot be reconciled with conventional Plate Tectonic reconstructions on a constant sized Earth. On an increasing radius Earth the restrictions imposed by an early-Mesozoic Panthalassa and Tethys Ocean, as well as circum-Pacific subduction of pre-existing seafloor crust, simply did not exist and were not required during small Earth plate reconstruction. Instead, a process of asymmetric to symmetric evolution of the East Pacific Ocean spreading ridge readily explains the complex crustal patterns shown by the Pacific Ocean seafloor mapping. Likewise, the island-arc-trench systems and extensional back-arc-basins are readily explained by crustal interaction along the plate margin boundaries during relief of surface curvature, especially in the older crustal regions.

Mediterranean Sea

The Mediterranean to Middle East region is a complex and contentious region on conventional Plate Tectonic reconstructions. In order to reconstruct the continents on a constant radius Earth, both Europe and Asia must be fragmented in order to close the Atlantic and Indian Oceans. On all reconstructions the Mediterranean region then forms the western apex of a large triangular-shaped ancient Tethys Ocean. From there, this ocean is inferred to widen eastward towards an even larger ancient Panthalassa Ocean which separated the ancient supercontinents of Gondwana in the south and Laurasia in the north.

The evolution of the Mediterranean to Middle East regions on an increasing radius Earth (Figure 10) represents the remnants of a more extensive continental Tethys Sea—as distinct from a conventional Tethys Ocean. The Tethys Sea will be shown later to have had an extensive crustal and sedimentary basin history, extending back to the early Precambrian times.

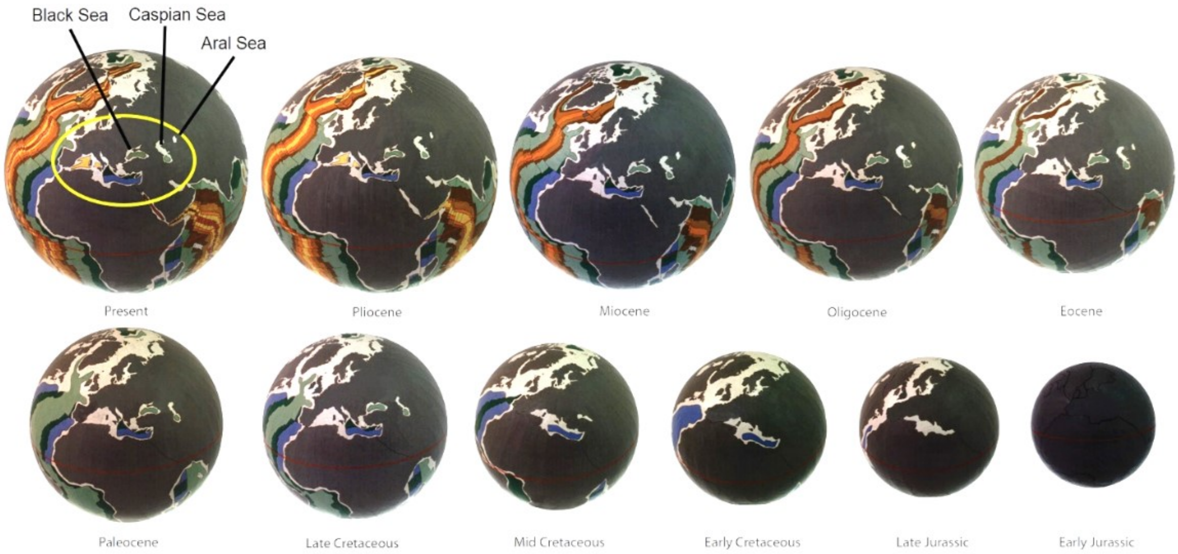

Figure 10 Mediterranean Sea small Earth spreading history, extending from the present-day back to the early-Jurassic.

On an increasing radius Earth the Mediterranean region initially developed during pre-Triassic times as a result of crustal extension between the ancient African and European continents. Crustal rupture within the ancient continental Tethys Sea then commenced during the Jurassic, which initiated opening of the modern Mediterranean Sea and crustal development within the Middle East region. The ancient Tethys Sea, in effect, represents the seabed of what is now the continental region of central Europe, the Middle East, and Asia.

Opening of the Caspian Sea followed during the early-Cretaceous Period. The Black Sea then followed during the mid-to late-Cretaceous and the Aral Sea during the Paleocene. These small seas all represent regions of continental crustal rupture and opening, which was initiated during complex clockwise crustal rotation occurring between the combined African-Arabian plate and central Europe.

Seafloor geological mapping shows that crustal extension within the Mediterranean to Middle East region was only active during Jurassic and early-Cretaceous times. From mid-Cretaceous to Miocene times complex crustal motions, including some localised compression between Africa and Europe, formed the Alpine Mountain belts. This event was followed by a continuation of continental crustal extension and renewed basin opening forming the young sedimentary basins presently located within much of central Europe.

The Alpine Mountain building event coincided with a northward extension of the North Atlantic Ocean spreading ridge which was marked by the opening of the Bay of Biscay, located between Spain and France, during the late-Cretaceous. Similarly, opening of the Persian Gulf and Red Sea also commenced during the Eocene and these are continuing to open to the present-day. Seafloor spreading was re-activated in the western Mediterranean region during the Miocene and was accompanied by continental rifting between West Africa and Spain.

On an increasing radius Earth, separation of the Gondwana and Laurasia supercontinents by a large Tethys Ocean, and similarly a north-south closure of the Tethys Ocean during the Mesozoic and Cenozoic Eras, is not required. Instead, opening of the Mediterranean to Middle East region occurred as a result of clockwise rotation and crustal extension between Europe and the Middle East, relative to the adjoining African-Arabian continent. This continental crustal motion, extending from the Iberian Peninsula to the Tibetan Plateaux, also resulted in the rotation of Italy and fragmentation of the Alpine mountain belts during the mid-Cretaceous to present-day times.

These increasing radius small Earth reconstructions also present a straightforward development history for the Black Sea region, the mountain belts of the Balkans, Turkey, and the Caucasus, the development of the southern Russian platform north of the Black Sea and the development of the Aegean Sea during the late-Cenozoic.

South East Asian Seas

The South East Asian region comprises the Philippine, South China, Celebes, Banda, and Java Seas. In this region the present-day South East Asia to New Guinea and Japanese Island chains represent complex island-arc systems. Conventional Plate Tectonic reconstructions on a constant sized Earth are particularly vague when it comes to reconstructing South East Asia. On these reconstructions the region is represented by small remnant crustal fragments, which are inferred to have existed at the eastern end of a large ancient Tethys Ocean where it merged with an even larger Panthalassa Ocean. During closure of both the Tethys and Panthalassa Oceans, the South East Asian Seas were then interpreted to represent marginal or back-arc basins. These basins were further separated from the various island-arcs by spreading along zones of inferred crustal subduction and deep trench development.

The development of the South East Asia basins and seas on an increasing radius Earth (Figure 11) is complex and progressive. Small Earth model studies show that development within this region was intimately associated with the formation and subsequent plate interaction of the North Pacific oceanic plate. On these small Earth models the region is shown to represent the fragmented remains of ancient intercontinental marine and continental sedimentary basins, as well as associated island-arc volcanic activity.

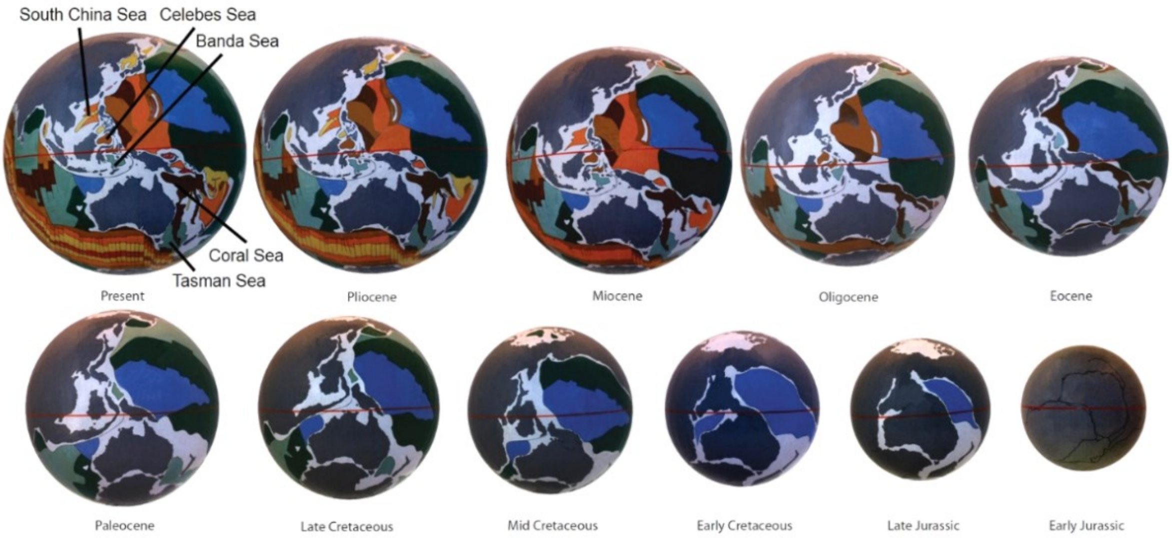

Figure 11 Southeast Asian and Southwest Pacific Basin small Earth spreading history, extending from the present-day back to the early-Jurassic.

The South East Asian region initially formed during early-Jurassic times. This region represents an area of marine basin opening, accompanied by deposition of sediments, and was located between the early Australian, North American, and Chinese continents. These basins first formed in conjunction with the initial rupturing and opening of the North Pacific Ocean. At that time, sediments eroded from the surrounding lands were redeposited within newly formed marine basins. These sediments were mixed with volcanic rocks, erupted along the precursors to the modern mid-ocean-ridge spreading zones, to form the early island-arc systems. Remnant sediments from this early opening event are now preserved as both continental shelf and marine plateau sediments, which are exposed as the South East Asian islands and submerged plateaux throughout the South East Asian Sea region.

Development of the South East Asia region has been further complicated by the plate motion history of Australia, relative to Asia, during opening of both the Pacific and Indian Oceans. Progressive crustal extension and opening between each of these continents occurred during late-Cretaceous to Pliocene times which then resulted in opening of the South China, Celebes, and Banda Seas, as well as fragmentation of the early South East Asian island-arc system.

The crustal fragments making up the South East Asian region have since undergone complex clockwise rotation, crustal fragmentation, plate interaction, and on-going island-arc volcanism. These events all occurred during an extended period of southeast to northwest crustal extension between the

Asian and Australian continental plates. This interpretation of the South East Asia region contrasts strongly with the conventional Plate Tectonic requirement for continental collision, the closure of pre-existing Tethys and Panthalassa Oceans, and complex subduction of the Australian and North Pacific plates beneath the Asian and Philippine plates.

Southwest Pacific Ocean

The Southwest Pacific Ocean region is also structurally complex and comprises the Coral and Tasman Seas. The region is predominantly made up of remnants of ancient seafloor crust and marine plateaux sediments. These sediments were initially deposited and later fragmented during Cretaceous to Paleocene times and again during Miocene to present-day times. The region has been further complicated by crustal plate motion and plate interaction occurring along the margins of the Indo-Australian and Pacific plates.

The southwest Pacific Ocean region is shown on small Earth models (Figure 11) to represent the fragmented remains of earlier marine basins and sediments, deposited within an early pre-Triassic South Pacific Ocean basin. Initially, this area opened as a passive marine basin during pre-Triassic times. The newly formed basin then formed part of the early South Pacific Ocean, prior to merging with the North Pacific Ocean during the Triassic Period.

During pre-Triassic times, West Antarctica and New Zealand were assembled adjacent to Australia and South America. Subsequent rifting and opening between South America, New Zealand, and West Antarctica initiated formation of the South Pacific Ocean. During Triassic to early-Jurassic times, New Zealand and New Caledonia were separated from Australia during opening of the Tasman Sea. These remained attached to Ecuador in Central America until final separation from South America during the mid-Jurassic times.

During the mid- to late-Jurassic an early New Zealand and New Caledonian continent comprising the Coral Sea plateau, Lord Howe Rise, and New Zealand island-arc complex were well established. This ancient continent then further fragmented and was partly submerged to form the present Southwest Pacific region. Asymmetric seafloor spreading first developed in the South Pacific Ocean and this spreading extended west during the Cretaceous into the Tasman Sea. This event further isolated the Lord Howe Rise and New Zealand continent from Antarctica and Australia.

On an increasing radius Earth, the Tongan to South Solomon and New Hebrides trench and island-arc systems represent complex zones of plate interaction between the New Zealand and New Caledonia continental plate and the South Pacific Ocean plate margins. This complex interaction developed during on-going changes in Earth surface area and surface curvature over time. The interaction of these plates resulted in a slow clockwise rotation of the southwest Pacific Ocean region along each of the established trench and arc systems. In addition, the New Zealand and New Caledonian plate was further fragmented and displaced during the Cenozoic Era.

The rapid development of symmetric-style seafloor spreading in the South Pacific Ocean resulted in further opening of the southwest Pacific Ocean region during the Cenozoic. Complex plate interaction and motion along the Kermadec and Tongan trench and arc systems again accompanied this opening during the early-Miocene. This crustal motion was also related to movement along the Alpine Fault system of New Zealand, which continues to the present-day.

On an increasing radius Earth, the southwest Pacific Ocean basin region cannot be reconciled with conventional Plate Tectonic reconstructions. Instead, this region represents a complex interplay of extensional crustal motion and opening between Australia, North America, South America, and Antarctica in conjunction with opening of the North and South Pacific Oceans during on-going changes to Earth radius and surface curvature.

Southern Ocean

Opening of the Southern Ocean is a paradox on conventional Plate Tectonic reconstructions and very little mention of this ocean is made in the literature. This paradox arises because there are no subduction zones available to absorb the extensive plate motion required to open this ocean or to explain the northward migration of all of the northern continents.

The Southern Ocean is located between the present Australian and East Antarctican continents. The ocean arbitrarily merges with the South Pacific and Indian Oceans to the east and west respectively. On an increasing radius Earth rifting and opening of the Southern Ocean first commenced in conjunction with opening of the Atlantic and Indian Oceans during the late-Jurassic (Figure 12). Further opening then initiated final separation between Australia and Antarctica during the Paleocene, some 65 million years ago. Symmetric-style seafloor spreading in the Southern Ocean has since extended west, in conjunction with the eastern arm of the central Indian Ocean spreading ridge, and east to form an extension of the East Pacific spreading ridge.

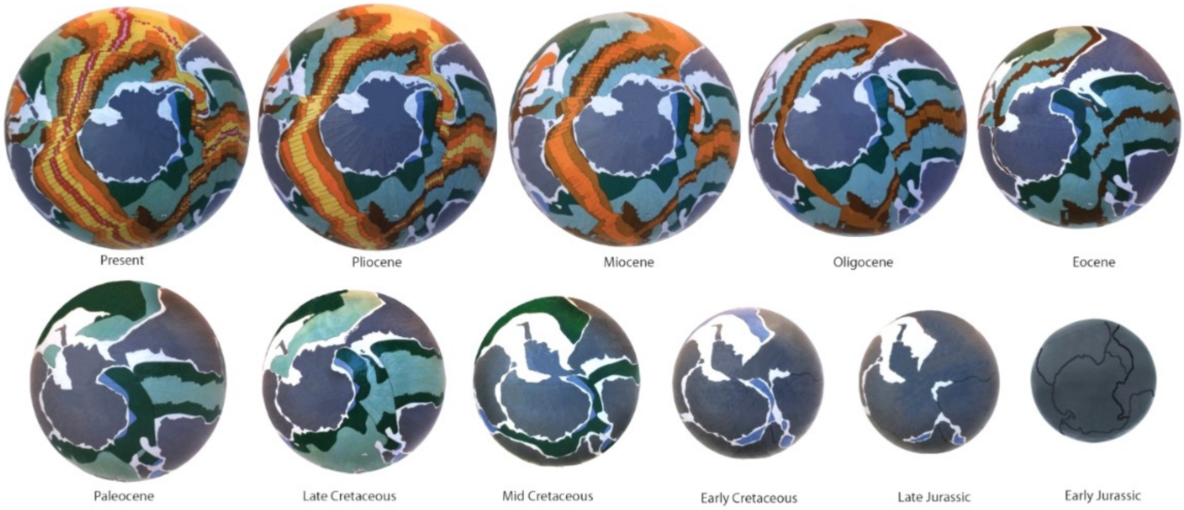

Figure 12 Southern Ocean small Earth spreading history, extending from the present-day back to the early-Jurassic.

On small Earth reconstructions, opening of the circum-polar Southern Ocean forms part of the extensive global network of mid-ocean spreading ridges. This opening and northward migration of the southern continents represents a natural consequence of breakup of the Pangaea supercontinent and increase in surface areas of the Southern and adjoining ocean basins during an increase in Earth radius and surface area.