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Harry Dickens
Independent scholar

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RECEDING NOAHIC FLOOD WATERS LED TO SEAFLOOR SPREADING: A PROPOSED GEOLOGICAL MODEL

Harry Dickens, Independent Scholar, harrydickens777@gmail.com

ABSTRACT

This paper makes the case that almost the entire Neoproterozoic and Phanerozoic geologic record has been impacted in some manner by the Noahic Flood and its aftermath. However, seafloor spreading, in this proposed model, is inferred to have initiated towards the end of the actual Flood Year, being enabled by the receding waters of the Flood. Material in this paper was based on a review of existing literature. Descriptions of formations in key regions were correlated in stratigraphic order with the historical stages evident from the record in the book of Genesis. This enabled a biblical young earth geological history model to be developed, including the receding waters and drying phases of the Flood Year. In a Flood Year model, I propose the following. Fountains of the great deep bursting forth in Noah's Flood caused Neoproterozoic supercontinent fragmentation. Enormous amounts of rain eroded continental topography and stripped vegetation off the land. Much of this vegetation floated and so no major coal deposits are found in Early Paleozoic strata. After the fountains closed, waters receded. Late Paleozoic so-called "glacials" of Gondwana, instead represent a time when detritus energetically flowed with the receding waters and eroded crystalline basement in a number of regions. Waters continued to recede and so pre-Flood vegetation came to ground, and became buried in grabens that formed as the fountain zones cooled. Subsequently, major Permian and Carboniferous coal deposits formed. Phanerozoic sea level reached a major low by the end-Permian and more land emerged. Drying became widespread by the Triassic and this coincided with the initial breakup of the Pangea supercontinent. Receding seawater introduced into the top of the mantle via fountain-fragmented zones drastically lowered the melting temperature and viscosity, both of which led to supercontinent breakup and seafloor spreading in the Mesozoic and Cenozoic. Passive margin sediments show little deformation during the drift phase and so are not indicative of continual cataclysmic processes. However, active margins such as collisional, mountain-building margins were sites of catastrophic processes and regions of great runoff of detritus to form thick sedimentary sequences on the continents.

KEYWORDS
Noahic Flood, receding waters, Late Paleozoic "Ice Age", drying, breakup, seafloor spreading, Gondwana, Laurasia.

I. INTRODUCTION

Plate tectonics and seafloor spreading are among the most significant geological processes on Earth. However, their emergence and development currently remain unresolved (Sobolev and Brown 2019). I consider that it is a vital witness to be able to provide an overall sequential biblical framework for global tectonics that can be backed up by sequential geological and stratigraphic information.

A catastrophic plate tectonic (CPT) model for Noah's Flood was put forward by young earth creationists (Austin et al. 1994; Baumgardner 1994). This was a pioneering attempt to try to tie aspects of geology together in a conceptual or theoretical physical way. However, its major limitation is its incomplete coverage in clear time order of both Scripture and specific stratigraphy. The hydroplate theory (HPT) (Brown 2008) is another such theoretical creationist theory. "Ground truthing" by way of regional case studies with specific geological formations in successive time order could improve CPT or HPT models. Relating such specific geology to each stage of the Flood recorded in Scripture, in successive time order would help.

The model proposed in this paper has geological case studies in time-stratigraphic and Scripture order. This paper proposes a biblical framework which may successively explain the origin of a number of geological features. This includes successive major regional unconformities, the so-called Late Paleozoic "Ice Age", contrasting coal floras of the Paleozoic and post-Paleozoic, Permian paleodrainage and missing sediment, the Early Triassic Coal Gap, indicators of aridity in Triassic strata, and the Mesozoic commencement of seafloor spreading along with associated tectonically quiescent passive margins.

II. PREVIOUS WORK

A. Earlier concepts

In 1858 Antonio Snider-Pellegrini proposed that rapid, horizontal movement of continents occurred during Noah's Flood. Snider-Pellegrini saw the evidence of the fit of continents either side of the Atlantic Ocean (Snider-Pellegrini 1858). Subsequent to Snider-Pellegrini, the theory of plate tectonics was developed but without reference to the Bible. Plate tectonics has been very useful to explain many features of today's Earth.

Continental drift was defined as the motion of continents relative to each other and even with respect to the Earth's mantle. The concept of continental drift has become an integral part of plate tectonics, which describes the tectonic motions of the Earth's surface in general, not only of the continents, but also of seafloor spreading. However, plates are considered to be coupled with the underlying mantle and its convection (Bercovici, 2003). Relative movement of continents is a striking feature of the Earth's tectonic development throughout the Cenozoic and Mesozoic and is ubiquitous in plate reconstructions spanning these eons (Torsvik and Cocks 2017; Torsvik 2020).

Understanding the progression of seafloor spreading is key for reconstructing the paleogeography of the Earth with all its implications from climate and sea-level variations to topography, orogeny, and notably the magnetic field history. It remains unclear how and when such supercontinents would form and breakup and what could be the typical dynamics leading from one supercontinent manifestation to the next (Nance and Murphy 2018).

B. Catastrophic plate tectonics (CPT)

The catastrophic plate tectonics (CPT) model for Noah's Flood (Austin et al. 1994; Baumgardner 1994, 2018; Clarey 2016), aims to tie a variety of aspects of geology together in a conceptual or theoretical physical way. This model uses computer modelling and aspects of the modern theory of plate tectonics. However, CPT does not clearly address in time order key stages of Noah's Flood recorded in Scripture. Formations representing the Flood Year's receding waters and drying phases seem to have not been considered in a specific time sequence in the CPT model. This is despite the length of these phases being of the order of 7 months (Genesis 8:1-19). The impact of 40 days and nights ofrain (implying enormous and global erosion of land, mass flows and sea level rise) is not emphasised compared with sea level rise by the raising of ocean floors displacing ocean water onto the continents. The conventional plate tectonic role of ocean floor displacing water onto the continents in the formation of Cretaceous interior seaways (such as the Western Interior Seaway of North America) is not discussed in the CPT model.

The CPT theoretical physical model lacks case studies tied to actual stratigraphic sequences on a full-depth, basin-wide scale in time order. Nomenclature of the geologic column (such as systems, for example, Cryogenian System and Cenozoic Erathem) is not applied to a regional case study, so it is difficult to place many geological features in their correct time or stage order within the CPT model.

Subduction and mathematical modelling is paramount in CPT, yet the relationship to actual mappable stratigraphy in successive time order is lacking. The CPT model has runaway subduction and bounce-back causing tsunami deposition on continents (Baumgardner 2018). However, outside of the Pacific Ocean, subduction zones appear to be missing. A key example is around Antarctica. No runaway subduction would have occurred there since there are no subduction zones in the Southern Ocean surrounding Antarctica, only spreading centres.

From seismic wave anomalies it can be inferred that lithosphere slabs have descended to the mantle (van der Meer et al. 2018). However, I am not aware that any direct samples of Paleozoic ocean floor have been recovered from subduction zones. This has been described by a YEC group as "virtual reality rather than observational reality" (Akridge et al. 2007). The known age of the ocean floor is Mesozoic and Cenozoic (Seton et al. 2020).

Some significant mappable geological features are not integrated into the CPT model, for example, diamictites, the Great Unconformity (contrasting with later continental breakup unconformities of varying ages for different oceans), the Mississippian-Pennsylvanian unconformity and passive continental margins. The Great Unconformity may be regarded as the most significant transition in the whole rock record (Peters et al. 2022). It is a globally recognised peneplanation surface on hard crystalline basement rocks, yet evidence of its deep erosion appears to lack an explanation in the CPT model.

C. Surface erosion events

A proposal has been made that surface erosion events enabled the development of plate tectonics on Earth. Accumulation of sediments at continental edges and in trenches then provided lubrication for the stabilization of subduction and development of plate tectonics. Sobolev and other secular authors focused on Neoproterozoic supposed "glacial" sediments as providing major lubrication by reducing friction on plate movement (Sobolev and Brown 2019).

D. So-called "glacial retreat"

Within numerous basins of the southern hemisphere, there is a significant association in time and space of so-called "glacial retreat" ("deglaciation") margins with rifting sites marked by Carboniferous-Permian unconformities (Yeh and Shellnutt 2016). The initial drifting of southern continents may have been triggered by weakening of crust due to differences in weight on, and thus differing stress between adjacent regions, along with isostatic rebound. Increased fluid pressure would have enabled brittle failure, and fault swarm development. Crustal rebound would have induced decompressional melting and upwelling of mantle-derived melts along pre-developed fault zones forming regional flood basalts (Yeh and Shellnutt 2016). Fluid flow into fault zones alters their permeability and may aid episodic earthquake activity by promoting the generation of high pore fluid pressures and facilitating the formation of weak secondary minerals (Menzies et al. 2016).

E. Introduction of seawater into the mantle

A model has been described of return flow of seawater into the mantle resulting in hydration of the mantle, rapid sea level drop, and appearance of large landmasses. The introduction of seawater into the mantle would have drastically lowered the melting temperature and viscosity of mantle materials, both of which would have activated mantle convection to drive tectonic plates (Maruyama and Liou 2005). Such a scenario fits well with the proposed model of receding Noahic Flood waters leading to seafloor spreading.

III. REGIONAL GEOLOGY

Descriptions of regional geology are presented in this section, derived from an extensive literature review. However, evidences of Late Paleozoic so-called "glacials" are reinterpreted in favour of mass flows. The discussion section of this paper, which follows the regional geology section, provides an interpretive framework for the geology in a proposed young earth biblical model.

A. Supercontinental fragmentation then global marine transgression

1. Neoproterozoic fragmentation and peneplanation

Gondwana, the southern component of the Pangea supercontinent, is said to have included the continental crust of Australia, Antarctica, the Indian Subcontinent, South America and Africa, and to have existed until continental breakup and drift commenced (Torsvik and Cocks 2013) (Fig. 1). Neoproterozoic fragmentation of West Gondwana includes the division of southern Africa's Kalahari Craton from the Rio de la Plata Craton of southeastern South America. Rift grabens separated the various Kalahari cratonic fragments (Frimmel et al. 2011).

Evidence for the fragmentation of East Gondwana in the Neoproterozoic is provided by the Darling Fault Zone on the western margin of Australia (Dickens 2018). This evidence includes thermal resetting downwards of radiometric dates towards the regional fault zone, hydrothermal alteration indicated by mineral petrography, tectonism associated with regional mafic dykes, a magnetotelluric (MT) conductivity anomaly indicating the presence of water in this regional fault zone, and high-temperature metamorphism associated with supercontinent fragmentation (Dickens 2018). The 1000-km-long Darling Fault forms the Perth Basin's eastern boundary against the Archean Yilgarn Craton. The Perth Basin (Fig. 2) is a relatively narrow, half-graben situated on the western continental margin of today's southwestern Australia.

Laurasia, the northern component of Pangea, consisted of North America, Europe and Asia (except peninsular Asia). It has been inferred that episodic rifting events at the margins of North America in the Late Neoproterozoic record supercontinent fragmentation (Bond et al. 1984; Hoffman 1989).

Modern thermochronological data indicates enormous Neoproterozoic erosional exhumation of even hard crystalline rocks, for example kilometers of erosion of granite and schist, and peneplanation (the Great Unconformity) at the Grand Canyon (McDannell et al. 2022).

2. Early Paleozoic global marine transgression

The Sauk megasequence global sea level rise followed the initial breakup of the supercontinent (Ford and Golonka 2003). Evidence of sea level rise includes an upward-fining sequence observed in Cambrian strata which has been interpreted as a deepening succession in locations such as the USA, Greenland, UK, Russia, Australia, Bolivia and Ghana (Morton 1984). "Global or worldwide marine transgression" is the descriptor in the secular literature (Cook and Shergold 1984; Matthews and Cowie 1979).

Around the world there is a very commonly recognised deepening-water succession going upwards from Cambrian towards Ordovician strata (i.e. a basal conglomerate, then orthoquartzite, then glauconitic sandstones, then marine shales and then limestones (Ager 1973). In North America, the large quantity of Cambrian–Early Or-

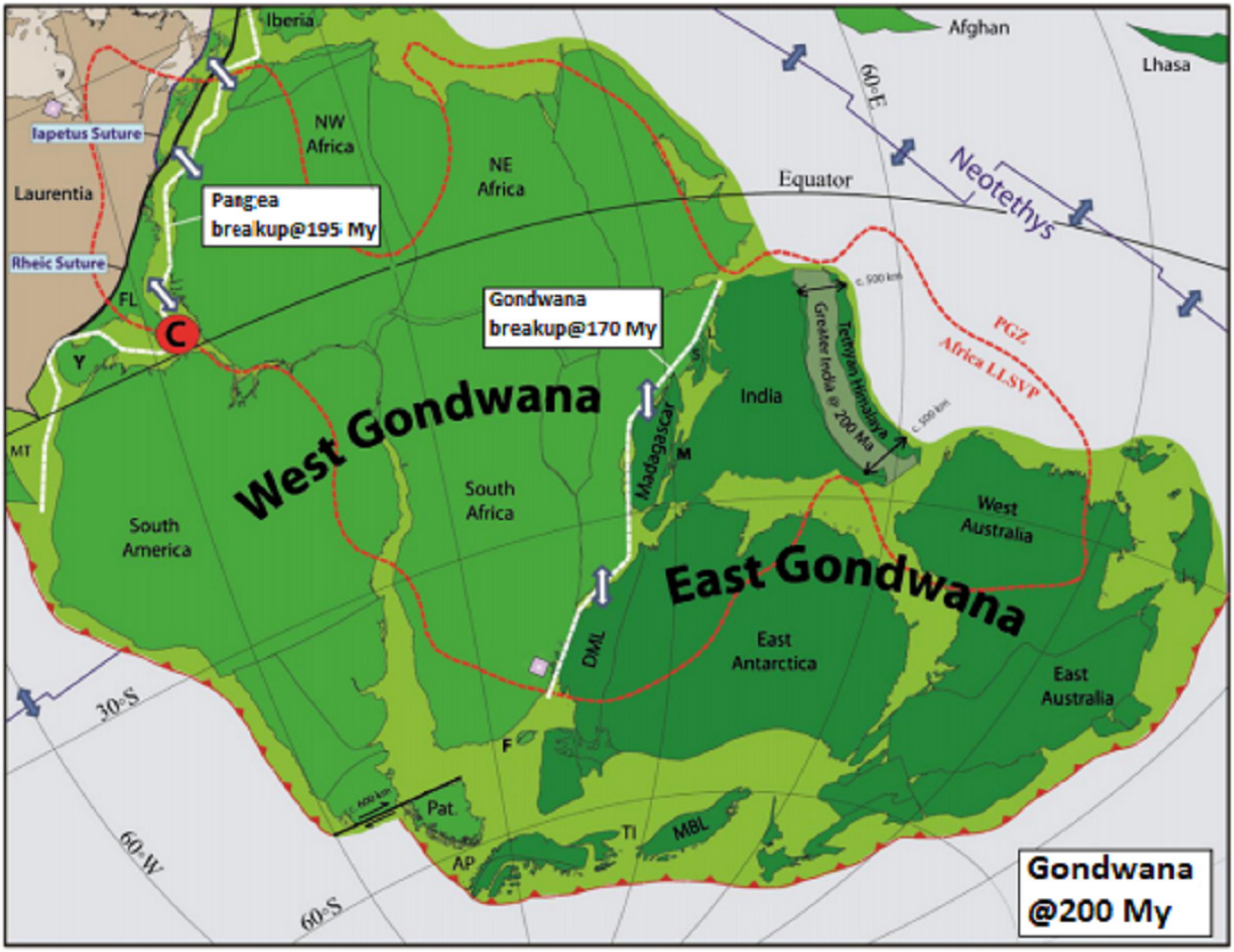


Figure 1. Gondwana at the start of the Jurassic (Torsvik and Cocks 2013).

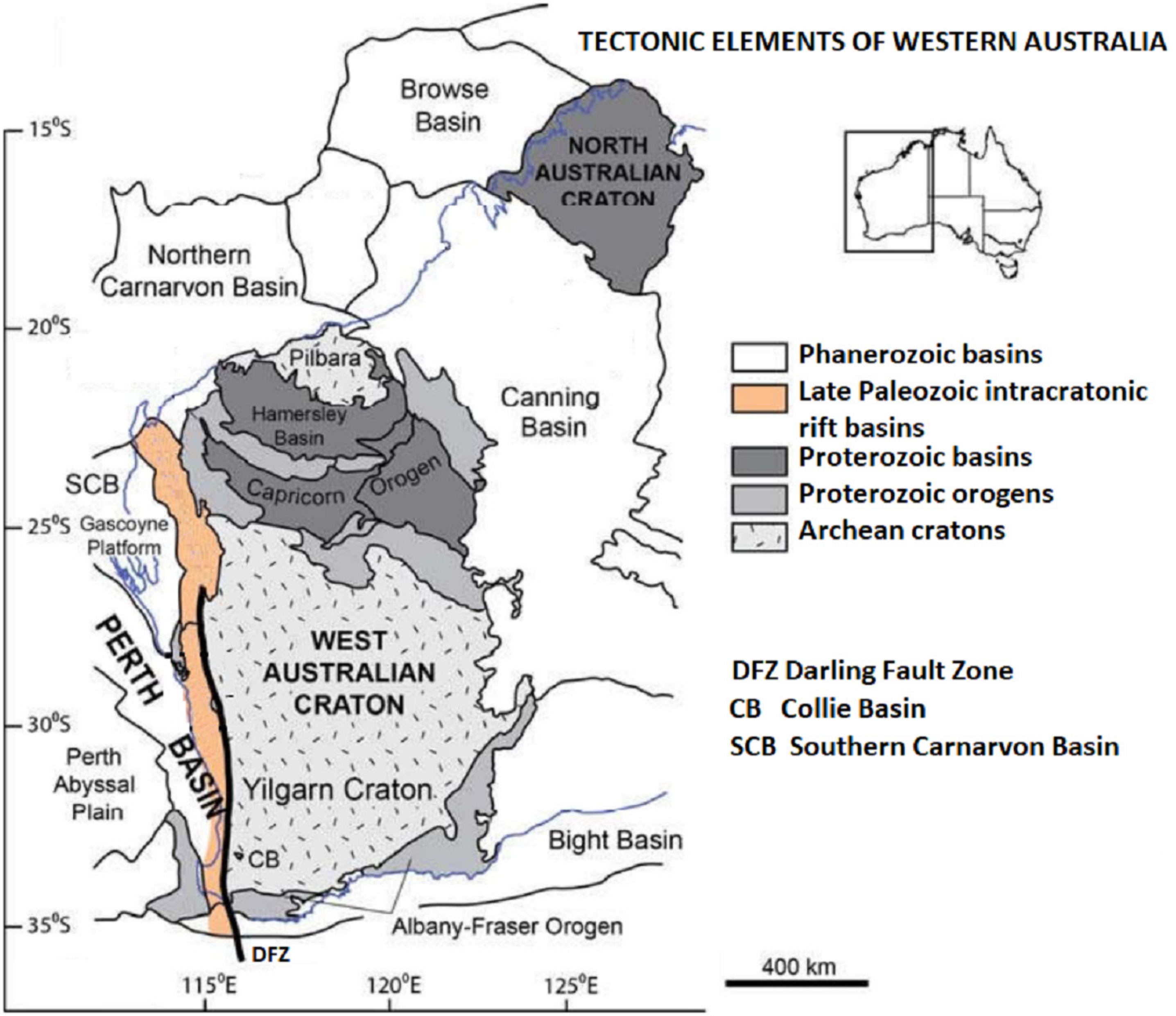


Figure 2. Map showing the tectonic setting of the Perth Basin of East Gondwana (after Dillinger et al. 2018).

dovician marine carbonates is known as the "Great American Bank" (Peters and Gaines 2012).

B. Late Paleozoic marine regression

1. Devonian Euramerica region redbeds

The Old Red Sandstone of Europe is very similar to the American Catskill redbeds. The Old Red Sandstone is inferred to have formed in a region with early marine regression of a shallow epicontinental sea, associated with the regional Acadian Orogeny (Prothero and Dott 2010).

Lower and Middle Paleozoic epeiric seas covered practically all the North American craton except during the Early Devonian regressive episode. The Acadian orogeny was the greatest orogeny for the Appalachian orogenic belt. Much of the craton was above sea level then and was being eroded (Prothero and Dott 2010).

The Devonian red clastic wedge deposits of eastern Greenland and northwest Europe, like those of the eastern United States, reflect the rapid erosion of high Acadian mountains. Sediments are inferred to have been transported in both directions away from a single great mountain range (Prothero and Dott 2010). Structurally the two margins of the North Atlantic Ocean are very similar in shape. With the opening of the North Atlantic Ocean, commencing in the Jurassic, these two areas were separated.

2. Mid-Carboniferous

a. Global

All over the world, most Mississippian deposits are typified by thick sequences of marine limestone (Prothero and Dott 2010). In cratonic sequences on all major continents there is a prominent and well-constrained Mid-Carboniferous unconformity (Blake and Beuthin 2008; Dyer et al. 2015; Hallam 1992). It has been inferred that this unconformity was established simultaneously in North America, North Africa, Europe, the Urals, Turkey, Uzbekistan, China and Australia (Lucien 2014, Saunders and Ramsbottom 1986). The Mid-Carboniferous unconformity is also found in South America (Spalletti et al. 2010).

Stratigraphic evidence from Mid-Carboniferous shelf and basin successions in numerous parts of the world indicates a major marine regression (Lucien 2014, Ross and Ross 1988). Regressions are inferred from karstification, erosional sedimentary hiatuses and other signs of dessication. A spectacular karst paleorelief of up to 100 m is recognizable in North Africa (Hallam 1992).

b. Laurasia

The Mid-Carboniferous unconformity coincides with the close of the Kaskasia cratonic sequence of Sloss (Saunders and Ramsbottom 1986; Sloss 1964). In North America it marks the Mississippian-Pennsylvanian boundary (Hallam 1992).

In the United States, the mid-Carboniferous is marked by a set of paleokarst features (Silvestru 2000). The Mississippian Redwall Limestone in the Grand Canyon is notable for its karst features, including caves. A Mid-Carboniferous paleovalley system has been inferred to have been incised in the central Appalachians, draining large areas of the emergent North American craton (Blake and Beuthin 2008).

In North America, Mississippian carbonate strata represent a transition from the marine conditions of the Middle Paleozoic to the more nonmarine conditions of Pennsylvanian and Permian time. At the end of the Mississippian, a major regression drained the craton. By the end of the Permian, practically the entire North American continent has been inferred to have stood above sea level, and great volumes of Pennsylvanian and Permian clastic sediments had been deposited (Prothero and Dott 2010).

c. Gondwana

Mid-Carboniferous uplift and exhumation of upland East Antarctica has been inferred to have led to "glaciation" and following this the region is said to have become the focus of Permian "post-glacial" flow of sediment in East Gondwana (Veevers 2009). An alternative interpretation is that East Gondwana was already an upland area and that receding waters of a marine regression caused exhumation on East Antarctica along with mass flow features, to be then followed by less energetic sedimentation. Sea-level fall associated with the Mid-Carboniferous unconformity has been interpreted as relating to the inception of a major phase of "glaciation" across Gondwana (Veevers and Powell 1987). The Late Paleozoic "glacial" episodes in Gondwana are reflected in transgressive-regressive depositional sequences, including cyclothems, in Euramerica (Veevers and Powell 1987). Euramerica, also known as Laurasia, is commonly said to have been a continent that incorporated North America, Greenland and Europe.

The evidence for major Gondwanan Late Paleozoic "ice sheets" has been inferred to be confined to the Late Carboniferous to Early Permian time range (Frakes 1979). Final "melting of the ice" in the Mid-Permian should have caused a comparably important sea level rise, which has not been apparent from the stratigraphic record. The Late Permian has been inferred to be a time of relatively low sea level stand, especially at the end (Hallam 1992). Thus, it is reasonable to conclude that glacial melting was not involved. The end Permian has been inferred to have had the lowest sea level of the Paleozoic and even of the entire Phanerozoic (Golonka and Kiessling 2002; Hallam 1992; Haq and Schutter 2008).

3. Late Paleozoic facies

Lacustrine deposits have been inferred within Carboniferous strata of the Panganzo Basin of Argentina, the Weber Sandstone of Colorado, Mazon Creek of the Illinois Basin, along with the Dunkard, Monongahela, and Conemaugh Groups of the Appalachian Basin, the Pennant Series of South Wales, and numerous other locations in other parts of the world. Lacustrine deposits have been inferred in Permian strata of the Rotliegende basins of Europe, the Karoo Basin of South Africa, the Mackellar formation of Antarctica, northwestern China, the Speiser Shale of Kansas, and other locations (Park and Gierlowski-Kordesch 2005).

Late Paleozoic fluvial deposits have been inferred in strata such as North America's Carboniferous Enrage Formation and Shepody Formation of New Brunswick (Cant 1982), Carboniferous Port Hood Formation of Nova Scotia (Gersib and McCabe 1981) and Permian Cook sandstone of the Midland Basin, Texas (Cant 1982); southwestern Australia's Permian (Freeman 2001); Europe's Carboniferous basins such as the Saar-Lorraine, Upper Silesian and Penarroya Basins (Oplustil et al. 2022).

An accelerating Late Permian sea level fall has been inferred based on the distribution on marine and nonmarine facies in successive time intervals throughout the world (Hallam 1992; Holser and Magaritz 1987). Subaerial exposure establishes the reality of sea level fall. Redbeds are the trademark of Permian and Triassic strata on five continents (Prothero and Dott 2010).

C. The Late Paleozoic "Ice Age" (LPIA)

From the Mid-Carboniferous onwards, "ice" is said to have expanded across South America, southern Africa, and Australia, and, at the start of the Middle Pennsylvanian, into southern Africa, Oman, and Arabia. A massive expansion of "ice" is claimed to have occurred at the Pennsylvanian-Permian boundary, with "glaciation" becoming bipolar at that time. "Ice sheets" have been inferred to have been at their maximum extent during the earlier Permian, after which they decayed rapidly over much of Gondwana (Fielding et al. 2008). However, it has been questioned why Gondwana did not have extensive "glacial" events throughout the Paleozoic, since Gondwana has been inferred to have been over the South Pole from the Neoproterozoic until Early Triassic. The secular search for the "smoking gun" of continental glaciation, particularly the so-called Late Paleozic "Ice Age", remains elusive (Blakey 2008).

A feature of Permo-Pennsylvanian coal-bearing strata, especially in North America and Europe, is the occurrence of numerous repetitious sequences known as cyclothems. Cyclothems are cyclical successions of carbonate, coal and clastic facies. Their origin has been proposed as being the result of repeated transgression and regression of water, submergence and emergence of land, and even due to waxing and waning of Gondwanan so-called "ice sheets" causing eustatic sea level fluctuations (Merriam 2005). The latter being a far-field record of the southern hemisphere affecting the northern hemisphere. The estimated time of the best known cyclothemic deposits in Euramerica and the thickest "glacigenic" sediment in Gondwana coincide (Fielding et al. 2008). However, if Late Paleozoic cyclothems in North America and Europe were caused by the waxing and waning of Gondwana glaciers, the associated sea-level fluctuations would have been global in scale. Thus, contemporaneous shallow and marginal marine deposits in Gondwana would also have been affected. An absence of Gondwana cyclothems indicates that Gondwana "ice sheets" can be precluded as the sole cause of cyclothems (Isbell et al. 2003).

D. Radial sediment transport from Antarctica

During the Permian and Triassic, the Gondwana sequence of India, Australia and southeastern Africa, and an upslope equivalent in coastal East Antarctica was deposited in a 7,500-km-wide alluvial fan that radiated through 180^o of arc from an inferred upland in East Antarctica (Veevers et al. 1994) (Fig. 3). The outwash fan extended toward the northern continental edge of Gondwanaland, which lay in northern Greater India and northwestern Australia. Detrital zircon provenance studies of Permo-Carboniferous "glacial" diamictites across Gondwana confirm transport of sediment for thousands of kilometers from Antarctica (Craddock et al. 2019).

Permian paleogeographic reconstructions for the western Australian margin have long emphasised dominant northward sediment transport along the axes of the Late Paleozoic rift basins (Fig. 2) (Haig et al. 2014). This is supported by northward-directed movement that radiated from the Gamburtsev upland in Antarctica during the Late Paleozoic "Ice Age" (Veevers 2006) (Fig. 3).

Veevers et al. (2008) proposed a Phanerozoic transcontinental transport system from Antarctica to Australia based on a characteristic distinctive detrital zircon age signature dominated by 700–500 My ages which is widespread in Gondwana through the Phanerozoic. Paleocurrent studies (Tewari and Veevers 1991) also indicate the flow direction from Antarctica (Fig. 3).

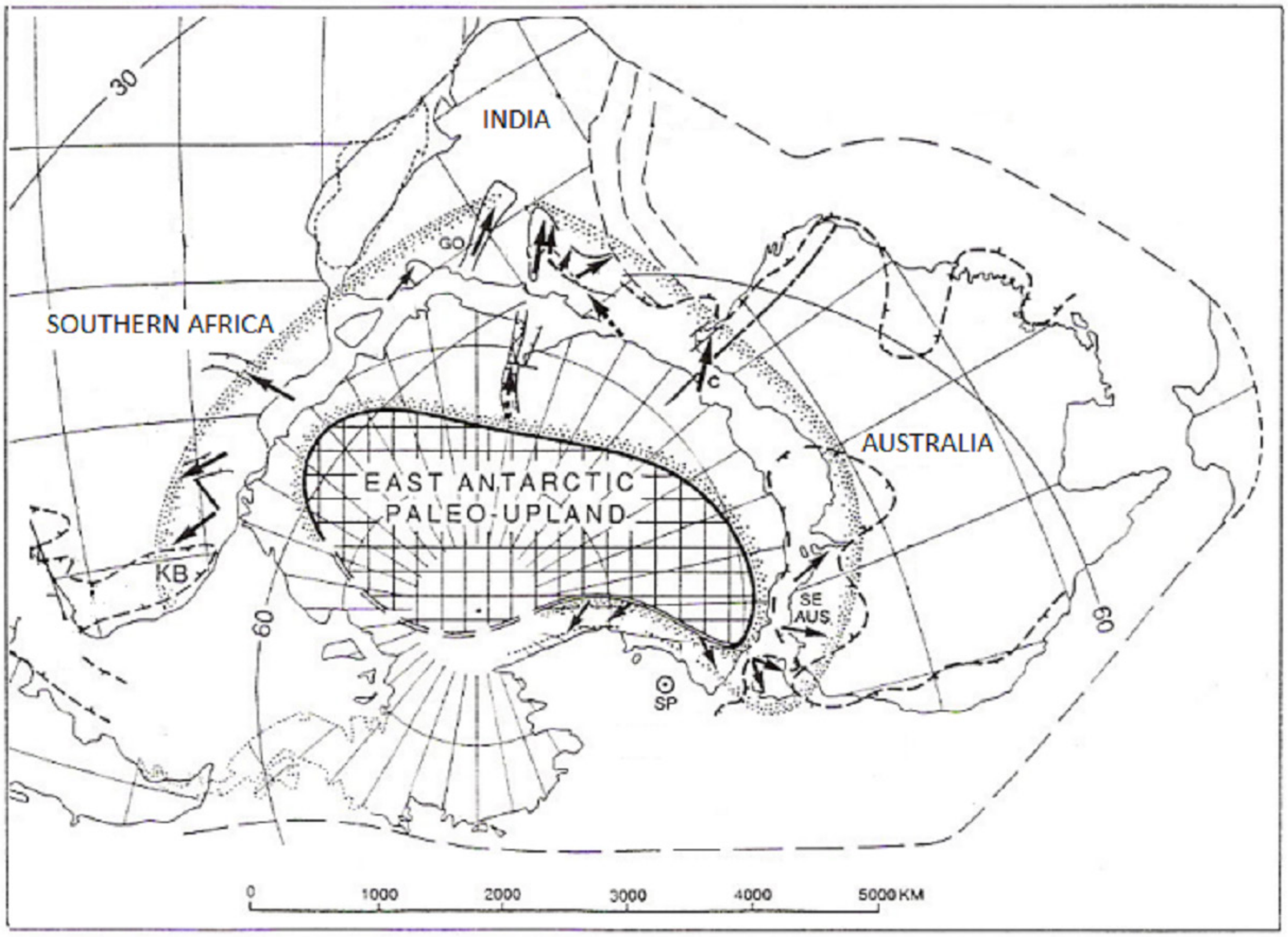


Figure 3. A reconstruction of Early Permian southern Pangea (i.e. Gondwana) with radial drainage from a paleo-upland in East Antarctica northward to areas including southwestern Australia (figure after Tewari and Veevers 1991). The arrows indicate the azimuth of Permian and Triassic sediment transport. This upland area may have been the source of Permian flora that later formed coal measures. The East Antarctic paleo-upland area may also have been the site of a geoid high from which supercontinent breakup and subsequent dispersal was driven by migration of southern continents to geoid lows (Gurnis 1988).

Gondwanan basin-fill successions show consistent three-fold stages of lowermost coarse-grained strata (represented by mass flow diamictites and poorly sorted conglomerates), overlain by shales that in turn are succeeded by shallow marine and commonly coal-bearing deltaic and fluvial sandstones. (Eyles et al. 2002). In the northern Perth Basin, for example, the Nangetty Formation diamictite is overlain by the Holmwood Shale and Irwin River Coal Measures (Fig. 4). The Nangetty Formation occurs on a major erosional unconformity on striated Precambrian crystalline basement. This formation contains dropstones and boulders (up to 6 m in diameter). Cobbles and pebbles display facets and striations, and these are found scattered throughout sandy silt and shale beds (Mory et al. 2005).

According to Eyles et al. (2002), so-called "glaciation" accompanied graben formation in southwestern Australia, beginning in the Carboniferous. This graben complex ran down the tectonically active western margin of southwestern Australia (Norvick 2004). So-called "glacial" sediments include the Mosswood Formation in the Bunbury Trough, the Shotts Formation of the Collie Sub-basin, and the Nangetty Formation of the northern Perth Basin (Fig. 4).

E. Late Paleozoic drainage and missing sediment

There is evidence of Late Paleozoic drainage in various parts of Gondwana. In South Africa's Witibank Coalfield, paleovalleys in the Permian coal seams are up to 5 km in lateral extent (Cairncross et al. 1988). Late Paleozoic paleovalleys in South America rest nonconformably on Precambrian basement and do not have any evidence of glacially-influenced deposition (Fedorchuk et al. 2019).

It has been inferred that westward transportation of detritus occurred via "glacial" valleys on the Yilgarn Craton and deposited into the western margin of Australia (Norvick 2004). Valleys (now paleovalleys) formed on the craton due to water draining towards the ocean. Figure 5 shows the example of the Avon River paleodrainage system in southwestern Australia, with its many large and extensive (hundreds of kilometers long) paleovalleys that in today's semi-arid zones contain salt lakes. These vast valleys cut across crystalline basement rocks of the Archean Yilgarn Craton. This system has been inferred to have initiated in the Permian (Freeman 2001). This drainage system may have been active in Late Permian times when sea level was low (Schopf 1974; Hallam 1992).

The paleovalleys in southwestern Australia have a distinctly differ-

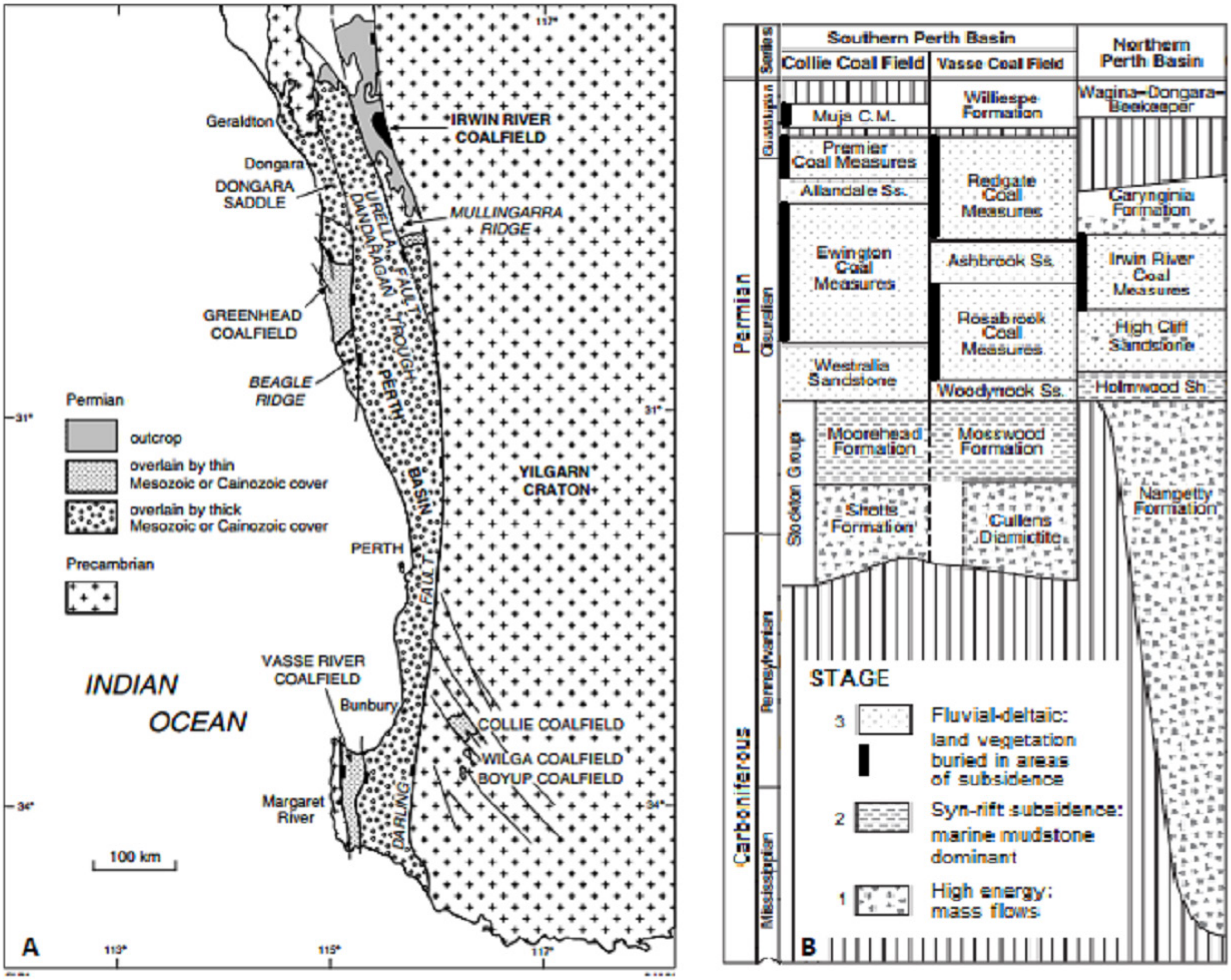


Figure 4. Perth Basin, southwestern Australia.
A: Map showing locations of the basin's Permian coalfields (after Le Blanc Smith and Mory 1995).
B: Permo-Carboniferous lithostratigraphic column (after Mory et al. 2008).

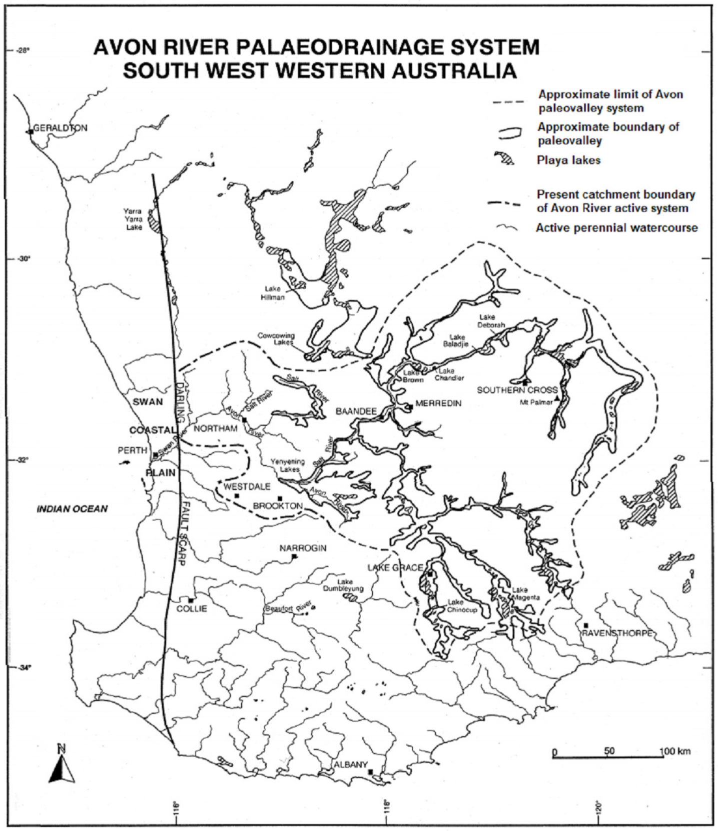


Figure 5. Avon River paleodrainage system, southwestern Australia (after Freeman 2001).

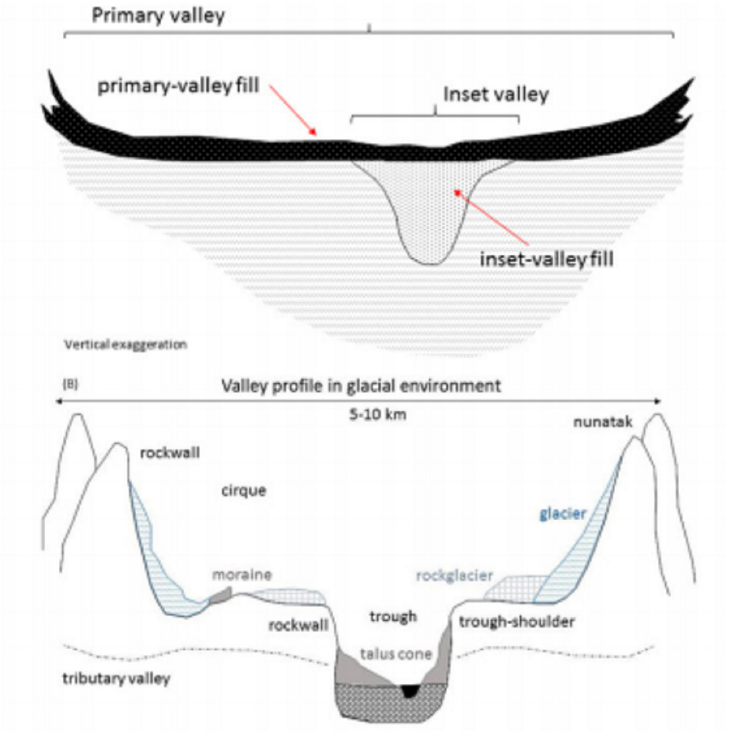


Figure 6. Representation of a cross section of paleovalleys in (a) southwestern Australia compared to (b) a valley incised by a glacier (after Heilbronn et al. 2018).

ent shape in cross-section to valleys incised by glaciers (Fig. 6). Most paleovalleys on southwestern Australia's Yilgarn Craton are missing the steep sidewalls and U-shaped valley (top cross section) which are normally expected of a valley carved by a glacier (bottom cross section). Inset valleys are generally less than a kilometer wide, and occupy a small proportion of the broad flat primary valleys. They are completely concealed and must be found with geophysical methods using the difference in gravitational or electrical properties with the surrounding bedrock (Braimridge and Commander 2005).

The Permo-Carboniferous "glaciation" is said to have been the most significant geomorphic event on the Yilgarn Craton leading to paleodrainage sytems, and it was followed by subsequent repeated infillings into the Tertiary (Finkl and Fairbridge 1979).

The evidence for significant Late Paleozoic terrestrial erosion on the vast Yilgarn Craton of Western Australia (Thomas 2014) raises the question of the eventual depositional site for these volumes of detritus (Sircombe and Freeman 1999). However, to date there is no known evidence of where the huge volume of eroded sediment went to. Several methods have been used to estimate the thickness of sediments eroded. These methods include coal rank (Lowry 1976), vitrinite reflectance (Le Blanc Smith 1993), and thermal modelling based on apatite fission track data (Olierook et al. 2019). These estimates of eroded thickness have ranged up to several kilometers.

F. Late Paleozoic coal deposits

Major coal deposits are found in strata from Mid-Carboniferous to end Permian, as well as Late Triassic to Cenozoic. It is a remarkable fact that no coal seam has yet been discovered in Early Triassic strata (hence the term "Coal Gap") (Fig. 7) and coal seams in Middle Triassic strata are scarce and thin (Retallack et al. 1996).

Over the passage of the so-called Late Paleozoic "Ice Age", and together with fluctuations of both physical and chemical conditions operating on Earth at that time, thick and geographically extensive coal deposits began to form (Gastaldo et al. 2020). -A broad chain of large coalfields of Carboniferous age is found in the northern hemisphere. It extends from eastern Northern America, through Europe, the Russian Federation and south into China (Fig. 7). In addition, a chain of Permian coalfields is found in the more southern (or Gondwanan) continents—Australia, India, southern Africa, South America and Antarctica (Shao et al. 2020) (Figs. 7 and 8).

A massive volume of organic debris was deposited and subsequently buried in Carboniferous-Permian strata. Extensive foreland and cratonic basins, formed in association with the Pennsylvanian−Permian tectonism, ensured the subsidence requisite for long-term preservation of buried organic matter (Nelsen et al. 2016).

China's Paleozoic coal-bearing basins have been inferred to be mainly large epicontinental sea basins. The shallow sea was the most important coal-forming sedimentary environment. Coastal delta and delta-detrital coast systems were important coal-forming sedimentary environments in the Late Palaeozoic. (Li et al. 2018). Such deltaic deposits host much of the world's coal reserves. Detailed mapping of sediment increments between regionally widespread Pennsylvanian coal marker horizons in the Illinois basin shows radiating shoe-string sand bodies similar to those in the modern Mississippi delta (Selley 1988).

There are numerous published records which provide evidence for

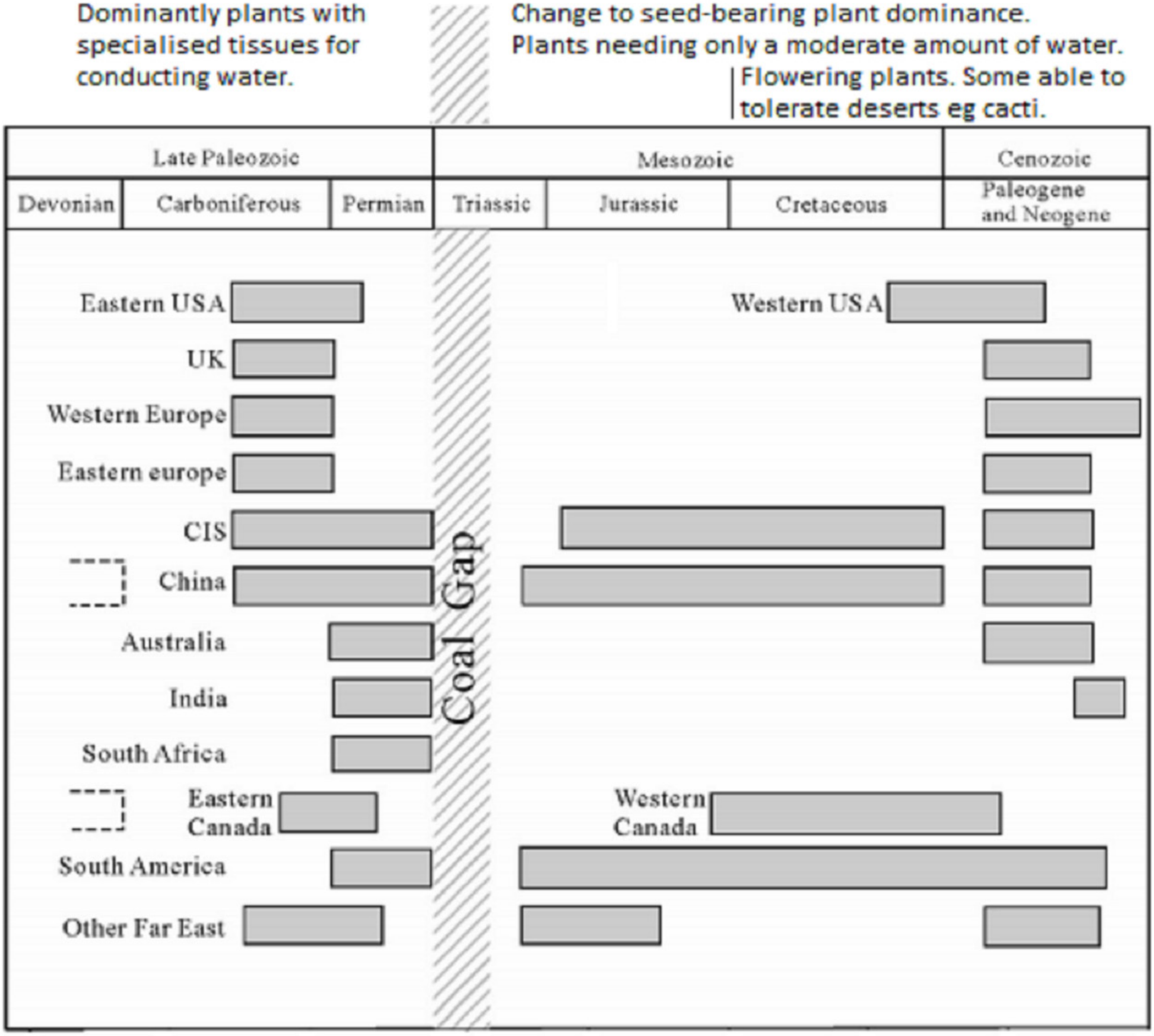


Figure 7. Global distribution of major coal deposits (after Shao et al. 2020) with broad trends in plants according to their use of water. Worldwide, coal deposits are absent in the Early Triassic (the Coal Gap) and Early Paleozoic strata. Post-Paleozoic plants are dominantly plants that need less water, compared with plants that were dominant in the Palaeozoic.

paleo-wildfires from the Late Paleozoic onwards (Jasper et al. 2021). Many Permian coals are very rich in macerals such as inertinite and the sub-maceral fusinite, which is thought to be charcoal from the burning of dry plant matter (Retallack et al. 1996). Such evidence for fires has been described in places such as Australia (Vajda et al. 2020), China (Cai et al. 2021), and Brazil (Benicio et al. 2019). A case has been put that Siberian Traps volcanic eruptions and intrusions burned large volumes of a combination of coal and vegetation (Elkins-Tanton et al. 2020). Evidence for coal combustion includes the presence of coal fly ash layers and cenospheres (hollow mineral spheres found as a coal combustion by-product at thermal power plants) at the end-Permian boundary in Arctic Canada (Grasby et al. 2011). Ejection of combusted coal ash into the atmosphere from Siberia has been considered to have been carried on global air currents to locations including Arctic Canada (Elkins-Tanton et al. 2020). Much literature has been written associating Siberian Traps volcanism with the end-Permian mass extinction which is widely regarded as the greatest mass extinction of lifeforms in the geological record.

The Permian coal-bearing sediments of the Perth Basin are considered to be part of the large alluvial outwash fan, bordering the highlands of Antarctica (Tewarri and Veevers 1991) (Fig. 3). The coal was deposited in a terrestrial braidplain, which in southwestern Australia drained towards the north-northwest (Wilson 1990). Foreset

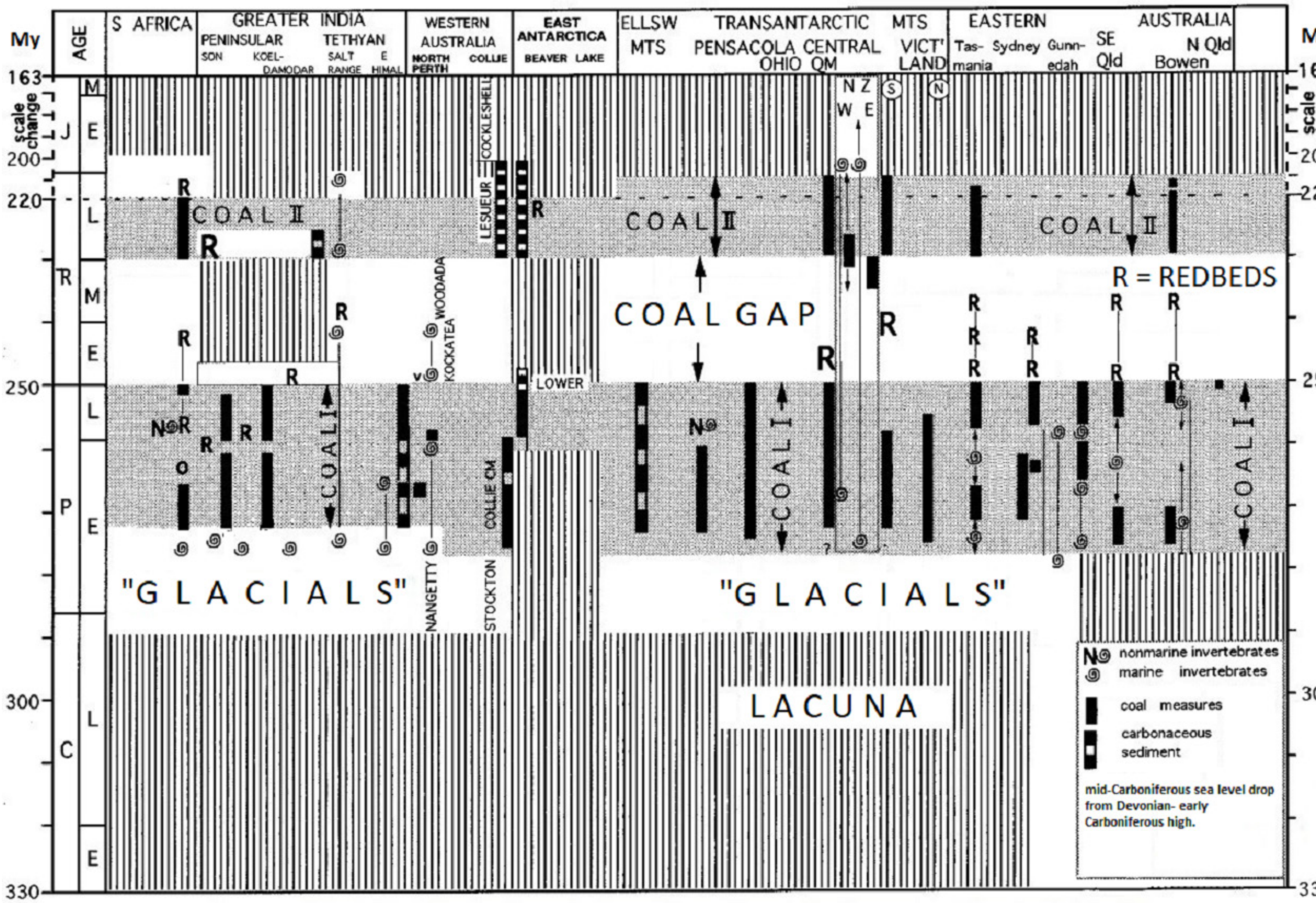


Figure 8. Timetable of Carboniferous to Jurassic environments of Gondwana's Antarctica, South Africa, Greater India and Australia. The lacuna, or absence of sedimentary deposition, indicates a time of erosion. This is consistent with erosion beginning in an East Antarctica paleo-upland (Tewari and Veevers 1991), followed by deposition of diamictites ("glacials") in Gondwanan basins. Deposition of the first coal measures (Coal I) occurred as sea level fell to the end-Permian minimum (Hallam 1984). Later there is the Early Triassic Coal Gap and the occurrence of Triassic redbeds. Red pigment replaced black at the gross change in environment and biota at the Permian-Triassic boundary (after Veevers and Tewari 1995).

bedding directions in cross-bedded sandstones of the Collie Coal Measures indicate palaeo-currents, and so sediment transport, was almost exclusively from the south. This direction is consistent across the area and throughout the sequence, and suggests that the present Collie Basin is a remnant of a much greater area of sedimentation (Wilde and Walker 1977). A map and cross-section through the Collie Basin are shown in Fig. 9.

G. Triassic drying

Extensively documented in the geoscientific literature is the view that there was a time of drying from at least the later Permian and Triassic, particularly in continental interior locations. In the Permo-Triassic, it has been inferred that land area became larger and the overall climate became warmer and drier. The Early to Middle Triassic corresponds with a first-order low sea level stand during the Mesozoic and the time of maximum continental emergence (Ford and Golonka 2003). Drying is attested by lithological, paleogeographic and floral indicators.

1. Lithologies

Terrestrial clastic deposits with evaporites and red beds are widespread in Triassic strata. These types of sediments occur in South America, western Europe, southwestern US, maritime Canada, northwestern Africa, and South Africa. Rift basins developed in the central and northern Atlantic region (Ford and Golonka 2003). The occurrence in Triassic strata of calcrete, gypsum, anhydrite, laterite, bauxite, red beds, lacustrine deposits and alluvial deposits are together lithological indicators of drying non-marine depositional environments (Chumakov and Zharkov 2003).

Calcrete is a calcium-rich hardened layer in or on a soil. It forms today on calcareous materials as a result of climatic fluctuations in arid and semiarid regions. Calcite is dissolved in groundwater and, under drying conditions, is precipitated as the water evaporates at the surface (Brittanica. Calcrete). Arid landscapes in outback Australia today have calcrete (Chen et al. 2002).

Sedimentary calcium sulphate, commonly known as gypsum, is found in nature in different forms, mainly as the dihydrate ($CaSO_4 \cdot 2H_2O$) and anhydrite ($CaSO_4$). They are products of partial or total evaporation of inland seas and lakes (Karni and Karni 1995). I have collected gypsum crystals from near the surface of modern dry salt lakes in the semi-arid Eastern Goldfields region of Western Australia.

Laterite is an iron-rich, subaerial, weathering product, commonly believed to develop as a result of intense, in situ substrate alteration. It comprises an important subset of a wider range of ferruginous and related aluminous (i.e., bauxitic) weathering products. Laterites owe their chief compositional characteristics to the relative enrichment of iron (and often aluminium), and the other less mobile parent rock constituents. This enrichment occurs under aggressive weathering conditions as a consequence of the greater mobility, and hence loss, of constituent silica, alkalis, and alkaline earths (Widdowson 2009).

Diagenetic physicochemical conditions reflect the climate regime. In arid to semi-arid areas, low annual precipitation creates an overall oxidizing environment, under which detrital magnetite is replaced by red-coloured hematite and hematite remains unaltered. Redbeds are notable in Gondwanan Triassic strata (Fig. 8).

2. Paleogeography

The worldwide synchronous switch from meandering to high-energy braided rivers, along with the expansion of alluvial fans at the Permian-Triassic transition has been documented (for example, in Russia, the Karoo Basin, and Australia). This change in fluvial style is consistent with the transition to Triassic aridity and mass wasting, and is against a background of global marine regression (Valentine and Moores 1970). In addition, soil carbonate oxygen isotope ($\delta^{18}O$), carbon isotope ($\delta^{13}C$), and geochemical signatures of weathering intensity provide evidence for a consistent pattern of deteriorating environments (Zhu et al. 2019).

Lacustrine basins can be recognised by their morphology, commonly fine-grained sediments, together with the absence of marine faunas (Picard and High 1972; Selley 1978). Lacustrine basin fossils may instead include freshwater bivalves and freshwater algae (Hallam 1981). Organic facies and geochemistry also provide evidence for lacustrine sediments (Michaelsen and McKirdy 1989).

The successive widening of Triassic arid and semi-arid belts of a su-

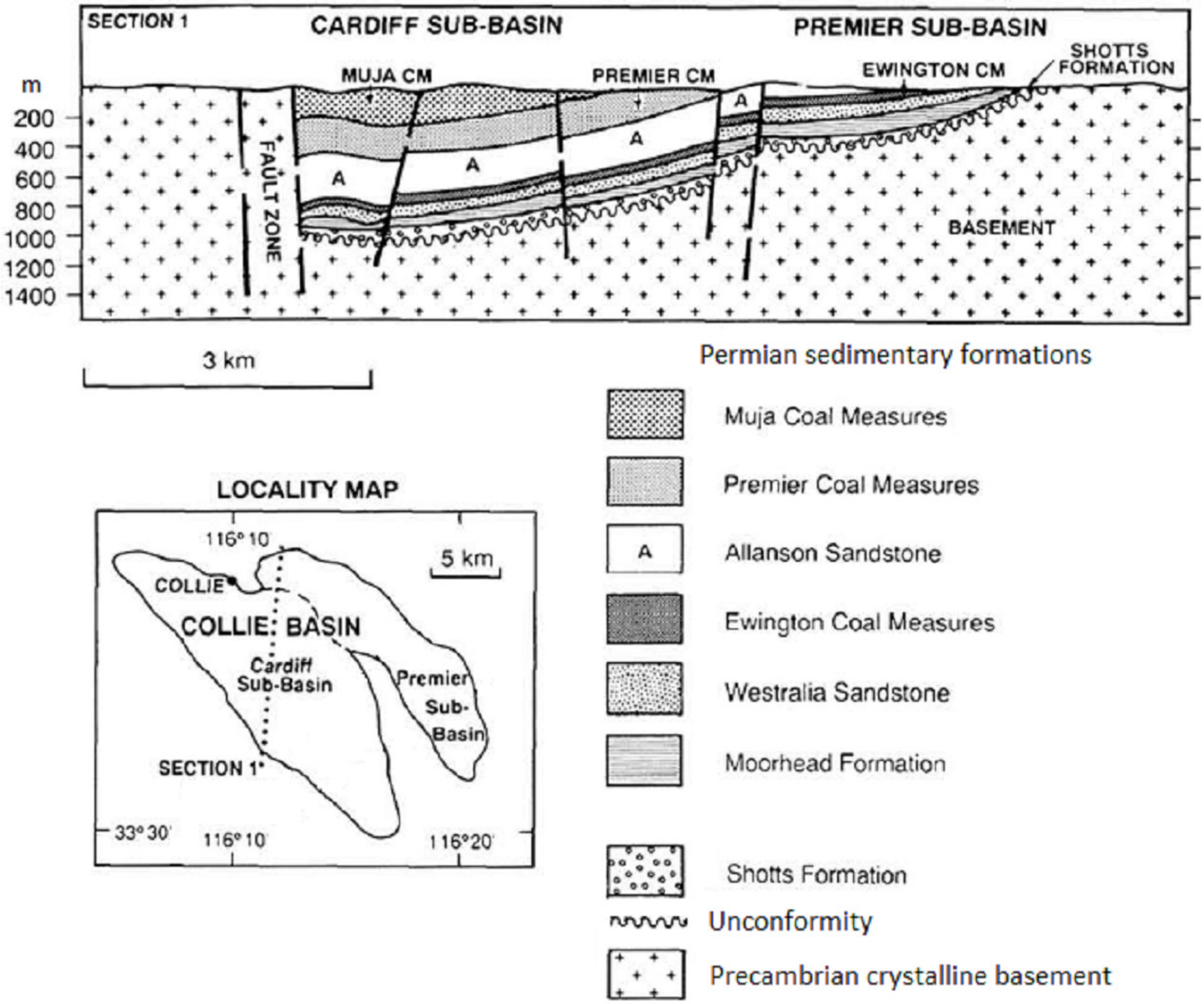


Figure 9. Map and cross-section through the Collie Basin, which is an outlier of the Perth Basin (after Le Blanc Smith 1993).

percontinent has been inferred from lithologies and flora (Chumakov and Zharkov 2003). Drying conditions are indicated by the wider paleolatitudinal spread of evaporite deposits in the Triassic compared with Permian strata (Retallack et al. 1996). Sedimentary evaporites are rocks precipitated from saturated surface or near-surface brines by hydrologies driven by solar evaporation (Warren 2006).

3. Flora

The onset of the Coal Gap at the Permian-Triassic boundary was a time of extraordinarily low sea level as determined by both sequence stratigraphy and the percentage of marine sedimentary cover (Hallam 1984; Haq and Schutter 2008; Peters 2011). Marine shelfal habitat area was reduced and a great area of land emerged. This included an enormous inner land with an extreme and arid climate, where many plant species which could resist heat and aridity became more prevalent (Chumakov and Zharkov 2003).

The proportion of plant types buried in post-Paleozoic strata is very different to those of the Paleozoic. Post-Paleozoic plants are dominantly plants that need less water compared with plants that were dominant in the Paleozoic strata (Fig. 7). Gymnosperms dominated, including many different forms of conifers. In addition, the wood-rich conifer and angiosperm-dominated source floras of Cenozoic coals differ radically from the mostly nonwoody floras of the Carboniferous (Nelsen et al. 2016).

Worldwide Jurassic coals have a higher proportion of flora generally better suited to drier land environments than flora of the previously mentioned Permian coals (Retallack et al. 1996; Orem and Finkelman 2003). The proportion of plant types buried in Jurassic strata is totally different to those of the Permian. For example, the Jurassic vegetation of Australia was predominantly made up of abundant southern conifers (Turner et al. 2009). Conifers do not grow in swamps, but in drier environments.

4. Mass extinction

A review has concluded that that of all the causal factors proposed to account for mass extinctions, marine regressions associated with sea level fall is the one that correlates best throughout the Phanerozoic (Jablonski 1986). As previously mentioned, the end Permian has been inferred to have had the lowest sea level of the Paleozoic and even of the entire Phanerozoic. This would imply significant marine habitat loss.

The Paleozoic terminated in a complex environmental catastrophe and mass extinction of life. This sharp paleobiological division led Phillips (1840) to introduce the term Mesozoic (middle life, with Triassic at the base) between the Paleozoic (old life, ending with the Permian) and Kainozoic (now Cenozoic; recent life, after the Cretaceous).

The latest Permian to earliest Triassic strata record the progressive disappearance of up to 80% of marine genera, pronounced negative carbon-isotope and strontium-isotope anomalies, massive flood basalts of the Siberian Traps, widespread anoxic oceanic conditions, a major sea-level regression, and exposure of shelves, a "Chert Gap" and "Coal Gap," and replacement of reefal ecosystems with microbial-dominated carbonate precipitation. The majority of ecosystems did not fully recover until the early Middle Triassic (Gradstein et al. 2020).

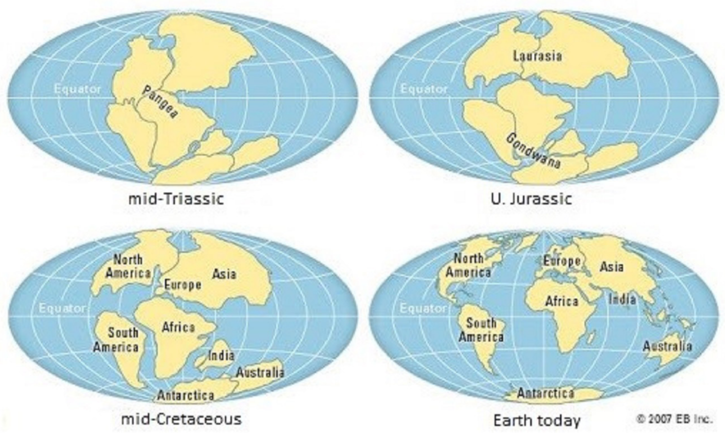


Figure 10. Stages of seafloor spreading (after https://www.britannica.com/science/plate-tectonics/Development-of-tectonic-theory. Accessed 8 February 2022)

- Mid-Triassic is before modern-day oceans opened up significantly.
- Upper Jurassic shows the initial rifting between West and East Gondwana, and separation of the Americas.
- Mid-Cretaceous shows the progressive isolation of Gondwanan landmasses and northward migration of India.
- By the Oligocene, Australia and Antarctica had separated.

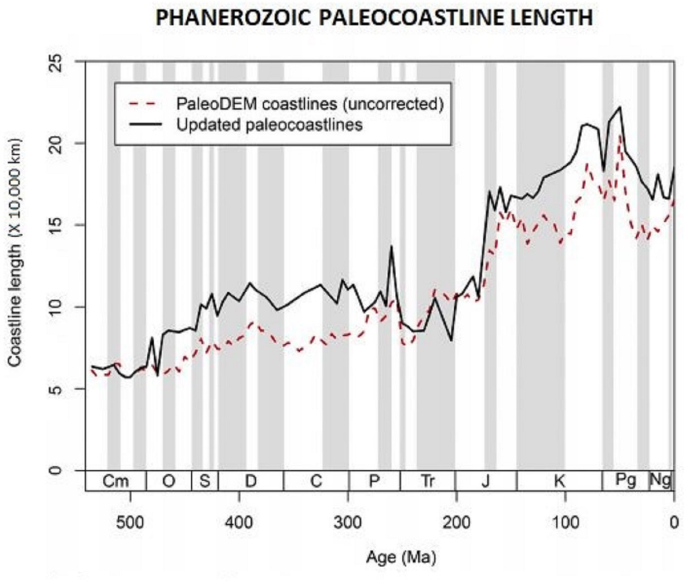


Figure 11. Change of paleocoastline length through time. Note the abrupt increase in the Mesozoic (after Kocsis and Scotese 2021).

H. Post-Paleozoic seafloor spreading

1. Successive phases of continental rifting and seafloor spreading

Initial continental breakup began in the Early Triassic (Muller et al. 2019). It is remarkable that this coincided with a time of sea level low and continental drying, as previously described. The rifting continued and intensified in the Late Triassic.

Rifting and breakup of Pangea is inferred to have taken place in stages (Fig. 10) (de Lamotte et al. 2015). The initial rifting included the development of rift basins about the north Atlantic and eastern Indian Oceans. The central North Atlantic and Australian Northwest Shelf rifted in the Jurassic, and the South Atlantic, Tasman Sea, and the East African margin broke up in the Cretaceous. By the end of the Mesozoic, India and Africa had begun to separate from Antarctica (Bois et al. 1982). The diachronous initiation of seafloor spreading along the present-day margin of the central North Atlantic Ocean is part of a larger trend that reflects the progressive dismemberment of Pangea (Withjack et al. 1998).

During the Jurassic, *Pangea* broke up into *Laurasia* to the north and *Gondwana* to the south, and this peak in rifting (Muller et al. 2019) is reflected in an abrupt increase in paleocoastline (Kocsis and Scotese 2021) (Fig. 11). The breakup of Gondwana initiated in the Early Jurassic with initial rifting between East and West Gondwana being preceded by the emplacement of extensive plume-related flood basalts in southern Africa and the Transantarctic Mountains. East Gondwanaland (Australia, Antarctica, India, Madagascar, and the Kalahari craton of southern Africa) separated from West Gondwanaland (Africa, Arabia and South America) (Baillie et al. 1994; Gibbons et al. 2013).

The second major phase of Gondwana breakup commenced in the earliest Cretaceous, when the South Atlantic Ocean began to open and Greater India commenced its northwestward rotation from Australia and Antarctica. This Early Cretaceous phase of seafloor spreading affected the Western Australian margin (Baillie et al. 1994). An example of a Cretaceous breakup unconformity is shown in Fig. 12. There was widespread basic volcanism along the southwestern margin of Australia related to breakup and the formation of oceanic crust (Norvick 2004). The Bunbury Basalt was extruded in the onshore Bunbury Trough of the southernmost Perth Basin. Aeromagnetic data over the Bunbury Trough shows basalt flows confined to paleovalleys on the breakup unconformity (Olierook et al. 2015) (Fig. 13). The basalt is columnar rather than pillow basalt, consistent with subaerial extrusion in paleovalleys. Paleodrainage appears to have been from south to north, which would have been similar to the south-to-north drainage system inferred to have existed between Antarctica and Australia during the Permian and Early Triassic (Olierook et al. 2015).

By the Mid-Cretaceous, a series of rift valleys formed a broad rift-divergence zone between Australia and Antarctica in which thick accumulations of terrestrial and lacustrine sediments accumulated. Australia became isolated from Antarctica by the Oligocene (Baillie et al. 1994) (Fig. 10).

Passive margins are found around many continents of the world. Examples include margins of the Atlantic Ocean, the Gulf of Mexico, and around Australia and Antarctica. They represent the transition between oceanic crust and continental crust which is not an active plate margin. They were constructed by sedimentation above continental rifts which created new ocean basins. Because there was no collision or subduction taking place in these particular zones, deformation and tectonic activity was minimal.

2. Post-Paleozoic sedimentation

a. Presence of non-marine sequences

In this paper reference has already been made to non-marine sedimentation. This includes Late Paleozoic lacustrine and fluvial deposition, Carboniferous karst, Permian fires, numerous indicators of drying in Triassic strata, floral trends, and Cretaceous subaerial

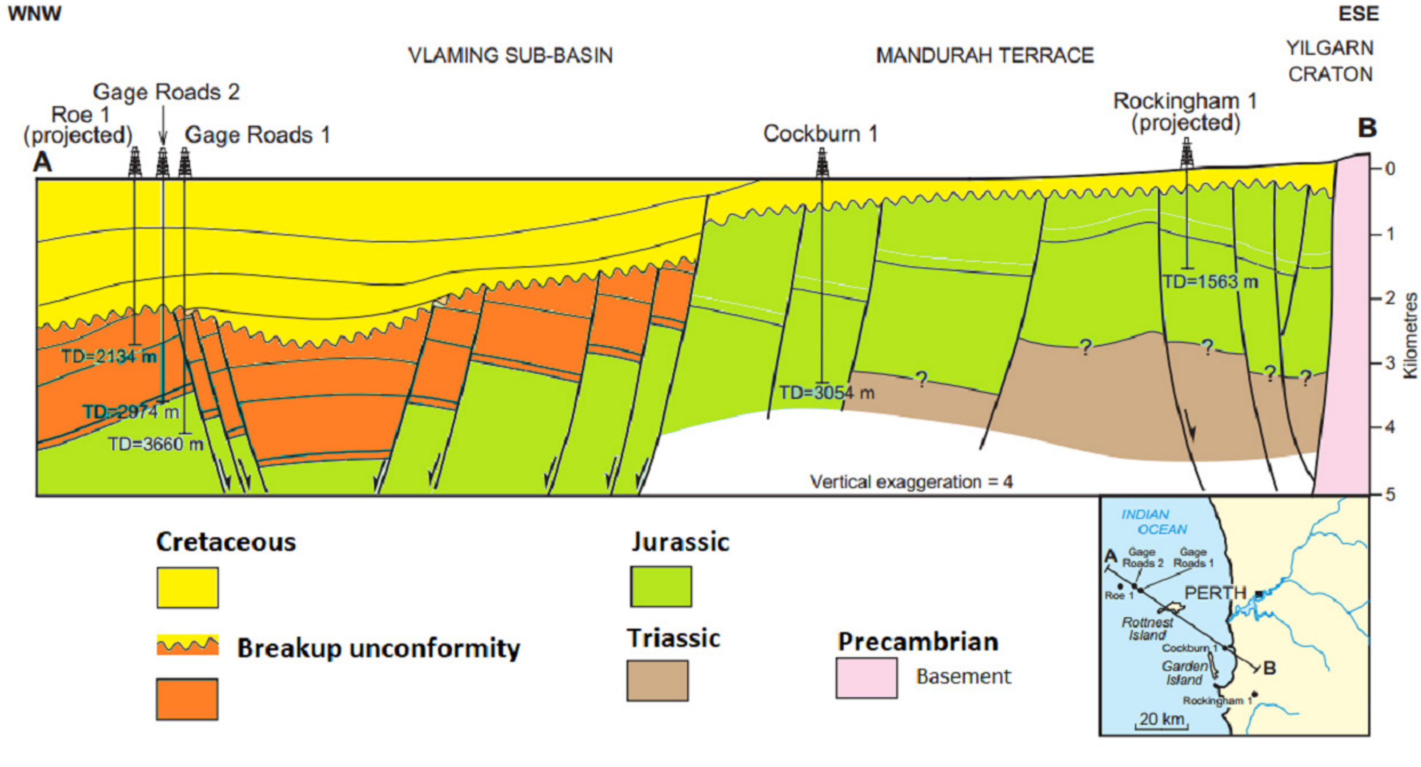


Figure 12. Cross-section extending from the crystalline basement of the Yilgarn Craton in the east to Mesozoic sedimentary rocks of the offshore Perth Basin in the west (after Crostella and Backhouse 2000). This cross-section shows an example of a Cretaceous continental breakup unconformity which truncates fault blocks of the underlying half-graben. From the Late Cretaceous, the southwestern margin of Australia became tectonically quiescent. The post-breakup passive margin strata show little deformation.

basalt. The post-Paleozoic was characterised by a great variety of depositional settings, including both non-marine and marine settings (Dickens 2022) (Fig. 14).

When the opening of today's oceans was underway, there was also continental mountain building, on active continental margins. Significant thick Mesozoic and Cenozoic sedimentary sequences formed with successive episodes of runoff from these mountains. Plants better suited to a drier land environment grew and became dominant (Fig. 7). Plants were transported by runoff from tectonically active mountain areas and buried in near-coastal environments (such as adjacent to North America's Cretaceous Western Interior Seaway) (Robinson Roberts and Kirschbaum 1995) and in lakes (for example in China) (Shao et al. 2020). This plant matter was buried and subsequently formed coal measures.

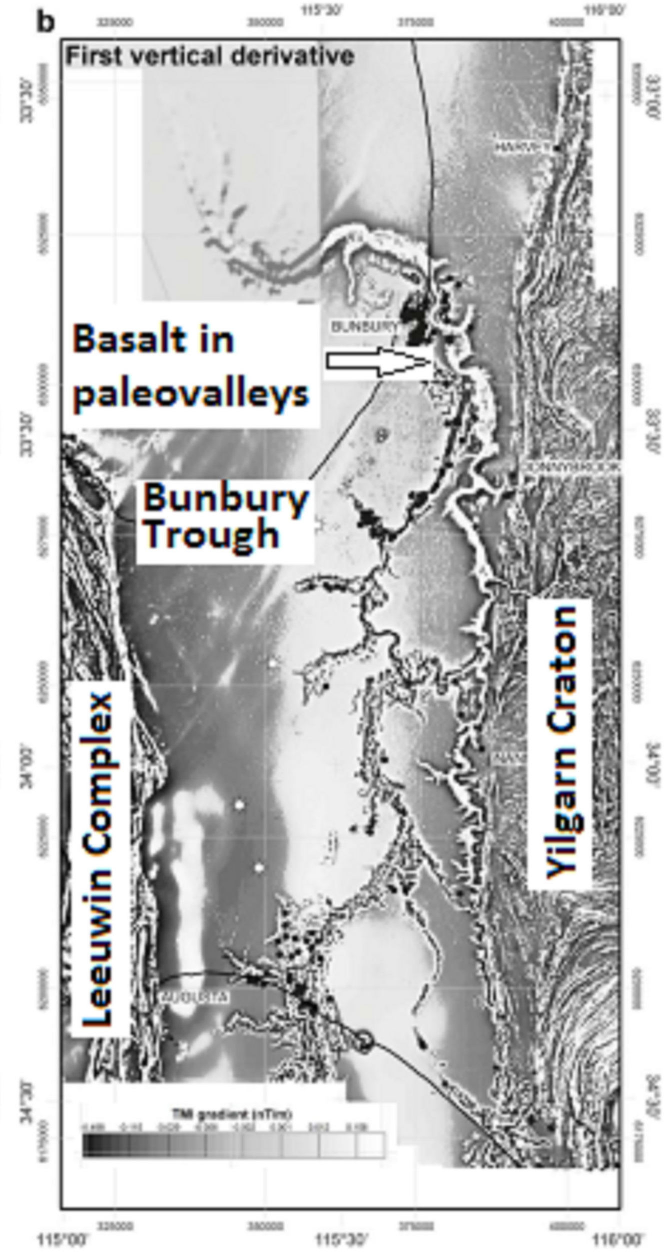


Figure 13. First vertical derivative of total magnetic intensity indicating Cretaceous basalt distribution in paleovalleys of southwestern Australia (after Olierook et al. 2015). The basalt is columnar rather than pillow in form, and together with occurrence in river valleys, subaerial extrusion is evident.

The thickest, most extensive Upper Cretaceous coals of the Western Interior of North America are associated with a time of mountain building, folding and thrusting in the Western Cordillera. The distribution of conglomerates and volcaniclastics indicate high-energy river systems flowing from the adjacent mountain front towards the Western Interior Seaway (Robinson Roberts and Kirschbaum 1995). The Paleogene Powder River Basin of the western USA contains the largest reserves of low sulfur sub-bituminous coal in the world (Clarey 2017). Low sulfur is generally an indicator of a freshwater, rather than marine water, depositional environment (Sari et al. 2017). In association with the mountain-building event known as the Laramide Orogeny (which uplifted much of the Rocky Mountains), vegetation was transported by rivers to broad floodplains and around lake margins. Basin subsidence and runoff from adjacent mountain ranges contributed to thick accumulations of sediment. The plant matter then became preserved as thick coal seams (Glass 1980).

The fossil record of inferred lacustrine settings indicates biodiversification from the Mesozoic onwards (Buatois et al. 2016). Post-Paleozoic coal in China is commonly interpreted by Chinese researchers to be associated with lacustrine basins (Dai et al. 2020; Li et al. 2018). Early–Middle Jurassic coal-bearing basins are inferred to have been large and medium-sized inland lake basins, in which alluvial-lake

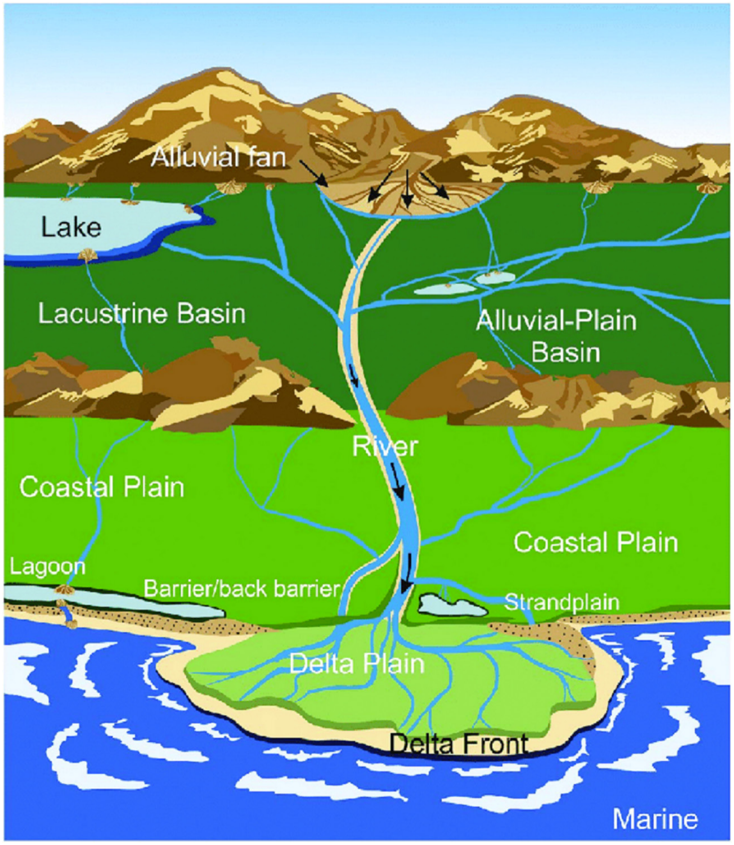


Figure 14. An idealized schematic diagram showing a representation of post-Paleozoic depositional environments including continental intermontane lacustrine, alluvial plain, coastal plain, river and delta plain (Dai et al. 2020). These are dominantly non-marine settings.

delta systems and lakeshore sedimentary environments were inferred to be the main areas for coal formation. Other examples of Mesozoic formations that incorporate lacustrine deposition have been described including North America's Morrison Formation (Frazier and Schwimmer 1987; Hagen-Kristiansen 2017), South America's Parnaíba Basin (Soares et al. 1978), Australia's Eromanga Basin (Michaelsen and McKirdy 1989), and rift basins in northern Africa (Guiraud et al. 2005).

b. Inland seaways

During times of seafloor spreading, newly created mid-ocean ridge basalt was hotter and its increased volume is inferred to have displaced oceanic water to overflow low-lying parts of continental crust and form interior seaways. However, the ocean did not complete-

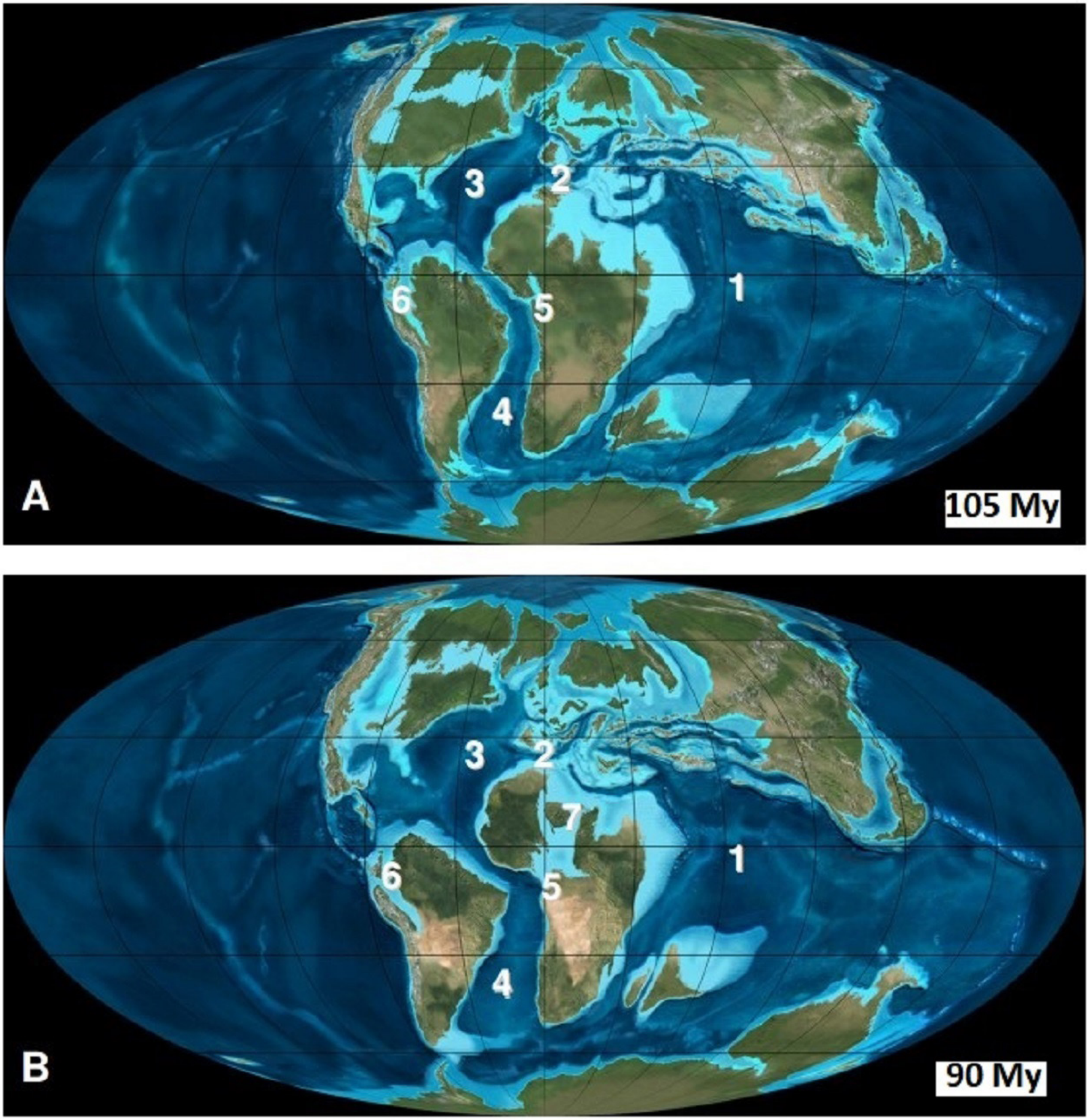
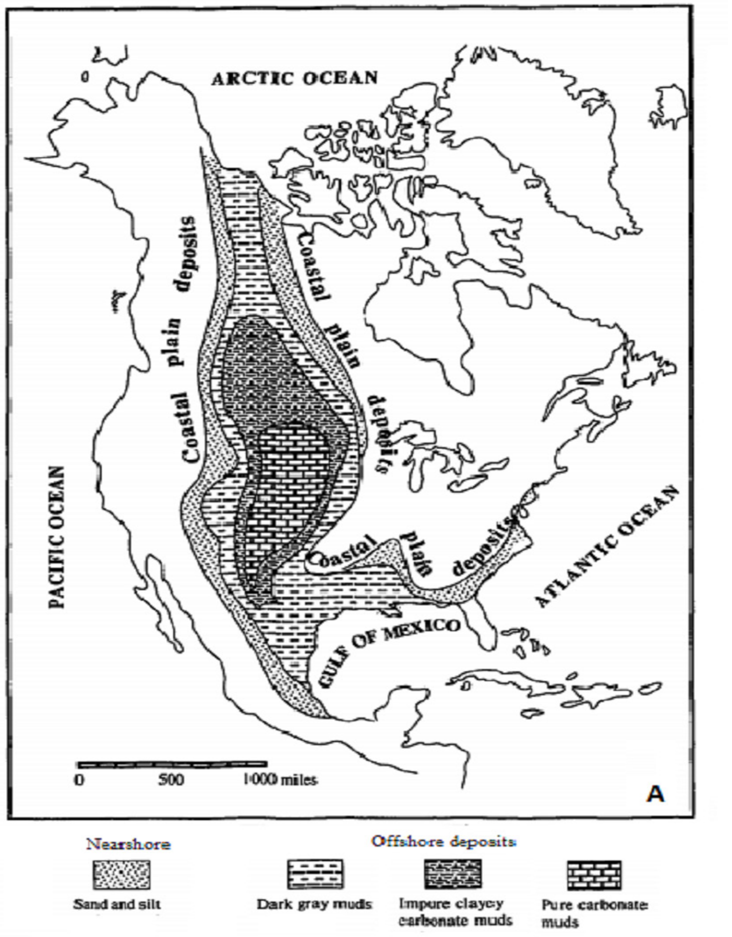


Figure 15. Global maps of the Cretaceous (105 My) and (90 My) showing the distribution of seaways and oceans. (1) Tethys Ocean, (2) Tethys Seaway, (3) Western Tethys, (4) South Atlantic, (5) Benue Trough, (6) South American Seaway, and (7) the trans-Saharan Seaway (Roney 2013). In the Cretaceous, North America had the Western Interior Seaway and northern Australia had the Eromanga Sea.



ly cover the globe at these times. There is rock and fossil evidence of Jurassic and Cretaceous interior seaways and continental margin flooding (Golonka and Kiessling 2002). The Sundance Seaway in western USA (Danise and Holland 2018) and the Sub-Boreal Seaway of the United Kingdom (Foffa et al. 2018) are examples of Jurassic seaways and basin subsidence. The Sundance Seaway was nearly 2000 kilometers long and was flanked on the west by a fold and thrust belt (Danise and Holland 2018). In the Cretaceous there were a number of seaways, including the Western Interior Seaway on the tectonically active margin of North America (Robinson Roberts and Kirschbaum 1995) (Figs. 15 and 16).

I. Pleistocene Ice Age and submarine canyons

Intense volcanic activity and increased ocean temperatures associated with seafloor spreading have been used to explain this Ice Age. The release of hot volcanic water warmed the ocean and strong evaporation from a much warmer ocean provided the water for the ice (Oard 1987, 2004). Water turning to ice caused sea level to drop around the globe.

Submarine canyons are found on all the continental shelves of the world. At the peak of the Pleistocene Ice Age, most continental shelves were subaerially exposed and underwent erosion when global eustatic sea level was ~120 m below its present position. Rivers incised valleys across what is today the continental shelf. The delivery of sediments to the shelf break during sea level low-stands provided a sediment source for down-slope turbidity flows and canyon incision (Harris and Whiteway 2011).

The Perth Canyon is an example of a submarine canyon located on the edge of the continental shelf, some 30 km offshore from Perth, Western Australia (Fig. 17). It is Australia's largest submarine canyon. It is roughly the length of the Grand Canyon, but twice as deep (reaching depths of 4 km below sea level) (Trotter et al. 2019).

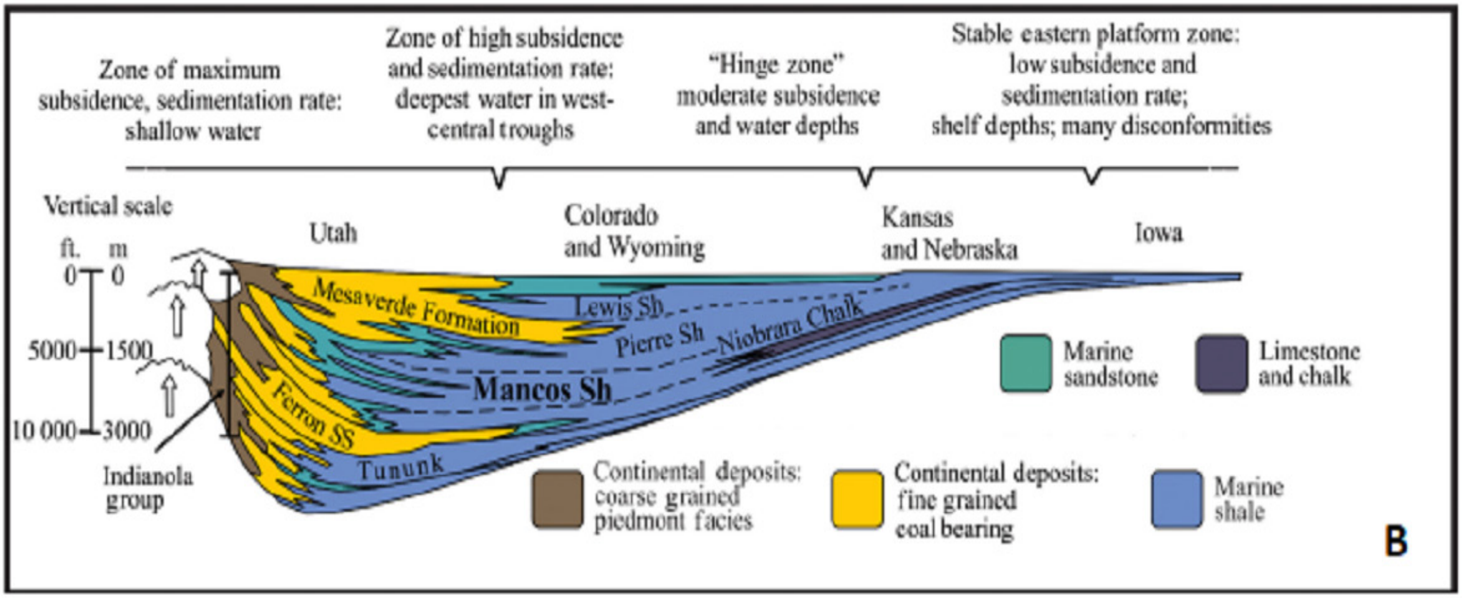


Figure 16. Western Interior Seaway, North America

A. Generalized map of the Western Interior Seaway during the maximum marine transgression of the Late Cretaceous (Pang 1995). Facies indicate the transition from nearshore to deeper water.

B. Cross-section of the subsided Western Interior Basin between Utah and the mid-continent. Continental deposits were derived from runoff from the Cordillera in the west. Marine deposits are found further east (after Birgenheier et al. 2017).

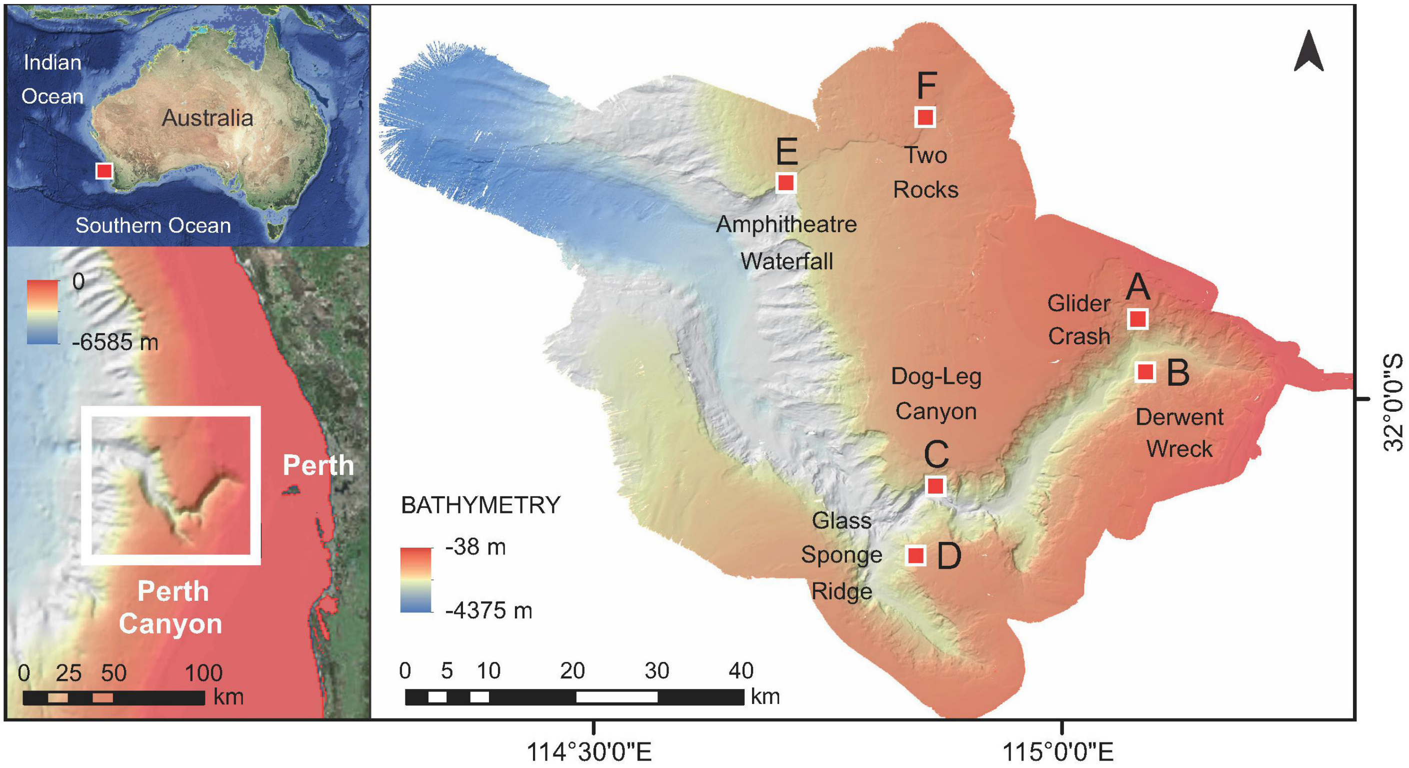


Figure 17. Satellite images of the location of the Perth Canyon and bathymetry map. Location of six ROV dive surveys (Sites A–F) are indicated (Trotter et al. 2019).

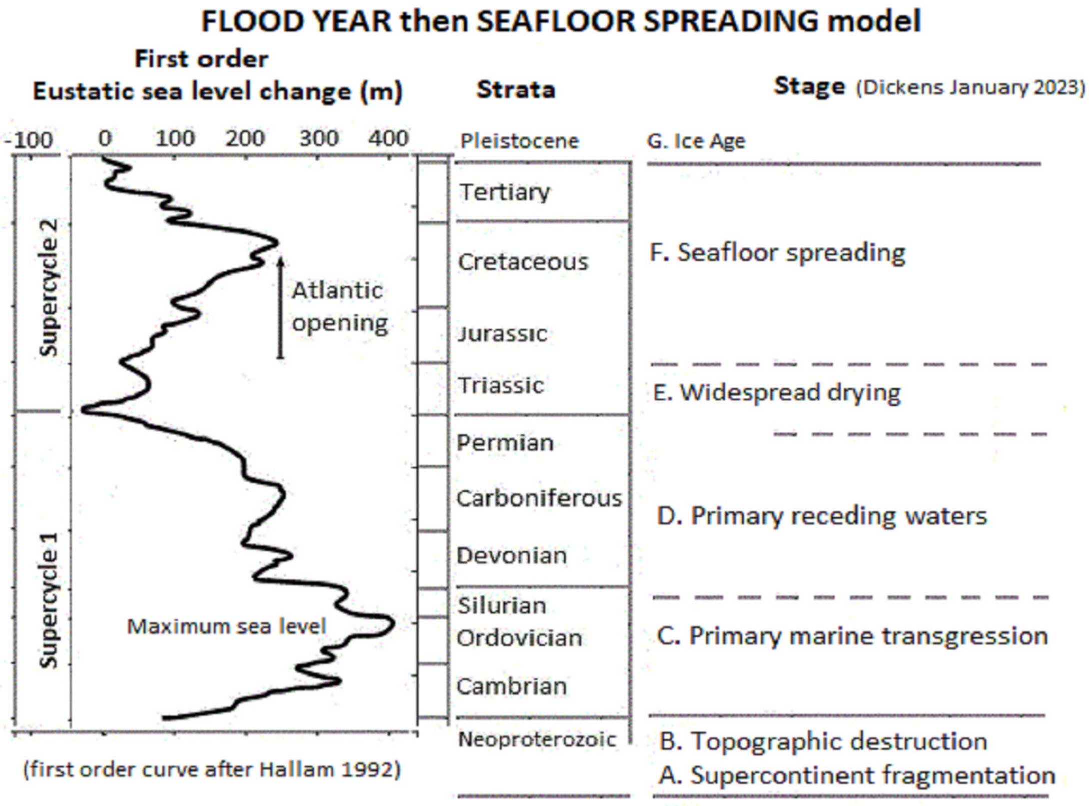


Figure 18. Stages (A to G) are inferred from scripture and are described sequentially in more detail in this paper. The stages in this figure are correlated to the first-order (global) sea level curve interpreted by Hallam 1992.

Figure 17. Satellite images of the location of the Perth Canyon and bathymetry map. Location of six ROV dive surveys (Sites A–F) are indicated (Trotter et al. 2019).

IV. DISCUSSION

I consider that almost the entire Neoproterozoic and Phanerozoic geologic record can be correlated with Noah's Flood and its aftermath. From the historical account in the book of Genesis, successive stages relating to Noah's Flood and its aftermath can be inferred (Fig. 18). The Flood Year account has specific processes including fountains bursting forth, 40 days and nights of rain, marine transgression, marine regression and drying. A portion of, but not the entire, Flood Year had a globe-covering ocean. Tectonic upheavals would have taken place during the Flood Year and its aftermath with erosion, sedimentary deposition and volcanic processes taking place. Megasequences are considered to reflect regional tectonism (Appendix C). The discussion section provides details of a proposed successive history model, which includes the receding waters of Noah's Flood and seafloor spreading. A summary of the model is provided in Appendix D.

Two first order global sea level cycles or supercycles can be seen in the sea level curve. They are associated with supercontinent fragmentation. I infer that:

1. Supercycle One correlates with Noahic Flood waters rising and falling. In this curve, the Ordovician is the highest sea level and I correlate this with globe-covering water at the peak of Noah's Flood.
2. Supercycle Two correlates with the subsequent time of seafloor spreading and opening up of the oceans now seen between today's continents. I infer that the Cretaceous high, relates to hot expanded mid-ocean ridges displacing water onto continents to form interior seaways, but not completely covering the continents.

Refer to Appendix B for more detail regarding sea level interpretation.

A. Initial supercontinent fragmentation

> *In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, on that day all the fountains of the great deep burst forth, and the windows of the heavens were opened.* (Genesis 7:11 ESV).

The Flood Year began with all the fountains of the great deep bursting forth. This is considered to have fragmented the supercontinent in the Neoproterozoic. As an example, evidence has been given indicating that the Darling Fault Zone is a region where the fountains of the great deep broke open and the continental crust of Australia and Greater India fragmented apart in the Neoproterozoic.

B. Stage of topographic destruction

> *And God said to Noah, "I have determined to make an end of all flesh, for the earth is filled with violence through them. Behold, I will <u>destroy</u> them with <u>the earth</u>.* (Genesis 6:13 ESV). [Underlining added for emphasis]
>
> *For in seven days, I will send <u>rain</u> on the earth forty days and forty nights, and every living thing that I have made I will <u>blot out</u> from the face of the ground."* (Genesis 7:4 ESV). [Underlining added for emphasis]
>
> *and they were unaware until the flood came and swept them all away, so will be the coming of the Son of Man* (Matthew 24:39).

The Great Unconformity on hard crystalline basement rocks in North America and other continents (Dickens 2016; Dickens 2018) is testimony to powerful continental denudation and the destruction of the pre-Flood world's topography due to enormous and globally extensive rain. The Great Unconformity at the Grand Canyon demonstrates that even granite and schist were eroded down kilometers (Karlstrom et al. 2021; McDannell et al. 2021) and peneplaned. This indicates catastrophic erosive destruction of pre-Flood land biomes with their terrestrial vertebrates. The long-held model of gradual destruction of ecological zones by the rising waters of Noah's Flood, known as the ecological zonation model (Clark 1946) is not consistent with extremely deep and powerful catastrophic erosion.

Stratigraphic and chemical evidence from the Precambrian-Cambrian transition demonstrates that the judgement of Noah's Flood was extremely severe. Worldwide, Cryogenian diamictites indicate great mass flows (Oard 1997). Silicon isotope studies point to waters that were saturated in silicon by the end of the Neoproterozoic (Gao et al. 2020), consistent with unprecedented continental erosion. The overall Neoproterozoic to Mid-Cambrian trend of increasing $^{87}Sr/^{86}Sr$ ratio is also consistent with continental denudation (Peters and Gaines 2012). This colossal global erosion may explain why no human skeletons have been recognised in Flood rocks. It is suggested that Neoproterozoic erosive slurries were exceedingly powerful and people caught in them were not fossilized, but abraded away (Dickens and Hutchison 2021a). This may also explain the lack of other terrestrial vertebrate fossils, such as dinosaurs, in Neoproterozoic to Paleozoic strata.

> *The voice of the Lord breaks the cedars; the Lord breaks the cedars of Lebanon.*
>
> *He makes Lebanon to skip like a calf, and Sirion like a young wild ox.*
>
> *The voice of the Lord flashes forth flames of fire.*
>
> *The voice of the Lord shakes the wilderness; the Lord shakes the wilderness of Kadesh.*
>
> *The voice of the Lord makes the deer give birth and strips the forests bare, and in his temple all cry, "Glory!"*
>
> *The Lord sits enthroned over the flood; the Lord sits enthroned as king forever* (Psalm 29:5-10 ESV).

Mention of the mabbul or early Flood (Boyd 2016) is also made in Psalm 29. Violent processes described include breaking of trees, forests stripped bare, earth shaking, and fire. I associate the origin of the early massive coal measures with the mabbul. In other words, the Paleozoic coal measures (Carboniferous-Permian) were derived from land vegetation stripped off the pre-Flood supercontinent by the action of enormous erosive currents generated by massive and geographically extensive rain, earth shaking, and volcanic-related fountains activity. Trees being of relatively low density (Chaturvedi et al. 2013) would have had a tendency to float near the surface of the waters during the global marine transgression. Streams flowing down hillsides and filled with floating timber are known in today's world (Chaithong et al. 2018). While the continent was being eroded, the level of the adjacent sea began to rise, until eventually the land was completely covered by water.

C. Marine transgression stage

> *The flood continued forty days on the earth. The waters increased and bore up the ark, and it rose high above the earth. The waters prevailed and increased greatly on the earth, and the ark floated on the face of the waters* (Genesis 7:17-18 ESV).

There are no significant coal measures before the Late Paleozoic. This is consistent with floating vegetation during the marine transgression stage and later coming to ground and being buried with sediment in the receding waters stage. Paleozoic epicontinental seas are characterised by shallow water depth (only tens of meters), wide range (extending hundreds to thousands of kilometers) and very gentle seabed slope (less than 0.01^o) (Hallam 1981; Zhang and Mi 2021). This is consistent with sedimentary deposition on land that was peneplaned early in the Flood Year.

D. Receding waters stage

> *The fountains of the deep and the windows of the heavens were closed, the rain from the heavens was restrained, and the waters receded from the earth continually. At the end of 150 days the waters had abated, and in the seventh month, on the seventeenth day of the month, the ark came to rest on the mountains of Ararat. And the waters continued to abate until the tenth month; in the tenth month, on the first day of the month, the tops of the mountains were seen* (Genesis 8:2-5 ESV).
>
> *The mountains rose, the valleys sank down to the place that you appointed for them* (Psalm 104:8 ESV).

1. Commencement

The receding and drying stages of the Flood Year took about 7 months (Genesis 8:1-11, Genesis 8:13-16). During these 7 months, land would have begun to appear and progressively increase in areal extent around the globe. There would be both marine and non-marine settings, rather than a globe-covering ocean. Non-marine depositional settings such as rivers and lakes would then have begun to appear on the supercontinent.

The primary marine regression phase of the Flood Year commenced after the Flood fountains stopped and the rain was restrained. Regional tectonism, such as subsidence and uplift, would have caused higher order sea level changes. Cooling, and thus subsidence, is inferred to have taken place after hydrothermal flows from the Flood fountains had ceased, with rift valleys and grabens forming in marine zones between supercontinent fragments (Fig. 1). Regional mountain building was also underway including the Acadian Orogeny, which is associated with early marine regression and the deposition of the Devonian Old Red Sandstone in the eastern United States and northwestern Europe (Prothero and Dott 2010).

The Mid-Carboniferous unconformity around the world is evidence that receding of Noahic Flood waters was proceeding on a global scale . Waters covering the Earth began to stream down into lower regions, especially rift and graben zones. For instance, the flow from Antarctica into the zone between Greater India and Western Australia (including what later became the Perth Basin half-graben).

2. Waxing and waning waters

> *And turn back do the waters from off the earth, going on and returning; and the waters are lacking at the end of a hundred and fifty days… and the waters have been going and becoming lacking till the tenth month; in the tenth [month], on the first of the month, appeared the heads of the mountains* (Genesis 8:3,5 YLT).

The description of waters going and returning in the receding waters stage of the Flood account provides a consistent explanation for Permo-Pennsylvanian cyclothems. There is no need to invoke sea level changes due to the waxing and waning of so-called "ice sheets." As previously mentioned, an absence of Gondwana cyclothems indicates that Gondwana "ice sheets" can be precluded as the sole cause of cyclothems (Isbell et al. 2003).

Gondwanan basin-fill successions show consistent three-fold stages of lowermost coarse-grained strata (represented by diamictites and poorly sorted conglomerates), overlain by shales that in turn are succeeded by shallow marine and commonly coal-bearing deltaic and fluvial sandstones (Fig. 4b). I infer that the three stages represent mass flow deposition, shales formed during subsidence and then coal-bearing strata formed as plants came to ground and were buried.

Within numerous basins of the southern hemisphere, there is a significant association in time and space of so-called "glacial retreat" ("deglaciation") margins with rifting sites marked by Carboniferous-Permian unconformities (Yeh and Shellnutt 2016). The sedimentology of the Perth Basin highlights the key part so-called "glacial melt waters" have in transporting coarse- and fine-grained clastic sediment to marine basins (Eyles et al. 2006). I infer that these waters were receding waters of the Flood Year, rather than "glacial melt waters".

3. Late Paleozoic mass flows

Instead of a Late Paleozoic "Ice Age," features such as diamictites, striated basement and so on are inferred to represent processes associated with energetically receding Flood waters.

Strata of the so-called Late Paleozoic "Ice Age" (LPIA) represent one of the best-researched intervals of Earth's history. However, unresolved issues remain. For instance, determining the climatic forcings that shaped 'glacial-deglacial' dynamics, accurately estimating associated "ice volume" and eustatic sea level changes, the nature and role of the oceans in the LPIA, and understanding feedbacks between the atmosphere, ocean, cryosphere, and biosphere (Montanez and Poulsen 2013).

A biblical alternative to a glacial origin for Permo-Carboniferous diamictites and conglomerates is that they formed as subaqueous mass flows while receding water of Noah's Flood energetically streamed off the supercontinent, eroding and striating crystalline basement rocks. Water drained into areas of subsidence and downfaulting. Significant erosion produced numerous features reminiscent of glaciation yet were formed by submarine mass flows (Oard 1997).

4. Pre-Flood vegetation comes to ground

Huge volumes of floating vegetation that had been stripped off the land early in the Flood Year would now have flowed down onto newly emerging land. With this primary regression of the Flood Year, these land plants flowed into lower-lying areas such as foreland basins or grabens of downwarped cratonic basins (Dai et al. 2020). Some vegetation that came to ground, dried and caught fire (Jasper et

Figure 19. An image to depict the waters flowing back into Flood fountain sites as described in this paper's model (figure after Dunkin 2022).

al. 2021). Downfaulting and further burial would enable the formation of significant Carboniferous and Permian coal measures.

The remarkable distribution of *Glossopteris* leaves in Permian terrestrial deposits across the Gondwanan continents was central to early arguments that these regions were once united in a vast supercontinent which later fragmented and drifted apart (McLoughlin 2017).

Permian coal measures found in grabens of the Collie Basin (Fig. 9) have been associated with fluvial sediments (Lowry 1976). However, from the well-layered nature of the coal seams enormous and widespread sheet flows are more likely to have taken place as Flood Year waters were streaming off the continent. The lack of seatearths and fossil roots (Lord 1952) also provide evidence that the coal seams were transported into place, rather than formed in an in situ disordered situation such as a swamp. Features found in swamps such as stumps, tree roots and fallen logs are not present.

5. Transport of "missing" Permian sediments

Permian sediments currently found in basins such as the Perth Basin may have covered a significantly greater area than their adjacent craton. Receding waters of Noah's Flood have been inferred to have eroded these sediments (Walker 2012). The previously mentioned evidence for significant erosion, raises the question of the eventual depositional site for these volumes of detritus (Sircombe and Freeman 1999). It is important to note that to date there is no known evidence of where the huge volume of sediment that was eroded went. I infer that the missing detritus may have flowed into fountain rift and graben sites (Fig. 19).

Today's erosional processes do not carve extensive and wide valleys into basement. Different processes must be responsible—catastrophic processes. Therefore, it is reasonable to conclude that receding floodwaters carved such wide valleys (Figs. 5 and 6) on the Yilgarn and other Gondwanan cratons.-

6. Permian accelerated sea level fall

Paleogeography and the distribution of marine invertebrate fossils suggests a significant global sea level fall in the Late Permian. The Late Permian marine regression and resultant erosion has been inferred in numerous locations around the world (Dong 2021). This includes China (Dong 2021), Canadian Arctica (Thorsteinsson 1974), Oman (Hauser et al. 2000), along with Norway and North America (Hallam and Wignall 1999). The end Permian has been inferred to have had the lowest sea level of the Paleozoic and even of the entire Phanerozoic (Golonka and Kiessling 2002; Hallam 1992; Haq and Schutter 2008) (Fig. 18). I correlate this global marine regression with the acceleration of the receding water stage of Noah's Flood.

Marine habitat loss, caused by the Late Permian global regression, has been invoked as a likely cause of the End Permian mass extinction of marine invertebrates (Erwin 1990; Hallam and Wignall 1999). This regressive event resulted in dramatic shrinkage of shallow seas as indicated by few complete marine sections known to range from the Middle Permian into the overlying Late Permian in most regions of the world (Chen et al. 2009; Ross and Ross 1994). At the end of the Paleozoic, the size of the landmass above sea level has been inferred to be 110–120% compared with the present-day landmass due to a worldwide regression (Valentine and Moores 1970).

A model has been described of return flow of seawater into the mantle resulting in hydration of the mantle, rapid sea level drop and appearance of large landmasses. The introduction of seawater into the mantle would have drastically lowered the melting temperature and viscosity of mantle materials, both of which would have activated plate tectonic processes (Maruyama and Liou 2005). Such a scenario fits well with the proposed model of receding Noahic Flood waters leading to seafloor spreading.

7. New plant growth

Noah's ark came to rest on the mountains of Ararat (Genesis 8:4) and initially only the tops of mountains were seen there (Genesis 8:5). Noah subsequently sent out a raven, and then a dove, to see if the waters had subsided from the face of the ground (Genesis 8:7-10). The second occasion the dove brought back a freshly plucked olive leaf so Noah knew that the waters had subsided from the earth (Genesis 8:11). Thus, the restoration of terrestrial plant growth was underway including pioneer species once new land emerged subsequent to the devastation caused by the mabbul.

E. Widespread drying

> *In the six hundred and first year, in the first month, the first day of the month, the waters were dried from off the earth. And Noah removed the covering of the ark and looked, and behold, the face of the ground was dry. In the second month, on the twenty-seventh day of the month, the earth had dried out.*
>
> *Then God said to Noah, "Go out from the ark, you and your wife, and your sons and your sons' wives with you"* (Genesis 8:13-16 ESV).

Devonian redbeds are found on the continental sides of today's North Atlantic region and are associated with uplift and subaerial exposure due to regional mountain building (Prothero and Dott 2010). In contrast, Triassic red beds are much more extensively distributed around the world. This includes South Africa, India, Australia, Antarctica

(Fig. 8), South America, western Europe, southwestern US, maritime Canada, China and northwestern Africa (Ford and Golonka 2003; Zharkov and Chumakov 2001).

Extensively documented in the geoscientific literature is the view that there was a time of drying from at least the later Permian and Triassic, particularly in continental interior locations. This is attested by lithological, fluvial, geochemical, and coal flora evidence as described earlier in this paper.

It is an intriguing fact that worldwide no coal seam has yet been discovered in Early Triassic strata (hence the term "Coal Gap") (Fig. 7) and coal seams in Middle Triassic strata are scarce and thin. This Coal Gap began with the last appearance of coal-forming plants at the end of the Permian, with no coal known anywhere until Middle Triassic strata. Permian levels of plant diversity and coal thickness do not reemerge until Late Triassic strata (Retallack et al. 1996).

The reason for the Early Triassic "Coal Gap" is a mystery to secular geoscientists. However, I believe that the Noahic Flood account can solve this mystery. As the earth dried late in the Flood Year there was a period of time before significant new vegetation (dominated by plants better suited to drier conditions) could grow and later be buried to form extensive new post-Paleozoic coal measures. Noah saw when the face of the ground was dry (Genesis 8:13), but waited a further 8 weeks (Genesis 8:14) to confirm that the earth had dried out before God gave the command to exit the ark (Genesis 8:16). This may have been to allow sufficient vegetation to sprout up that could feed the animals exiting the Ark on an ongoing basis (Warren Johns pers. comm.).

Late Permian Siberian Traps continental flood basalt volcanism and associated coal fusinite provide evidence for dry land and fires.

F. Seafloor spreading stage

1. Returning waters lower mantle silicates melting temperature

I consider it very significant that the end Permian major sea level fall (Hallam 1992) and Triassic drying coincided with the initial rifting of Pangea in the Early Triassic (Muller et al. 2019).

Significant volumes of water are inferred to have returned to within

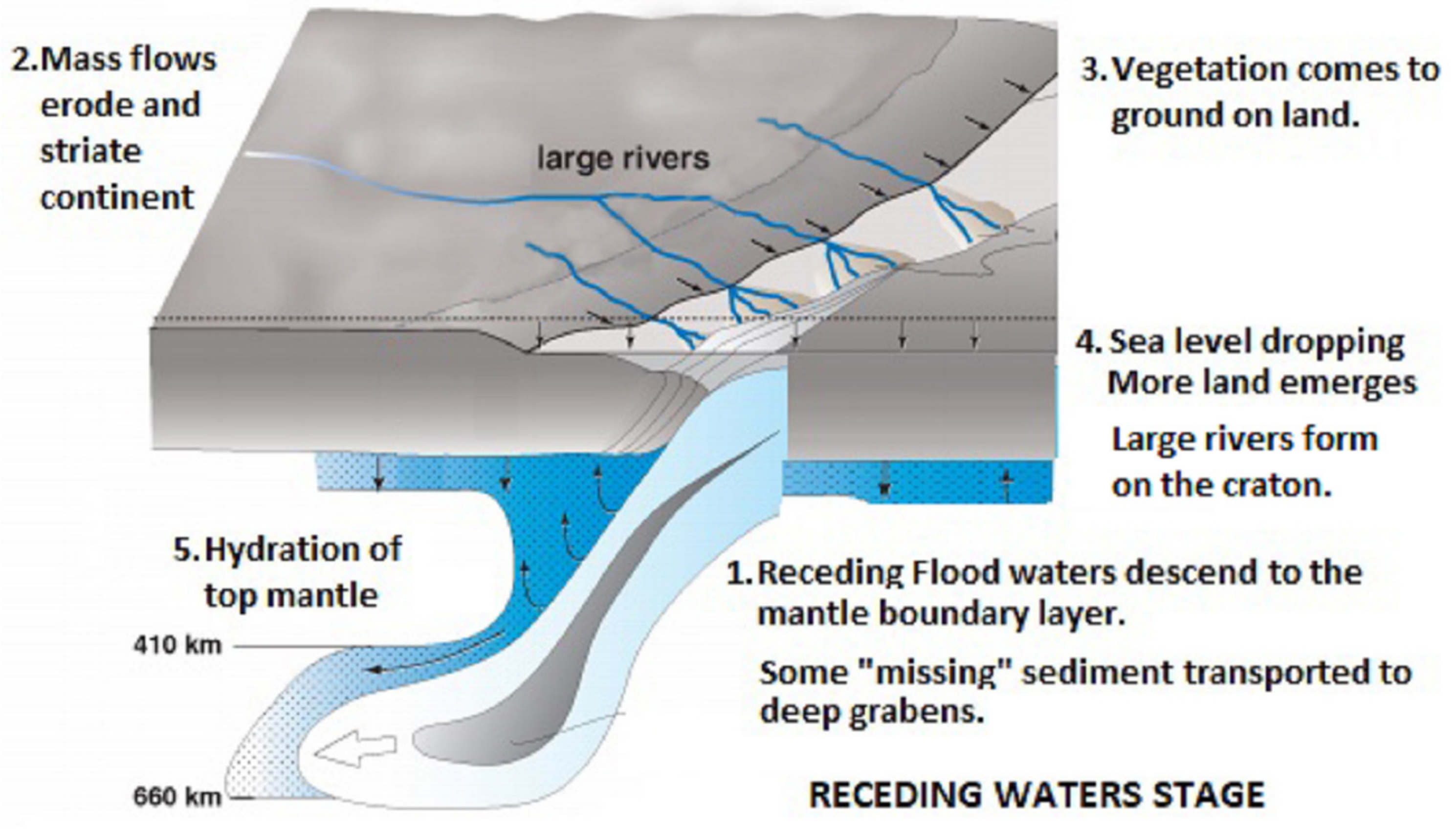


Figure 20. Schematic model diagram showing inferred effects on a fragmented continental margin of the receding waters stage of Noah's Flood (figure modified from Maruyama and Liou 2005).

1. Waters drain from continents and transport continental clastics towards offshore grabens in fragmentation zones formed after the fountains of the great deep closed. Waters descend to the mantle boundary layer. Some "missing" sediments transported to deep graben zones.
2. Mid-Carboniferous to Early Permian – Marine regression. Surface of continental basement rocks striated and mass flows form especially adjacent to the continental margin (not an Ice Age).
3. Late Paleozoic—Pre-Flood vegetation comes to ground on the continent, downfaulted and buried to subsequently form coal measures.
4. Late Permian – Sea level drop accelerates and more land emerges. Large rivers with wide valleys form on cratons.
5. Triassic – Area of drying on continental surface extends.
   Accumulated returning waters hydrate the mantle boundary layer (410-660 km) forming dense hydrous silicates and lowering the viscosity. Magmas were generated by lowering the melting temperature of silicates in the mantle. Hydration softened and weakened rocks, thereby lowering the internal friction of rocks and enhancing mantle convection. Pangea rifting was underway.

the Earth, especially in the vicinity of Flood fountain zones where the supercontinent fragmented. The buildup of water returning to within the Earth would subsequently have lowered the melting temperature and viscosity of mantle silicates. Thus, mantle convection was enhanced, enabling seafloor spreading to get underway. I infer that seafloor spreading is a consequence of the Flood Year's receding waters.

Fluid flow into fault zones alters their permeability and may aid episodic earthquake activity by promoting the generation of high pore fluid pressures and facilitating the formation of weak secondary minerals (Menzies et al. 2016). Thus, receding waters of Noah's Flood flowing into deep opened fractures in fountain zones (graben zones between continental fragments) could enable reactivation of rifting, culminating in seafloor spreading.

Minerals, such as ringwoodite, in the mantle boundary layer (at 410–660 km) could store about five times greater water than the total volume of seawater on the present-day Earth's surface (Maruyama and Liou 2005) (Fig. 20).

It has been proposed that supercontinents break up and migrate away from sites of mantle upwelling (geoid highs) (Gurnis 1988). Thus, rifted continental fragments of Gondwana would have been carried away from the Antarctic palaeo-upland (Fig. 3) as seafloor spread apart, enabled by a hydrated mantle boundary layer. When the modern geoid is plotted over the position of the continents and plate boundaries during the Mesozoic, the geoidal low corresponds in position to the circum-Pacific subduction zones (Chase and Sprowl 1983).

2. Post-Paleozoic continental tectonism and coal formation

Mesozoic and Tertiary coals are found in much more diverse tectonic and sedimentary environments than Paleozoic coals (Bois et al. 1982; Dai et al. 2020; Fig. 14). Most Paleozoic hydrocarbon reservoir rocks were deposited in platform basins of gentle gradient and with relatively lower sedimentation rates. Paleozoic epicontinental seas were shallow and their gently sloping seabed was consistent with erosive peneplanation of pre-Flood topography (Dickens 2022). In contrast, Tertiary hydrocarbon reservoirs are found in tectonically active margins and rapidly subsiding basins (Bois et al. 1982).

Significant Mesozoic and Tertiary coal measures and thick sedimentary sequences formed during a time of continental mountain building and regional burial episodes on active continental margins when the opening of today's oceans by way of seafloor spreading was underway. Plants better suited to a drier land environment grew and became dominant compared with plants that have specialised tissues for conducting water (Fig. 7). Plants were transported by runoff from tectonically active mountain areas and buried in near coastal environments (such as adjacent to North America's Cretaceous Western Interior Seaway) and in lakes (for example, in China). This plant matter subsequently formed coal measures.

3. Seaways on continents

> *The mountains rose, the valleys sank down to the place that you appointed for them. You set a boundary that they may not pass, so that they might not again cover the earth* (Psalm 104:8-9 ESV).

The Jurassic Sundance Seaway of the North American Cordillera is an example of a site of subsidence associated in time with adjacent non-marine mountain building. Jurassic and Cretaceous seaways may have been extensive, but the surface of the earth was not completely covered with water by this time. Such seaways were commonly bounded by mountains on active continental margins.

4. Generally quiescent tectonism on passive margins

Passive margins increased as Pangea progressively broke up. A passive margin is one formed by rifting followed by seafloor spreading. Present-day passive margins are found around the world and have an aggregate length of 105,000 km, even longer than the spreading ridges (65,000 km) (Bradley 2008). An example is shown in Fig. 12 where post-breakup passive margin sediments show little deformation and are inferred to have been relatively quiescent tectonically (Olierook et al. 2016).

The average speed of opening of the Atlantic Ocean may be used as an example to illustrate that the ocean opening rate may have been consistent with quiescent tectonism. Using the Atlantic Ocean width of 1600 km and 40 days as a minimum duration, then the average speed of opening is less than 2 km/hour) (Appendix A). Such an average rate would not be expected to be a hindrance to migration of people and animals after the exit from Noah's Ark.

5. A Bible verse consistent with extensional geotectonics

> *To Eber were born two sons: the name of the one was Peleg, for in his days the earth was divided, and his brother's name was Joktan* (Genesis 10:25 and 1 Chronicles 1:19 ESV).

Henry M. Morris in his 1984 book *The Biblical Basis for Modern Science* indicated that since the word for "divided", used in connection with the division of languages (Hebrew *parad*), was different from that used in the days of Peleg (Hebrew *palag*) when the earth was divided (Genesis 10:25), there existed the possibility that two different dividings were in view, one being that of the nations, the other a physical division of the continents. Peleg was born about a century after Noah's Flood and lived to the age of 239. A Hebrew scholar concluded from detailed linguistic data that Genesis 10:25 referred to a division of the landmass by water in a post-Flood biblical catastrophe (Northrup 1979, 2004).

Such linguistic evidence is consistent with the proposal that continental rifting and related movements occurred shortly after the actual year of Noah's Flood (but as a consequence of the receding waters of the Flood Year). This would fit well the model in this paper of a Triassic drying and end-Flood scenario, since continental rifting to initiation of drift really got underway then (Kocsis and Scotese 2021) (Fig. 11).

The verses describing Earth division taking place during the days of Peleg, are consistent with Pangea's breakup and seafloor spreading having taken place over a period of time and possibly even during the approximately two centuries of Peleg's life.

G. Pleistocene Ice Age

> *From whose womb did the ice come forth, and who has given birth to the frost of heaven?* (Job 38:29 ESV).

Seafloor spreading was associated with basaltic volcanism and heated oceanic water. Strong oceanic evaporation and volcanic aerosols were then factors in reducing temperatures and bringing on the Pleistocene Ice Age (Oard 1987). The ice dropped the sea level and submarine canyons were formed.

CONCLUSION

Records in the book of Genesis have time-markers and particular successive historical stages can be recognized. From the geological record, historical stages can also be recognized. The challenge is how to correlate the two records. Regional geology and case studies were described. A biblical young earth history model was then developed in a successive stage-by-stage manner. Specific geological evidence ("ground truthing") derived from an extensive literature search, has been used to infer processes in historical order. This included the destruction of pre-Flood topography, global marine transgression, receding and drying phases, along with consequences in the Flood Year's aftermath. Almost the entire Neoproterozoic and Phanerozoic record is considered to have been impacted by Noah's Flood and its aftermath.

The model presented here provides a mechanism for the initiation of seafloor spreading and plate tectonics within a young earth biblical framework. There is a remarkable temporal coincidence between the sea level low at the end Permian, significant continental drying in the Triassic and the beginning of supercontinent breakup. I propose that the receding waters of Noah's Flood returned to Flood fountain sites and reached the top of the mantle. Hydration by seawater lowered the silicate melting temperature and viscosity at the top of the mantle. That process enhanced mantle convection enabling Gondwana to rift further and seafloor spreading to take place. Waters streaming from an Antarctica highland into zones where Flood fountains had previously been active enabled Gondwana to drift apart. Passive margin sediments show little deformation. Thus, in a biblical timeframe, passive margin sediments formed relatively fast during seafloor spreading, but their deformation was not catastrophic. However, on active (collisional) margins, new mountains formed.

This paper proposes a biblical framework which may successively explain in time order the origin of a number of geological features. These features include the major Mid-Carboniferous unconformity, the so-called Late Paleozoic "Ice Age", Late Paleozoic coal measures, the Coal Gap; plant types through time, cyclothems, Permian paleodrainage and missing sediments, indicators of aridity in some Triassic strata, and the Mesozoic commencement of seafloor spreading along with associated passive margins.

The Bible's record of the drying stage of Noah's Flood, in the context of successive stages, has received little attention in young earth creationist literature. It is hoped that newly presented geoscientific information will help fill a missing gap in Flood Year models and encourage further discussion, especially regarding which strata represent the end-Flood period. The successive stages (not neglecting the drying stage) merit further investigation and correlation with the regional geology of specific provinces of the globe.A scriptural and young Earth geological event sequence was developed using regional geology case studies derived from an extensive literature search. This new young earth creationist geohistory model, incorporating seafloor spreading as a consequence of receding Noah's Flood waters, is summarized in Appendix D.

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THE AUTHOR

Harry Dickens (pseudonym) works as a senior geologist for a basin studies group in a Geological Survey in Australia. He has had a keen interest in geology for over 50 years and has more than 35 years' professional experience in petroleum and mineral exploration. His qualifications are in geology, geophysics and gemmology. He has delivered presentations in North America, Asia, UK and around Australia. Harry has written YEC papers on rapid petroleum formation, Precambrian geology and the Bible (including banded iron formations), as well as the geochemical and erosional effects of Noah's Flood. He presented at the 2018 ICC in Pittsburgh.

APPENDIX A

SOME SCENARIOS FOR THE SPEED OF OPENING OF THE ATLANTIC OCEAN

Approximate maximum width of today's Atlantic Ocean is 1,600 km or 990 miles.

			Approximate average rate of opening		
	Duration	Hours	km/hr	mph	m/sec
	40 days	960	1.67	1.03	0.46
	150 days	3600	0.44	0.28	0.12
Year of Flood	1 year	8760	0.18	0.11	0.05
	100 years	876600	0.0018	0.0011	0.0005
Life of Peleg	239 years	2095074	0.0008	0.0005	0.0002

All these average rates are less than average walking pace and apparently not catastrophic. However, rates may not have been smoothly uniform but could have been episodic in parts.

APPENDIX B

SEA LEVEL INTERPRETATION

Exxon geologists Peter Vail and others estimated sea level changes using interpretation of seismic sections to determine the extent of coastal onlap evident from strata in sedimentary basins around the world (Vail et al. 1977). Their motivation was commercial – to aid in the finding of oil and gas. Their approach gave clues as to the subsurface location of petroleum system elements, such as hydrocarbon source rocks and reservoir rocks.

Sea level interpretation by British geologist and palaeontologist Professor Anthony Hallam is based not just on seismic stratigraphy, but also on numerous additional techniques. These techniques include paleogeographic mapping and hypsometry, depth-related invertebrate and algal groups, glauconite concentration, phosphorites, oolitic ironstones, oceanic anoxia, seawater strontium ratio and facies correlation. Times of sea level rise over land are marked by an excess of carbonates over siliclastics (Hallam 1992). At the 2018 International Conference on Creationism, Hallam's petrographic description of aeolian sandstone (Hallam's 1981 book Facies interpretation and the stratigraphic record) was used to indicate that the Permian Coconino Sandstone was not aeolian (Borsch et al. 2018).

To estimate depth of sea level, Hallam used regional scale observations from exposed geologic sections, including sedimentary facies and fossils (along with estimates of the areas of flooded continental interiors). Hallam has used a wide range of specific depth indicators.

These include distribution of major fossilizable invertebrate and algal groups; marginal marine environments characterized by reduced diversity compared with fully marine environments; interpretation of continental and marginal marine environments and facies (alluvial, aeolian, lacustrine, glacial, deltaic and coastal plain deposits); recent phosphorites occurrence at depths of a few hundred metres within 40^0 of the equator; evaporite-bearing continental red beds; continuous pelagic deposition and widespread marine anoxicity; and heavier carbon-isotope values in marine calcareous organisms and organic matter (Hallam 1992).

Hallam's highest first-order sea level peak is in the Ordovician. This is consistent with the peak in marine carbonate dominance that occurs during the Great American Carbonate Bank and is unrivalled in the Phanerozoic of North America. More than 80% of the sedimentary rock packages in the Late Cambrian and Early Ordovician there are marine carbonates.

The second-highest first-order sea level peak of the Phanerozoic is inferred to be in the Cretaceous. This is consistent with the Cretaceous being a time of flooding of low-lying parts of stable cratonic areas of the world, but not completely covering the continents. This was during a time of seafloor spreading, with hot expanded mid-ocean ridges displacing water onto land to form interior seaways such as the Western Interior Seaway in North America, the Eromanga Sea in Australia, trans-Asian and trans-African interior seaways.

At the Paleozoic-Mesozoic boundary a marked first-order sea level low is inferred. This is consistent with a great volume of literature providing evidence for a time of widespread drying from at least the later Permian and Triassic, particularly in continental interior locations.

I use the terms primary (or first order) receding waters and primary (or first order) marine transgression. This is because the first order global sea level curve may be overprinted by less areally extensive tectonic effects in various regional areas giving secondary and higher order, higher frequency sea level changes. Higher order cycles of sea level may relate to more regional or local causes including orogenic (mountain building) and tectonic events (uplift, downwarp and thrusting), basin filling as sediments were eroded from uplifts, timing and rates of plate motions, mid-oceanic ridge growth rates and subsidence of mid-ocean ridges. Laterally-extensive sandstone beds in the late Paleozoic and Mesozoic of North America can be related to energetic runoff as mountains were built during the Late Paleozoic Sonoma Orogeny and Alleghanian Orogeny, and Mesozoic rifting of Atlantic Ocean and Cordilleran orogenies (Dickinson et al. 1983). Each of today's continents may have had distinctive regional tectonism and associated higher order sea level changes. The Early Devonian regional marine regression of eastern North America and Europe is an example of a higher order sea level change associated with the Acadian orogeny.

Smaller unconformity-bounded units include Carboniferous "cyclothems" which have been referred to as fourth-order sea level cycles (Ross and Ross 1987).

APPENDIX C

MEGASEQUENCES REFLECT REGIONAL TECTONISM

I commend Dr Tim Clarey and co-workers for gathering the data of the dimensions, especially volumes (from mapped areal extents and thicknesses), of the megasequences around the world. However, I respectfully disagree with the assertion that the lateral extent, volume, and thickness of the megasequences may indicate the height of sea level (Clarey and Werner 2018).

Regional tectonism and higher sedimentary volumes

I believe that regional tectonism (along with non-marine versus marine indicators of the formations themselves) needs to be taken into account. The greater dimensions, especially of the later three megasequences, are associated with times of greater regional tectonism at a time of seafloor spreading, together with mountain-building on active continental margins. With greater topographic relief due to tectonism (such as mountain-building), and with rain, the more the erosive runoff and the greater volume and thickness of sediment deposited. Key examples follow (consistent with Fig. 21):

Africa – From the Jurassic onwards (Zuni and Tejas megasequences), Gondwana rifted resulting in the African plate as we now know it, with most tectonic activity controlled by extension and hotspot activity (Dirks et al. 2003). To a first approximation, Africa has experienced a single, long-duration cycle of erosion since the start of the Jurassic (Burke and Gunnell 2008).

South America – From the Jurassic (Zuni and Tejas megasequences) tectonic activity was caused by the breakup of Gondwana. Intracratonic basins received lithic fill derived from recently formed reliefs (mountain building such as the Andes) (Mabesoon et al. 1981).

North America – From the Jurassic (start of Zuni megasequence), Pangea breakup was underway (including opening of the Atlantic Ocean) along with Cordilleran mountain building (Dickinson 2004). Marine carbonates dominated the first three megasequences (to the Mid-Carboniferous) but from Mid-Absaroka, clastics dominated (Peters 2006).

Note: Neoproterozoic sedimentary strata on the western margin of North America can be of the order of 10 km in thickness (Dickens and Hutchison 2021b). Such strata are a good indicator for the uniquely enormous erosion and peneplanation of the supercontinent, rather than an indicator of high sea level at that time.

Europe – This continent has a complex tectonic and sedimentary history. The Kaskasia megasequence is associated with the Variscan fold belt. The Absaroka megasequence is associated with the beginning of the splitting of Pangea and the formation of new rifts and their filling. Zuni and Tejas megasequences are associated with the transtensional zone between Europe and Africa since the Jurassic, when the Atlantic Ocean opened (Plant et al. 2005).

Asia – The first three megasequences (to Mid-Carboniferous) may represent shallow seas whereas the last three megasequences have high volume (Clarey 2022) at a time of continental drift and detritus runoff from continental mountains. Tejas has the highest volume due to runoff from the Himalayan mountains (Clarey 2022) which arose when India collided with Asia.

"Tectonic setting is the principal controlling factor of lithology, chemistry, and preservation of sediment accumulations in their depocenters, the sedimentary basins." (Veizer and Mackenzie 2014, p. 402).

The preservation of the sedimentary record is a function of tectonic setting, with sediments on continental crust surviving back into the Precambrian, while the continuous record of passive margin sedi-

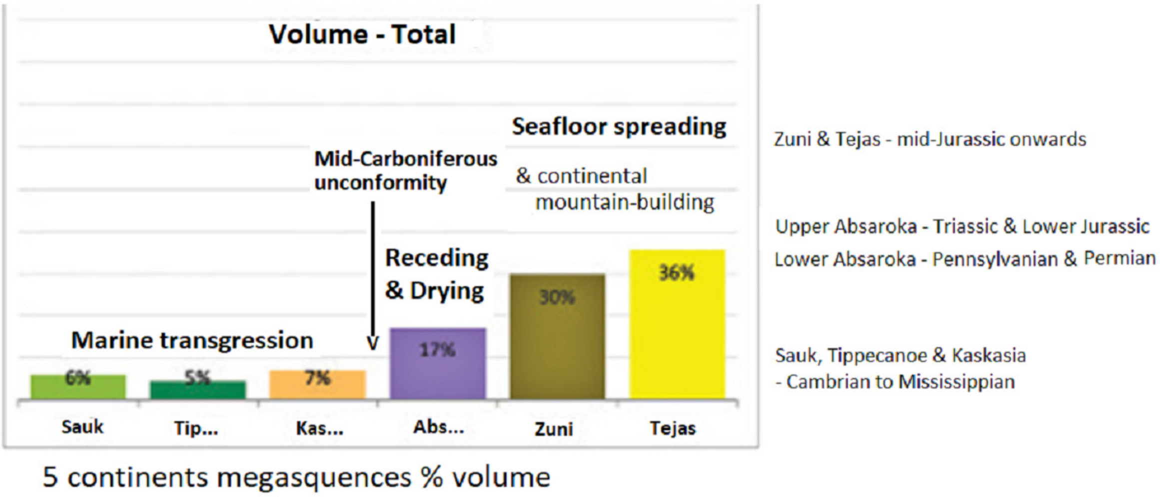

Figure 21. Graph of the percent volume for each megasequence across five of the world's continents. Maps and graphs show that Asia follows the same general patterns as North and South America, Africa, and Europe (Clarey 2022). Inferred key stages in Noah's Flood and its aftermath have been added, along with the stratigraphic range of grouped megasequences.

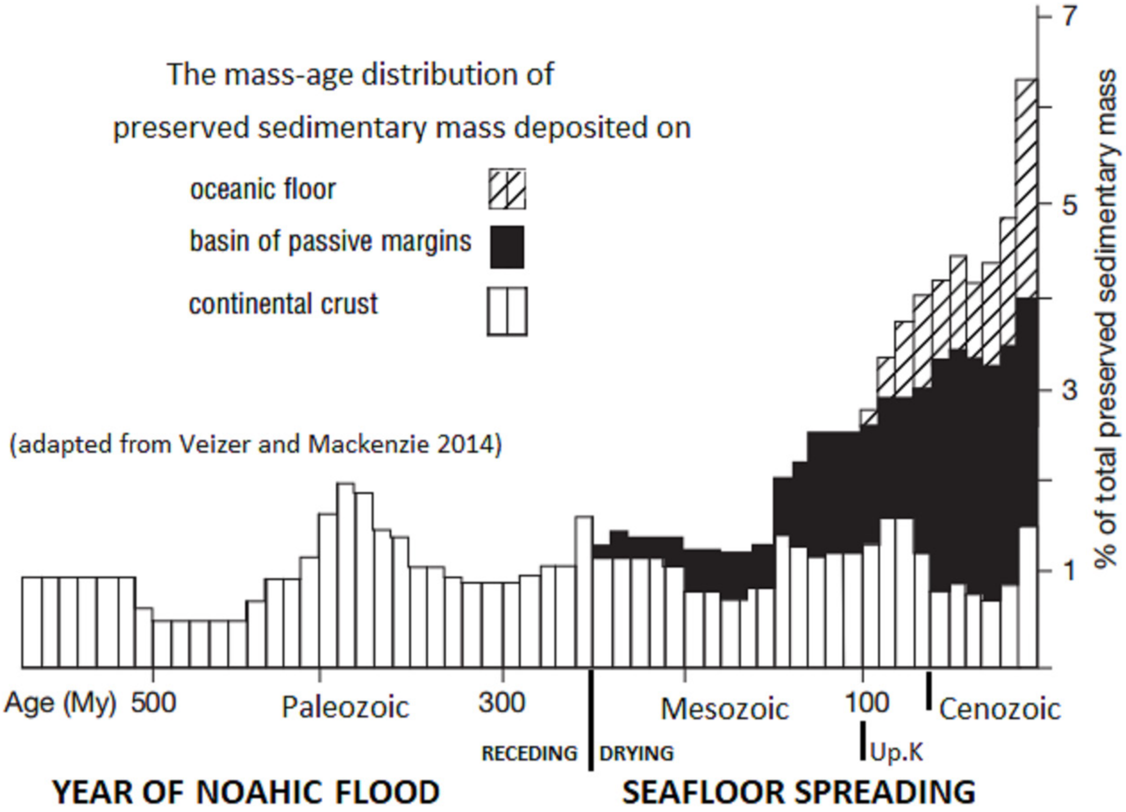

Figure 22. The mass-age distribution of preserved sedimentary mass for the Phanerozoic (graph after Veizer and Mackenzie 2014), with inferred receding Noah's Flood waters leading to seafloor spreading.

ments begins at 250 My ago (Triassic) and that of the ocean floor sediments at 100 My ago (Mid-Cretaceous). During the time of seafloor spreading/continental drift significant mass was added on passive margins (seawards-tapering sedimentary wedges dissected by faults) as well as on the oceanic floor (Veizer and Mackenzie 2014) (Fig. 22).

I infer that the initial supercontinent fragmentation occurred in the Neoproterozoic, but the opening up of today's oceans was later—in the Mesozoic and Cenozoic.

Lower volumes with marine transgression

Lower volume of earlier megasequences (e.g. Sauk, Tippecanoe) as lower relief topography and less runoff during marine transgression (after the Neoproterozoic peneplanation, e.g. Great Unconformity).

During marine transgression, such as in the Cambrian, the coastline moves landwards and the marine area enlarges. With transgression over shorelines, sediments are commonly thin and there is a *reduced* sediment influx to basin (Cattaneo and Steel 2003).

Dickens and Hutchison (2021b) interpreted the drop in Late Cambrian and post-Cambrian $^{87}Sr/^{86}Sr$ ratio values to be caused by complete inundation of land surfaces and no longer direct continental erosional impact of rain on the land. Formerly the increase in the Neoproterozoic $^{87}Sr/^{86}Sr$ ratio was associated with global continental erosion (Peters and Gaines 2012).

Mid-Carboniferous (top-Kaskasia) unconformity

Around the world there is a Mid-Carboniferous unconformity (between marine Mississippian limestone and more non-marine Pennsylvanian strata) and this indicates marine regression (Saunders and Ramsbottom 1986). Mississippian Redwall Limestone in the Grand Canyon is notable for its karst features, including caves, and this is an indicator of rainwater on exposed limestone, and so also regression (receding sea level).

Drying indicators in Absaroka megasequence

Extensively documented in the geoscientific literature is the view that there was a time of drying indicated by at least the later Permian and particularly in Triassic strata, particularly in continental interior locations. Evidence has been described in this paper. However, these evidences appear to have been overlooked or discounted in the existing young earth creationist literature, perhaps due to differing end-Flood model biases.

APPENDIX D

A YOUNG EARTH CREATIONIST GEOHISTORY MODEL INCORPORATING SEAFLOOR SPREADING AS A CONSEQUENCE OF RECEDING NOAH'S FLOOD WATERS.

STAGE	PROCESSES	PRODUCTS (Geology)
Pleistocene. **G. Ice Age.**	Strong evaporation of heated oceanic waters, and volcanic aerosols, bring on continental ice sheets and lower sea level.	Submarine canyons on continental shelves.
Early Triassic to Tertiary. **F. Seafloor spreading.**	Seafloor spreading and opening up of today's oceans at a modest rate. Hot expanded mid-ocean ridges - water displaced onto continents to form seaways (not a globe-covering ocean). Mountain building on continents active margins and thick sedimentary sequences deposited from mainly non-marine detritus runoff. Burial episodes, fossilisation and new coal measures form.	Passive margin sediments (little deformation) above break-up unconformities on half-grabens. Interior seaway marine sediments on continents (eg Cretaceous Western Interior Basin). Low sulfur coals indicate freshwater. Triassic first appearance of terrestrial vertebrate fossils such as dinosaurs.
Triassic. **E. Widespread drying.**	Increased occurrence of non-marine environments. Water that receded into top mantle lowers silicate melting temperature and viscosity, enhancing mantle convection and enabling seafloor spreading to get underway.	Calcrete, gypsum, anhydrite, laterite, bauxite, red beds, lacustrine and alluvial deposits. Coal Gap then dominance of coal flora better suited to drier conditions. (Exit from ark).
Late Paleozoic. **D. Primary receding waters.**	Primary marine regression accelerates with energetic mass flows off continents (not a Late Paleozoic "Ice Age"). Pre-Flood vegetation comes to ground and buried in grabens. Sea level falls to the widespread End Permian low, reduction of shallow marine habitats and extinction of marine invertebrates. Fountains closed, cool. Subsidence and grabens form.	Worldwide Mid-Carboniferous unconformity. Diamictite (mass flow deposits) with overlying Carboniferous and Permian coal measures in grabens. Some non-marine deposition underway, such as river systems, lakes. Devonian redbeds in a regional area.
Early Paleozoic. **C. Marine transgression**.	Vegetation floats with rising waters. Ensuing maximum marine transgression onto continent. 40 days and night rain.	Global absence of Early Paleozoic coal measures. Marine sedimentary layers over peneplaned supercontinent (Great Unconformity).
Neoproterozoic. **B. Topographic destruction.**	Immense water flows and ferocious erosion and peneplanation of even hard crystalline basement rocks of the supercontinent. Mass flows. Vegetation stripped off the land. Thorough abrading of terrestrial vertebrates outside of the ark.	Cryogenian diamictites. Great Unconformity. Global absence of terrestrial vertebrate skeletal fossils such as dinosaurs in Paleozoic strata.
Neoproterozoic. **A. Supercontinent fragmentation.**	Flood fountains burst and water flows commence.	Regional hydrothermal zones e.g. Darling Fault Zone.