Geosciences **2013**, 3, 331-353; doi:10.3390/geosciences3020331

OPEN ACCESS

geosciences

ISSN 2076-3263

www.mdpi.com/journal/geosciences

Article

Geodynamic Reconstructions of the Australides—2: Mesozoic–Cainozoic

Christian Vérard and Gérard M. Stampfli *

Institute of Earth Science, University of Lausanne, Géopolis, Quartier Mouline, Lausanne CH–1015, Switzerland; E-Mail: xian_verard@hotmail.com

* Author to whom correspondence should be addressed; E-Mail: gerard.stampfli@unil.ch; Tel.: +41-21-692-4306; Fax: +41-21-692-4305.

Received: 23 March 2013; in revised form: 29 April 2013/ Accepted: 13 May 2013/ Published: 4 June 2013

Abstract: The present work, derived from a full global geodynamic reconstruction model over 600 Ma and based on a large database, focuses herein on the interaction between the Pacific, Australian and Antarctic plates since 200 Ma, and proposes integrated solutions for a coherent, physically consistent scenario. The evolution of the Australia–Antarctica–West Pacific plate system is dependent on the Gondwana fit chosen for the reconstruction. Our fit, as defined for the latest Triassic, implies an original scenario for the evolution of the region, in particular for the "early" opening history of the Tasman Sea. The interaction with the Pacific, moreover, is characterised by many magmatic arc migrations and ocean openings, which are stopped by arc–arc collision, arc–spreading axis collision, or arc–oceanic plateau collision, and subduction reversals. Mid-Pacific oceanic plateaus created in the model are much wider than they are on present-day maps, and although they were subducted to a large extent, they were able to stop subduction. We also suggest that adduction processes (*i.e.*, re-emergence of subducted material) may have played an important role, in particular along the plate limit now represented by the Alpine Fault in New Zealand.

Keywords: Australia; Antarctica; Tasmania; New Zealand; Lord Howe Rise; Tasman Sea; west Pacific; plate tectonics; geodynamic reconstructions

---

1. Introduction and Method

Reconstructions for East Gondwana since the latest Triassic (*ca.* 200 Ma) are usually presented without their interaction with the West Pacific (e.g., [1–4] among others). However, questions regarding the Gondwana–Pacific margin include: what was the Gondwana fit (*i.e.*, the fit of Gondwana's numerous pieces) at *ca*. 200 Ma, in particular concerning Tasmania, New Zealand, the Challenger and Campbell plateaus, and all "pieces" east of Lord Howe Rise; why and how did the Tasman Sea open, and perhaps more interestingly, why did the Tasman Sea stop opening; how does the "Australian" tectonic pattern extend into Antarctica?

In this paper, we develop solutions to these and other questions derived from a full global reconstruction model centred in the Australia–Antarctica–West Pacific (AUS–ANT–W.PAC) area, reconstructing not only continental zones but also the oceanic realm. These solutions might not be unique, but better match the geological data, are physically coherent, and follow strict plate tectonic rules at global scale (spherical geometry). The starting reconstruction in the latest Triassic corresponds to the geodynamic scenario for the evolution of the Australides (termed after [5]) as proposed for the Palaeozoic in a companion paper [6]. The techniques and definitions used to create the model were partly presented in [7,8] and [9,10]. However, key criteria are summarised in the companion paper [6]. The notion of a GeoDynamic Unit (GDU), in particular, defines any area with its present-day geometry that underwent the same geodynamic history since 600 Ma. GDUs are shown as non-deformable elements in order to enable geological information to be transferred back in the past, but tight (untight) fits are used not to underestimate crustal extension (shortening). All geodynamic information compiled in the PaleoDyn Database [9] is attached to every GDU. The term "terrane" is given to one or a series of GDUs having a common history for a certain period of time. The model comprises 48 reconstructions over 600 Ma every 5 to 20 Ma, made on the sphere in Europe fixed reference frame, and the "pseudo-absolute" position ("pseudo-" because not constrained by palaeo-longitude) is shown with a palaeomagnetic grid using the apparent polar wander path (APWP) modified after [11].

2. Gondwana Fit

A "good" fit for Gondwana in the latest Triassic is a key feature for understanding both the Palaeozoic and Mesozoic-Cainozoic evolution of the AUS–ANT–W.PAC realm. The retained solutions are presented in Figure 1b (which link the two companion papers), and are based on the following justifications:

(1) Present-day continent-ocean boundaries (COB; Figure 1a) are defined on the combined analysis of gravity (GRACE; [12]), magnetic (EMAG2; [13]), and topographic/bathymetric (ETOPO1; [14]) data. The COB is drawn at the base of the continental slopes (maximum concave curvatures, *id est* maximum second derivative), where the gravity gradient is maximum (maximum first derivative) and the magnetic pattern of ocean crust are not yet present. Such a definition corresponds well, at the scale of our reconstruction, with the COB as defined by existing seismic transects (e.g., [15–19]) and can be applied continuously all along the COB. Note, however, that our COB definition corresponds to the boundary of the "main" continental crust, and that potential denuded mantle is included in the oceanic part. Potential left-over continental slices abandoned on denuded mantle, therefore, cannot be taken into account at the scale of the reconstructions (see [20] and subsequent discussion in [21] and references therein; [22]).

(2) Australia and Antarctica are fitted geometrically, being careful to fit in particular the Naturaliste Plateau (AUS) and Bruce Spur (or Bruce Rise; ANT). Consequently, the space left between Victoria (AUS) and Northern Victoria Land (ANT) can be well fitted by Tasmania, if the Bass Strait is assumed to be a rift that underwent a strike-slip displacement. Although the strike-slip movement of Tasmania has been questioned (e.g., [23] and see debate in [24–26]), it has previously been put forward by many authors, because it allows for the fitting of Palaeozoic geological features of AUS and ANT (see in particular, [27–30]).

(3) Contrary to the model proposed by [1], we do not break the Lord Howe Rise in two, but in three, (Figure 1b) in order to avoid gaps generated during the closure of the Tasman Sea. The two fractures chosen within the Lord Howe Rise follow lineaments observed on the bathymetric, gravimetric and magnetic maps (the position of the northern fault corresponds to the fault suggested by [1]). The fit also tracks back the flow lines defined by magnetic anomalies [1,31–34] and is guided by imprints of transform faults.

Figure 1. **(a)** Present-day configuration (000 Ma) showing GDUs with ETOPO1 as background (topography/bathymetry of the bedrock (ice removed); [14]). Abbreviations are as in **(b)**, except for: AS, Auckland Spur; Fio. and Rise, Campbell Fiordland and Campbell Rise; N, Norfolk Ridge; N.-Z., New Zealand; NC, New Caledonia Ridge; NEO, New England Orogen; NVL, Northern Victoria Land. In Green are names of Australian cratons, with Yilgarn, Pilbara, Grawler, Curnamona-Broken Hill [C.-BH] and the North Australian [N.Aus] cratons (comprising Kimberley, Tanami, Mount Isa, Tennant Creek [TC], and Pine Creek cratons). **(b)** Reconstruction in the latest Triassic (*ca*. 200 Ma; "Gondwana Fit"). In grey are names of GDUs not directly intervening in the present paper, and in black, more directly intervening GDUs. Abbreviations are provided in the figure note. Orthographic projections; this figure is in part derivative from the Neftex Geodynamic Earth Model, © Neftex Petroleum Consultants Ltd. 2011.

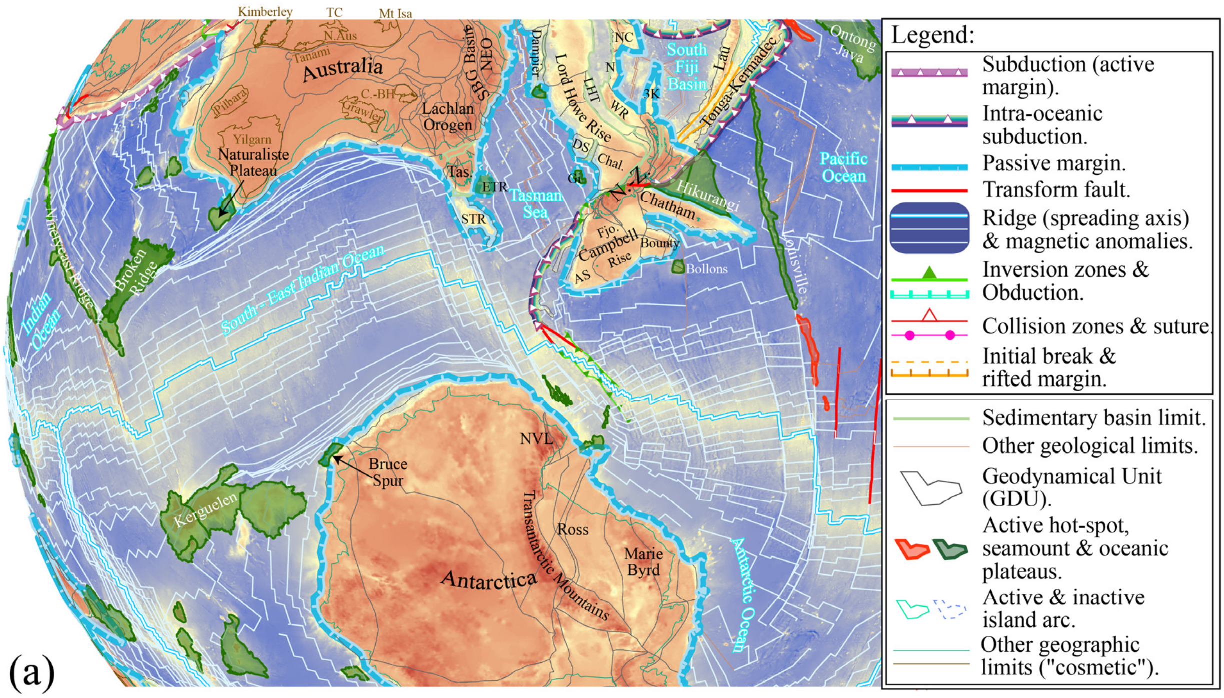


Figure 1. *Cont.*

Notes: Ant-Pen, Antarctic Peninsula; Auck.Sp, Auckland Spur; BB, Bendigo-Ballarat; BC, Bass Canyon; Bel, Bellona Plateau; Blg, Belgrano; Berk, Berkner Island; BHd, Bird's Head; BM, Barnard Metamorphics; BW, Bencannia-Wertago; Bw, Bowers; Byg, Bygrave; C.Aus, Central Australia; C.LHR, Central Lord Howe Rise; CamFio, Campbell Fiordland; CamR, Campbell Rise; CH, Coffs-Harbour; Chal, Challenger Plateau; Ches, Chesterfield Plateau; Cun, Cunnamulla; Dol, Dolleman; DS, Dolphin Spur; Ell, Ellsworth Mountains; ETR, East Tasman Rise; Fio.-NZ, Fiordland province of New Zealand, comprising South Buller terrane, South Takaka terrane, and the future South Median Tectonic Zone (MTZ); GgL, Garnpung Lake; Gi, Gilbert Seamount Complex; GRC, Glenelg River Complex; H, Howqua; HB, Hogdkinson-Broken Ridge; HE, Hill-End; Is, Iselin Bank; J, Mount Jack; K, Kayrunnera; Kan, Kanmantoo; Kg, King Island; LW, Lake Wintlow; M, Melbourne; Md, Menindee; Mel, Mellish Rise; Mo, Molong; MtE, Mount Erebus; Na, Narooma; N.Aus, Northern Australia; N.LHR, North Lord Howe Rise; Nb, Nambucca; Ne.-NZ, Nelson province of New Zealand, comprising North Buller terrane, and North Takaka terrane; Pat, Patuxent; PTk, Paka Tank; PTu, Parkes-Tumut; RB, Robertson Bay; RG, Rockeley-Gulgong; S.Aus, Southern Australia; S.LHR, South Lord Howe Rise; Sand, Sandy Island; SBG, Sydney-Bowen-Gunnedah Basin System; SBo, South Bounty Plateau; SBS, South Bollons Seamount; SC, Schlossbach Cape; Sim, Simpson; STR, South Tasman Rise; Stv, Stavely; Stw, Stawell; SW, Shoal Water; Tab, Tabberbbera; Tas., Tasmania, comprising NW-, north-western Tasmania, SW-, south-western Tasmania, C-, central Tasmania, E-, eastern Tasmania; Tex, Texas; Thu, Thurston Island; Trans.Mtns, Transantarctic Mountains; W.Aus, Western Australia; W.NC, Western New-Caledonia Ridge; Wen, Wentworth; WO, Wagga-Omeo; WT, Wandilla-Tablelands; YT, Yarrol-Tamworth.

(4) Following [1] (and references therein), we assume that the East Tasman Rise, part of the South Tasman Rise and Gilbert Seamount Complex mask continental basements. However, bathymetric data indicates a north-south transform fault west of the East Tasman Rise, indicating southward displacement of the latter. Similarly, we regard Bellona Valley (between Dolphin Spur and Challenger Plateau) as a rift resulting from a north-south extension, prior to the Tasman Sea opening (see below). Such north-south movement was possible if a transform fault separated the Dolphin Spur and

Challenger Plateau from the South Lord Howe Rise. Gravimetric, magnetic and bathymetric lineaments were used to draw the GDU limits. Doing so, and contrary to previous interpretations (e.g., [1,35] among others), the Dolphin Spur and Challenger Plateau GDUs can fit against the Bass Canyon between Tasmania and Lord Howe Rise.

(5) With the latter fit, there is enough space to place New Zealand and Campbell Plateau in the Ross Sea embayment. In terms of geometry, there is no reason to disconnect the Challenger Plateau from the Nelson province (*i.e.*, south-west) of New Zealand. Moreover, we consider it reasonable to align the Anatoki Fault (Nelson province of New Zealand) with the boundary between the Buller and Takaka Terranes in Fiordland province (south New Zealand) prior to the Alpine Fault strike-slip movement (e.g., [27–29,36–38] among others). However, in such configuration, the Campbell Plateau overlies to a large extent (*ca.* 550 km) not only the Ross Sea but also the Transantarctic Mountains of Antarctica. Again, the bathymetric, gravimetric and in particular the magnetic maps show a lineament, which runs through the Campbell Plateau. Hence, we split this area in two, and the southern part (namely the South Campbell plateau, South Bounty plateaus and the South Bollons seamount) are placed against the Amundsen and Marie Byrd GDUs, following the Southern Ocean flow lines deduced from magnetic anomalies [34]. Splitting the Campbell Plateau in two is not a new hypothesis; [39] reached the same conclusion. Note, however, that large intra-continental extension (*i.e.*, non-rigid deformation >250 km) as proposed, for instance by [40,41], is still necessary to account for the current geometry between the Ross Sea and Campbell Plateau.

(6) The Wanganella-Reinga, Norfolk and West New Caledonia GDUs are placed against the Lord Howe Rise in order to close the New Caledonia Basin. Seismic profiles ([19,33]; augmented by Stampfli, *unpublished data* from SHELL) suggest the New Caledonia Basin is an abandoned rift (*i.e.*, no oceanic crust, but see [42] for different interpretations), with Cretaceous sediment infill.

(7) The position of the Sepik and Java GDUs, together with the reconstruction of the northern Australia and Indonesia realm, will be discussed elsewhere. However, the main observations in support of placing the Sepik and Java GDUs against the eastern margin of Australia are: the GDUs have Australian affinities; the central ophiolites in the Sepik GDU suggest the presence of a subduction zone in the Jurassic and obduction in the Cretaceous (see [43–46]); and the Java GDU comprises also high-pressure rocks with K-Ar ages of 124–119 Ma [47]. Therefore both GDUs display subduction related sequences that are present on the eastern margin, but not in the northern margin of Australia, where these GDUs are currently located. Subsidence curves, in particular, attest to the existence of a passive margin on the northern margin of Australia where the aforementioned rocks cannot have formed.

(8) All GDUs of New Zealand north and west of the Median Tectonic Zone (MTZ; or "Median Batholith" after [48]) are considered allochthonous (namely Brook-Murihiku, Maitai-Dun Mountain, Caples-Haast-Torlesse, Esk Head-Pahau GDUs, and Northland Ophiolite, Waipapa, Rakaia, and Whakatane-Pahau-Waioeka GDUs; see [38] for a recent synthesis). The former plate boundary represented by the MTZ must continue off shore to the east of South New Zealand. The magnetic map indicates two domains separated by a lineament that runs in the Campbell Plateau, and then along the Bounty Plateau and the Bollons seamount. We regard, therefore, the North Bounty Plateau, North Bollons seamount as well as the Chatham Rise as equally allochthonous. Finally, although geological data are lacking (except for New-Caledonia; see below), we place also East New-Caledonia, Loyalty

Ridge, Three Kings, among the allochthonous GDUs as shown below (Lau Ridge, and Tonga-Kermadec Ridge being recently formed as intra-oceanic arc and remnant arc).

3. Geodynamic Reconstructions

3.1. Jurassic Evolution—Passive Margin Setting

The eastern coast of Gondwana is an active margin in the latest Triassic (Figure 1; see our model for the Palaeozoic, [6]). The magmatic arc runs from South America along the Antarctic-Peninsula [Ant-Pen], Maher, Amundsen, along the South Bollons Seamount [SBS], South Bounty Plateau [SBo] and Campbell Rise [Camp], which correspond to the continuation of the future MTZ in New Zealand, and along the Wanganella-Reinga [WR], Norfolk [N], Sepik and Java GDUs.

North of Australia (along the Moresby and North Australia GDUs), seismic data and subsidence curves indicate the existence of a passive margin. It is beyond the scope of the present paper to detail the geodynamic evolution of North Australia and South-East Asia (for that region, see [49,50]).

The Karoo Trapps erupt in South Africa (~183 Ma; e.g., [51–56]) together with the Ferrar Volcanics in Antarctica. The latter were presumably emplaced in a rift setting along the Transantarctic Mountains ([50,57,58] and references therein).

In our model, the Sepik and Java GDUs rift off in the Toarcian (Figure 2a) based on seismic and stratigraphic data from the Lord Howe Trough [LHT] (Stampfli, *unpublished data* from SHELL), which suggest that a passive margin developed in the middle Jurassic. Accordingly, the model shows an oceanic crust in the Elise Sea, and the Sepik–Java as well as the Norfolk [N], West New-Caledonia [WNC], Sandy Island [Sand], Mellish Rise [Mel] GDU margins are passive in the Callovian (Figure 2b).

Meanwhile, continental break-up initiates in the present-day Ross Sea, while Gondwana starts splitting in two. Although not constrained for that age, hot spot activity is tentatively represented in the area covered by the South Tasman Rise [STR], Iselin Bank [Is], and the edge of the Auckland Spur [Auck.Sp] (close to the present-day Mount Erebus area). Such activity might have played a role in the extensive rifting processes. Subduction propagates north of Bird’s Head [BHd] and Sula, which begin to rift off.

In the Kimmeridgian (Figure 2c), rifting creates the Victoria Land Basin, Central and Eastern Basin of the Ross Sea [59–62], bounded by what we name the Ellsworth Fault on one side, and the David Glacier Fault and Alpine Fault on the other side. Bird’s Head and Sula slide along the northern margin of Australia, driven by slab roll-back processes.

Figure 2. Geodynamic reconstructions from (**a**)–(**d**) Lower Jurassic to Lower Cretaceous; (**e**)–(**h**) Lower Cretaceous to mid Cretaceous; (**i**)–(**l**) Upper Cretaceous to latest Palaeocene; (**m**)–(**p**) Early Eocene to Early Miocene; (**q**) and (**r**) mid Miocene to Present-day. Same legend as per Figure 1. Views, centred on the Tasman region, with palaeomagnetic grid (grey dashed line, 10° spacing, after [11] Orthographic projections; this figure is in part derivative from the Neftex Geodynamic Earth Model, © Neftex Petroleum Consultants Ltd. 2011.

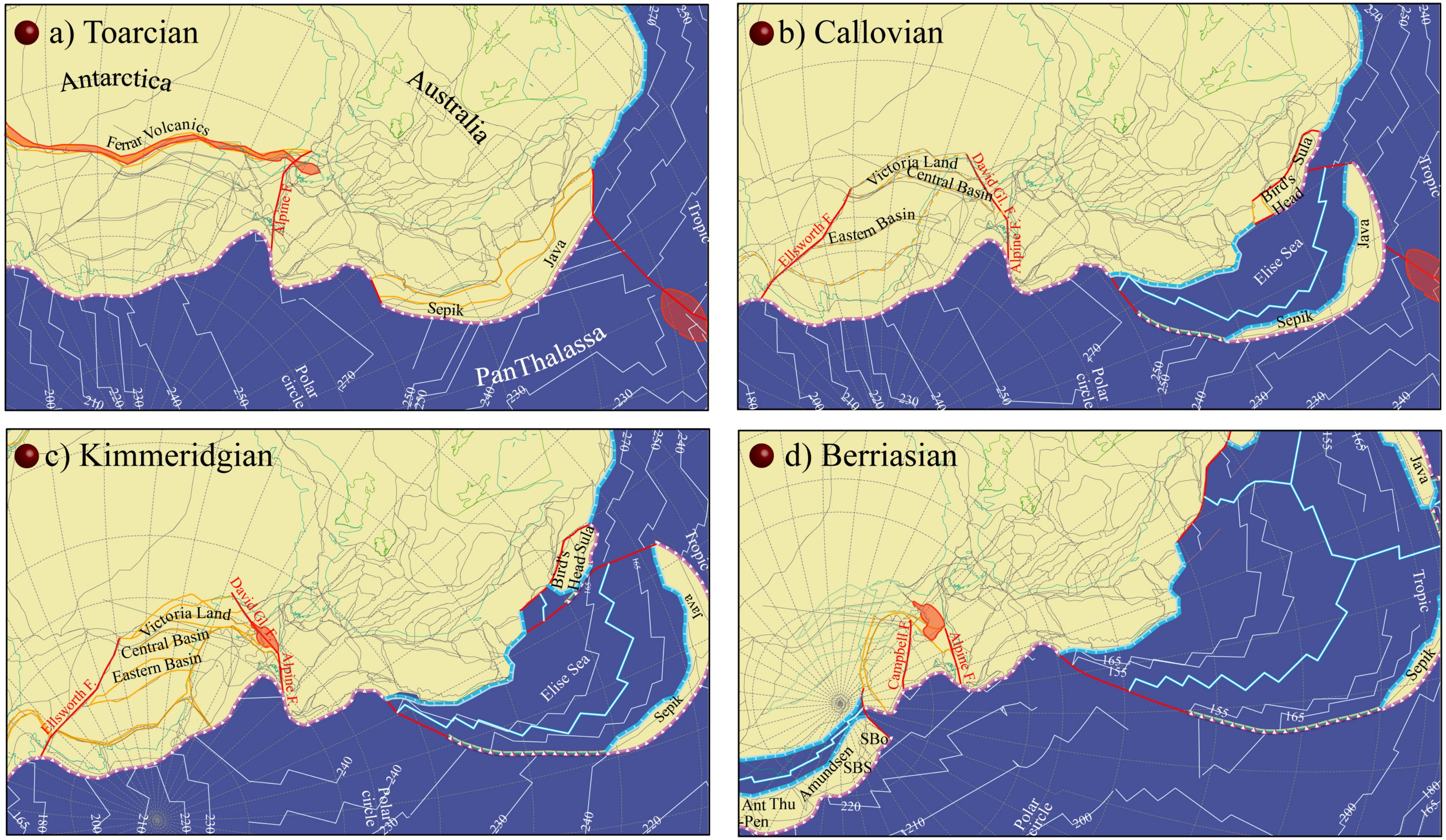


Figure 2. *Cont.*

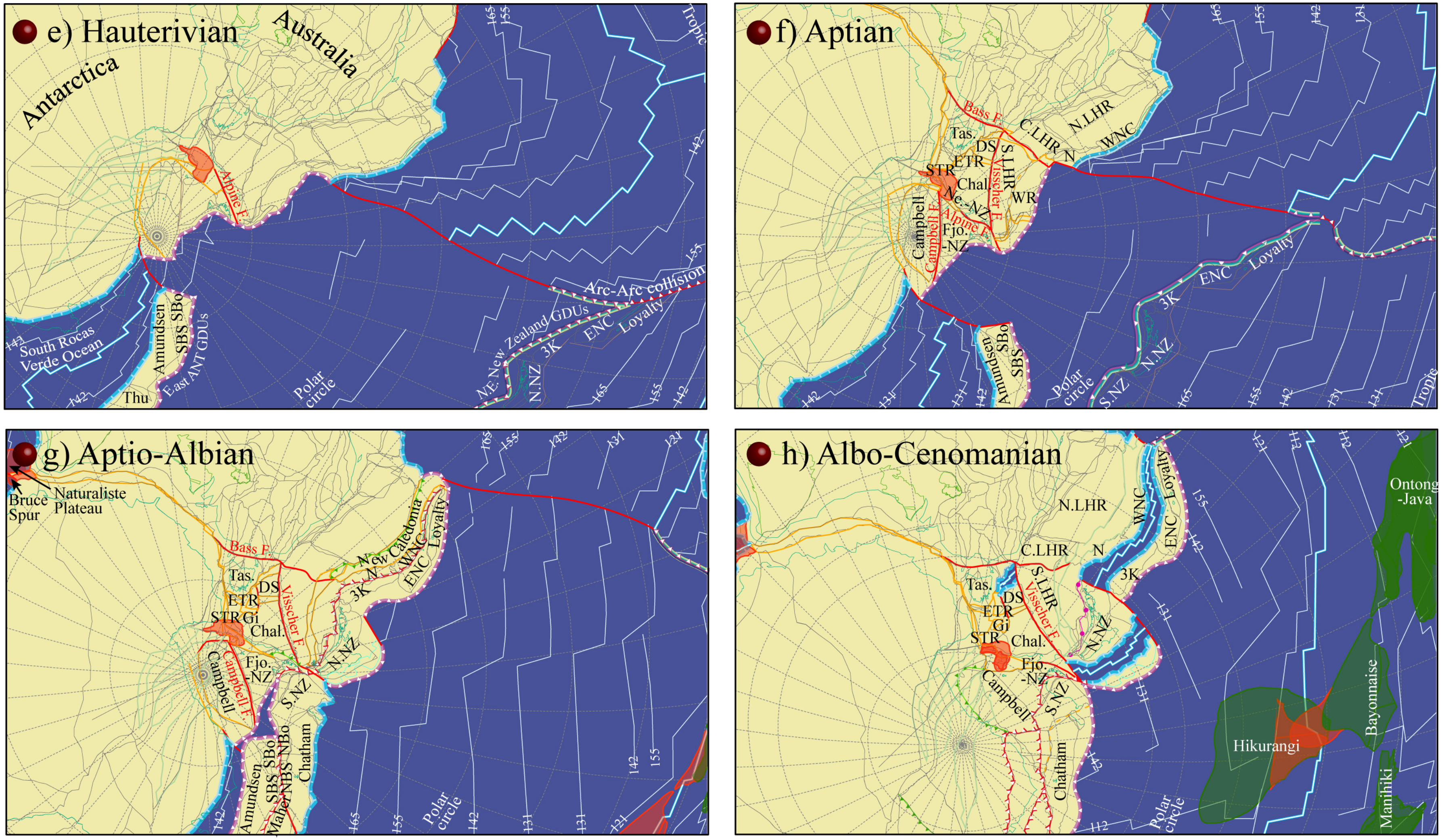


Figure 2. *Cont.*

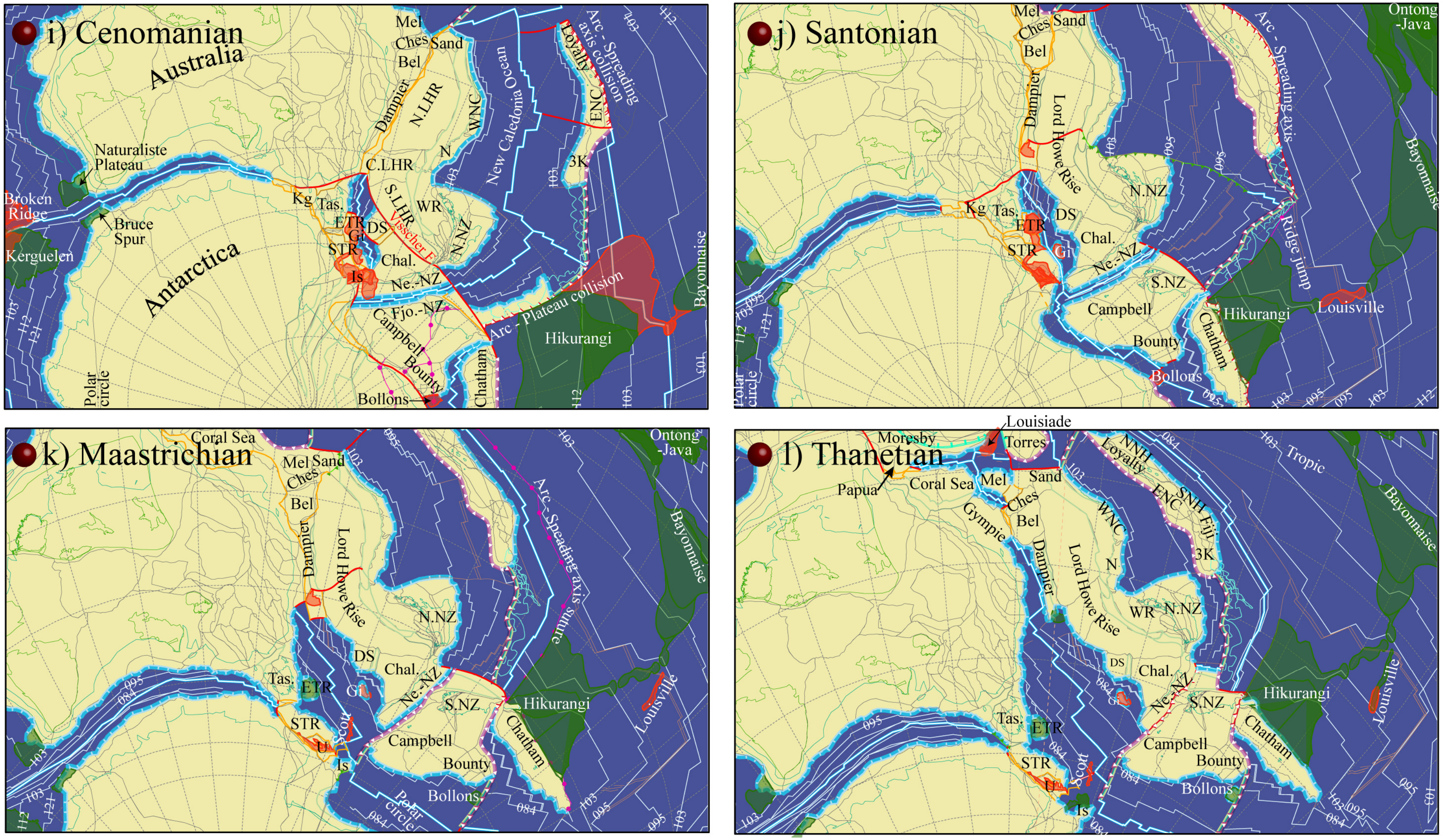


Figure 2. *Cont.*

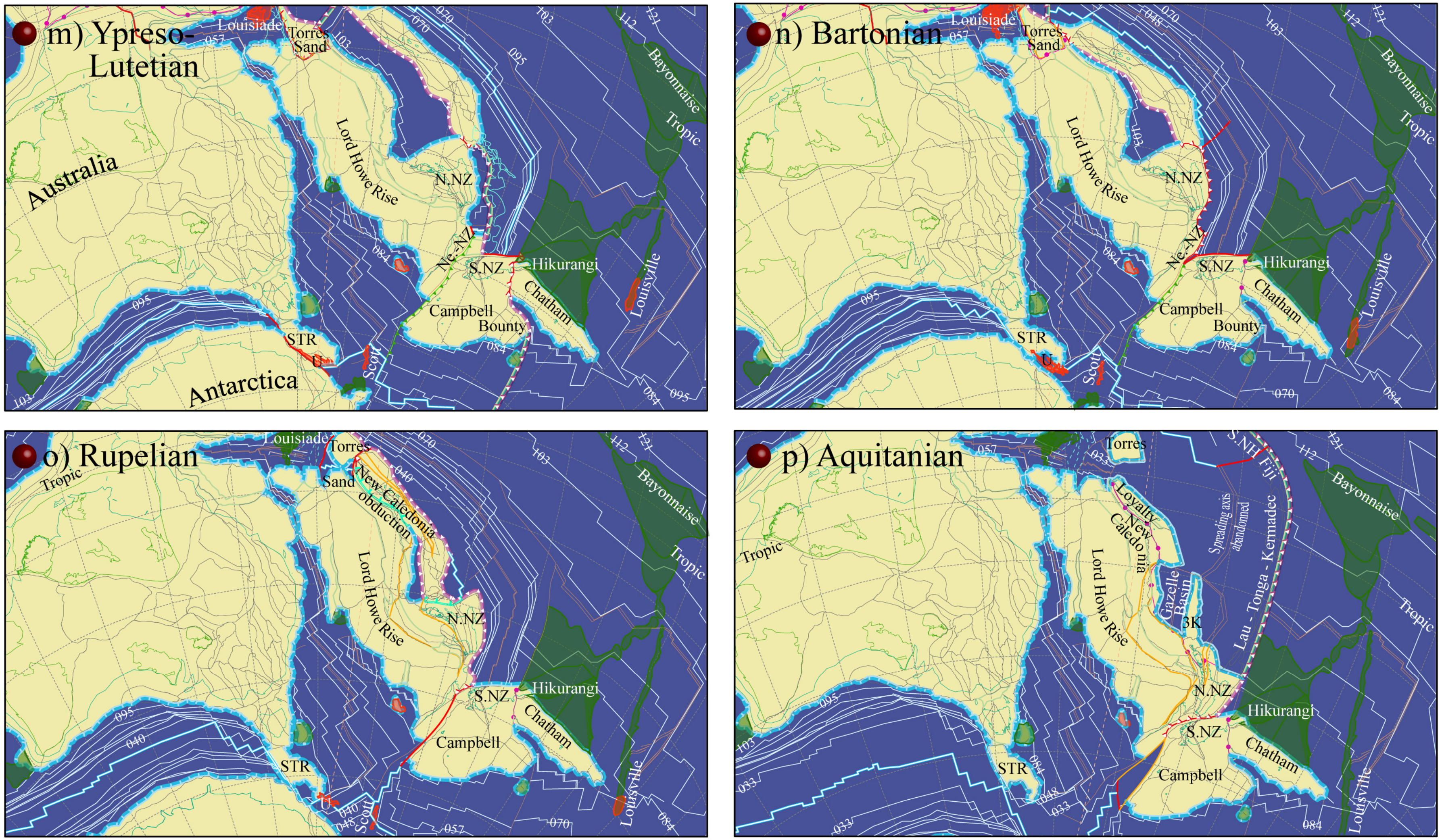
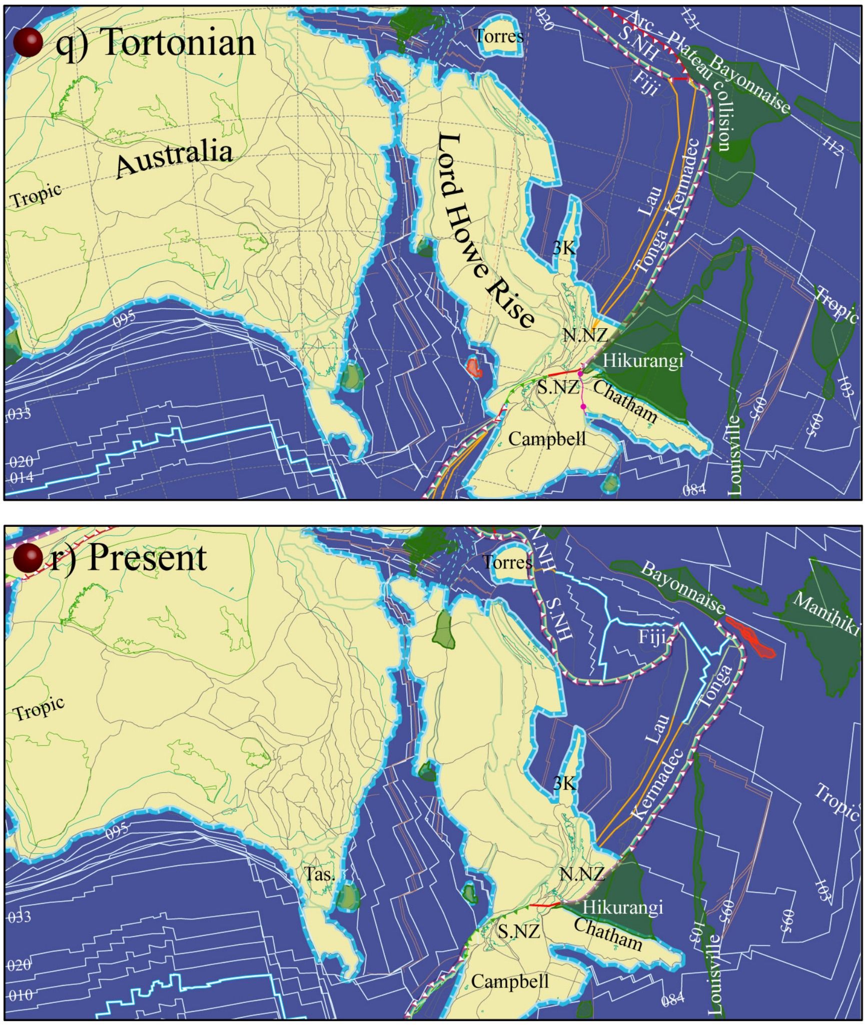


Figure 2. *Cont.*



3.2. Early Cretaceous Evolution—Passive Margin Inversion

The East ANT GDUs (namely the Antarctic-Peninsula [Ant-Pen], Thurston Island [Thu], Amundsen, South Bollons Seamount [SBS], and South Bounty [SBo] GDUs) are detached (Figure 2d), while abandonment of the other rifts explains the Ross Sea sedimentary basins. The Antarctic branch of the Rocas Verdes Ocean is created [63–67]. Subduction roll-back, potentially assisted by hot-spot volcanism in the South Tasman Rise area, favoured rifting around the Campbell Plateau (now comprising the Campbell Rise and Auckland Spur GDUs) and Fiordland province of New Zealand [Fio.-NZ]. The latter, bounded by the Alpine and Campbell Faults, migrates faster to the "south" than the Campbell Plateau, which rotates about a pole of rotation located on the plateau.

Meanwhile, an intra-oceanic island arc originating from the Triangular Zone of the Pacific (*i.e.*, the magnetic anomalies forming a triangle east of the Mariana Islands and north of Micronesia; see [34]) migrates towards the south (see also [66]). The island arc (thus, considered as having no continental basement) consists of the "North-East New Zealand GDUs" (Figure 2e); namely the West New-Caledonia [WNC], Loyalty, Three Kings [3K], North New Zealand [N.NZ] (comprising the Northern Ophiolite, Rakaia, North Maitai-Dun Mountain, Waipapa, and Pahau terranes), South New Zealand [S.NZ] (comprising Brook-Murihiku, South Maitai-Dun Mountain, Caples-Haast-Torlesse, and Esk Head-Pahau terranes), North Bounty [NBo], North Bollons Seamount [NBS], Chatham Rise, Maher, Bellinghausen, Alexander Island, and Smith Elephant GDUs. A transpressive arc-arc collision occurs in our Hauterivian reconstruction (Figure 2e) in the Pacific between the tails of the “North-East New Zealand” island arc which moves south and the Sepik arc which moves north.

Soon after collision, large intra-Pacific plume heads reach the surface close or directly on the mid-Pacific oceanic spreading ridge (e.g., 119–125 Ma after [68]; see also [69]; 120–115 Ma after [70]; *ca*. 120 Ma after [71]; 119–126 after [72] and references therein; 124.6 ± 1.6 Ma after [73]). The resulting plateaus subsequently become of great importance in preventing arc migration (see below).

Magnetic anomalies in the Indian Ocean (modified relative to [34]) require transtensive movement between ANT and AUS on the Aptian reconstruction (Figure 2f). The Bass Fault creates and decouples Tasmania from main land Australia, and South Lord Howe Rise [S.LHR] from Central and North Lord Howe Rise [C. & N.LHR]. This continental break-up might have been facilitated by the formation of the Naturaliste Plateau (AUS) and Bruce Spur (ANT), during or after the break-off of India from Antarctica (Figure 2g, left).

A fault, that we name the Visscher Fault (Figure 2f–h), is also inferred to form between S.LHR and the Challenger Plateau [Chal], and is parallel to the Campbell Fault. Such configuration allows not only Fio.-NZ to keep on moving southwards, but also the north-south extension creating the Bellona Valley between Dolphin Spur [DS] and S.LHR together with the transfer of the East Tasman Rise [ETR] along Tasmania [Tas.].

Arc–arc collision, diachronous from “north” to “south”, occurs between the “North-East New Zealand” GDUs and the East ANT GDUs (explaining the high pressure rocks on Smith Island and Elephant Island; [74,75]). Contrary to other models (e.g., [35,76] among others), we only permit a passive margin to turn into an active margin when there is a “good reason”, the collision of an arc being in general the most reliable associated event (see, for instance, numerical modelling on passive margin inversion by [77]).

The arc–arc collision is complete on the Albian reconstruction (Figure 2g) from the Antarctic Peninsula to the North Lord Howe Rise area. Subduction has inverted along the East ANT GDUs, closing the Rocas Verdes Ocean. Subduction reversal also explains why the Jurassic magmatic arc lies predominantly to the west of the Cretaceous arc in the Antarctic Peninsula [78]. Since the ocean is not closed in front of the Fio.-NZ GDU, the north-south extension south-east of Tasmania continues, concurrently with the ongoing rifting between ANT and AUS, the setting-up of Naturaliste Plateau and Bruce Spur, and the first effusion bringing about the Kerguelen Plateau (e.g., ~110 Ma after [79]; 118–119 Ma in the Southern Kerguelen after [80]; see also [81,82]).

Seismic profiles in the New Caledonia basin indicate basin infill of probable mid-Cretaceous age (e.g., [19,42]). Those data are interpreted as recording rifting away of the GDUs lying east of Lord Howe Rise. Rifting, however, stopped and the basin was moderately inverted, an event we relate to the arc–continent collision. Furthermore, the driving forces are considered large enough for the subduction to invert immediately after collision, and the passive margin of North New Zealand [N.NZ], Three Kings [3K], East NewCaledonia [ENC] and Loyalty ridges to turn into an active margin (therefore now regarded as a continental crust).

In the Pacific, the main part of the Hikurangi and Bayonnaise (also named North Melanesian or Melanesian Border) plateaus form in turn on the spreading ridge (e.g., 118–96 Ma after [71]). As partly proposed by [68], these locations and correlation are required for the plateaus to end up in their present-day position.

3.3. Late Cretaceous Evolution—Re-Opening

All GDUs on the east side of Antarctica collide (Figure 2h), and subduction inversion occurs equally along the South New Zealand [S.NZ], Chatham Rise, Maher, Bellinghausen, and Alexander island GDUs. Associated fault reactivation is tentatively proposed to justify, in part, the high altitude of the Vinson Massif (~5 km) in the Ellsworth mountain ranges (although differential erosion due to glaciation may play an important role; see also interpretations and discussion in [83]).

The N.NZ–Loyalty arc detaches and move “eastwards” creating the New Caledonia Ocean, while the Pacific LIPs migrate “westwards”. The creation of an ocean is required since seismic profiles and subsidence curves indicate the existence of a passive margin with no evidence of magmatic arc remnants prior to the Oligocene [19,84]. The arc, off N.NZ, is shifted from the 3K–Loyalty arc by a transform fault (corresponding to the current Vening-Meinesz Fracture Zone).

Stretching between Dolphin Spur and Tasmania-Bass Canyon is large enough (about 300 km) for oceanic lithosphere creation to occur. Unlike [1] for instance, the model suggests, that oceanic crust generation is much older in the area (Albian–Cenomanian herein instead of Santonian for [1]).

The Naturaliste Plateau and Bruce Spur separate on the Cenomanian reconstruction due to diachronous (*i.e.*, “west” to “east”) oceanic accretion between AUS and ANT (Figure 2i). Very slow spreading is implied and may have led to mantle denudation, with crustal production—and magnetic anomalies—occurring later on; this potentially reconciles the different points of view concerning the debate on the exact timing of rift to drift transition (see [21] and numerous references therein). The hot-spot magmatic activity now focuses on the present-day middle Kerguelen Plateau and Broken Ridge. Transtensive movement between Tas. and ANT, and Tas. and AUS triggers rotation of the King Island [Kg] GDUs and rifting in the Bass Strait. The implied extension rate and the present-day magnetic pattern (EMAG2; [13]) suggests that oceanic crust in the Tasman Sea propagates east of the Gilbert Seamount Complex [Gi]. Extension also creates a rift zone northwards, east of the Dampier Ridge.

Northern and southern parts of the Campbell Plateau, Bounty Plateau and Bollons Seamount are in place (marked by a suture zone in Figure 2i) together with Fio.-NZ and South New Zealand. The Chatham Rise, however, detaches again, with nascent sea-floor spreading [85]. Although not constrained by data, oceanic accretion is represented along the future Alpine Fault, between Ne.-NZ and Fio.-NZ, because of the requirement of over 250 km of extension.

In the Pacific, the Hikurangi Plateau is still considered to be active and much wider than visible on present-day map (see below). The southern part of the Hikurangi Plateau collides with the arc detached from N.NZ. Meanwhile, the Loyalty arc also “collides with” the Pacific oceanic spreading axis.

As a consequence of the collision with the spreading axis and the Hikurangi Plateau, subduction inverts (Figure 2j), and the back-arc basin (*i.e.*, the New Caledonia Ocean) starts to close in the Santonian. The former accretionary ridge ceases, and the ridge jumps south of the Chatham Rise, as shown by magnetic anomalies [34]. Subsequently, the oceanic accretionary system ceases between the Chatham Rise and the “Campbell–South New Zealand (Cam-S.NZ) block”, as the Hikurangi Plateau equally collides with the Chatham Rise. The latter two GDUs (namely Hikurangi and Chatham), as well as all previously mentioned LIPs now reside on the Pacific plate. Note that the ridge jump, south of the Chatham Rise, might have been favoured by hot-spot magmatism in the Bollons Seamount [86]. The "Cam-S.NZ block" breaks off and drifts away from Antarctica. The spreading axis, south of the Chatham Rise, connects the Tasman sea, where a ridge jumps also occurs. The oceanic spreading axis now lies between the Gilbert Seamount Complex [Gi] and the Eastern and Southern Tasman rises [ETR & STR], as shown by magnetic anomalies [1,31–34,87].

Magmatic activity (LIPs) near the Hikurangi Plateau stops and hot-spot magmatism initiates the Louisville Seamount Chain (Figure 2k). Subduction propagation north of the Mellish Rise [Mel], Coral Sea, and Moresby area, initiated on the Santonian reconstruction, creates rifting west of the Dampier Ridge, along the Bellona [Bel] and Chesterfield [Ches] plateaus, and forms the Queensland Trough, south of the Coral Sea GDUs (comprising the Queensland Plateau and Marion Plateau GDUs).

Present-day magnetic anomalies in the Tasman Sea, South-East Indian Ocean and Pacific Ocean [34] imply that the "Cam-S.NZ block" undergoes compression in the Maastrichtian. Accordingly, subduction initiates on both the eastern and western sides of the latter block.

3.4. Tasman Sea Main Opening Phase

With shortening (Figure 2l), the "Campbell–South New Zealand block" collides with Chatham Rise on the western side and Ne.-NZ on the eastern side. The Tasman Sea opens further north between AUS and Dampier Ridge, but there is still no connection with the South-East Indian Ocean to the south. Magmatism, corresponding nowadays to the Umitaka Bank [U] and Scott Island Bank, is presumably active in the transtensive rift limiting the STR from ANT.

Magnetic anomalies (e.g., [88,89]) suggest that the Papua and Moresby GDUs break off to open the Papua Basin, but collide with a series of GDUs that now form the Woodlark area, and the Papua (Milne) Ophiolites are obducted (e.g., [90]). Only the Torres GDU can migrate further south, whereas the Louisiade Plateau is set up. The extension that led to the opening of the Papua Basin, also displaced the Mellish Rise GDU [Mel], creating the Marosszeky Gap, a rift basin between Mel and Ches, and the Cato Trough between Mel and the Coral Sea and Gympie GDUs. As in [36] for instance, the Cato Trough is shown with sea-floor spreading because of the extension rate and patterns of the bathymetric/gravimetric/magnetic maps (*cf.* COB definition, above), although no direct evidence has been found for it.

Torres and Sandy Island [Sand] GDUs collide on the reconstruction at the turn of Ypresian–Lutetian (Figure 2m). The Tasman Sea spreading axis stops, and the accretionary ridge, south of the Campbell Plateau, connects the accretionary system of the South-East Indian Ocean (between AUS and ANT) through the transtensive rift between STR and ANT. The connection is indicated by magnetic anomalies, south of the STR (e.g., [31]), and probably fostered by hot-spot magmatism of the Umitaka [U] and Scott Island Banks.

The boundary between Ne.-NZ and the "Cam-S.NZ block" turns to be transtensive, and is represented by an inversion zone in Figure 2m. The material subducted during the transpressional phase might then re-emerge. Such phenomenon is termed "adduction", and has already been theoretically explored using analogue modelling [91].

Magnetic anomalies (as provided by [34]) overlap continental area and are non-symmetric, although the Hellinger's code [92] used to define them should create symmetrical features. Using modified magnetic anomalies, however, we follow [34] in connecting the South-East Indian with the Antarctic oceanic spreading ridges on our Bartonian reconstruction (Figure 2n), yielding passive margins along AUS and ANT.

Meanwhile, the N.NZ–Loyalty magmatic arc collides with N.NZ (Pahau GDU) to the south, and Torres and WNC to the north. The area in between is not yet closed.

3.5. New-Caledonia Obduction and Final Evolution

The back-arc closure eventually leads to the New-Caledonia obduction (e.g., [93,94]; and [76,95]) on our reconstruction of the Early Rupelian (Figure 2o). The event gives a solution to trigger subduction inversion (usually not mentioned in other studies), generating an active margin along North New Zealand [N.NZ], Three Kings [3K], Fiji, North and South New-Hebrides [N.NH & S.NH], and Torres. The latter moves around the New Caledonia and Loyalty Ridges, as implied by magnetic anomalies and transform fault imprints, while 3K, Fiji, N.NH and S.NH rift off.

The "Cam-S.NZ block", belonging to the Pacific plate, rotates counter-clockwise relative to the Australian plate to which belongs Ne.-NZ. Note that the plate limit in this area is the future Alpine Fault. The northern part of the plate limit is, therefore, a transpressive collision, whereas the southern part is a transtensive plate limit, represented by an oceanic spreading axis in Figure 2o, although adduction processes may still occur.

The movement, described for the Early Rupelian along the future Alpine Fault, develops further on the reconstruction in the Early Burdigalian (Figure 2p), so that the transpressive collision in the northern area is longer, and the spreading axis in the southern area propagates to the north. The area in between, along the Campbell Plateau (Auck.Sp and CamFio GDUs), should undergo adduction processes.

The Torres GDU has stopped moving eastwards, when the oceanic ridge jumped in the magmatic arc (according to magnetic anomalies; [96]). The arc collapses and splits, creating the South Fiji Basin and the Lau–Tonga–Kermadec magmatic arc. The latter is represented as an oceanic arc, although it would not be surprising, according to the present model, to find remnants of Torres, Loyalty, New Caledonia and Three Kings in the basement of the arc (*i.e.*, fragments with basement of continental nature). We regard the Gazelle Basin (or Norfolk Basin, between 3K and N) as being formed of oceanic crust, although we have no constraint except our COB definition (see above). Given this uncertainty, it cannot be decided whether the southern South Fiji Basin spreading axis acted after, or simultaneously, with the Gazelle Basin spreading axis. However, magnetic anomalies in the north of the South Fiji Basin indicate that the spreading axis ceased after anomaly C7 (~24 Ma; [97–99]), and jumped again in the Lau–Tonga–Kermadec magmatic arc.

On the Tortonian reconstruction (Figure 2q), the Alpine fault has become a clear transpressive plate boundary. The southward movement of the Pacific plate relative to the Australian plate triggers the resumption of a subduction zone: the Macquarie Ridge. The New-Hebrides GDUs [N.NH & S.NH] collide with the Ontong-Java and Bayonnaise Plateaus, inducing again subduction reversal. The Tonga–Kermadec arc, on the contrary, is relatively free to migrate eastwards, and the Lau Ridge is abandoned as the arc collapses and splits.

The Lau Ridge is an abandoned arc (Figure 2r), separated from the Kermadec magmatic arc by the Havre Trough and from the Tonga magmatic arc by the Lau back-arc basin (e.g., [100]). We speculate that the Louisville Seamount chain somewhat hampers the migration of the Kermadec arc (southern part), whereas the Tonga arc (northern part) opens at fast rate; the discrepancy is observable in present-day GPS measurements (e.g., [101]). The New-Hebrides–Fiji magmatic arc migrates south-westwards, opening the North Fiji Basin ([102]; see details of the North Fiji Basin opening in [103]). However, the Pacific plate keeps on moving southwards relative to the Australian plate, subducting most of the Bayonnaise and Hikurangi Plateaus.

4. Conclusions

The present work re-appraises the Mesozoic-Cainozoic evolution of the Australia–Antarctica–West Pacific system. The model shows a series of tectonics events that can be related to geodynamic causes, such as, for example, inversion of subduction due to arc–continent collision or magmatic arc–oceanic spreading ridge collision. Such relationships are usually lacking in other studies. The model is coherent with all data compiled in the PaleoDyn global database [9], and proposes an integrated scenario for the evolution of the Antarctic–Australian system, coupled with the West Pacific system.

According to the model, the "North-East New Zealand GDUs" are exotic and stop, by collision, the movement of the "East ANT GDUs" and the development of the New-Caledonia Rift Basin. Subduction reverses, and slab-roll back opens the New Caledonia Ocean since the mid-Cretaceous. Meanwhile, the Tasman Sea starts its sea-floor spreading consecutive to a North–South movement, which is not mentioned in other studies (e.g., [1,36]). The New Caledonia Ocean opens, but stops because of the arc–plateau and arc–spreading axis collisions, which inverse again the sense of subduction. The Tasman Sea spreading axis ceases, because of the following coeval events: the formation of the Papua (Milne) Ophiolites and Torres collision to the north, the closure of the New-Caledonia with collision along N.NZ to the east, and the spreading ridge connection of the South-Pacific Ocean with the South-East Indian Ocean through a transform fault along STR to the south.

We note that oceanic plateaus created in the model are much wider than what can be seen on present-day topographic maps. It implies plateaus can be subducted to large extent, although they also lead to arc–plateau collision and subduction reversal. We also believe that adduction processes should be considered in geodynamic or tectonic models, since they could play an important role, in particular where tectonic plates undergo large strike-slip movements.

Moreover, the model has implications on oceanic palaeo-current circulation and palaeo-climatic reconstructions, and suggests that the opening of the "Tasman Gateway" is not really effective prior to the Rupelian, which is consistent with other works (e.g., [104] among others).

However, we stress that a model is a model, and a number of choices were made with few data. We hope, therefore, future field works will soon challenge our model. In particular, it would be fundamental to prove the existence of the Campbell Fault, to date the different hot-spot volcanisms mentioned above and to check their relationship with rifting processes, to precisely locate COBs and date sea-floor formation, and to supplement the magnetic anomaly database in many basins of this fascinating and challenging region.

Acknowledgments

We gratefully thank Cyril Hochard, Laurent Thum, Claire Gracia-Garay, Kennet Flores-Reyes, and all members of the Stampfli's working group for sharing their data, ideas, and time with us. We kindly acknowledge Petroconsultant IHS Global S.A. (Geneva) and Shell (UK) for access to their database. The Swiss National Fund (SNF) is equally acknowledged for funding the present work. The work was carried out as part of the research program of the University of Lausanne on the "Stampfli geodynamic model", which is now owned by Neftex Petroleum Consultants Ltd. and attached to the "Neftex Earth Model". We are grateful to Neftex for allowing us to present in this publication some details from the geodynamic model obtained prior to 28 February 2010.

Declare

References

1. Gaina, C.; Roest, R.; Müller, D.; Symonds, P. The opening of the Tasman Sea: A gravity anomaly animation. *Earth Interact.* **1998**, *2*, 1–23.
2. Sutherland, R. Basement geology and tectonic development of the greater New Zealand region: An interpretation from regional magnetic data. *Tectonophysics* **1999**, *308*, 341–362.
3. Müller, D.; Gaina, C.; Clarke, S. Seafloor spreading around Australia. In *Billion-Year Earth History of Australia and Neighbours in Gondwanaland*; Veevers, J., Ed.; GEMOC Press: Sydney, Australia, 2000; pp. 18–28.
4. Veevers, J. Gondwanaland from 650–500 Ma assembly through 320 Ma merger in Pangea to 185–100 Ma breakup: Supercontinental tectonics *via* stratigraphy and radiometric dating. *Earth Sci. Rev.* **2004**, *68*, 1–132.
5. Vaughan, A.; Leat, P.; Pankurst, R. Terrane processes at the margin of Gondwana: Introduction. *Geological Society London Special Publications* **2005**, *246*, 1–22.
6. Vérard, C.; Stampfli, G.M. Geodynamic reconstructions of the Australides—1: Palaeozoic. *Geosciences* **2013**, *3*, 311–330.
7. Stampfli, G.; Borel, G. A plate tectonic model for the Paleozoic and Mesozoic constrained by dynamic plate boundaries and restored synthetic oceanic isochrons. *Earth Planet. Sci. Lett.* **2002**, *196*, 17–33.
8. Stampfli, G.; Borel, G. The TRANSMED Transects in Space and Time: Constraints on the Paleotectonic Evolution of the Mediterranean Domain. In *The TRANSMED Atlas: The Mediterranean Region from Crust to Mantle*, Cavazza, W., Roure, F., Spakman, W., Stampfli, G., Ziegler, P., Eds.; Springer Verlag: Berlin, Germany, 2004; pp. 53–80.
9. Hochard, C. GIS and Geodatabases Application to Global Scale Plate Tectonic Modelling. Ph.D. Thesis, University of Lausanne, Lausanne, Switzerland, 18 April 2008.
10. Stampfli, G.; Hochard, C.; Vérard, C.; Wilhem, C.; von Raumer, J. The formation of Pangæa. *Tectonophysics* **2013**, *593*, 1–19.

11. Torsvik, T.; van der Voo, R. Refining Gondwana and Pangea palaeogeography: Estimates of Phanerozoic non-dipole (octupole) fields. *Geophys. J. Int.* **2002**, *151*, 771–794.
12. Tapley, B.; Ries, J.; Bettadpur, S.; Chambers, D.; Cheng, M.; Condi, F.; Gunter, B.; Kang, Z.; Nagel, P.; Pastor, R.; *et al*. CGM02—An improved Earth gravity field model from GRACE. *J. Geod.* **2005**, *79*, 467–478.
13. Maus, S.; Barckhausen, U.; Berkenbosch, H.; Bournas, N.; Brozena, J.; Childers, V.; Dostaler, F.; Fairhead, J.; Finn, C.; von Frese, R.; *et al*. EMAG2: A 2-arc-minute resolution Earth Magnetic Anomaly Grid compiled from satellite, airborne and marine magnetic measurements. *Geochem. Geophy. Geosyst.* **2009**, *10*, Q08005:1–Q08005:12.
14. Amante, C.; Eakins, B. *ETOPO1—1 Arc-minute Global Relief Model: Procedures, Data Sources and Analysis*; NOAA Technical Memorandum NESDIS NGDC-24; National Geophysical Data Center, Marine Geology and Geophysics Division: Boulder, CO, USA, 2009.
15. Stagg, H. The structure and origin of Prydz Bay and MacRobertson shelf, East Antarctica. *Tectonophysics* **1985**, *114*, 315–340.
16. Willcox, J.; Stagg, H. Australia's southern margin: A product of oblique extension. *Tectonophysics* **1990**, *173*, 269–281.
17. Stagg, H.M.J. Report of the Planning Workshop on a Marine Geoscience Mapping Program in the Australian Ocean Territory: Gold Creek Homestead, Gungahlin, ACT, 18–20 February, 1997; Australian Geological Survey Organisation, Petroleum and Marine Division: Canberra, Australia, 1997.
18. Direen, N.; Borissova, I.; Stagg, H.M.G.; Colwell, J.; Symonds, P. Nature of the continent–ocean transition zone along the southern Australian continental plateau: A comparison of the Naturaliste Plateau, SW Australia, and the central Great Australian Bight sectors. *Geological Society London Special Publications* **2007**, *282*, 239–263.
19. Collot, J.; Geli, L.; Lafoy, Y.; Vially, R.; Cluzel, D.; Klingelhöfer, F.; Nouzé, H. Tectonic history of northern New-Caledonia Basin from deep offshore seismic reflection: Relation to late Eocene obduction in New-Caledonia, southwest Pacific. *Tectonics* **2008**, *27*, TC6006:1–TC6006:20.
20. Boger, S. Antarctica—Before and after Gondwana. *Gondwana Res.* **2011**, *19*, 335–371.
21. Direen, N.; Boger, S. Comment on "Antarctica—Before and after Gondwana" by S.D. Boger Gondwana Research, Volume 19, Issue 2, March 2011, Pages 335–371. *Gondwana Res.* **2011**, *21*, 302–304.
22. Direen, N.; Stagg, H.M.G.; Symonds, P.; Norton, I. Variations in rift symmetry: Cautionary examples from the Southern Rift System (Australia–Antarctica). *Geological Society London Special Publications* **2012**, *369*, doi:10.1144/SP369.4.
23. Tikku, A.; Cande, S. On the fit of Broken Ridge and Kerguelen Plateau. *Earth Planet. Sci. Lett.* **2000**, *180*, 117–132.
24. Whittaker, J.; Müller, D.; Leitchenkov, G.; Stagg, H.; Sdrolias, M.; Gaina, C.; Goncharov, A. Major Australian-Antarctic plate reorganisation at Hawaiian-Emperor bend time. *Science* **2007**, *318*, 83–86.
25. Whittaker, J.; Müller, D.; Leitchenkov, G.; Stagg, H.; Sdrolias, M.; Gaina, C.; Goncharov, A. Response to comment on "Major Australian-Antarctic plate reorganization at Hawaiian-Emperor bend time". *Science* **2008**, *321*, 490.
26. Tikku, A.; Direen, N. Comment on "Major Australian-Antarctic plate reorganisation at Hawaiian-Emperor bend time". *Science* **2008**, *321*, 490.

27. Stump, E.; White, A.; Borg, S. Reconstruction of Australia and Antarctica: Evidence from granites and recent mapping. *Earth Planet. Sci. Lett.* **1986**, *79*, 348–360.
28. Borg, S.; de Paolo, D. A tectonic model of the Antarctic Gondwana margin with implications for southeastern Australia: Isotopic and geochemical evidence. *Tectonophysics* **1991**, *196*, 339–358.
29. Glen, R.; Scheibner, E.; van den Berg, A. Paleozoic intraplate escape tectonics in Gondwanaland and major strike-slip duplication in the Lachlan Orogen of southeastern Australia. *Geology* **1992**, *20*, 795–798.
30. Scheibner, E.; Basden, H. *Geology of New South Wales—Synthesis. Volume 1 Structural Framework*; Geological Survey of New South Wales: Sydney, Australia, 1996.
31. Weissel, J.; Hayes, D. Evolution of the Tasman Sea reappraised. *Earth Planet. Sci. Lett.* **1977**, *36*, 77–84.
32. Schreckenberger, B.; Roeser, H.; Symonds, P. Marine magnetic anomalies over the Lord Howe Rise and the Tasman Sea: Implications for the magnetization of the lower continental crust. *Tectonophysics* **1992**, *212*, 77–97.
33. Lafoy, Y.; Brodien, I.; Vially, R.; Exon, N. Structure of the basin and ridge system west of New-Caledonia (Southwest Pacific): A synthesis. *Mar. Geophys. Res.* **2005**, *26*, 37–50.
34. Müller, D.; Sdrolias, M.; Gaina, C.; Roest, R. Age, spreading rates and spreading symmetry of the world's ocean crust. *Geochem. Geophys. Geosyst.* **2008**, *9*, Q04006:1–Q04006:19.
35. Schellart, W.; Lister, G.; Toy, V. A Late Cretaceous and Cenozoic reconstruction of the Southwest Pacific region: Tectonics controlled by subduction and slab rollback processes. *Earth Sci. Rev.* **2006**, *76*, 191–233.
36. Cooper, R.; Tulloch, A. Early Palaeozoic terranes in New Zealand and their relationship to the Lachlan Fold Belt. *Tectonophysics* **1992**, *214*, 129–144.
37. Gibson, G. Medium-high-pressure metamorphic rocks of the Tuhua Orogen, western New Zealand, as lower crustal analogues of the Lachlan Fold Belt, SE Australia. *Tectonophysics* **1992**, *214*, 145–157.
38. Wandres, A.; Bradshaw, J. New Zealand tectonostratigaphy and implications from conglomeratic rocks for the configuration of the SW Pacific margin of Gondwana. *Geological Society London Special Publications* **2005**, *246*, 179–216.
39. Crook, K.; Feary, D. Development of New Zealand according to the fore-arc model of crustal evolution. *Tectonophysics* **1982**, *87*, 65–107.
40. Siddoway, C.; Fanning, M. Paleozoic tectonism on the East Gondwana margin: Evidence from SHRIMP U-Pb zircon geochronology of a migmatite-granite complex in West Antarctica. *Tectonophysics* **2009**, *477*, 262–277.
41. Tulloch, A.; Ramezani, J.; Mortimer, N.; Mortensen, J.; van den Bogaard, P.; Maas, R. Cretaceous felsic volcanism in New Zealand and Lord Howe Rise (Zealandia) as a precursor to final Gondwana break-up. *Geological Society London Special Publications* **2009**, *321*, 89–118.
42. Van de Beuque, S.; Auzende, J.-M.; Lafoy, Y.; Bernardel, G.; Nercessian, A.; Régnier, M.; Symonds, P.; Exon, N. Transect Sismique Continu Entre l'Arc des Nouvelles-Hébrides et la Marge Orientale de l'Australie: Programme FAUST (French Australian Seismic Transect) [in French]. *Compte Rendu l'Acad. Sci. Ser IIA Sci. Planet. Sci.* **1998**, *327*, 761–768.

43. Monnier, C.; Girardeau, J.; Pubellier, M.; Polvé, M.; Permana, H.; Bellon, H. Petrology and geochemistry of the Cyclops ophiolites (Irian Jaya, East Indonesia): Consequenses for the Cenozoic evolution of the north Australian margin. *Mineral. Petrol.* **1999**, *65*, 1–28.
44. Monnier, C.; Girardeau, J.; Pubellier, M.; Permana, H. L'ophiolite de la chaîne centrale d'Irian Jaya (Indonésie): Évidences pétrologiques et géochimiques pour une origine dans un bassin arrière-arc [in French]. *Compte Rendu l'Acad. Sci. Ser IIA Sci. Planet. Sci.* **2000**, *331*, 691–699.
45. Pubellier, M.; Monnier, C.; Maury, R.; Tamayo, R. Plate kinematics, origin and tectonic emplacement of supra-subduction ophiolites in SE Asia. *Tectonophysics* **2004**, *392*, 9–36.
46. Lus, W.; McDougall, I.; Davies, H. Age of the metamorphic sole of the Papuan Ultramafic Belt ophiolite, Papua New-Guinea. *Tectonophysics* **2004**, *392*, 85–101.
47. Parkinson, C.; Miyazaki, K.; Wakita, K.; Barber, A.; Carswell, D. An overview and tectonic synthesis of the pre-Tertiary very-high-pressure metamorphic and associated rocks of Java, Sulawesi and Kalimantan, Indonesia. *Isl. Arc* **1998**, *7*, 184–200.
48. Mortimer, N.; Tulloch, A.; Spark, R.; Walker, N.; Ladley, E.; Allibone, A.; Kimbrough, D. Overview of the Median Batholith, New Zealand: A new interpretation of the geology of the Median Tectonic Zone and adjacent rocks. *J. Afr. Earth Sci.* **1999**, *29*, 257–268.
49. Hall, R. Cenozoic geological and plate tectonic evolution of SE Asia and the SW Pacific: Computer-based reconstructions, model and animations. *J. Asian Earth Sci.* **2002**, *20*, 353–431.
50. Hall, R.; van Hattum, M.; Spakman, W. Impact of India-Asia collision on SE Asia: The record in Borneo. *Tectonophysics* **2008**, *451*, 366–389.
51. Tingey, R. *The Geology of Antarctica*; Oxford Monographs on Geology and Geophysics 17; Oxford University Press: Oxford, UK, 1991.
52. Cox, K. Karoo igneous activity, and the early stages of the break-up of Gondwanaland. *Geological Society London Special Publications* **1992**, *68*, 137–148.
53. Duncan, R.; Hooper, R.; Rehaček, J.; Marsh, J.; Duncan, A. The timing and duration of the Karoo igneous event, southern Gondwana. *J. Geophys. Res.* **1997**, *105*, 18127–18138.
54. Dalziel, I.; Lawver, L.; Murphy, J. Plumes, orogenesis, and supercontinental fragmentation. *Earth Planet. Sci. Lett.* **2000**, *178*, 1–11.
55. Golonka, J.; Bocharova, N.-Y. Hot spot activity and the break-up of Pangea. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **2000**, *161*, 46–69.
56. Martin, A. Gondwana breakup *via* double-saloon-door rifting and seafloor spreading in a backarc basin during subduction rollback. *Tectonophysics* **2007**, *445*, 245–272.
57. Stump, E. *The Ross Orogen of the Transantarctic Moutains*; Cambridge University Press: Cambridge, UK, 1995.
58. Elliot, D.; Fleming, T. Occurrence and dispersal of magmas in the Jurassic Ferrar large igneous province, Antarctica. *Gondwana Res.* **2004**, *7*, 223–237.
59. Rooney, S.; Blankenship, D.; Alley, R.; Bentley, C. Seismic Reflection Profiling of a Sediment-Filled Graben Beneath Ice Stream B, West Antarctica. In *Geological Evolution of Antarctica*, Proceedings of the 5th International Symposium on Antarctica Earth Sciences, Cambridge, UK, 23–28 August 1987; Thomson, M., Crame, J., Thomson, J., Eds.; Cambridge University Press: Cambridge, UK, 1991; pp. 261–265.

60. Bosum, W.; Damaske, D.; Behrendt, J.; Saltus, R. The Aeromagnetic Survey of Northern Victoria Land and the Western Ross Sea during Ganovex IV and a Geophysical-Geological Interpretation. In *Geological Evolution of Antarctica*, Proceedings of the 5th International Symposium on Antarctica Earth Sciences, Cambridge, UK, 23–28 August 1987; Thomson, M., Crame, J., Thomson, J., Eds.; Cambridge University Press: Cambridge, UK, 1991; pp. 267–272.
61. Tessensohn, F.; Wörner, G. The Ross Sea Rift System, Antarctica: Structure, Evolution and Analogues. In *Geological Evolution of Antarctica*, Proceedings of the 5th International Symposium on Antarctica Earth Sciences, Cambridge, UK, 23–28 August 1987; Thomson, M., Crame, J., Thomson, J., Eds.; Cambridge University Press: Cambridge, UK, 1991; pp. 273–277.
62. Cooper, A.; Davey, F.; Hinz, K. Crustal Extension and Origin of Sedimentary Basins Beneath the Ross Sea and Ross Ice Shelf, Antarctica. In *Geological Evolution of Antarctica*, Proceedings of the 5th International Symposium on Antarctica Earth Sciences, Cambridge, UK, 23–28 August 1987; Thomson M., Crame J., Thomson J., Eds.; Cambridge University Press: Cambridge, UK, 1991; pp. 273–277.
63. Storey, B.; Mair, B.; Bell, C. The occurrence of Mesozoic ocean floor and ancient continental crust on South Georgia. *Geolog. Mag.* **1977**, *114*, 203–208.
64. Mukasa, S.; Dalziel, I. Southermost Andes and South Georgia Island, North Scotia Ridge: Zircon U-Pb and muscovite $^{40}Ar/^{39}Ar$ age constraints on tectonic evolution of Southwestern Gondwanaland. *J. South Am. Earth Sci.* **1996**, *9*, 349–365.
65. Stern, C.; de Witt, M. Rocas Verdes ophiolites, southern South America: Remnants of progressive stage of development of oceanic-type crust in a continental margin back-arc basin. *Geological Society London Special Publications* **2003**, *218*, 665–683.
66. Vérard, C.; Flores, K.; Stampfli, G. Geodynamic reconstructions of the South America–Antarctica plate system. *J. Geodyn.* **2012**, *53*, 43–60.
67. Flores-Reyes, K. Mesozoic Oceanic Terranes of Southern Central America—Geology, Geochemistry and Geodynamics. Ph.D. Thesis, University of Lausanne, Lausanne, Switzerland, 18 December 2009.
68. Taylor, B. The single largest oceanic plateau: Ontong-Java–Manihiki–Hikurangi. *Earth Planet. Sci. Lett.* **2006**, *241*, 372–380.
69. Henig, A.; Luyendyk, B. The Manihiki Plateau, Hikurangi Plateau, Wishbone Scarp, and Osbourn Trough: A Review and Analysis. In Proceedings of American Geophysical Union Fall Meeting 2007, San Francisco, CA, USA, 10–14 December 2007; Abstract #T12A-01.
70. Hauff, F.; Hoernle, K.; Werner, R.; van den Bogaard, P.; Timm, C.; Klügle, A. Geochemistry and Age Data from the Manihiki Plateau (R/V SO193): Multiple Volcanic Events form EM1-FOZO-HIMU Mantle Sources within a Single Oceanic LIP. In Proceedings of American Geophysical Union Fall Meeting 2008, San Francisco, CA, USA, 15–19 December 2008; Abstract #V53A-2117.
71. Hoernle, K.; Hauff, F.; van den Bogaard, P.; Werner, R.; Mortimer, N.; Geldmacher, J.; Garbe-Schönberg, D.; Davy, B. Age and geochemistry of volcanic rocks from the Hikurangi and Manihiki oceanic plateaus. *Geochim. Cosmochim. Acta* **2010**, *74*, 7196–7219.

72. Tejada, M.-L.; Suzuki, K.; Kuroda, J.; Coccioni, R.; Mahoney, J.; Naohiko, O.; Sakamoto, T.; Tatsumi, Y. Ontong Java Plateau eruption as a trigger for the early Aptian oceanic anoxic event. *Geology* **2009**, *37*, 855–858.
73. Timm, C.; Hoernle, K.; Werner, R.; Hauff, F.; van den Bogaard, P.; Michael, P.; Coffin, M.; Koppers, A. Age and geochemistry of the oceanic Manihiki Plateau, SW Pacific: New evidence for a plume origin. *Earth Planet. Sci. Lett.* **2011**, *304*, 135–146.
74. Tranter, T. Accretion and Subduction Processes along the Pacific Margin of Gondwana, Central Alexander Island. In *Geological Evolution of Antarctica*, Proceedings of the 5th International Symposium on Antarctica Earth Sciences, Cambridge, UK, 23–28 August 1987; Thomson, M., Crame, J., Thomson, J., Eds.; Cambridge University Press: Cambridge, UK, 1991; pp. 437–441.
75. Trouw, R.; Ribeiro, A.; Paciullo, F. Structural and Metamorphic Evolution of the Elephant Island Group and Smith Island, South Shetland Islands. In *Geological Evolution of Antarctica*, Proceedings of the 5th International Symposium on Antarctica Earth Sciences, Cambridge, UK, 23–28 August 1987; Thomson M., Crame J., Thomson J., Eds.; Cambridge University Press: Cambridge, UK, 1991; pp. 423–428.
76. Cluzel, D.; Aitchison, J.; Picard, C. Tectonic accretion and underplating of mafic terranes in the Late Eocene intraoceanic fore-arc of New-Caledonia (Southwest Pacific): Geodynamic implications. *Tectonophysics* **2001**, *340*, 23–59.
77. Baes, M.; Govers, R.; Wortel, R. Switching between alternative responses of the lithosphere to continental collision. *Geophys. J. Int.* **2011**, *187*, 1151–1174.
78. Kellogg, K.; Rowley, P. Tectonic evolution of south-eastern Antarctica Peninsula. In *Geological Evolution of Antarctica*, Proceedings of the 5th International Symposium on Antarctica Earth Sciences, Cambridge, UK, 23–28 August 1987; Thomson, M., Crame, J.; Thomson, J., Eds.; *Cambridge University Press*, Cambridge, UK, 1991; pp. 461–465.
79. Frey, F.; Coffin, M.; Wallace, P.; Weis, D.; Zhao, X.; Wise, S.; Wähnert, V.; Teagle, D.; Saccocia, P.; Reusch, D.; *et al*. Origin and evolution of a submarine large igneous province: the Kerguelen Plateau and Broken Ridge, southern Indian Ocean. *Earth Planet. Sci. Lett.* **2000**, *176*, 73–89.
80. Duncan, R. A time frame for construction of the Kerguelen Plateau and Broken Ridge. *J. Petrol.* **2002**, *43*, 1109–1119.
81. Wallace, P.; Frey, F.; Weis, D.; Coffin, M. Origin and evolution of the Kerguelen Plateau, Broken Ridge and Kerguelen Archipelago: Editorial. *J. Petrol.* **2002**, *43*, 1105–1108.
82. Ingle, S.; Weis, D.; Scoates, J.; Frey, F. Relationship between the early Kerguelen plume and continental flood basalts of the paleo-Eastern Gondwanan margins. *Earth Planet. Sci. Lett.* **2002**, *197*, 35–50.
83. Dalziel, I. The Ellsworth Mountains: Critical and Enduringly Enigmatic. In *Antarctica: A Keystone in a Changing World*, Proceedings of the 10th International Symposium on Antarctic Earth Sciences, Santa Barbara, CA, USA, 26 August–1 September 2007; USGS Open-File Report 2007–1047, Short Research Paper 004.
84. Katz, H. Plate margin transition from oceanic arc–trench to continental system: The Kermadec–New Zealand example. *Tectonophysics* **1982**, *87*, 49–64.
85. Grobys, J.; Gohl, K.; Eagles, G. Quantitative tectonic reconstructions of Zealandia based on crustal thickness estimates. *Geochem. Geophy. Geosyst.* **2008**, *9*, Q01005:1–Q01005:18.

86. Davy, B. Bollons Seamount and early New Zealand–Antarctic seafloor spreading. *Geochem. Geophy. Geosyst.* **2006**, *7*, Q06021:1–Q06021:18.
87. Stock, J.; Molnar, P. Uncertainties in the relative positions of the Australia, Antarctica, Lord Howe, and Pacific plates since the Late Cretaceous. *J. Geophys. Res.* **1982**, *87*, 4697–4714.
88. Weissel, J.; Watts, A. Tectonic evolution of the Coral Sea Basin. *J. Geophys. Res.* **1979**, *84*, 4572–4582.
89. Cande, S.; Mutter, J. A revised identification of the oldest sea floor spreading anomalies between Australia and Antarctica. *Earth Planet. Sci. Lett.* **1982**, *58*, 151–160.
90. Smith, I. Volcanic Evolution in Eastern Papua. *Tectonophysics* **1982**, *87*, 315–333.
91. Shemenda, A. Modelling of the opening mechanism for certain types of back arc basins. *Oceanography* **1985**, *25*, 204–210.
92. Hellinger, S. The uncertainties in finite rotations in plate tectonics. *J. Geophys. Res.* **1981**, *86*, 9312–9318.
93. Avias, J. Overthurst structure of the main ultrabasic New-Caledonian massives. *Tectonophysics* **1967**, *4*, 531–541.
94. Paris, J.-P. *Géologie de la Nouvelle-Calédonie: Un Essai de Synthèse* [in French]; Mémoires du Bureau de Recherches Géologiques et Minières (B.R.G.M.) Volume 113; B.R.G.M.: Paris, France, 1981.
95. Chardon, D.; Chevillotte, V. Morphotectonic evolution of the New-Caledonia ridge (Pacific southwest) from post-obduction tectonosedimentary record. *Tectonophysics* **2006**, *420*, 473–491.
96. Weissel, J.; Watts, A.; Lapouille, A. Magnetic anomaly evidence for late Paleocene to late Eocene seafloor in the southern New-Hebrides Basin. *J. Geophys. Res.* **1981**, *87*, 243–251.
97. Weissel, J.; Watts, A. Tectonic complexities in the South Fiji marginal basin. *Earth Planet. Sci. Lett.* **1975**, *28*, 121–126.
98. Ballance, P.; Pettinga, J.; Webb, C. A model of the Cenozoic evolution of northern New Zealand and adjacent areas of the southwest Pacific. *Tectonophysics* **1982**, *87*, 37–48.
99. Davey, F. The structure of the South Fiji Basin. *Tectonophysics* **1982**, *87*, 185–241.
100. Weissel, J. Evolution of the Lau Basin by the growth of small plates. In *Island Arcs, Deep Sea Trenches and Back-Arc Basins*; Maurice Ewing Series Volume 1; Talwani, M., Pitman, W.C., III; American Geophysical Union: Washington, DC, USA, 1977; pp. 429–436.
101. Bird, P. An updated digital model of plate boundaries. *Geochem. Geophy. Geosyst.* **2003**, *4*, 1027:1–1027:52.
102. Chase, C. Tectonic history of the Fiji Plateau. *Geolog. Soc. Am. Bull.* **1971**, *82*, 3087–3109.
103. Ruellan, E.; Lagabrielle, Y. Subductions et ouvertures océaniques dans le Sud-Ouest Pacifique [in French]. *Géomorphol. Relief Process. Environ.* **2005**, *2*, 121–142.
104. Lagabrielle, Y.; Goddéris, Y.; Donnadieu, Y.; Malavieille, J.; Suarez, M. The tectonic history of Drake Passage and its possible impacts on global climate. *Earth Planet. Sci. Lett.* **2009**, *279*, 197–211.