A super-mobilistic Earth expansion hypothesis: Australia's voyage to the East (Case Study Nr. 2)

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Abstract. One of the greatest inconsistencies of Plate Tectonics is the assumption that after breakup of Gondwana India migrated about 6000 kilometers to the north. In contrast, geological data are indicating that India was never too far away from Eurasia because the Tethys was only a belt-like sea, only hundreds of kilometers wide. Against the accepted "truth" of the northward journey of India the present paper puts forth the hypothesis according to which it is Australia that travelled thousands of kilometers, only not to the north but to the southeast[1], leaving a mythical Argoland behind. However, most of us have a much more earth-bound name for Argoland. They call it plainly … Africa.

„I believe that … at no times was the separation between northern and southern continents a wide one."
Anthony Hallam, 1981

Introduction. Usually the followers of Plate Tectonics consider themselves as mobilists, contemptuously looking down on Earth scientists persisting in 'old-fashioned' fixist ideas. This is one reason why they fundamentally reject the hypothesis of Earth Expansion and pigeonhole all that is coming from this direction of research. Truly plate tectonicists did not mention that inside the little community of earth expansionists there are some that have at least as mobilistic views as their own on Earth's evolution. However, mobilism rather has become a dogma, and thus a hindrance, when we try to interpret the crust of the ocean floor from the point of view of a constant radius Earth.

Under pressure of reality of expanding ocean floors and the assumption of an Earth of constant size, plate tectonicists are steadily looking for 'subducted oceans', mainly interpreting ophiolites as 'escaped' old oceanic crust. Yet, I have stressed repeatedly that ophiolites occurring in fold belts are no witnesses of paleo-oceans (Strutinski, 1987, 1990; Strutinski et al., 2006) and so did a couple of other authors (e.g. Sonnenfeld, 1981; Storetvedt, 1990). Occasionally even adherents of the plate tectonics hypothesis had to admit this evidence. For instance, Hall (1984), referring to the ophiolites of the Arabian margin, noted that the evidence "is inconsistent with the view that they originated at the spreading centre of a major ocean, or in back-arc basins. Instead, it is argued that these ophiolites represent discontinuous 'oceanic' rifts formed *within* the Arabian passive margin." His paper, even thoroughly founded on field data, had been rejected by straightjacketed referees, but finally (and "reluctantly") published by the editors of the volume of the ophiolite conference held in London in 1982. Observations from different other parts of the world confirm Hall's statements and show additionally that the emplacement of ophiolites was closely linked to shear systems, in analogy

[1] See Added in proof note at the end of the paper.

with that operating in the actual Gulf of California (Kelts, 1981; Trümpy, 1982; Strutinski, 1990 and references therein).

„Palaeomagnetic results are often taken, especially by geologists, to be much more exact than they actually are".
Paul S. Wesson, 1970

Tethys and its 'Gondwanan' border. The classical plate-tectonics example of a sea "transformed" into an ocean is the Tethys, or rather two Tethyses (Paleo- and Neotethys). And this in spite of the fact that most geological, sedimentary and paleontological data suggest that the Tethys was an epicontinental sea/seas that did not represent a true barrier for faunal and floral exchange between Eurasia and India (Ahmad, 1983; Stöcklin, 1983, 1984, 1989; Blieck et al., 1988).

After analyzing the Upper Triassic fauna from Maleri and Tihki (Central India), von Huene (1940) concluded that, as a whole, the forms are much alike those of the Lower Keuper from the northern hemisphere, some southern biota being, however, present. Colbert (1958) confirmed this statement and asserted that

> *"the Maleri fauna points quite clearly to the fact that this is essentially a northern assemblage of vertebrates that extend to the peninsular region of India from the Eurasiatic landmass at the beginning of the Late Triassic times".*

He defended this position (Colbert, 1984) also after the advent of Plate Tectonics, according to which India should have been separated from Asia at that time by thousands of kilometers of ocean.

In his analysis of the biogeographic relations between the northern and southern continents during the Mesozoic and Cenozoic, Hallam (1981) reasoned that "the paleobiogeographic data provide a serious constraint that cannot be ignored" when asserting a long lasting northward drift of India (**Fig. 1**). But it was ignored and it still is! Despite this, data still come out evidencing that peninsular India had tight pre-collision relationships with Laurasian biota and did not develop a noteworthy endemic fauna and flora, as it should after a journey of tens of million years in total isolation (Briggs, 2003; Rust et al., 2010). Curiously enough, when endemic biotas are mentioned, even from southern India, they have largely Asian rather than Gondwanan affinities (Holloway, 1974). And, as Mani (1974) emphasized, Ethiopian ('Gondwanan') biota represents the *latest intrusive element* in the Indian subcontinent. Needless to say that under the auspices of the ruling plate-tectonics dogma biogeographers were surprised about the apparent deficiency of Indian connections toward Africa and Madagascar (Rust et al., 2010). Yet, Briggs (2003) and Karanth (2006) argue that the absence of endemic forms implies that during its northward journey India must have continued to change fauna and flora with Africa and Madagascar. By doing so they put into question the idea of the solitary drift of India toward Eurasia and trivialize the – truth be told - remote kinship of the Indian and African/Madagascan biotas. Other authors, who realistically noticed the nearly absence of Gondwanan "pre-drift biotas" in the subcontinent, have speculated that due to an extremely rapid passage of India across latitudinal zones autochthonal forms got extinct or remained restricted to "small areas of suitable habitat" (Holloway, 1974). A related hypothesis by which the presence of Asian faunal elements in India before the commonly accepted Eocene collision could be explained was proposed by Milner et al. (2004) who favored a 'fast' drifting scenario for India, by which suturing with Asia was accomplished already in the latest Maastrichtian.

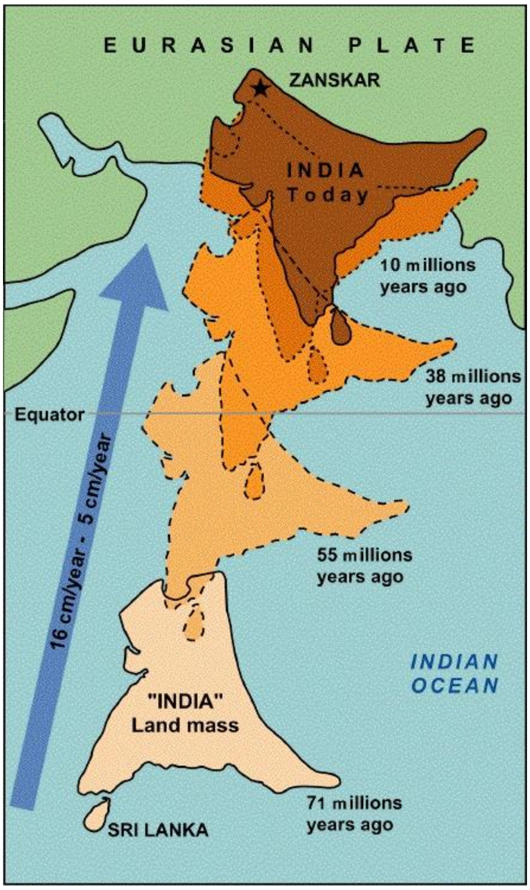

Fig. 1 Succesive positions of India on its northward journey according to the Plate Tectonics hypothesis (from Wikipedia "Indian subcontinent")

An ever-growing amount of data insistently suggests that India was never too far from mainland Asia and that the biotic links between these two regions persisted all through the Mesozoic. Attempts to underrate these connections and to find *ad hoc* explanations for missing links to other Gondwanaland fragments are unconvincing and evidently dictated by the imposed dogma of a wide ocean – the Tethys – that assumedly existed during the Mesozoic and until the Lower Tertiary between Gondwana and Laurasia. No one has criticized this position more fiercely than Stöcklin (1984):

> *"The geological evidence against the existence of a Permo-Scythian Tethys Ocean and against any substantial development of an oceanic Neotethys in earlier than Cretaceous time has become too persistent, too conspicuous, too alarming to be disregarded any longer or to be explained away by subduction… It simply points to the non-existence of a Tethys Ocean in Permian-Early Triassic time. It also means that, if no Permo-Scythian Tethys Ocean and at best a Late Triassic incipient Tethys rift was available for subsequent subduction, opening of the Indian Ocean in Jurassic time cannot have been compensated by Tethyan subduction. This calls in question the very fundamentals of the plate-tectonic concept and its paleomagnetic premise."*

Exactly this was done by the 'whistle-blower' Storetvedt, a Norvegian paleomagnetist who showed that instead of assuming that India had drifted north by about 54 degrees of latitude, one could equally accept – using the same paleomagnetic data – a clockwise rotation of India of about 135 degrees (Storetvedt, 1997, 2003). I agree with Storetvedt when he asserts that "the paleomagnetic conclusion in favour of a mega-scale northward translation of India clearly had a very fragile foundation" (Storetvedt, 2003). Anyhow, I disagree with him about his own explanation of an exceptionally large clockwise *in situ* tectonic rotation of India even if certain rotation most probably took place. But there still remains a third alternative: Earth expansion. This has been shown among others by Carey (1976, 1988) and Owen (1983). In trying to recreate Pangea, both reached the conclusion that the gaping gore between India and the Asian continent, e.g. the Tethys Ocean of Plate Tectonics (**Fig. 2**), would disappear on an Earth with a smaller radius, in accord with geological and paleontological data. Ironically enough, those who accept expansion of the Earth do not accept an expanded Tethyan Sea while those who reject expansion defend *their* expanded Tethys!

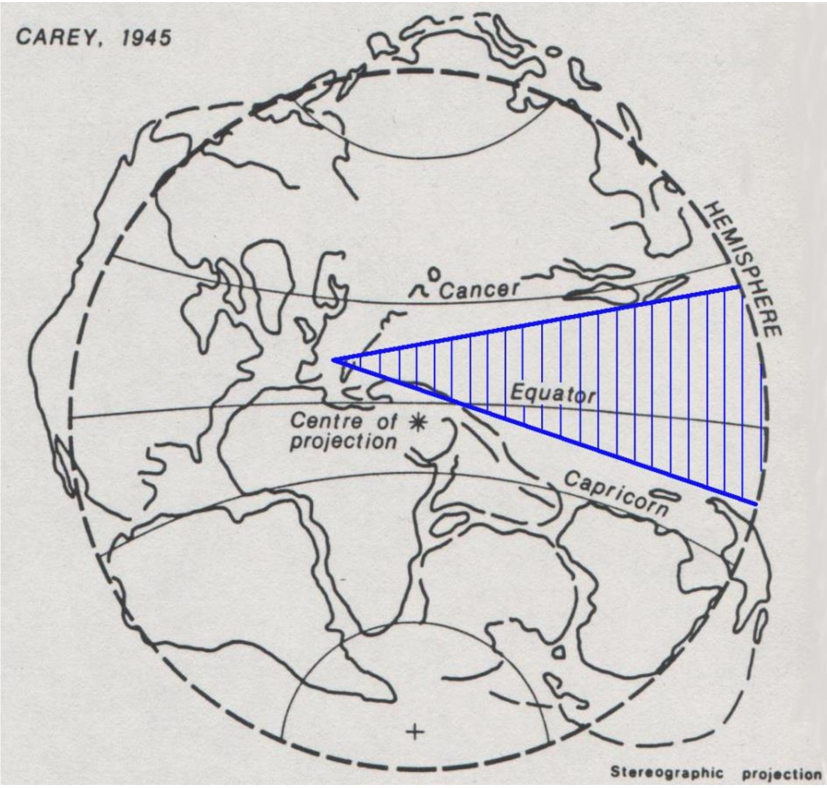

Fig. 2 A gaping gore (blue-hatched) between the northern and southern continents occurs by trying to restore Pangea on a globe of actual dimensions. This has been interpreted by Plate Tectonics to represent the oceanic domain of the Tethys. (modified from Carey, first draft of the book *Theories of the Earth and Universe*)

„The phenomenologically different behavior of cratons and orogens is not due … to their different rigidity or plasticity, but to immovedness (not immovability!) of cratons and movedness of orogens."
Alfred Rittmann, 1942

Considerations on 'rigid' and 'soft' lithosphere. For better understanding the following sections I feel that I must make some clarifications on the rheological behaviour of the crust and upper mantle. I am deeply dissatisfied by the term 'collision' so much used and overrated in Plate Tectonics terminology. To paraphrase Carey (1983), I would go so far as to say that "the deeply rooted doctrine that orogenesis implies *collision (*instead of *crustal shortening* in the original version) is the most illusory and pernicious sophistry in the history of geology". Similarly I have problems with lithospheric 'indenters' penetrating into 'softer' or easier to deform lithosphere, as asserted for instance by Molnar & Tapponnier (1975) for the Himalayan orogen and its surroundings. Based on the classical work of Schwinner (1924) and on newer literature regarding simple shear (e.g. Tchalenko, 1970), strain heating (Reitan, 1968a; 1968b, 1969, 1988) and deformation of the lithosphere (England & Jackson, 1989; Silver, 1996) I have shown on different occasions that steady deformation is the main factor causing 'weakening' or 'softening' of the lithosphere and that 'rigid lithosphere' means only lithosphere *temporarily not subject to deformation*. As, according to Schwinner, lithospheric scale compression between equally 'rigid' blocks is the least capable to deform rocks while tension has only local importance, the principal mechanical factor generating deformation *and* strain heating is simple shear preferentially along transcurrent systems (Strutinski, 1987, 1990, 1997, 2001).

Deformation is in fact caused by lithospheric creep and therefore it takes place under the rule of laminar flow and particularly of *open-channel flow* and cannot be satisfactorily resolved by assuming rigidly behaving plates. Most deformation occurs along linear belts that are characterized by lengths one or two orders of magnitude greater than widths. On Earth the largest linear belts are the orogens. The most important of them (Caledonian, Variscan, Alpine) are considered to have been initiated and evolved along their time-equivalent equator (Carey, 1983; James, 1994; Storetvedt, 1997). According to our concept the equatorial orogens resulted from geosynclines which were created above eastward-creeping *asthenocurrents* (Strutinski & Puste, 2001; Strutinski et al., 2003). At the time of their initiation geosynclines are usually straight and evolve under a self-equilibrated stressfield. Mechanically they can be equated to open channels (**Fig. 3A**). However, during their later evolution the equilibrium is most frequently disturbed and as a result the nascent orogens turn into oroclines. One of different possible causes that disturb the equilibrium could be rifting that destroys at least one of the two 'rigid' walls of the open channel (**Fig. 3B**). As a consequence the channel is

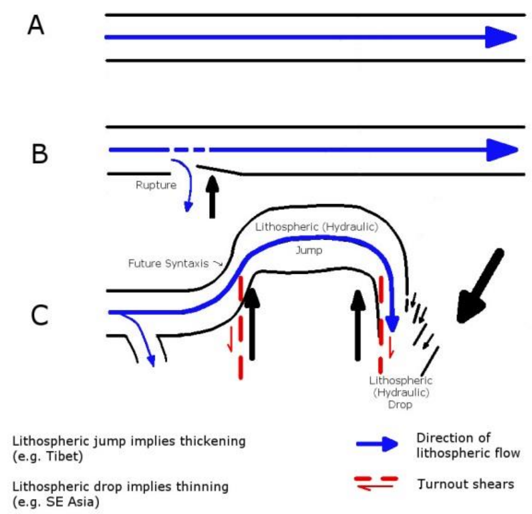

Fig. 3 The fluid mechanics model of the formation of the Himalayan double orocline (see text for details)

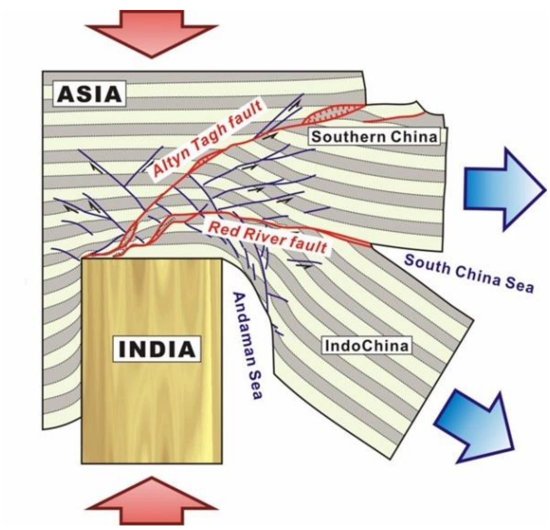

Fig. 4 The rigid plate indenter model of the Himalayan chain. Slightly modified after Ching et al.(2008)

shifted in the direction of maximum stress, turnout shears occur and the sectional area is drastically reduced until the increasing velocity of the flow reaches a critical point when the breakthrough into the direction of minimum stress gets started. A large area is 'invaded' by the flow, a process that in fluid mechanics is known as hydraulic jump. We shall speak instead of a lithospheric jump (Fig. 3C). After a passage that permits a renewed velocity increase the flow will be relieved and may entrain its 'embankments'. This is equivalent to the hydraulic drop in fluid mechanics, in our case a lithospheric drop.

The above description presents in fact a new vision of the evolution of the Himalayan chain that stands in contrast to the "rigid plate" indenter model of Molnar and Tapponnier (1975) (**Fig. 4**). The main difference is the fact that in my model the evolving orogen is viewed as an active zone of creeping thus behaving specifically vis-à-vis a 'rigid' indenter. The model turns the attention to the deep levels of the lithosphere where the motor of motion and deformation is believed to be located, and does not overemphasize the behavior of the brittle upper crust. A similar more elaborate model was recently presented for the Himalaya-Tibet region by Yin and Taylor (2011).

"Australia separated from Gondwana … at about the same time as India, but moved less quickly northwards".
Robert Hall, 1998

The Africa/Arabia/Madagascar-Australia/New Guinea/New Zealand (AAMANN)-Connection. I'll make it short: why has no one remarked until now that the Central Indian Ocean offers – like the Atlantic –an example of conjugate margins? I mean the conjugate margins of Eastern Africa and Western Australia. I understand that plate tectonicists, convinced of the long lasting solitary 'flight' of India to the north were not much interested to analyze other versions. But why did not challenge earth expansionists such views? In their Pangean reconstructions all of them placed Australia to the east (in present coordinates) of India, no one tried to attach it to Africa and thus reconsider its initial position to India. If expansionists accept on solid grounds that India was always near to Eurasia, they have to look for another mode to close the Indian Ocean in order to establish the relations between continental blocks prior to Gondwana breakup. And what is nearer as to apply the same rules as the great majority of earth scientists do when analyzing the drift history of the Central Atlantic? From **Figures 5** and **6** it is obvious that Western Australia can be neatly attached to East Africa, with the North West Cape nestling up against the Tanzanian coast near Mombasa. Of course the situation is not as unambiguous as in the Atlantic because in the Indian Ocean continental blocks occur in between (Southeast Asia, India, Seychelles, Madagascar) which seem to have prevented Australia's eastward drift. However, this is the *present* situation. Madagascar, considered in plate tectonic reconstructions to have drifted from Africa southeastwards, may, on the contrary, have been sheared to the north at some time after its departure from the mainland. Its initially more southern position relative to the African continent was argued by Vogel and Schwab (1983). It can likewise be proved that the Seychelles continental fragment drifted to its present position after Australia arrived at a more eastern longitude. Moreover it seems probable that Australia was sheared off the southwestern Seychelles/India block once it began its travel to the southeast. The situation presented is compatible with the generally accepted

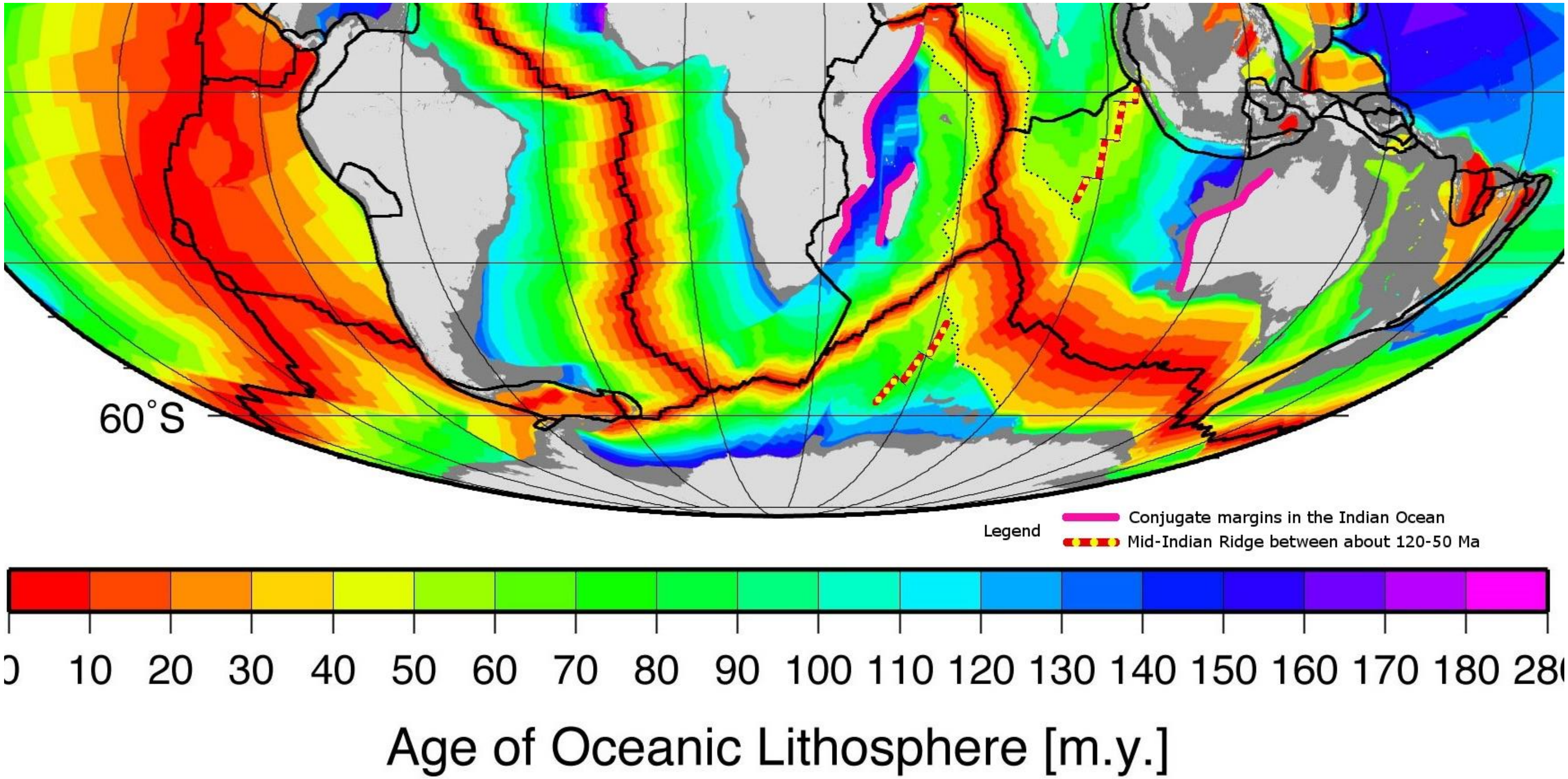

Fig. 5 The oceanic age chart of the southern hemisphere showing the conjugate margins of Eastern Africa/Australia and Eastern Africa/Madagascar, respectively. The oceanic ridge active during the Middle-Cretaceous – Lower Tertiary, between about (120) 90 and 43 Ma, is also figured. It is cut by the actual Southeast Indian Ridge, which became active since the Eocene, about 43 Ma ago. Detail of the Oceanic Age Chart after Müller et al. (2008), with minor modifications.

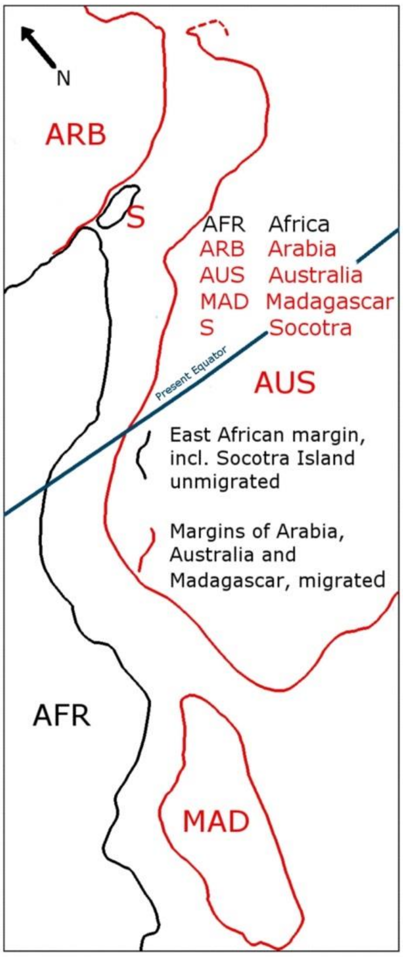

Fig. 6 The geometric fit of the continents bordering the eastern and western margin of the actual Indian Ocean at the time before breakup of Gondwana. The margins include the shelf regions. Africa is considered fixed to its actual coordinates (equator is shown), while margins of the other landmasses were migrated in order to realize the best fit. The contours were taken from a globe scaled 1:42.500.000 to prevent large distorsions. They are, however, unavoidable under the acceptance that the Earth has expanded.

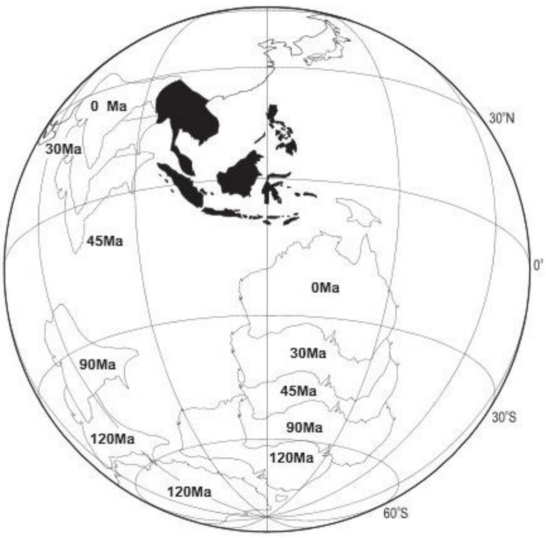

Fig. 7 The northward migration of India and Australia according to Hall (1998).

age of the ocean floor but is contradicted by paleomagnetic data. As in my view these data are spoiled by the constant-size Earth assumption, I do not take them into much consideration. I showed further up that they are in deep conflict with the paleobiogeographical data, which, on the contrary, yield helpful arguments in favor of the here presented hypothesis.

Clearly inconsistent within the Plate Tectonics framework are assumptions according to which Australia stayed during most of the Mesozoic at high latitudes (e.g. Heine et al., 2004; Scotese, 2002, see Scotese's Paleomap Project) or drifted to the north, albeit at a much slower speed than India (Hall, 1998). The latter concept is nicely illustrated on a planiglobe presented by Hall (Hall,1998, Fig. 3, here **Fig. 7**). Such views are decidedly contradicted by well-established paleogeographic and paleobiogeographic data coming from Western and Eastern Indonesia and Northern Australia/New Guinea (Struckmeyer & Yeung, 1991; van Gorsel, 2014). In spite of the fact that Northern Australia (including New Guinea, the Outer Banda Arc and East Sulawesi) showed remarkable paleogeographic and paleobiogeographic similarities with Arabia during the Triassic that point to proximity under equal climate conditions (see, among others, Marcoux and Baud, 1995), plate-tectonic reconstructions place Arabia on the equator and Australia far away at high latitudes. The similarity of fauna is greatest in the Triassic, being of southern Tethyan type, but tends to diminish progressively beginning with the Upper Jurassic (van Gorsel, 2014). This growing dissimilarity seems to be due to the fact that Northern Australia/New Guinea apparently left the intertropical zone and entered the temperate zone of southern latitudes. However, it seems that even under these circumstances the Australian-East Indonesian fauna was more related to the southwestern Tethyan fauna (Alps, Oman) than to that from Southeastern Asia, including West Indonesia. Particularly during the Cretaceous the latter was characterized by its northern Tethyan affinity, while Australian-East Indonesian fauna developed endemic forms (van Gorsel, 2014). Taken together, the presented features are strong arguments in favor of a solitary drift of Australia and its bordering lands from the northwest to the southeast. According to Struckmeyer and Yeung (1991), the southerly drift of Australia was finished by the end of the Upper Cretaceous or in the lowermost Tertiary when the rifting between Australia and Antarctica set in. However, it is only since the Middle Eocene that Australia is moving forcibly northward. When it 'collided' with the Sunda Arc, its endemic fauna, the result of the long isolation, encountered the Southeast Asian fauna that was strikingly different. This "sharpest biotic demarcation on the planet" (Brown and Diesmos, 2009) was noticed for the first time by Alfred Russel Wallace, who draw the corresponding front line that bears his name.

Not only paleobiogeography favors a 'contiguous-to-Africa' original position of Australia but also many of the actual faunal and floral links to Madagascar that did not necessitate India as an intervening land bridge. Some of these links are so spectacular, that they are considered real enigmas. The great actual distance between Australia and Madagascar, the apparent absence of linking land bridges and the fact that according to conventional science these territories never were in close proximity rendered it difficult to apply normal patterns for explaining biotic links between them. Sometimes Antarctica was considered to be the stepping-stone in the dispersion of taxa (see, e.g., Yoder and Nowak, 2006; Datta-Roy and Karanth, 2009). This may partially apply. As seen in the next section, Australia departed from Madagascar not earlier than during the Upper Cretaceous, after the basalt flooding caused by the Marion hotspot (about 90 Ma ago). Therefore it is not unrealistic to explain the existence of sister taxa in Madagascar and the Australian landmass by vicariance. The relations between Madagascan and Australian biotas are particularly striking when the absence of corresponding links to mainland Africa is considered. In addition, as stressed by Warren et al. (2010), despite of Madagascar's extreme isolation from India and proximity to Africa, a high proportion of its biota shows Asian affinities. A conclusion that emerges is that Africa was the first to be fully isolated biogeographically from the rest of Gondwana, but that affinities of vertebrate fauna" from the latest Cretaceous of Madagascar, India and South America indicate a significant degree of cosmopolitanism among southern Gondwanan biota that can best be explained via terrestrial connections among these landmasses well into the Upper Cretaceous." (Yoder and Nowak, 2006). Interestingly, Australia is not specifically mentioned by these authors , probably because they did not have in mind a closer geographical connection to its more westerly Gondwanan neighbours.

However, the biogeographic links with Madagascar exist and some of them are briefly itemized in the following.

a. Invertebrates. Page et al. (2007) mention the presence of the genus *Parisia,* a subterranean atyid (Crustacea: Decapoda: Caridea), in both Australia and Madagascar and comment that "the occurrence of *Parisia* in Madagascar as well as Australia may argue for Gondwana ancestry".
b. Rainbow fishes. The similarity between *Melanotaeniidae* from Australia/New Guinea and *Bedotiidae* living in Madagascar is striking and "a close relationship has been intimated by numerous authors dating back to the early twentieth century" (Sparks and Smith, 2004). Interesting to note that there are no sister group relations between Madagascan and African genera in spite of the fact that the continent is only a few hundred kilometers apart. The conclusion is that an oceanic barrier sufficiently old, yet not large, obviously represents a barrier in the dispersion of freshwater fishes. The sister group relationship between the Melanotaeniids and the Bedotiids must therefore be accounted for by Gondwanan vicariance. Sparks and Smith suppose a land connection between Australia and Madagascar via Antarctica and the Kerguelen Plateau, but according to my view, a direct link existed, at least until the Upper Cretaceous.
c. Sleeper gobies. Chakrabarty et al. (2012) show that the blind, cave-adapted goby *Typhleotris*, endemic to karst habitats in southwestern Madagascar, is the sister group to *Milyeringa*, endemic to similar subterranean systems (in both cases caves in Eocene limestone) in northwestern Australia, locations separated today by nearly 7000 kilometers. As these genera represent some of the least vagile organisms on Earth, their affinity can only be explained by assuming vicariance between populations on once abutting landmasses, e.g. Australia and Madagascar.
d. Coelacanths. The fact that these fishes did not survive the extinction event at the end of the Cretaceous except the genus *Latimeria*, whose distribution at present is restricted to the extreme ends of the Indian Ocean (**Fig. 8**), may throw some light upon a pre-Tertiary proximity between Australia and Madagascar/Africa.

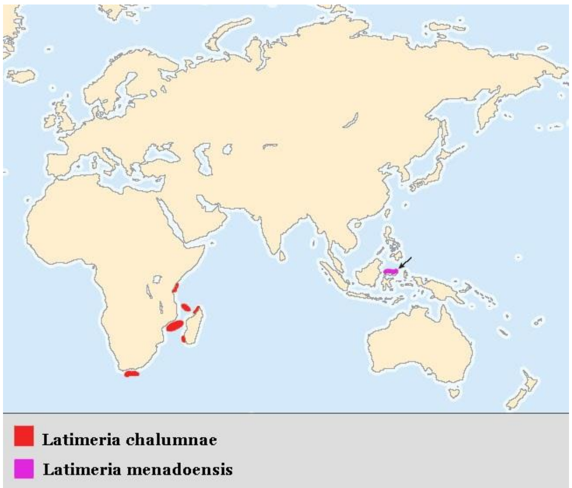

Fig. 8 Distribution of the ‚living fossil' *Latimeria* on opposite sides of the Indian Ocean (from Anaxibia)

e. Caecilians. A notable absence of an animal group from two landmasses may also point to their once close vicinity and relatedness with reference to their fauna and flora. Thus, it is surprising that caecilians, limbless amphibians that are common in Africa, the Seychelles, India, Southeast Asia as far as the Wallace Line, and South and Central America, are totally absent in Madagascar and Australia. This cannot be pure coincidence and substantiates in my eyes the view that oceanic barriers may not be easily overstepped by dispersion.

f. Ratites. In a recent paper, Mitchell et al. (2014) evidenced on mitochondrial sequence data that the extinct elephant bird of Madagascar and the kiwi from New Zealand are sister taxa. To explain the distance of almost 12000 kilometers between the actual habitats of the two palaeognaths, the authors assumed that the common ancestor of these flightless birds must have been flighted and capable of long distance dispersal. The strongest argument in supporting their hypothesis is the assumption that ”Madagascar and New Zealand have never been directly connected”. However, they admit that

“molecular dating provides limited power for testing hypotheses about ratite biogeography. Depending on taxon sampling, estimates for the basal divergence among palaeognaths are equally consistent with the separation of Africa ≈ 100 Ma and the Cretaceous-Tertiary boundary (≈ 65 Ma)”.

By the assumption advocated herein, that Australia was connected with Madagascar until the Upper Cretaceous, the arguable suggestion of a flighted ancestor to two flightless descendants so widely separated geographically becomes superfluous.

g. Boabs. A problematic link between Africa/Madagascar and Australia is the genus *Adansonia*. Pettigrew et al. (2012) note that

“The curious biogeography of Adansonia has caused much speculation […]. The disjunct distribution – in particular, the presence of A.gregorii in Australia, so far from the other species – is unusual. It was originally presumed that the genus represents a relict of the Gondwanan land mass; however, genetic analyses have demonstrated the genus probably arose only 10 million years ago (Ma), long after Gondwana fragmented (Baum et al., 1998).”

Therefore and because of the genetic close relation between *A. gregorii* and the African species *A. digitata* long distance oceanic transport of seed pods is presently favored as a means of dispersal of *Adansonia* into northwestern Australia. However, there are some problems with this hypothesis:

- the shell of the *A. gregorii* seed pods is the thinnest of all the *Adansonia* species which makes it unlikely to have survived floating across the ocean;
- the directions of present-day ocean currents are unlikely to have facilitated the seed pods to reach the coasts of northwestern Australia;
- it is difficult to understand why the seed pods bypassed Madagascar or other islands from the vicinity of mainland Africa but reached Australia.

"All published plate tectonic models for the Australian-Antarctic plate pair imply improbable plate tectonic scenarios…"
Joanne M. Whittaker, Simon E. Williams, R. Dietmar Müller, 2013

Australia's voyage to the Southeast (assuming Africa fixed) – a daring scenario?

Triassic. As part of Pangea, Australia was situated in the actual northwestern Indian Ocean, occupying the entire Somali and most of the Arabian Basin as well as a part of the Mid Indian Ocean Basin (**Fig. 9**). I assume that the northern margin of this block now situated along the central part of Papua-New Guinea (compare Plate 1 in Hamilton, 1979) was contiguous with the actual Oman zone and thus part of the just initiating southern flank of the Alpine geosynclinal 'open channel'. A Triassic-Jurassic rifting and breakup is documented by detached fragments of the margin and by rift sequences in the sedimentary record. According to Pigram and Davies (1987), the rifting may have initiated the Neo-Tethys and/or the Proto-Pacific Ocean, while in my interpretation it documents the initiation of the Tethyan trough. A regression of the sea in the late Early Triassic is marked by fluvial or paralic to shallow marine deposits (Struckmeyer and Yeung, 1991). Large portions of the continental margin were emergent. This situation continued through the Middle Triassic. During the Upper Triassic locally carbonate platforms developed, with deposition of reef limestones of Dachstein and Hallstatt type (Kristan-Tollmann and Tollmann, 1982).

Jurassic. During the Lower and Middle Jurassic fluvial to fluvial-lacustrine as well as shallow marine environments prevailed. Along the rifted margin slope deposits and outpourings of basic volcanics have been recorded. In the Upper Jurassic a transgression took place and bathyal shales became widespread. Magnetic lineations off northwestern Australia and in the Mozambique and West Somali Basin attest the beginning of oceanic spreading during the Middle-Upper Jurassic, at about 157-165 Ma (Royer and Coffin, 1992) or around 170 Ma (Gaina et al., 2013). In my interpretation Madagascar was attached not to India (e.g. Gaina et al., 2013), but to southwestern Australia and rifted away from Africa at the same time. Drifting of Australia/Madagascar with simultaneous opening of the Mozambique und Somali Basins must have been resolved to the northeast by sinistral shearing along southwestern India to which the Seychelles were attached. The structure that is just in the right position to represent the scar between the sheared continental blocks is the so-called Amirante Ridge and Trench Complex (ARTC) in the Mascarene Basin. This structure is an enigma in the plate tectonics framework being explained in different unsatisfactory ways (see Mukhopadhyay et al., 2012). For me it is just one of many shear-belts that abound in the substrate of the Indian Ocean. To the north, the destruction of the southern 'wall' of the Tethyan 'open channel' by the drifting away of the 'Australian module' triggered the northward encroachment of India against Tibet and the initiation of the left-lateral Chaman shear system. A dextral rotation of the Indian subcontinent may have been connected to this initial phase of shearing.

Cretaceous. A relatively quiescent phase followed after the Jurassic rifting. During the Lower Cretaceous siltstones and sandstones grading northwards into deep-facies black shales were deposited along the northern border of Australia/New Guinea (Struckmeyer and Yeung, 1991). According to Gaina et al. (2013) seafloor spreading became extinct about 123 Ma ago in the

Mozambique/Somali Basin. Basic and intermediate volcanic rocks that have been encountered in the stratigraphic record of some New Guinea terranes were regarded by Brown et al. (1980) as indicators of a volcanic arc. According to my interpretation, they may have resulted from shear heating along the tectonic boundary between Australia and India which I mentioned before. During the Upper Cretaceous, about 100-90 Ma ago, a new phase of rifting started, that took place almost simultaneously to the east (resulting in the Tasman Sea) and to the west of Australia. To the west ocean spreading commenced along the Northeast Indian Ridge (NEIR). In its northern part it is possible that spreading started some 20 Ma earlier, shortly after the cessation of rifting in the Mozambique/Somali Basin. The 'jump' from the old to the new ridge may have been triggered by the beginning of the activity of the mantle plume responsible for the emplacement of the Rajmahal traps at about 118 Ma. Other than in plate-tectonic reconstructions based on the assumption of India drifting northward, it is not possible for us to link directly the Rajmahal traps with the Kerguelen mantle plume. While in the north the advance of India against Tibet proceeded further, in the south – probably in direct connection to the activity of the Marion plume – Australia broke away from Madagascar. Its southeastward drift, which, as shown earlier, is supported by the faunal change from low-latitude Tethyan to high-latitude temperate forms, must have been limited to the south by a 'transform', more exactly by a shear system similar to the one that enabled slip against India/Seychelles. I assume that this shear system is in part still recognizable in the morphology of the Indian Ocean and that it is represented by the Diamantina Zone along the southern margin of Australia and its counterpart, the Labuan Basin, along the northeastern border of the Southern Kerguelen Plateau (Munschy et al., 1992) (**Fig. 9**). Before the beginning of rifting along the Southeast Indian Ridge (SEIR) about 43 Ma ago these zones were contiguous. Both are characterized by their extremely rough topography (Munschy et al., 1992) and linear feature. Therefore different authors interpreted them as the expression ('scar') of an extinct very slow-spreading ridge (e.g. Cande and Mutter, 1982; Mammerickx and Sandwell, 1986; Munschy, 1998). However, from within the Diamantina zone alkali basalts and peridotites were recovered. According to Chatin et al. (1998), the basalts cannot be related to ocean spreading processes and thus they interpret the zone as being due to crustal thinning between Australia and Antarctica. They also mention the age of 93 Ma for the initiation of the process, an age that fits well with the beginning of the separation between Australia and Madagascar advocated herein. Both the rugged topography and the occurrence of peridotite are remarkable features characterizing shear zones like oceanic or continental 'transforms'. As I assumed almost 20 years ago, most 'transforms' in the oceanic domain are in fact conjugate Riedel shears that accommodate the shear component of spreading (Strutinski, 1997). The Diamantina/Labuan Zone does not represent such an oceanic 'transform' but is, in my eyes, a true transcurrent system, the **Diamantina/Labuan Shear System (DLSS)**, along which Madagascar and Australia drifted thousands of kilometers apart. A hint on the shear nature of this zone is given by Gaina et al. (2007), who noted:

> *"The Broken Ridge-Kerguelen Plateau experienced some shear motion prior to their separation, and some minor deformation that may be related to this event is imaged in seismic reflection lines as a deformation zone with more chaotic or disturbed sediments."* [2]

The identification of the transcurrent character of the DLSS implies that 43 Ma ago, when spreading along the SEIR began, Australia and Antarctica contacted each other along a tectonic boundary and thus, that the Wilkes Land now opposite to Australia was never the Gondwanan neighbour of it. The

[2] See Added in proof note at the end of the paper.

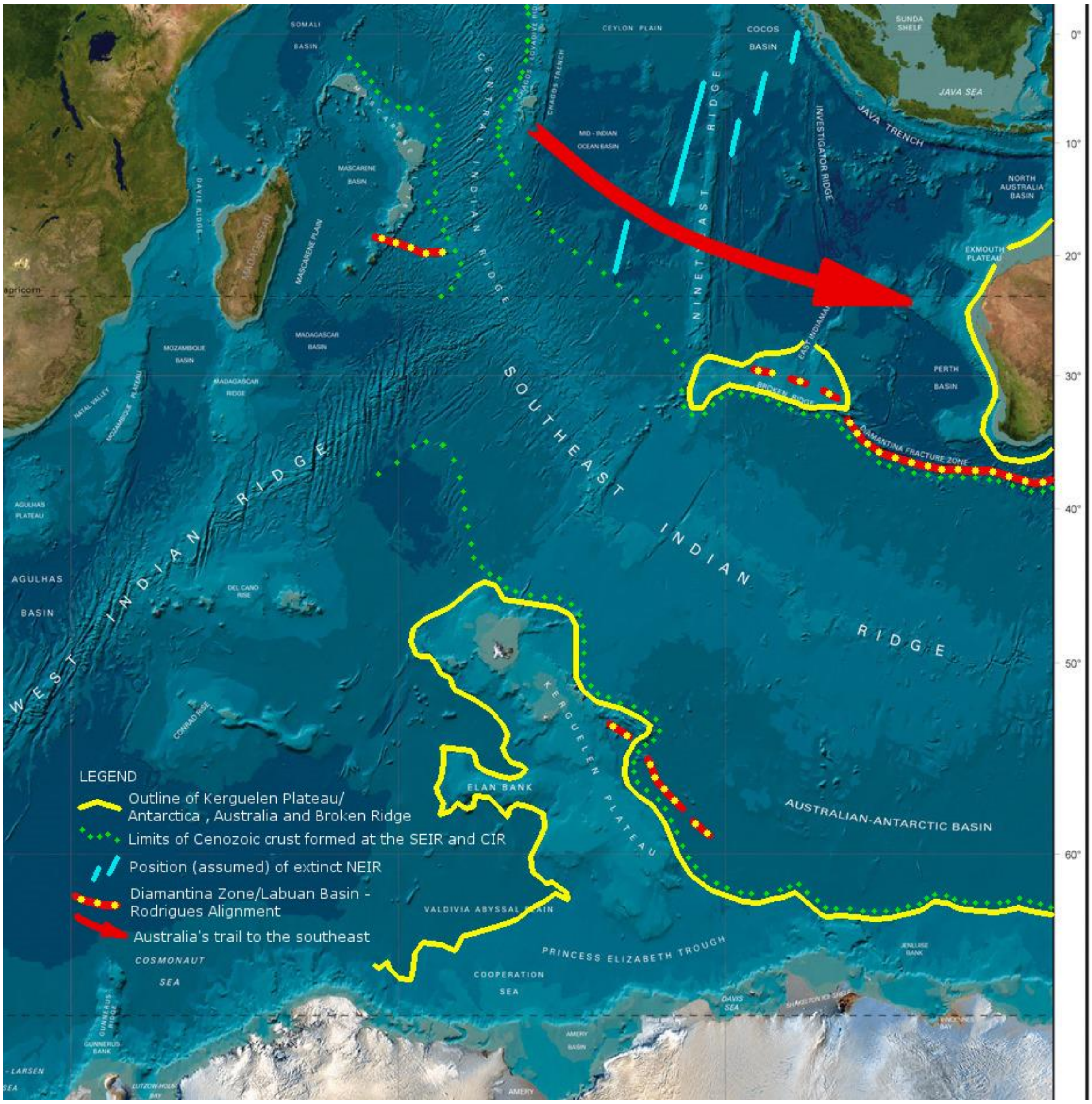

Fig. 9 Australia's voyage to the southeast – an assumption at variance with plate-tectonics models. It greatly allows for the accepted ages of Indian oceanic crust, but not for the geophysically inferred position of extinct spreading ridges. Background map: cut-out from ETOPO1 Global Relief Model (Amante, C. & Eakins, B.W., 2009)

shelf of Wilkes Land does indeed not favor the idea that it lay in the Great Australian Bight. This position would better suit the Enderby Land, an assumption that implies important dextral shear between Australia and Antarctica being in accord with the hypothesis supported herein. To the west the DLSS - the 'scar' separating the Australian and Antarctica 'plates' – disappears under the younger basalts of the Broken Ridge. At the extreme end, west of the Central Indian Ridge, it is highly probable that the Rodrigues Ridge represents the most remote witness of this important shear system which was probably active between 90 and 43 Ma, i.e. during the time of Australia's southeastern journey. This ridge is, like many others, an enigma for Plate Tectonics. As noted by Bhattacharya and Chaubey (2001), "the trend of the Rodrigues Ridge does not have any apparent relationship with transform faults or magnetic lineations produced at the Central Indian Ridge". On the contrary, it could well be integrated in the model proposed here.

Lower Tertiary. The southeastward drift of Australia continued until middle Eocene times at the latest. The southern half of New Guinea was mostly emergent during the Paleocene, whereas in the north deep water pelitic sedimentation persisted (Struckmeyer and Yeung, 1991). In South Australia I assume that the DLSS continued its activity by intense shearing, creation of short-lived local troughs or ridges, emplacement of ophiolites and tectonic imbrication. I am almost convinced that, if the DLSS would occur above sea level, plate tectonicists would recognize it as an accretionary complex similar to that occurring on Timor and consequently having to admit that it represents a paleo-subduction zone.

Once the SEIR initiated as a medium-spreading ridge by the Middle Eocene (43 Ma ago), the activity of the DLSS came to an end and Australia began drifting to the north. This evolutionary stage is beyond the scope of this paper.

Conclusions

The scope of this paper was to show that there are at least as many arguments in favor of a southeastern drift of Australia subsequent to the breakup of Gondwana as there are for the favorite assertion of Plate Tectonics: northward drift of Greater India. Cartographical, stratigraphical, paleontological as well as paleobiogeographical and biogeographical arguments stand against geophysical, mainly paleomagnetic ones and it must be said very clearly that, as it already happened in the past, most geologists - with some notable exceptions – are too inclined to "wilt before the physicists' heat" (Carey, 1988). I wished that stories like that told by Carey, according to which "a procession of geologists reexamined the data and found that, of course, the age of the Earth" was more or less that predicted by the great authority, Lord Kelvin (i.e. 100 Ma!) should not repeat again and again. Wishful thinking, I agree, at least in this respect!

Accepting that India was never too far from Eurasia means, however, that subduction must seriously be called into question. There will be scorn and cover-up from the majority clung to this dogma. However, maybe some of those unbiased may try to test and falsify the facts and hypotheses presented herein.

Added in proof: In 1965 Van Bemmelen intuitively wrote: "The eastward drift of Australia is marked at its starboard by the dextral transcurrency of the Diamantina Fracture zone", an insight completely buried under the arriving avalanche of the Plate Tectonics nouveau-wise.

Read also the Addendum at the end of this paper

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"Despite the considerable amount of existing knowledge about the Cretaceous, the biogeographic relationships of two continents are inconsistent with almost all paleomaps based on geophysical determinations. These are Australia and India."
J.C.Briggs, 1995

Addendum

Based primarily on the interpretation of paleomagnetic data, the hypothesis of Plate Tectonics claims that after breakup of Gondwana India drifted in isolation thousands of kilometers to the north to meet Laurasia; and that for a time interval of at least 100 Ma. According to my hypothesis it was Australia that made a long journey from Eastern Africa first to the southeast and then to the north to its present position, on an expanded globe. Isolation over tens or even hundred million years and longer would have meant that Indian fauna should have become highly endemic. *This is definitely not the case*. India was obviously the confrontation scene between typical Gondwanan and Laurasian taxa right from the time shortly before the breakup. Thus, Sengupta (2002) stresses that India is the only place on Earth where Late Triassic metoposaurid amphibians of Laurasian affinity (known especially from Europe, North America but also northern Africa) are found in close temporal and spatial relationship with chigutisaurids which are believed to have originated in Australia and were restricted to Gondwana. While this situation could - albeit problematically - be regarded as due to a still existing Pangea, showing a broad land connection between Africa/South America and Europe/North America (see figure 3 of Cox, 1974), the fact that no endemism occurred on the Indian subcontinent after its supposed separation from Gondwana about 165 Ma ago cannot be explained in terms of plate-tectonic assumptions. But even for the Late Triassic an assumed coefficient of 76 % of faunal similarity between terrestrial tetrapods from Laurasia and Gondwanaland (Cox, 1974) is in better accordance with the hypothesis of an Earth of reduced dimensions at that time. As already mentioned, the biotic links between India and Africa are surprisingly poor during the Jurassic and Cretaceous and do not lend support to the idea that India remained contiguous to Africa during its northward drift as assumed by Chatterjee and Hotton (1986), Briggs (1995, 2003) and Karanth (2006). Moreover, Chatterjee and Hotton (1986) argued that there are no geological and paleontological links between India and Madagascar.

Very important from the point of view expressed in this paper is the conclusion of Chatterjee (1984) according to which there are no data in support of a direct connection between the eastern margin of India and Australia or Antarctica. This position is further sustained by Dickins and Shah (1987) who deny the possibility of Eastern India to have been situated adjacent to Western Australia during the Permian. These data argue against the almost universally held view according to which Australia was situated to the east (incl. southeast and northeast) of India, no matter how fundamentally paleotectonic reconstructions differ in other respects (compare, i.a., the reconstructions of Smith and Hallam, 1970; Carey, 1976; de Wit et al., 1999; Scalera, 2001; Scotese, 2002; White et al., 2013). At the same time they constitute circumstantial evidence in favor of my idea of a more westerly position of Australia with respect to India prior to Gondwana breakup.

Endemism that should be remarkable in India if the plate-tectonics assumptions were true is, by contrast, extremely evident on the Australian continent. According to Briggs (1995), "the fact that 33 % of the Australian early Cretaceous [tetrapod] families are endemic indicates, by itself, the presence of a barrier to the rest of the world." To my understanding, the "barrier[s] to the rest of the world" were the different oceanic troughs created inside the actual perimeter of the Indian Ocean beginning with the Upper Jurassic. They totally isolated Australia from all other continental masses for a time of at least 65 Ma (from the middle Cretaceous until the Miocene). This isolation is the obvious reason why Alfred Russel Wallace was in the position to draw such a clear-cut boundary between the Indo-Malayan and the Austro-Malayan faunal provinces. Wallace's Line is in fact strongly sustaining my hypothesis and – in the absence of a similar faunal boundary separating India from Eurasia – refutes the far-distance travel hypothesis of India.

The complexity of Archean and Proterozoic terrains in all Gondwanan fragments now surrounding the Indian Ocean (Africa, India, Australia, Antarctica) or occurring within it (Madagascar, the Seychelles) renders it questionable to use data from the literature in order to argue in favor or against India's or Australia's drift hypotheses. Evidently most authors admit spatial contiguity between western India and eastern Madagascar in which case the Seychelles would represent a connecting link between them (Ashwal et al., 2002). Based on their thorough analysis of the igneous rocks from the Seychelles, Ashwal et al. (2002) see, however, a somewhat greater resemblance between the granitic rocks of the Seychelles and the age-equivalent Malani Igneous Suite of Rajasthan in northwestern India than between the Seychelles granites and the igneous rocks occurring in northeastern Madagascar (Daraina Complex). We may therefore cautiously suggest that only the Rajasthan rocks are the counterparts of the Seychellean granites, whereas the Daraina Complex may rather correspond to the Leeuwin Complex from southwestern Australia. Recent data (Collins, 2003) show that the granitic rocks of the Leeuwin Complex were emplaced at ca 750 Ma and then deformed and metamorphosed at ca 550-500 Ma. These data correspond exactly with those characterizing the Daraina Complex. Particularly the deformation of both complexes seems to be an effect of the Pan-African event, which apparently left no trace in northwestern India and the Seychelles. In my opinion this fact has been totally ignored in paleotectonic reconstructions that constantly place Madagascar along the western coast of India. Thus, if the parallelization of Daraina and Leeuwin Complexes is justified, then the juxtaposition of Madagascar and southwestern Australia could be imagined. It is only one instance in which tectonic evolution before the breakup of Gondwana favors my hypothesis and argues against the northward drift of India. Other examples awaiting recognition may still exist.

The main goals of this paper are the assertion of the contiguousness of Eastern Africa and Western Australia within Gondwanaland and the southeastern drift of Australia (Africa considered fixed) after Gondwana breakup. This does not mean that the fit presented in **Figure 6** is the only imaginable. I figured another one that also includes the pre-drift position of Antarctica. It is presented in **Fig. 10**. Taking into account the geometric features of the Great Australian Bight I suspect that the best fit into the bight would be Dronning Maud Land of Antarctica. This presupposes an even greater dextral displacement between Australia and Antarctica than that assumed further up in this paper along the DLSS. Interestingly the same solution for the fit of Australia and Antarctica was also adopted by Brösske more than fifty years ago (Brösske, 1962). The assumption also implies that separation by rifting and seafloor spreading between Australia and Antarctica took place already in the Late Jurassic and not in the Early Tertiary as generally accepted (e.g., Torsvik et al., 2008). On the Australian side witnesses of this severance could be the basaltic/doleritic rocks of Middle Jurassic age that crop out south of South Australia on the islands of Kangaroo and Tasmania (Milnes et al., 1982;

Faure and Mensing, 2010), while on the Antarctic side it is the oceanic crust of Late Jurassic age occurring in the Riiser-Larson and Weddell Seas (Torsvik et al., 2008).

Clearly the solution presented in **Figure 10** is far from perfect because it considers Antarctica as a single block instead of distinguishing between West and East Antarctica. Besides, my representation could not be handled using a computer program. Therefore reconstructions from **figures 6** and **10** are only intended to suggest that different possibilities may be imagined for the pre-drift situation of Gondwanaland, all opposed to the generally accepted one which assumes original contiguity of Africa with India and the 6000 kilometers northward drift of the latter.

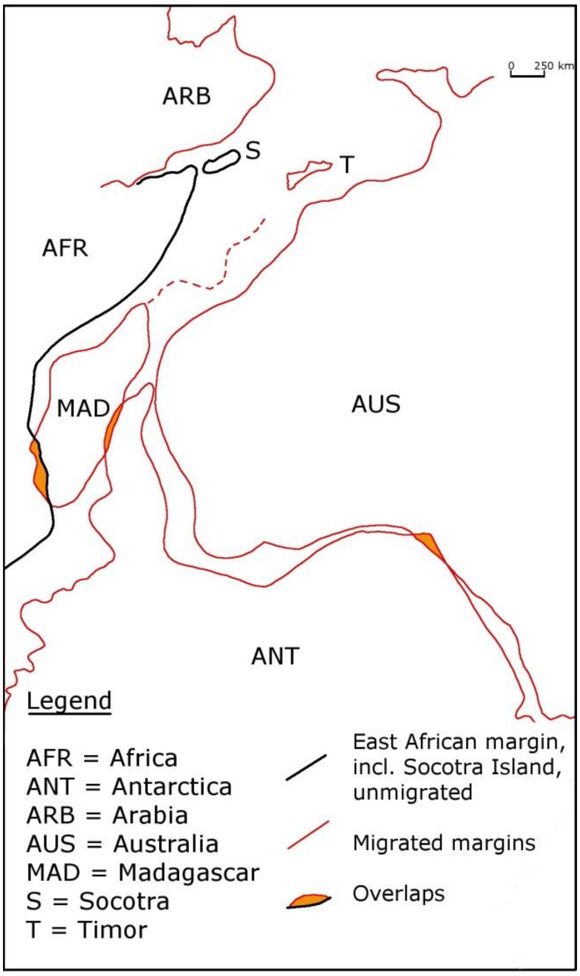

Fig. 10. Fit of constituent parts of Gondwana before breakup and formation of the Indian Ocean. Inherent to presentations in Figures 9 and 10 is the assumption that Australia and East Antarctica separated already during the Upper Jurassic, at the same time as Africa broke away from the rest of Eastern Gondwana. In this situation the unusually elongated Ferrar LIP (=large igneous province) might mark the rupture between East and West Antarctica along the dextral shear zone assumed by Schmidt and Rowley (1986). The broken line includes the Exmouth Plateau to the northwestern Australian margin.

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