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Should Plate Tectonics be replaced by Expanding Earth?

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We learned about the great concepts of Expanding Earth, Continental drift and Plate Tectonics during our graduate and post graduate studies of geology during the 1970s at the University of Lucknow. Subsequently, as Ph.D. students at the Aligarh Muslim University, we focused on the Gondwana assembly in India (Late Paleozoic-Mesozoic) and one of us (RCT) later synthesized the Indian Gondwana Paleogeography in collaboration with the Australian Plate Research Group (John Veevers) for East Gondwana while reconstructing and interpreting Gondwana Master Basins in relation to Pangaea. We took more interest in the concepts of 'Earth Expansion' and 'Plate Tectonics' in the late twentieth century when the Late Prof. F. Ahmad inspired us to re-examine these concepts in the light of various geological evidence. Prof. Ahmad was associated with Prof. S. Warren Carey in his early research career and published his ideas on Gondwana Paleogeography followed by a commentary on continental drift and Earth expansion. We received inspirations by mutual discussions with the Late Prof. F. Ahmad of Aligarh Muslim University, and Dr. V. Raiverman of the Oil and Natural Gas Commission of Dehradun. We continue to be encouraged by the scientific arguments and thoughts presented in research papers and books published from time to time by Earth expansionists.

The geology, biotic contents, pole positions and structure of the northern margin Indian Plate are features which attracted our attention. We read the scientific ideas of many researchers published in various journals and books. We have not attended any scientific gathering of Earth expansionist groups, though we are in email contact with Stephen Hurrell and James Maxlow.[1] Our ideas are based on the logical geological evidence and voluminous literature perused by us in this regard.

The discussion in the following pages convinced us to accept Expanding Earth and forgo the hypothetical Plate Tectonics model of the Earth evolution. We strongly believe that the Earth is expanding through time. The Plate Tectonic concept is merely hypothetical with no geological evidence.

Indeed, the two opposing concepts of Earth expansion and Plate Tectonics are in agreement as far as the ocean floor spreading and progressive separation of the continents. However, Plate Tectonics explains the creation of new crust along the mid-oceanic ridges and consumption of a more or less equal amount of oceanic crust in the deep sea trenches as subduction, so that the Earth continues to be a constant diameter. The earlier proposed Earth expansion concept does not accept "subduction" and consequently the Earth is progressively increasing in diameter, the southern hemisphere somewhat faster than the northern hemisphere. The advent of the new global tectonics about six decades ago, used to explain the present configuration of the Earth, has been considered as a great revolution in the history of Earth Science. However, analysis of the past geological rock record, biotic content, paleoclimatic, structures and paleopole positions do not readily verify the concept. Solely dependent on paleomagnetic data, Plate Tectonicists advocated that India was originally a part of the Tibetan plate, after separation to the southern

[1] *See also the chapters by Stephen Hurrell and James Maxlow.*

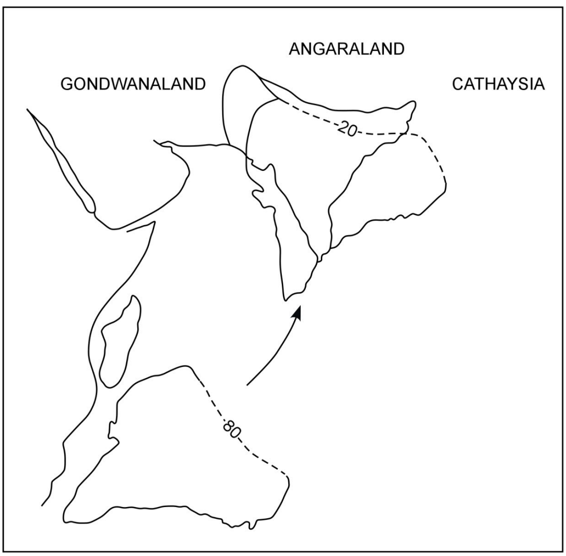

Fig 1. *India, after migrating from the southern hemisphere, rejoined northern Gondwanaland on the north-west, Angaraland on the north and Cathaysia on the north-east. This junction line should, therefore, exist and be visible all along from the Arabian Sea to the Bay of Bengal.*

hemisphere in the region of Madagascar in the Upper Paleozoic, about 30° - 35° S latitude. Further, the return journey of the continent began in the Cretaceous until final collision with Gondwanaland along the west, Angaraland (Tibet) in the north and Cathaysia in the north-east and east, in Eocene-Oligocene, in exactly the original position (Fig. 1).

The proposed subduction of about 3500 km area of oceanic crust in between is considered to have been oceanic crust; all this oceanic crust along the Indus-Tsangpo Suture is a myth and hypothetical (Khan and Tewari, 2016). There is confusion regarding the time of collision of Indian and Tibetan plates as it is considered as old as Late Cretaceous to as young as Eocene-Miocene about 50 Ma ago (Najman *et al.*, 2010; Hu *et al.*, 2016). Recently Xiao *et al.*, (2017) concluded that the terminal Indian–Tibetan plate collision occurred at 14 Ma.

In view of arguments and counter arguments in favor and against the modern global Plate Tectonics, it seems reasonable to re-visit the concepts of Plate Tectonics and Earth expansion in light of past rock record, biota and past climate across the continental landmasses.

The Subduction Enigmas

In the early 19th century, the close matching opposing coastal margins of continents inspired scientists to fit together matching opposing landmasses in a common frame and to display evidences from rock record and biotic contents of the past. Suess's (1889) concept of a supercontinent Gondwanaland and its subsequent fragmentation and sinking into ocean floor was subsequently questioned because sinking of about 60km thick less dense (average density 3.0-3.4 g/cm^3) continental rock beneath the relatively denser ocean basalt rock (average density between 4.0-5.7 g/cm^3) with greatly increasing geostatic pressures is not possible (Fig. 2). The frictional forces required for such a phenomenon should be enormous and the preposition that the less dense subducting plate can plunge into a denser material has not been addressed as yet. A simple force balance calculation can convincingly explain the aforesaid scenario as shown in the box of Fig 2.

Evidently, it shows that inequality is not satisfied - therefore a pushing force cannot produce subduction. Recall that this includes the subduction favorable assumption that there is no drag force i.e., (F=0). A pulling force cannot be occurring because rocks have no tensile strength. Therefore, based on above simple mathematical exercise, there is no chance of any subduction as visualized.

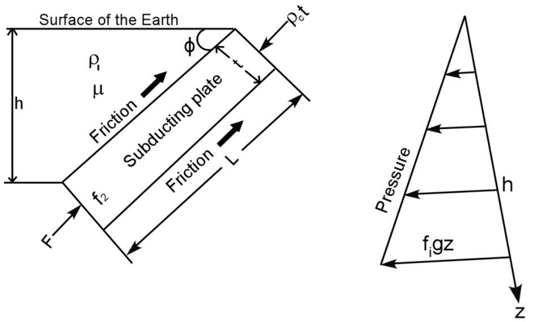

Fig 2. *A simple force balance calculation can convincingly explain that less dense rock can not sink beneath the relatively denser ocean basalt rock with greatly increasing geostatic pressures.*

Let us have a subducting plate (Fig.2) of length L, a thickness, T, depth H, density ρ_2, and is inclined at an angle relative to surface θ. The plate undergoes a compressive stress through the earth's rock mass that has a density ρ_1. Let us consider that solid to solid friction between the plate and the host rock occurs with a coefficient of μ and acts to a depth H. The lithospheric pressure at a depth of z is the mean density $\rho_1 gz$. Drag forces F oppose movement at the leading edge of the subducting plate. To make subduction as likely as possible we have to make the following assumptions:

- The thrusting force, $\sigma_c T$, is perfectly aligned with the subduction angle θ.
- The thrusting force does not exceed the crushing strength of the subducting plate.
- The plate is denser than the mantle surrounding it. This assumption is necessary otherwise the plate would not sink. Actually, the mantle through which the plate must push is much denser than the plate.

For subduction, the sum of forces acting down and to the left must exceed the sum of the forces acting up and to the right *i.e.*

Net thrust + body forces > friction on top and bottom surfaces

$$(\sigma_c T - F) + g(\rho_2 - \rho_1) LT\sin\theta > [\rho_1 g(H/2)L\mu] + [\rho_1 g(H/2) + \rho_2 gT\cos\theta]L\mu \qquad (1)$$

This simplifies to calculate inequality in dimensionless form as

$$(\sigma_c - F/T) / (\rho_1 gL\sin\theta) + (\rho_2/\rho_1 - 1) > [L/T + (\rho_2/\rho_1)\cot\theta]\,\mu \qquad (2)$$

The standard coefficient of static friction for rock is 0.606 and is not temperature dependent until temperature exceeds 350° C.Typical values for the inequality are as follows:

$\sigma_c = 2\times10^8$ N/ m^2 g=9.8 m/sec^2 ρ_1=3200 kg/m^3 ρ_2=3500kg/m^3

L = 160 km T =80 km μ =0.606

Now assuming here F = 0 and putting these values in inequality equation (2) we have

0.04 = 0.09 > [2.0+1.894]*0.6, or

0.13 > 2.34

Hall *et al.*, (2003) presented a numerical model to explain "that it is highly unlikely that the entire oceanic crust at a fracture zone will spontaneously founder". It's very hard to digest that oceanic crust suddenly sinks into the mantle when it is a certain age; in this case it is 180 Ma old. What about the continental crust that is much thicker and older? Probably, the logical explanation for subduction is that the oceanic crust ages and cools, its density increases so that an instability arises and the plate sinks spontaneously in the mantle under its own weight and therefore a self-sustaining subduction zone does not form from a homogeneous plate. Gurnis *et al.*, (2004) proposed that to initiate subduction, the externally applied compressive stresses and moderate convergence are necessary and a likely mechanism would be through transfer of stress induced by collision, leading to forced subduction initiation elsewhere. Indeed, all recent geological collisions have resulted in large mountain ranges and to date there is no evidence that collision leads to subduction. The formation of the Alpine-Himalayan chain represents the collision of India and Africa with Eurasia in the closure of the Tethyan Ocean. According to Gurnis' theory, if large scale collision stress transfer occurred, one should expect subduction to have initiated elsewhere within the Indian and African plates. However, no new subduction zones have initiated south of either India or Africa, or at least any such subduction zone has not been discovered till date.

Early in the 20th century, Alfred Wegener (1924) also proposed that all the Earth's landmasses had coalesced to form Pangaea, a super continent shaped like a giant letter C (fig. 3) that straddled the equator and extended towards the poles.

By the end of 199 Ma ago, perhaps tectonic forces would have slowly begun to split the super continent in Laurasia (north) and Gondwana (south) and drifted through the ocean floor to their position. The tectonic forces for the break up of the supercontinent, the mid-oceanic

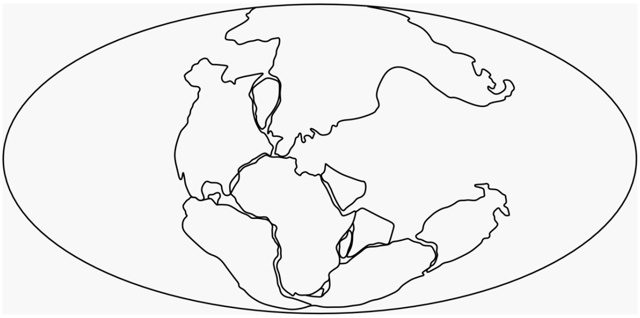

Fig 3. *Shape conformities in the classical Pangaea.*

ridges, are recognized only since the Mesozoic or late Paleozoic, but what mechanism was responsible for the earlier break-ups or for return journeys is not specified. Thus, whereas the oldest age recorded from continental areas is of the order of 3.8 billion years, the oceans are nowhere older than 2.2 billion years, which incidentally corresponds to the final break up of supercontinent Pangaea. Plate Tectonics supporters explained this by subduction of the oceanic areas, however, it is surprising that nowhere has an older oceanic crust survived, or at least none has been discovered to date. Recently the finding of Precambrian and Cambrian rocks near the crust of the Mid-Atlantic ridge contradicted the theory of Plate Tectonics. According to the Plate Tectonic theory the rock of sea floor cannot be more than 5 to 10 million year old. Recently Marvin (2018, p. 17) raised serious doubts regarding the origin of tectonic plates and their existence in the first place. The lack of proof is reflected in the disparity of proposed onset time of Plate Tectonics that vary between 0.85 Ga and > 4.2 Ga.

Number of Tectonic plates

The study conducted by Bird (2003) suggest 52 plates identified on the basis of earthquake locations and further suggested that there should be more small plates, whereas Harrison (2016) proposed a total of 159 plates in all. The largest plate (Pacific) is about 103.3 Mm^2 found underneath the Pacific covering about 20% of the Earth area and the smallest about 273 km^2, whereas, our Eurasian plate, the third largest, is about 67.8 Mm^2. Plate boundaries are defined mainly on the basis of earthquakes and volcanic activity. Therefore, one would expect a close correspondence between plate edges and earthquakes volcanoes belts, but the pattern of earthquakes around the Pacific has been undermined in deep sea regions previously thought to be aseismic (Pratt, 2000). Another major problem is that several "plate boundaries" are purely theoretical and hypothetical, and appears to be nonexistent, including the northwest Pacific boundary of the Pacific, North American, and Eurasian plates, part of the southern boundary of the Pacific plate, and most of the northern and southern boundaries of the South American plate.

Is subduction possible in an arc or trench?

Along trenches with concave arcs, massive folds and mountain building should be apparent at the hinge of the subducting lithospheric plate. Similarly, in convex trenches, large extensional faults perpendicular to the trench would have to occur, yet neither of these two conditions is observed. The entire Pacific basin has trench systems that are arcuate in shape and not straight as must be in physical law of mass balance. It is therefore not impossible for the lithospheric plate to subduct in an arcuate shape without either significant compression in a concave arc or extension in a convex arc.

Abraham Ortelius, a Dutch map maker, was probably the first who proposed the possibility of Continental Drift as early as 1596. Wegener's theory of Continental Drift (1912) and similar suggestions made by Taylor (1910) was systematically ignored for about five decades. The term "Plate Tectonics" was first used by Tuzo Wilson, when he defined the transform faults. Plate Tectonics is based upon the idea that the crust of the Earth is composed of a set of moveable plates that are in motion. According to most Plate Tectonics supporters, ophiolite and blueschists are rocks that are fashioned under very high pressure but low temperature, and only formed in a subduction zone. On the other hand nearly all ophiolites are less than a billion year old; while the most ancient blueschists found in China are about 800 Ma, thus negating the evidence of subduction or Plate Tectonics. Molnar and Tapponnier (1975, p. 419) stated that "because of the buoyancy of continental lithosphere, subduction of one continent beneath another is often assumed to be impossible. Instead, the motion between the two continents is presumed to stop abruptly, suturing them along a young orogenic belt, and causing a marked change in the relative plate motion or the formation of a subduction zone elsewhere". Van Andel (1984) conceded that Plate Tectonics had serious flaws and that the need for a growing *ad hoc* modification cast doubt on its claim to be ultimate unifying global theory.

Stratigraphic, structural, and sedimentological data across the suture zone have for decades been interpreted as indicating an early to middle Eocene age for this collision (Dewey and Bird, 1970; Molnar and Tapponnier, 1975), widely cited as ~50Ma. There is unanimity among Plate Tectonics about the amount of shortening and convergence of India and Asia since this collision. Molnar and Tapponnier (1975) and Patriat and Achache (1984), estimated 3000km since ~50Ma, far exceeded the amount of coeval shortening documented in the Himalaya and Tibet (1000-1500km) (Dewey *et al.*, 1988). Recently DeCelles *et al.*, (2014) and Garzanti and Hu, (2014) obtained the same amount of shortening, with collision reconstructed at ~50-58 Ma but plate convergence being up to ~3600 km, and estimated crustal shortening within Asia (600-750 km) (Johnson, 2002; van Hinsbergen, *et al.*, 2011) and the Himalaya (up to 900km). An explanation for this mismatch is possibly due to the different collision dates 14 Ma (Xiao *et al.*, 2017), collision at 34Ma (Aitchinson, *et al.*, 2007), or 40Ma (Bouilhol *et al.*, 2013), or 44 Ma (Gibbons *et al.*, 2015). However, if this underthrusting has taken place and the supposed 500 km shortening along the Himalaya is added to it there would inevitably have been a displacement of over 1000 km in the continuity of the Baluchistan coast, wherever this junction of the Indian plate with the Asian plate is. River terraces in various parts of the Himalayas are almost perfectly horizontal and untilted, suggesting that the Himalayas were uplifted vertically, rather than as a result of horizontal compression (Ahmad, 1990). Collision models generally assume that the uplift of the Tibetan Plateau began during or after the early Eocene (~50 Ma), but paleontological, paleoclimatological and sedimentological data conclusively show that major uplift could not have occurred before the earliest Pliocene time (5 Ma) (Meyerhoff, 1995). Raiverman (1992, p.148) pointed out that the uplift of the Himalaya and the Tibetan Plateau was very short in duration, sometime between the Late Pleistocene and Holocene and it was entirely vertical with little or no horizontal translation. Vertebrate fossil records from Hundes basin of Tibet including Panthelop, Bos, Equus, Rhinoceros, and Hippopotamus (Norin, 1946) reveal an affinity with the Upper Siwalik fauna and indicate that as late as the Mid-Pleistocene the Tibet Plateau was at a low attitude strengthen aforesaid interpretation.

The Suture Zone Concept

The line of junction of the two plates (Indian and Tibetan), the suture zone, must be present on all the three sides, Afghanistan-Baluchistan, Tibet, and Myanmar (Fig.1). On the west it is identified as the Chaman Fault, in the north it is Indus-Tsangpo Suture Zone (ITSZ), but in the east it is not clearly marked and hence different authors identify it as a different feature from Thailand to the western margin of Myanmar. The collision of the Indian plate and Tibetan plates along ITSZ is supposed to have been taken place in the Eocene-Oligocene and has resulted in ophiolite obduction, according to the Plate Tectonic concept. However, the suture zone terminates at Rinbun, southwest of Lhasa (Fig. 4) within the Jurassic slates intruded by 40 Ma old granites (Beloussov *et al.*, 1979). Indeed, there is no trace of the suture zone east of this point, and this raises the question: what happened to the suture in front of Assam that falls east of Rinbun and where was this part of the ocean subducted?

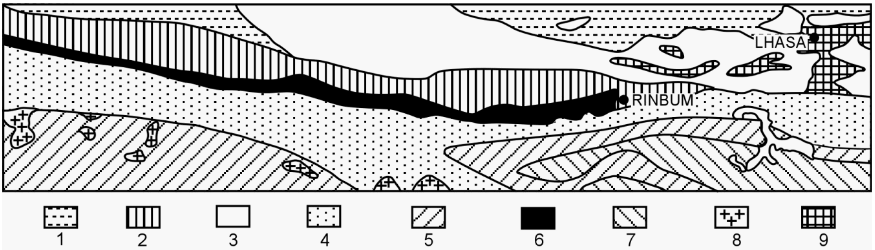

Fig 4. *The Indus Tsangpo Suture Zone ends abruptly at Rinbun, southwest of Lhasa. East of it there is no trace of Indus Tsangpo Suture.1- Lingzizang Formation; 2-Xigaze Group; 3-Triassic Flysch; 4 -Jurassic sediments; 5 -Gangdise belt; 6 - Himalayan granite; 7 – Ophiolites; 8 - Cretaceous sediments; and 9 - Lhasa granite. (After Girardeau et al., 1985)*

Recently Khan and Tewari (2017 and 2018) reexamined the geological and structural features of the northern margin of the Indian subcontinent and questioned the validity of any such feature to be called a 'Suture Zone'. Instead, an ancient 'Rift Valley' is present which is suitably explained with the expanding earth concept.

Recent research has shown that the initial collision took place within the central part of the Indus-Tsangpo Suture Zone (ITSZ) between 65-63 Ma, then spread dichotomously outward towards both the eastern and western Himalayas. This is in contrast with the generally accepted model which postulated an initial collision in the western Himalayas at 55-50 Ma that systematically shifted eastwards. Indeed, the followers of global tectonics are neither sure of the point of collision between India and Tibet nor its time but accept the concept to fit their lines of reasoning without evidence (see: Ding *et al.*, 2017 and references therein).

However, ophiolites in the Indus-Tsangpo Suture according to Peishing and Xibin (1984) belong to two episodes; a Jurassic-lowest Cretaceous and later a Lower Cretaceous, this would mean that the ophiolite emplacement took place millions of years before the supposed collision. These ages, indicated by radiometric dating, are confirmed by associated faunal remains. Peishing and Xibin (1984) and Ding *et al.* (2017) provided evidence that obduction of ophiolite usually occur prior to continental collision. Thus, the metamorphic sole within the ITSZ has been dated between 130-120 Ma - significantly older than an Eocene-Oligocene collision between India and Asia. These ophiolites in the Indo-Tibetan region are not only confined to within the two plates, but are discontinuous with several small breaks.

Moreover, as described elsewhere the ophiolites in the ITSZ belong two different ages. In the case of the Indus-Tsangpo ophiolites Liang Rixuan and Bai Wanji (1984) pointed out that temperatures of 1105-1240° C and a pressure of 27-46 kbar were reached. This, according to these authors, would conform to a depth of 80-140 km. Evidence is, thus, unequivocal that the emplaced rock formations originated at great depths and were in molten state when they arrived at the surface, and individually and collectively the belief is that these are obducted oceanic crust, and hence also the suture concept. Had there been formed oceanic crust, obducted in the process of continental collision, there would, perhaps, not have been two emplacements, nor would have they differed to this context in their physical and chemical characteristics, and certainly would they not have suggested high temperatures and pressures in the region of their origin. Thus the Indus-Tsangpo was not a suture zone along which a supposedly long travelled India had collided with the northern blocks, whatever be the explanation for the paleomagnetic data suggesting this long continental drift.

Drifting of India

It is believed that India travelled some 9000 km in 85 million years (Chatterjee *et al.*, 2013) at an average rate of about 11.5 cm/year – a fantastic speed when compared to the maximum rate obtained along the oceanic ridge today, about 12 cm/year, i.e. about 6 cm/year on either side of the ridge. Indeed, the rate must have been considerably higher and there might have been a long break in the drift. Yet, there is no reason why a much faster rate of spreading could not have obtained, even as an exception, one should nevertheless be able to recognize the counterpart of India, on the other side of the ridge, and that too, must have similarly drifted.

During the Late Cretaceous (80 Ma) India drifted away from Madagascar and began to move northward, isolated from other Gondwana continents. As a result, the Tethyan oceanic crust of the Indian plate began to subduct beneath Eurasia to accommodate the northward journey of the Indian plate. This subduction is estimated to be order of 500 km. This activity is said to be still in progress at the rate of 2cm/year (Armijo *et al.*, 1984) and even 5cm/year (Klootwijk, 1986). Some have even invoked double subduction to explain a rate of subduction of as much as 15cm/year (Jagoutz *et al.*, 2015). Plate Tectonics proposes that the Indian plate, a part of the Gondwana supercontinent during the Permian through to the Jurassic, gradually rifted and drifted northward, colliding first with the Kohistan Ladakh Arc (KLA) during Late Cretaceous (95-65 Ma) before India's terminal collision with Asia, in the early Eocene. Jagoutz *et al.*, (2015) suggested that the collision of India with KLA occurred at 50 Ma. It is believed to have travelled some 9000 km in 160 million years (Chatterjee *et al.*, 2013; Chatterjee and Bajpai, 2016). We are therefore led to believe that 9000 kms of Tethys oceanic crust simply vanished by subduction, leaving only a small ophiolite remnant along its northern, northeastern and northwestern margins.

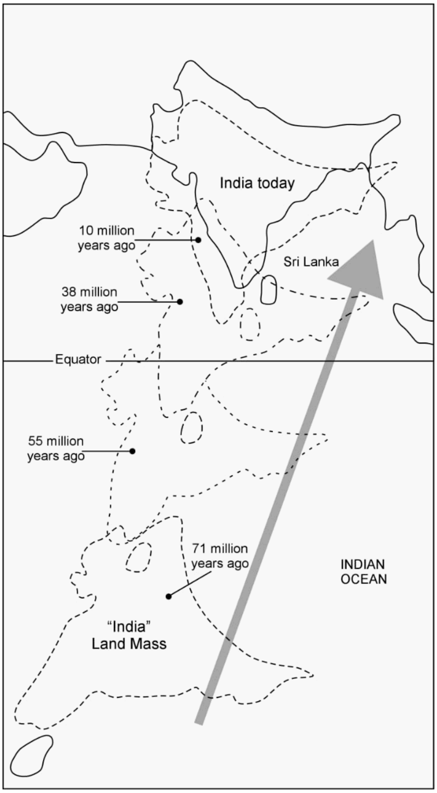

Fig 5. *The drift of India according to Plate Tectonics.*

In most plate reconstructions, India is shown as an island continent during late Cretaceous for millions of years. Such an extended period of continental isolation should have produced a highly endemic vertebrate fauna and we should find some evidence of it, if in fact it ever existed. On the contrary, long term isolation of India, between rifting and collision with Eurasia is also not supported by the vertebrate fossil evidence and Colbert (1973, p.406) is justified in raising the question that if India was drifting northward like an island in the Jurassic and Cretaceous how is it that its dinosaurs and mammals are very similar to those of other landmasses. Thus the concept of the great northward drift of India (see Chatterjee and Bajpai, 2016) is refuted, and the paleomagnetic evidence used to support the drift shall have to be revised, or more probably reinterpreted. Khan and Tewari (2016) provided several geological and biotic evidences and suggested nonexistence of the Gondwanaland supercontinent with no drifting of the Indian subcontinent. On the other hand, Sarwar and Khalil (2017) concluded that there is no evidence that India collided with Asia. The application of the Plate Tectonic model to explain India's incredibly long drift, both in space and time, has not been verified by paleontological and paleogeographic data.

Biotic Evidence Against Isolation of India.

Recently, in Indian amber, 50 Ma old insects (arthropods) were found that are close relatives of species found in Eurasia at the time, suggesting that there may have been island chain linking India and southern Asia by 50 Ma ago (Rust, *et al.*, 2010). Recently, dinosaur's bones of Sauropods, theropods and ornithopods, as well as nests and eggs fragments, have been obtained from the Cauvery Basin, southern India and the Khasi Group, northeast India (Goswami *et al.*, 2013; Fernandez and Khosla, 2015). During the early Triassic, two terrestrial families of labyrinthodont amphibians were widely distributed in Pangaea: the Lyddekerinidae and Brachyopidae. The dicynodonts, perhaps semi–aquatic, genus Lystrosaurus is known in the lower Triassic beds of South Africa, Antarctica, India, China, European USSR and Colbert (1984) reports that it might be present in South America. Rage (2016) thought that the dispersal in both Gondwanian and Laurasian areas was still possible by the end of Triassic, as exemplified by the prosauropod dinosaurs. On the other hand, Cox (1975) has summed up the situation by stating "sixty families of terrestrial tetrapods are known from the Triassic. Their distribution shows clearly that all the land areas which we now recognize as separate continent were then still joined to one another" for "there does not even seem to have been any difference between faunas of Laurasia and of Gondwanaland". From these distributions, it appears that no intra-Pangaeain barriers obstructed the wandering of Triassic land vertebrates. Therefore, the imaginary barrier, an oceanic Tethys, which had been presumed between Gondwanaland and Eurasians continents, should be given up - it did not exist in the Paleozoic or Mesozoic, and perhaps never thereafter. Certainly the paleo-Tethys existed, as an epicontinental or incursive sea, lying largely between the Indian Arabo-African Cratons in the south, and the Siberian and Russian Cratons in the north. It probably covered a very large part of Europe, and extended in the east to the China, Indo-China, the East Indies, and eastern Australia. If the interpretation that Tethys was epicontinental in the central Asia is accepted, it would follow that India has not migrated from the southern hemisphere, as often suggested on paleomagnetic evidence. Instead, it has always been where it is, except for a counter clockwise rotation, beginning around 65 Ma ago, when Carlsberg Ridge came into being.

Colbert (1973) noted the abundance of early Jurassic and Late Cretaceous dinosaur fossils in India and commented that there had to be overland communication between India and other continental regions throughout these times. Similarly, the discovery of mammals, dinosaurs and crocodiles of Madagascar in Late Cretaceous that are closely related to forms in India, and South America (Krause *et al.*, 1997; Verma *et al.*, 2016), also negates isolation of India and points to overland communication. On the other hand, the terrestrial faunal resemblance between India-Africa and India-Europe throughout the Mesozoic suggests that there were close terrestrial links between India, Africa and Europe during this vast span of time (Verma *et al.*, 2016; Chatterjee and Bajpai, 2016). These authors and many other workers using the Plate Tectonic model have conveniently used several bridges at various times to explain the faunal links of India with Africa, Asia and Europe. The recent discovery of Simosuchus-like Notosuchian crocodiles from the Cauvery Basin southern India, is the first report of the group outside the Late Cretaceous of Madagascar (Prasad *et al.*, 2013) and their findings strengthened earlier evidence from other vertebrate groups for close biotic links between India and Madagascar in the Late Cretaceous - most likely through dispersal via the Seychelles Plateau at the close of Late Cretaceous i.e., 66 Ma (Rage, 2003), as well as a discontinuous land connection between India and Africa via the Seychelles block-Amirante Ridge, and Providence bank-northern tip of Madagascar and east coast of Madagascar that existed in Late Cretaceous i.e., 81 Ma (Ali and Aitchinson, 2005). Moreover, biota of Australia, New Zealand and Madagascar landmasses, that has been isolated for much of the Cenozoic, makes it clear that diverse evolutionary trends takes life in uniquely different directions within a few million years. India should have acted no differently if it was totally isolated for any substantial length of time. If there was no oceanic gulf north of the Himalayas, there is no getting away from an Earth of considerably smaller diameter, as suggested by Carey (1988), for this "gulf" cannot be closed on a globe of the Earth's present diameter. Before the Earth expanded, the sea level must have been much higher even when we take into account the melting of the polar ice caps. Geoscientists have found fossils of sea creatures on every continent, from immature to fully grown in rock layers well above sea level.

THE EXPANDING EARTH CONCEPT

Paleoclimatology Evidence

The Paleoclimatology record is preserved from Proterozoic time to the present in the geographic distribution of evaporite, coals, and glacio-marine tillites. The locations of these paleoclimatic indicators are best explained by stable rather than shifting continents (Boucot and Gray, 1987), and by periodic change in climate, from globally warm or hot to globally cool (Meyerhoff *et al.*, 1996). In the Carboniferous and Permian glaciers covered parts of Antarctica, South Africa, South America, India, Tibet, and Australia. A shallow Epicontinental Sea within Pangaea could have not provided the required moisture because it would have been frozen during the winter months. These glaciations are easier to explain in terms of the continents' present position; nearly all the continental ice centers were adjacent to or near the present coastlines, or in high plateau and/or mountain lands not far from the present coasts as suggested by Pratt (2000). Plate Tectonics supporters believe that the continents have shifted since the start of the Cenozoic (some 65 Ma), yet this period has seen significant alternations in climatic conditions. During early Pliocene time the width of the temperate zone has changed by more than 15° (1650 km) in both the northern and southern hemisphere. The uplift of the Tibetan Plateau appears to have played an important role in the late Cenozoic climatic deterioration (Ahmad, 1990; Raiverman, 2002). To decide whether past climates are compatible with the present latitudes of the region, it is essential to take account of vertical crustal movements, which probably have significant changes in atmospheric and ocean floor, and distribution of land and sea (Ahmad, 1990; Dickins, 1994).

Biopaleogeography Evidence

Meyerhoff *et al.*, (1996) concluded that the major biogeographical boundaries do not coincide with the computer-based plate boundaries postulated by Plate Tectonics supporters. Nor do the proposed movements of continents correspond with the known migration routes and directions of biogeographical boundaries. In most cases, the discrepancies are very large and not even an approximate match can be claimed. The known distributions of fossil organisms are more consistent with an earth model like that of today than with continental drift models, and more migration problems are raised by joining the continents in the past than by keeping them separated (Smiley,1992; Scalera, 2003). It is unscientific to select a few faunal identities and ignore the greater number of faunal dissimilarities from different continents that were supposedly once joined. There was widespread distribution of the Glossopteris flora in Gondwanaland, but it rarely pointed out that this flora has been found in northeast Asia for example, mammal distribution indicates that there was no direct physical connection between Europe and North America, Australia and East Asia, and Antarctica and Australia during late Cretaceous and Paleocene times but suggests temporary connection during Eocene. Most of the Plate Tectonic proponents have suggested an initial disconnection with no subsequent reconnection but very few drifters recognized intermittent land bridges after the supposed separation of the continents (Chatterjee and Scotese, 2010; Chatterjee and Bajpai, 2016 ; and many more). Various oceanic ridges, rises, and plateau perhaps served as land bridges and some of them may have been partly above water at various times in the past.

Paleopole and Earth's Diameter

The paleopole position for any geological period can be determined by two altogether independent lines of evidence – paleomagnetism and deposits formed by the polar ice caps of the time. Thus, pole positions for almost all the geological ages have been determined by the former method, but data are not available from the ice deposits, particularly so for the North Pole. The South Pole migration path based on glacial deposits has been worked out by Ahmad (1960) from the Ordovician to the Permian and the Cambrian pole position has been recognized since. These tentative polar positions do not often coincide with those determined by paleomagnetic evidence. The Cambrian North Pole, according to paleomagnetic data was situated in the present Indian Ocean and migrated northward across northeastern Siberia to its present position, having remained almost all through within the Pacific. The South Pole in Cambrian was located in northwest Morocco, whereas it was in the present Gulf of Guinea (northeast Brazil, then) in the Ordovician. Thereafter, it moved southeast ward progressively to the southeast of Natal in the Permian, being located almost in the middle of Antarctica, in the Pangaea assembly. In Smith and Hallam's (1970) reconstruction it was in Antarctica, although not in the middle, whereas Irving's (1977) 250 Ma pole is about 1500 km away to the southeast (Fig. 5). The Permian position pole moved gradually south to its present location. The upper Permian North Pole was in Verkhoyansk area and the South Pole to

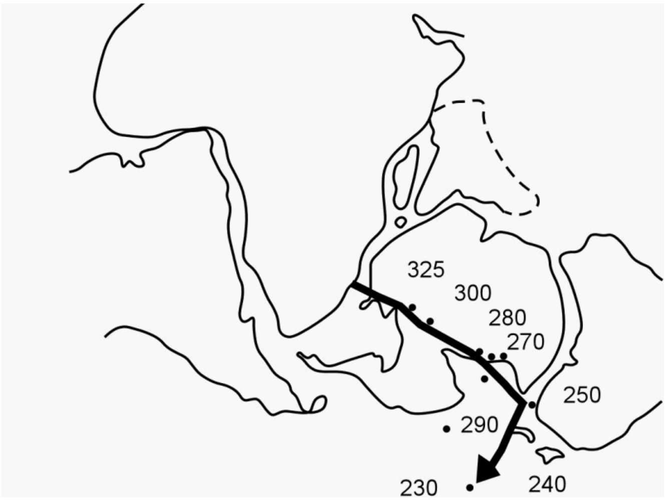

Fig 6. *Polar migration route of South Pole after Irving (1977)*

the southeast of Africa (Van der Voo and French, 1974; Irving, 1977). These pole positions indicate the diameter of the Earth must have been 55-60% of the present at that time. Irving's (1977) Cambrian North Pole is confirmed by glacial deposits in Montezuma, northwest Tasmania whereas; Cambrian South Pole was admittedly located in northwest Morocco, or just across the existing coast. These two pole positions yield a diameter about 50% of the present. It is evident that in the 250 Ma, since the Permian expansion was much more than in the immediately prior 250 Ma since the Cambrian.

A mathematical result (see box) shows that the current volume of the Earth is 355.5% greater than the primitive volume at a time period of 180 Ma. The radius of the Earth is 152.6% greater which means that the average growth rate of the Earth's radius is 1.22 cm/year. Marvin (2018) measured the surface area and radius of that cover a time interval of 30 Ma and results shows that the radius of Earth at 180 Ma ago was 4174.69 km and increases to 4892.51 km at 90 Ma and at present it is 6371 km corresponding surface area of 0.2190 x 10^{12} km^2 at 180 Ma then increased to 0.3008 x 10^{12} km^2 at 90 Ma and further increased to 0.5100 x 10^{12} km^2 i.e. at present. Hurrell (2011) described various methods, such as dynamic similarity, leg bone strength, ligament strength etc. that can be used to estimate reasonably accurate values of ancient gravity. The ancient gravity calculated yielded a value of 25% of the present gravity value at 300Ma and increased to 65% of the present at 50 Ma using various estimation methods (see Hurrell 2011, graph Fig. 1). It is concluded that paleogravity, surface area and supporting geological and paleontological and paleoclimatology

Another assessment of the expanding Earth can be made with the following mathematical equation:

At present, the total area of continental crust is 2.19 x 108 km^2, covering 42.9% of the primitive Earth surface. If the oceanic crust of maximum 180 Ma old is eliminated, all continents join together in to supercontinent on a smaller sphere.

The radius and volume of the primitive Earth at 180 Ma was:

Surface area $A = 4 \pi R^2$ Volume $V = 4/3 \pi R^3$

$R = \sqrt{A}/ 4 \pi$ $V = 4/3 \text{ x} 3.143 \text{ x } [4174.6]^3$

$R = \sqrt{2.19 \text{ x } 108 / 4 \text{ x } 3.143}$ km $V = 0.3047 \text{x } 10^{12} \text{ km}^3$

$R = 4174.6$ km

Current physical characteristics of Earth

Radius = 6371 km. Volume = $1.0832 \text{ x } 10^{12}$

constraints rule out the collision and underthrusting of Indian plate and evidently support the Earth expansion model.

From the above explanations it is concluded that the Indus-Tsangpo Suture Zone (ITSZ) concept based on paleomagnetic data and Plate Tectonic is not valid. All available field evidence suggest that India has retained its present relationship with the northern continents and hence also with its western and eastern neighbours. No seismic activity is recorded along it, which would have been inevitable if subduction was in progress. Moreover, outpouring of magma took place in the Jurassic-Cretaceous, and again in early Cretaceous, when India should have been, according to Plate Tectonicists, in the southern hemisphere.

The concept of the double thickness of the crust in Tibet, supposed to suggest that India is progressively underthrusting it is not justified. Indeed this unusual thickness continues to the south of the suture, and thereafter decreases gradually to the Himalayas and farther south, indicating the progressive shallowing of the epi-continental Tethys southward. Also important is the fact that a thick wall of ophiolites stands between the two plates, and if it is a consequence of collision, then it has been there from the moment the collision took place. It is practically impossible for the Indian plate to pass through this wall.

The poles for the Permian are confidently identified and indicate the Earth must have been about 55-60 % of the present diameter. Both the Cambrian poles can be similarly identified with reasonable confidence and yield a diameter 50% of the present. Mathematically calculated radius of the Earth from 180 Ma to present suggests unequivocally that the radius of Earth was smaller and expanded progressively. And a progressively increasing rate of expansion supported by a decline in the gravitational constant from about one third to about one half of the present from Precambrian up to Mesozoic. Shield (1997, p. 960) has pointed out that "the success of any scientific theory is not measured by being in fashion or by how many followers but whether it can stand up to the test of time".

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The *Hidden History of Earth Expansion* presents the personal histories of some of the most well-known researchers into Earth expansion in 14 original essays. In addition to furnishing us with their personal histories, as they strived to explore the seemingly overwhelming evidence for confirmation of Earth expansion, the authors' highlight areas where further research is required.

The chapters expressly written for the book are:

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