Indus-Yarlung-Tsangpo Suture Zone Concept- A Second Opinion

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Abstract

It is believed that Greater India migrated from the southern hemisphere, collided with Gondwanaland, Angaraland and Cathaysia, thereby closing an intervening oceanic Tethys along the Indus-Yarlung-Tsangpo Suture Zone (IYTSZ).The suture zone is placed along the Chaman Fault in the Baluchistan-Afghanistan area in the west, and the Indus-Yarlung-Tsangpo in the north, whereas along the east from Thailand to the western Myanmar, identified as different features almost arbitrarily by various authors. However, the Chaman Fault shows younging southward with a number of breaks in the Baluchistan region and abruptly stops short of the coast, taking a sharp turn to the west. More important, the Indus- Yarlung-Tsangpo Suture Zone terminates at Rinbun to the west-southwest of Lhasa, and passes into Jurassic slates/ granites. The extensive Permo-Carboniferous fluvio-glacial deposits and the presence of Gondwana flora and fauna on either side of the Indus-Yarlung-Tsangpo suture suggest continental continuity from Peninsular India to northern Tibet in the Paleozoic. There was also a continuity of climatic zones from the Indian to the Tibetan side of the platform, atleast from Proterozoic to the Quaternary period. The presence of Triassic Gondwana vertebrates in China, Indochina, Mongolia, and Siberia supports free two-way land routes between India and aforesaid landmasses even in Mesozoic. Therefore, various geological arguments based on observed field data do not support the existence of Indus-Yarlung-Tsangpo Suture Zone as a suture zone of modern plate tectonic concept. Instead, it is better explained as a rift valley formed more than 100 Ma prior to supposed collision because the ophiolite emplacements confined to the north and south by steeply dipping faults.

Keywords: Indus-Yarlung-Tsangpo Suture; Plate Tectonics; Chaman Fault; Rift Valley; Gondwanaland.

1- Introduction

Alfred Wegner (1924) has been credited for the concept of one continent, Pangaea, over the globe, and one ocean, Panthalassa; the present continents were more or less carved out of the former. Alex Du Toit (1937) postulated at least two or even four continents, Laurasia, and Gondwanaland, and perhaps also, Angaraland and Cathaysia placing Gondwanaland over the South Pole, and all others in the northern tropical belt- the vast area in between have been occupied by Tethys. The concept gained ready acceptance, and the Gondwanaland was treated as a separate entity. The oceanic Tethys was later modified to a triangular gulf, closing near the Black Sea or farther west, when Pangaea was resurrected. Carey (1976) demonstrated that this “triangular gulf” was an artifact and would be closed if the Earth were of a smaller diameter. Waterhouse (1986) has shown that the great wedge-shaped ocean that gaped eastwards between Laurasia and Gondwana, seems to be discredited by detailed geology and faunal distribution. Moreover, Dickins (1999) suggested that the triangular gulf was not based on geological data but resulted from fitting South America and South Africa thus either pulling all of Asia down to the south or making some arbitrary split to form a wide eastward facing Tethyan gulf. It suited the global plate tectonics to collide Greater India with Angaraland, and subduct continental or ocean crust alike, for the Himalayas were to them the paradigm for continent-continent collision. Detailed field studies in the Karakorum and Tibet suggest that sediments of the supposed southerly and northerly shores were genetically related and should not be far apart. Statistical studies of faunal distributions affirm that the two shores lay in juxtaposition, south of the equator. The Indus-Yarlung-Tsangpo Suture does not mark a vast Permian sea-way or ocean, now closed. Even before the so-called global plate tectonics concept was introduced, Tethys was believed to have been closed, reopen, and then closed again, with an imaginary trench somewhere in central Asia subducting 3000-5000 km of oceanic crust. Tethys is believed to have vanished completely, leaving only small ophiolitic remnants along its northern, northeastern and northwestern margins which is simply too hard to reconcile especially considering all the physical problems involved in subduction (Choi, 2006; Pitchin, 2016).

Based on paleomagnetic studies, Greater India is supposed to broke away from Pangaea in the late Paleozoic from southern hemisphere position besides Madagascar, to collide with the Tibetan plate. Mid-oceanic ridges are believed to be responsible for this return journey in the Eocene-Oligocene, exactly in its ***original*** place. Moreover, the mid-oceanic ridge responsible for India's southward migration must have been of considerable altitude in the middle,- it could have been very like the Mid-Atlantic Ridge, if not higher, a veritable sub-oceanic Himalaya – and for it to get completely subducted seems rather difficult to envisage. Later, the Indian plate is believed to have thrust below the Tibetan plateau. The underthrusting is estimated to be of 500 km and such activity is said to be still in progress at the rate of 20 mm/year (Armijo *et al*., 1984) and even 50 mm/year (Klootwijk, 1986). Recently, Jagoutz *et al*. (2015) have even invoked double subduction to explain high rate of subduction of as much as 140 mm/year. 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. Indeed, the absence of a displacement along the coast suggests that neither there has been any underthrusting of the Indian plate beneath Tibet, nor any shortening along the Himalaya. Moreover, the Indus-Yarlung-Tsangpo Suture Zone is seismically inactive and the suggested underthrusting seems to be producing no seismic disturbance in the area, or any cause by this activity underneath the Tibetan plate. For a 30-35 km plate to ***smoothly*** slip underneath a 30-35 km thick plate is obviously inconceivable. Also, no suggestion has ever been offered as to why the Indian plate sank by an unprecedented 30-35 km to underthrust the Tibetan plate and with greatly increasing geostatic pressure with depth. Indeed, there is no field evidence for this supposition.

The global plate tectonic concept is based on the conventional continental drift theory. However, there are yet several limitations and geological constraints as pointed out by the geoscientists' time to time (Cwojdzinski, 2016; Hurrell, 2017; Maxlow, 2018). Among others, the Indus-Yarlung-Tsangpo Suture is considered as suture zone to facilitate northward drift; collision and subduction of Indian plate. Indeed, the geology of the northern margin of Indian and southern margin of Tibetan plates do not amply justify the above feature as a suture. Recently, Khan and Tewari (2017) pointed out that all the channel flow distributed in the hanging wall is in accordance with the result that the Indian continent did not experience any subduction. Indeed, the latest geophysical data presented by Gao *et al*. (2016) strengthen the above interpretation.

The present contribution discusses the origin and status of the so-called Indus-Yarlung-Tsangpo Suture Zone, and to refute the arguments of global plate tectonics supporting the collision. The study is based on well-known paleontological and structural data, and glacial-marine sediments from Tibet and other opposite regions.

2- The Indus-Yarlung-Tsangpo Suture Zone

If the Indian subcontinent has migrated from southern hemisphere and joined back the northern continent in the original position, the suture zone, the line of junction of the two plates, must be present on all the three sides, Afghanistan-Baluchistan, Tibet and Myanmar (Fig. 1). On the west it is identified as Chaman Fault, in the north it is the Indus-Yarlung-Tsangpo Suture Zone, but in the east it is not clearly marked and hence by different workers it is identified in different features from Thailand to the western part of Myanmar, almost arbitrarily.

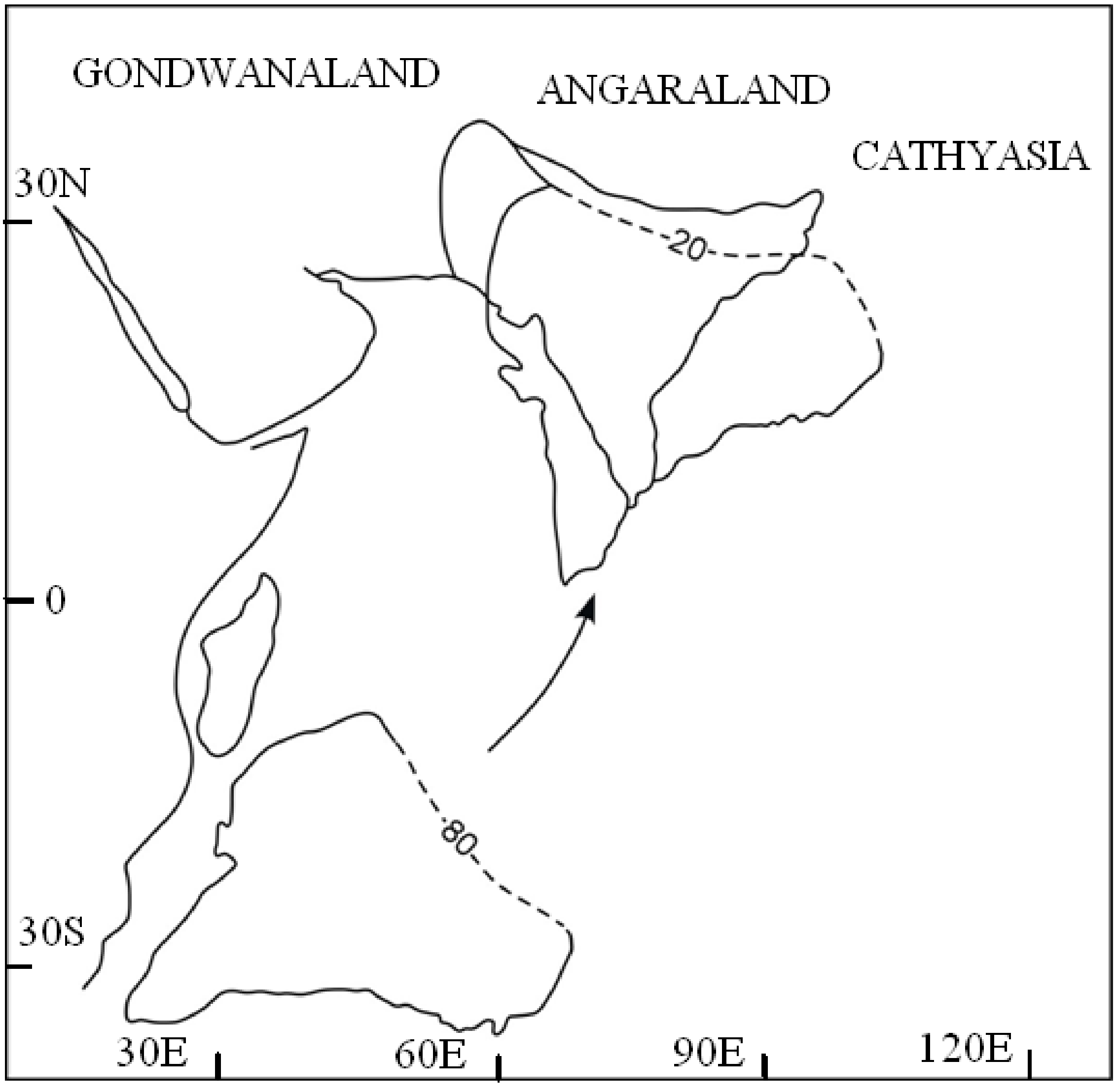

Figure 1) Greater India migrated from the southern hemisphere and collided with the Asia plate about 20 Ma ago. Part of the Indian plate is underthrust below the latter (after Powell, 1979).

2.1- Confusion on Timing of Collision

According to Plate tectonics model, it is believed that India drifted northward across a vast Tethys and collided with the various Eurasian blocks and arcs. Indeed, there is no unanimity regarding the time of the collision of India-Asia along the Indus-Yarlung-Tsangpo Suture inasmuch as it is considered as old as the Late Cretaceous to as young as the Oligocene-Miocene about 50 Ma ago (Najman *et al*., 2010; Hu *et al*., 2016; and references therein). Very recently, Xiao *et al*. (2017) concluded that terminal India-Eurasia collision occurred at 14 Ma. Thus, there is a great deal of confusion regarding the time of collision among the Plate tectonic communityand suggestions are given that it has taken place within a wide range any time between > 65Ma and < 40Ma (Zhang *et al*., 2012). It seems likely that different plate tectonic followers are neither sure of collision between India and Asia nor its time but accepting the concept to fit their lines of reasoning.The Indus-Yarlung-Tsangpo Suture zone stops more or less abruptly near Rinbun, west-south-west of Lhasa and there is no trace of IYTSZ farther east (Fig. 2). Its place is taken, however, by Jurassic slates and intrusive granites dated as 40 Ma (Beloussov *et al*., 1979). Thus, the suture zone dies out in a rock formation much older than the supposed collision and suturing. In fact, during the Jurassic India should have been in the southern hemisphere, if the plate tectonics model is valid. If so, than where did the ocean in front of Assam subduct? It means that a length of over 800 km and an oceanic area of 2.5 million kms are involved. It, too, must have moved northward almost as much as the rest of India. Where did it disappear?

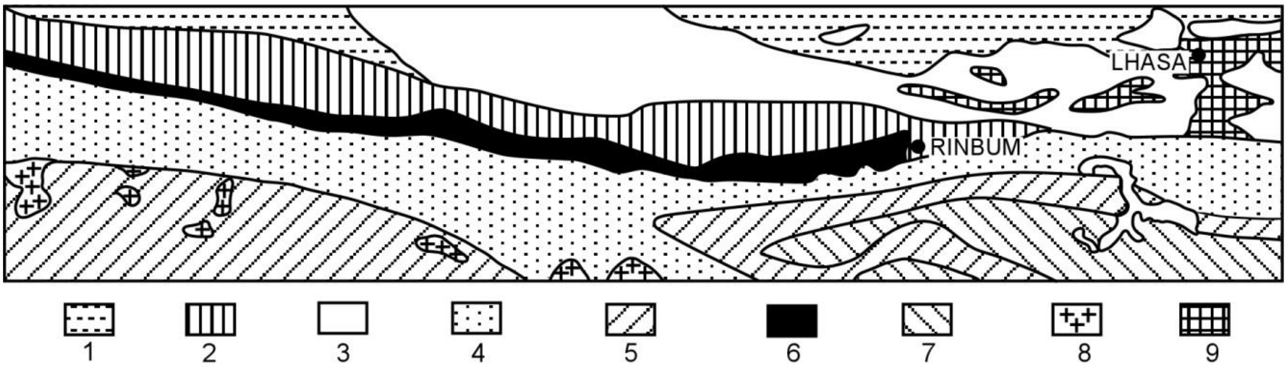

Figure 2) The Indus Tsangpo Suture is noted for its ophiolite and Triassic mélange and ends abruptly near Rinbun, southwest of Lhasa. East of it there is no trace of it (after Girardeau et al., 1985): 1. Lingzizang Formation; 2.Xigaze Group; 3. Triassic Flysch; 4. Jurassic sediments; 5.Gangdise Belt; 6.Himalayan Granites; 7.Ophiolites; 8. Cretaceous sediments; 9. Lhasa Granites

Ophiolites in the Indus-Yarlung-Tsangpo suture belong to two different episodes, Jurassic-Lowest Cretaceous and later a Lower Cretaceous (Bao Peishing and Wang Xibin, 1984) implying that the ophiolite emplacement took place millions of years ***before*** the supposed collision and suturing. Stoneley (1974) admitted that the ophiolites were emplaced while that the Indian continent was presumably still some hundreds of kilometers and in fact thousands of kilometers away from Eurasia; and Tapponnier *et al.* (1981) worried that the ophiolites occurred earlier than at the end of the Eocene, which places new constraints on subduction speculations. Le Pichon (1978) placed Greater India 1000 km away from the then border of Eurasia in the Eocene, and, accordingly, envisaged this much of shortening in the Himalayas. However, if India migrated at an average rate of 50 mm/year it must have travelled same distance in 20 Ma, and then only the collision must have taken place, perhaps in the Oligocene. In view of this evidence, Najman *et al.* (2010) and Xiao *et al.* (2017)

asserted that the Indus-Yarlung/Zhangbo ophiolite in the fore-arc basement of the Asian active margin was probably obducted during Eocene, just because it fits in with the new global tectonic concept. Further, Gopel *et al.* (1984) suggested that just the existence of two ophiolites in itself placed constraints on the new global plate tectonic model. Moreover, these ophiolites in the Indo-Tibetan region are not only confined to within the two plates, but are discontinuous, with several small intervening breaks. On the contrary, all extrusions of ophiolites in the Chaman Fault region took place well away from the fault and lie entirely on the two opposite plates (Fig. 3). No protagonists and antagonists of the concept has offered an explanation for this phenomenon, for if they are all allocthonous there should be some remnant, some evidence of their former existence along the actual plate junction as well.

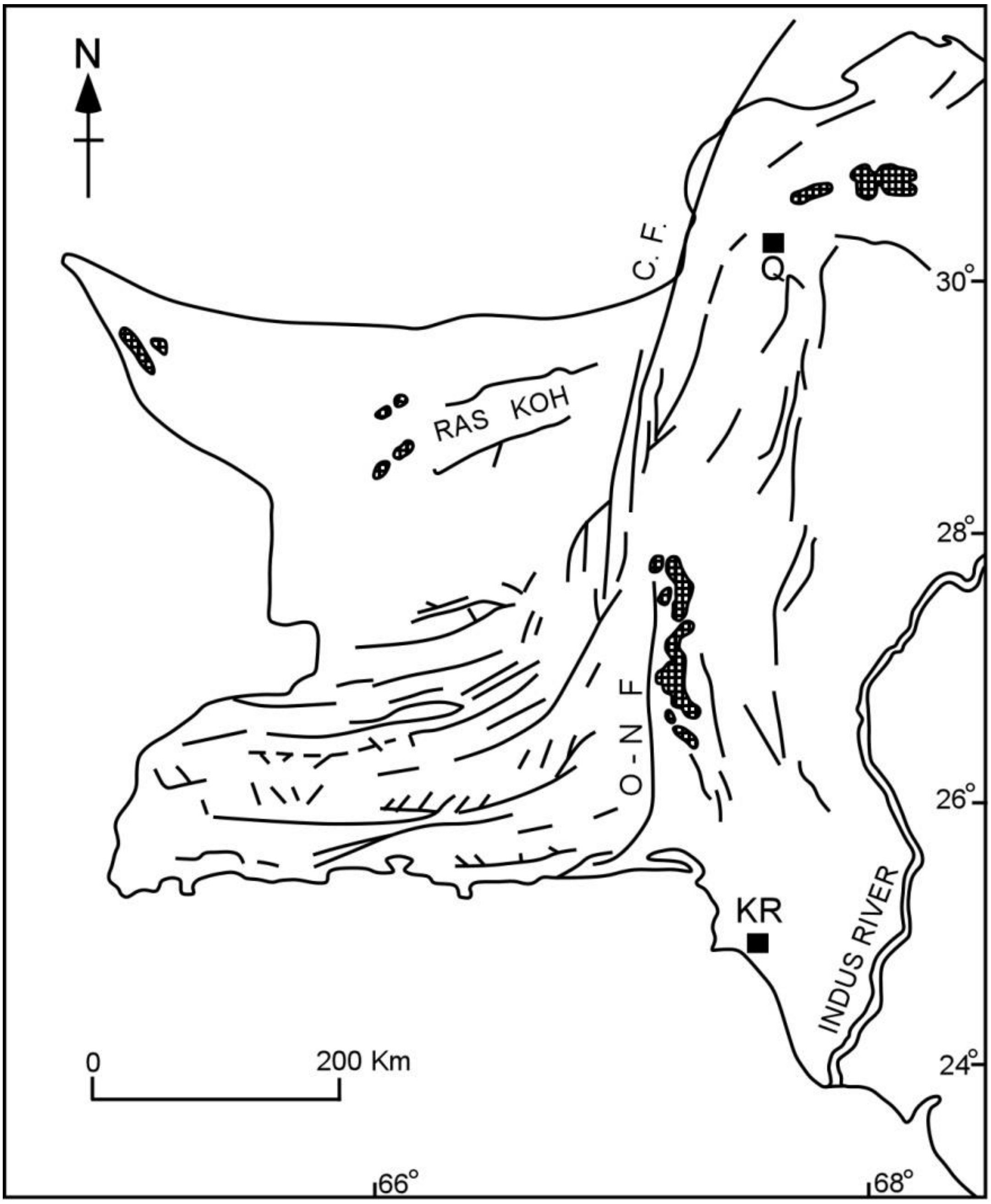

Figure 3) The ophiolites have resulted along the Chaman Fault; however, lie well to the east and west of the fault. Note no fault crosses the coastal area; instead all take an abrupt turn to the west (after Quittmeyer, Farah & Jacob, 1979)

Significantly, while the ophiolite emplacement was taking place in the Indus-Yarlung-Tsangpo Suture Zone, intermediate-acid volcanic were being outpoured extensively over the Lhasa terrane, to form a vast batholiths. Magma outpouring was perhaps on a massive scale and bespeak of tension. This activity continued into Tertiary and is correlated with the Himalayan episodes (Khan and Tewari, 2017).

2.2- IYTSZ: A Suture or a Rift Valley

More important, the ophiolites are confined on the two sides by almost vertical walls (Tapponnier *et al*., 1981) and suggestive of a rift valley and not suture zone. Raiverman (1992), additionally, point out that typical ophiolites are not present throughout the length of a suture. These rocks were studied by Bao Peishing and Wang Xibin (1984) and Bai *et al*. (2004) who concluded that the magma seem to have tapped two different levels of the mantle. The Lower Cretaceous emplacement occurs largely as pillow lava and occupied the northern margin of the suture zone. Liang Rixuan and Bai Wanji (1984), from the study of included minerals, believed that magma originated at a temperature of 1105-1240^{o}C and a pressure of 27-46 kb. Subsequently, Robinson *et al*. (2004) and Yang *et al*. (2007) reported the occurrence of a variety of ultra-high pressure minerals (UHPM) such as diamond, moissanite, native metal and PGE alloys derived from oceanic lithosphere mantle have been found in the ophiolite complex. This according to these authors, would conform to a depth of 80-140 km. Significantly, holocrystalline chromites ore if often carries warty structures, whereas diamond, moissanite, being minerals formed in low oxygen fugacity, but at high temperature and pressure, as well as native iron have been discovered from this formation (Liang Rixuan and Bai Wanji, 1984; Robinson, *et al*., 2004). These evidences suggest that the emplaced rock formations originated at great depths and were in molten state when they arrived at the surface, negating the belief of obducted oceanic crust, and hence also the suture zone concept. Had there been formed of oceanic crust, obducted in the process of continental collision, there would ***not*** have been two separate emplacements, nor they differed in their physical characteristics, and certainly would not have suggested high temperatures and pressures in the region of their origin. Radiometric dating of the ophiolite complexes preserved along the Indus-Yarlung-Tsangpo Suture Zone and obducted onto the northern continental margin of India in Xigaze (Tibet) yielded an age of 119± 25 Ma from the southern ophiolite, whereas an age of 80 ± 5 Ma from a garnet amphibolites was given by the northern ophiolite. Bao Peishing and Wang Xibin (1984) have compared these ophiolites with the mid-oceanic ridge basalts and found them entirely different. Furthermore, Crawford (1979) pointed out that it is not correct to assume genetic continuity of those along the IYTSZ and those of western sector. Ophiolites may be wrongly identified as relics of former oceanic crust. They may instead be mantle derived material related to deep crustal disturbances. On the other hand, Yin *et al*. (1998) based on field observation and petrographic studies deny the presence of obducted ophiolite suite. They do not think the blueschists are related to subduction and therefore maintain that they cannot be used as evidence of a suture zone.

Lately, three other suture zones, Bongong-Nujiang, Kokoxilo and Lilien (Fig. 4) have been reported from the Tibet, and are progressively older northward. They are identical in character with IYTSZ, and the effusive are very similar to those existing along the mid-oceanic ridges. It is of utmost interest that they progressively became younger from north to south. It is believed, therefore, that the Indian plate separated repeatedly from the northern landmass, and then returned to rejoin it. In fact, more than a hundred similar basic bodies have been reported, ranging in age from Devonian to Permian (Bally *et al*., 1980). All are suspected to represent suture belts. This would mean that the Indo-Tibetan plate behaved like a veritable shuttle-cock. Xiao Xuchang (1980) and Metcalfe (2001), however, denied these repeated detachments and northward drifts of the Gondwanaland fragments.

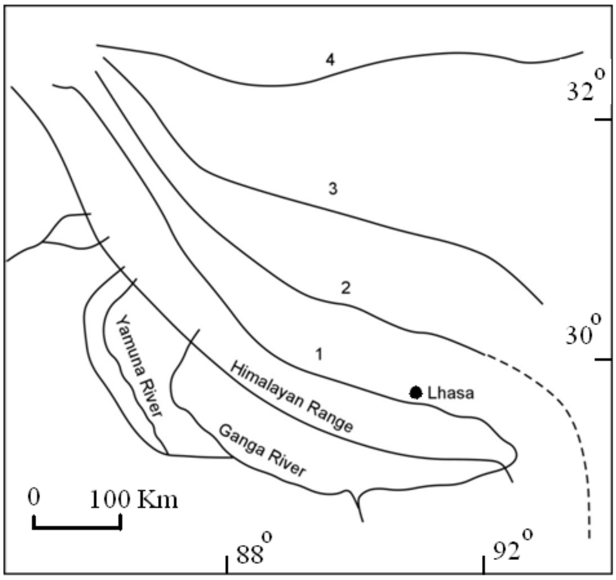

Figure 4) North of the Indus Tsangpo Suture zone there are three other suture zones. 1. Indus Tsangpo Suture; 2. Bongong-Nujiang Suture; 3. Kokoxilo Suture;and 4. Lilien Suture. All these suture zones progressively younger southward.

3- Glacial Deposits and Associated Fauna

Of significance also is the fact that Tibetand Yunnan north of Indus-Yarlung-Tsangpo Suture Zone, carries widespread Gondwana affinity Permo-Carboniferous glacial deposits. They extend over the entire Tibetan region, right up to Kun Lun Mountain, being present underneath every exposure of Permo-Carboniferous formation. These fluvio-glacial deposits carry fauna of Gondwana affinities, including ***Stepanoviella, Eurydesma*** and others, and locally, the ***Glossopteris*** flora (Metcalfe, 2001; Xiaochi 2002). In the face of this, the assertion by Allegre *et al*. (1984) that flora did not contain a single Gondwana element is rather unexpected. Huan Jiqing discussed about these glaciations in detail towardsthe end of the 1984 Chengdu Symposium and reiterated that it carried cold water fauna and suggested that the boundary between the Indian plate and Eurasia lay somewhere to the north, ruling out the Indus-Yarlung-Tsangpo Zone was the suture between India and Tibet (see also: Xiaochi, 2002). Tapponnier, *et al*. (1981) emphasized that there seems to be no unambiguous paleontological proof of the Gondwana origin of the Lhasa terrane …... for instance, is a Cathaysian block and not necessarily of Gondwana origin. They thus, not only denied the very existence of the Gondwana fauna and flora (Metcalfe, 2001; Xiaochi, 2002,) just because Tibet as a part of Gondwana block did not fit in with their new global tectonic concept. But there was no comment about the Carboniferous and Early Permian diamictite, concurrent cold water fauna and ***Glossopteris*** flora found over a large expanse on the Qinghai plateau and on Qiangtang, Boashan and Tengchong terranes (Wopfner, 1996; Metcalfe, 2001; Xiaochi, 2011) or that ***Dicynodontdae,*** the terrestrial animal of Permian to Triassic, long supposed to be representative of southern continent biota is now discovered in China (Zheng Haixiang, 1984) or that the oldest fossiliferous sediments in the Lhasa terrane are Upper Carboniferous and contain a low diversity Gondwana fauna which includes brachiopod, bryozoans, conodonts, corals and stromatoporoids (Chang Chengfa *et al*., 1986 and others). This fauna also existed in western Qiangtang terrane, Thailand, Malaysia, Myanmar and Australia (Laurie and Burrett, 1992; Nicolle and Metcalfe, 1999) and should go a long way to prove that these regions were together in the Paleozoic and India could not then have been in the southern hemisphere. The evidence, therefore, unequivocal that the Tibetan glacial deposits had Gondwana affinities and Chang Chengfa *et al*. (1986) and Xiaochi (2002) admitted that the Lhasa terrane was derived from Gondwanaland, also that the terrane was still a part of Gondwanaland in the Lower Paleozoic.

4- Eurasia-India Continental Continuity

Lower Paleozoic sequences and faunas of the Qaidam, Kun Lun, and Ala Shan blocks are similar to those of the Tarim block and also to South and North China (Chen and Rong, 1992) and these blocks according to Ge Xiaohong *et al*. (1991) are disrupted fragments of a larger Tarim terrane. This biogeographic data suggests that North China, South China, Indochina, including Lhasa and Qiangtang blocks was a part of Greater Gondwana until atleast in the Early Paleozoic and even later. The close faunal affinities, at various taxonomic levels, suggest continental contiguity of these blocks with each other and with Greater Gondwana at this time. Then when did the Indian plate brake off and move to the southern hemisphere? Waterhouse (1992) believed that the fauna and flora of Greater Gondwana and Tibet had much in common and demanded that, "The thesis that Indus-Yarlung-Tsangpo Suture Zone (TYTSZ) marked the closure of a vast Paleozoic-Mesozoic Tethys must be abandoned. Whereas, Zheng Haixiang (1984) was more specific that the IYTS- belt is not entitled to be a suture zone between India and Asia and that both sides of the IYTS-belt belong to the same tectonic system. And Wang Naiwen (1984) was emphatic that "It is unbelievable that the Indus-Yarlung-Tsangpo Suture Zone is the suture between the South and North continents", whereas, Wu *et al*. (2014) pointed out that the Indus-Yarlung-Tsangpo Suture Zone cannot represent Neo-Tethys ocean but probably relic of a vanished super slow spreading oceanic basin. Xiaochi (2002) has, similarly concluded on the basis of the distribution of Gondwana-affinity biota that basins whose remnant are now represented by the Yarlung-Tsangpo Suture and the Bongong-Nujiang Suture did not exist at the time, and the vast area south of Tibet and west of Yunnan formed a part of the northern margin of Gondwana. Confirmatory evidence for this conclusion is provided by the radiometric ages of the basic igneous rocks and the paleontological (radiolarian) age of the cherts, which now mark the sutures; these are of Jurassic age in the Bongong-Nujiang suture and of Cretaceous age in the Indus-Yarlung-Tsangpo Suture Zone. Recently Xiao *et al*. (2017) rightly suggested on the basis of composition, geometry and age, the exposed narrow site of the Indus-Yarlung-Tsangpo ophiolite belt cannot be simply considered as the final geometric surface, the single suture formed by the collision between India-Eurasia.

5- Line of Evidence from Vertebrate Fauna

Also relevant is the fact that the Kashmir Permian vertebrate fauna, with ***Archaegosaurus, Actinodont***, ***Lysiptergium*** and others is identical with that of Europe, and the Permian vertebrate fauna of China, Mongolia and Africa are identical. Smith (1988) pointed out that the Lhasa biota show closest similarities to the Himalayan biota where glaciations are most pronounced. In India, then thousands of kilometers away at the time in the southern hemisphere as advocated by new global plate tectonics, the existence from the Permian to Triassic fauna and flora similar to that of China and Tibet and Himalaya would have been impossible and cannot be explained. Indeed, there is no escape from the fact that India ***and hence Greater Gondwanaland*** and Tibet were together and formed a single Super continent, Pangaea, the only that existed at the time . Also, the entire Mesozoic sediments in the Lhasa terrane overlying the Permian glacigene are shallow marine origin (Chang Chengfa, *et al*., 1986; Metcalfe, 2001), and farther north, beds of fresh water origin carry typical Triassic vertebrate of Greater Gondwanaland affinities. These include ***Lystrosaurus, Preteresuchus, Metaposaurus, Platosaurus*** and an a number of other forms from China, Korea and central Asia, ***Lystrosaurus,*** itself, having been present in

Europe, South and East Africa and Antarctica as well, bespeaking of a single landmass over the Earth. Colbert (1979) is justified in raising the question that if India was drifting northward like as island in the Jurassic and Cretaceous, how is it that its dinosaurs are very similar to those of other land masses. Thus, the concept of the great northward drift of India is refuted. The presence of these vertebrates in India and China simultaneously provide impelling evidence for the existence of a vast land bridge between two continents and opening the gates of faunal migration (Chatterjee and Scotose, 1999; Prasad and Manhas, 2007) ruled out the oceanic Tethys in the form of a triangle reaching up to Black Sea or further west. Khan and Tewari (2016) discussed the occurrence of a number of common forms between the northern and southern continents, including ammonites, fresh water fauna, and even insects, all of which could not cross even the narrowest oceanic area intervening between India and China. Recently Yuan Dong-Xu (2014) has described conodonts common to the two flanks of the Indus-Yarlung-Tsangpo Suture Zone from the Paleozoic and the Triassic. The evidence for a submarine rift related to the detachment of the Lhasa terrane from Gondwanaland is therefore not valid (Chang Chengfa *et al*., 1986). Several taxas belonging to ***docodont*** mammals were widely distributed in both Gondwanian and Laurasia continents, at least up to the end of Jurassic-Cretaceous are positive proof that there were overland communication between India and other continents at that time (Prasad and Manhas, 2007). Prasad *et al*. (2013) reported the occurrence of Indian ***Simosuchus***-like ***Notosuchian*** crocodile from the Caurey Basin in India strengthened earlier evidence from the vertebrate groups for close biotic links between India and Madagascar in the Late Cretaceous- most probably through dispersal via the Seychelles Block. On the other hand, in the Triassic a geosynclines seems to have developed in the area covering the two sides of the Indus-Yarlung-Tsangpo Suture Zone and hence the fauna on the two sides was identical. Further, it may be pointed out that the Jurassic vertebrates too, had a similar distribution.

Another constraint in Plate tectonic model is the presence of equatorial and Tethyan nature of the Late Jurassic-Cretaceous fauna at the southern tip of India (Meyerhoff and Meyerhoff, 1974), which indicates that India has not moved since at least the Late Cretaceous. This would lend to the argument that India has always been close to where it is today. Kashfi (1988) has analyzed a vast range of geological data, from Iran and the rest of Middle East and concluded that nothing in the geological record supported a separation between Arabia-Africa and the Middle East in the Phanerozoic as there are strong stratigraphic and paleontological correlations throughout the region- even between Iran and Central Asia. In support of this assertion, he points to the facies continuity of the Pre-Cambrian-Cambrian salt deposits from western India, Pakistan, Iran, and Persian Gulf to Arabia (see also: Boucot and Gray, 1987). He also pointed out that there is no convincing evidence and correlation between the alleged present or past subduction zones with seismicity in the area. The random distribution of ophiolites and volcanic are also strong evidences against Plate tectonic concept.

It is therefore quite evident that there is a distinct lack of endemism among the Indian Mesozoic terrestrial vertebrates- suggesting the Indian landmass was not isolated enough to accomplish that. Looking at the biota of landmasses such as Australia, New Zealand, and Madagascar that have been isolated for much of the Cenozoic- it is clear that diverse evolutionary trends take life in uniquely different direction within a matter of a few millions of year. India should have acted no differently had it ever been totally isolated for any substantial length of time. Meyerhoff *et al.* (1996) showed how the Gondwana realm biotic element (Lower Permian-Cretaceous) extended northward through India, China and Mongolia on to northeastern Siberia, and how the Tethyan biota's extended southward from southern India to Arabia, Australia and New Zealand-questioning the plate tectonic constructs of Tethyan evolution and isolation.

6- The Chaman Fault and the Suture in Myanmar

The concept advocated in the global plate tectonic hypothesis that Greater India drifted northward and collided with the Asian plate leaves one with no alternative but to concede that the junction of the two plates must be continuous, ***without even a minor break***, from the coastal area west of Karachi, through Tibet and then on to the east through Myanmar. The well-known Chaman-Ornach-Nal Fault in Baluchistan and Afghanistan are supposed to be this junction on the west (Lawrence *et al*., 1992; Kazmi and Jan, 1997). On the other hand, there is no trace of the Indus-Yarlung-Tsangpo Suture Zone east of Rinbun, southwest of Lhasa, or through Arakan Yomas in Myanmar on the east of this hypothetical Indian plate. The suggested continuation over the area is widely speculative and has no significance. This western junction as such calls for a detailed discussion given hereunder. Appropriately enough, the Chaman Fault is sinistral and could have provided the northward movement of the Indian Plate. Auden (1978) examined the Chaman fault in Afghanistan and concluded that 300 km of sinistral movement had taken place along it since the Eocene. Lawrence and Yeats (1979) examined the fault in the Nushki area of northern Baluchistan, comparing the geology on both sides, and concluded the movement was only 200 km. This large decrease in the amount of transcurrent movement over a few hundred kilometers casts doubt about the suggested origin of the feature.

Farther south, the Chaman Fault has several breaks (Fig. 5), the longest being of 9 km on the Chaman fault, wherein there is no trace of activity in the area where the fault should have been.

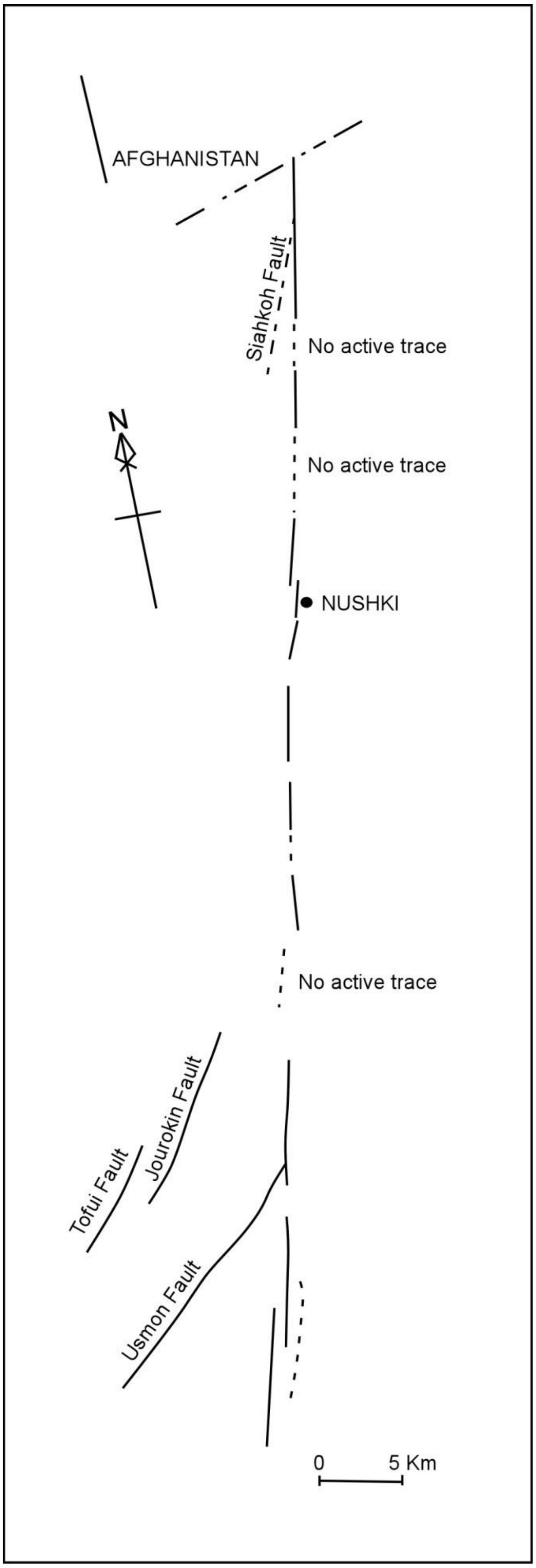

Figure 5) The Chaman Fault shows several breaks in the Nushki section and then, like all other faults in

the area takes a sharp turn to the west (after Lawrence and Yeats, 1979).

Moreover, it splays in westward trending branches and it disappears near the locality of Nal and eastward near Nal it reappears as Ornach-Nal Fault. None of these features fit-in with the suture zone concept and bespeak of a progressive weakening southward of the Chaman Fault (Kazmi and Jan, 1997).

Also, the Chaman Fault has been active and a major earthquake event M=7.6 along it in 1935 destroyed the entire city of Quetta and still active, occasionally causing severe earthquakes and the latest one in the year 2013 (Rehman *et al*., 2014). The ***en-echelon*** Ornach- Nal Fault exists about 50 km to the east and continues to the coast where like all other faults in the area takes a sharp turn to the west. Not a single fault continues to the end of the continental crust, which would have been inevitable if any of these faults formed the suture zone along which India moved from south to north. Had the Chaman Fault been really a suture, it would have been involved in a transcurrent movement atleast of the order of 1300 km and not merely 200 or 300 km (Crawford, 1979, p.107). Lawrence and Yeats (1979) neither accounted for the Murgha-Faqirzai Slates and Shaigalu Sandstones to the east of the Chaman Fault lying against serpentinites gabbros, dunites etc. to the west, nor for these formations occurring on both the sides of the Chaman Fault farther south. It would be difficult to explain if the Eastern Block has migrated thousands of kilometers away, for, admittedly, geosutures should “separate plates of quite different geological age, structure and sedimentary history”.

A number of extrusions of ophiolites in the Chaman Fault region took place well away from the fault and lie entirely on the two opposite plates (Fig. 3). Gansser (1979) considered that the ophiolites were allocthonous, but it would appear vestige along the fault itself, some evidence of their former existence along the actual plate junction as well. Since no subduction/collision is believed to have taken place their presence require some explanation. In any case igneous activity does not seem to have any connection with the Chaman Fault. The tiny effusive obviously have come from the mantle like those in the Indus-Yarlung-Tsangpo belt or the hundreds of exposures over the entire Tibetan plateau, that have no connection with the sutures in the area. It is also similarly significant that movement along the Chaman-Ornach-Nal Faults does not even slightly displace the coastal area in the Baluchistan region. Had these faults been the junction of the Indian and Asian plates, the 300 km movement in southern Afghanistan would certainly have displaced by a like amount the coasts on the eastern side of the junction believed to be along the Ornach-Nal Fault. However, as pointed out above this fault does not cut across the crustal block and could not, in any case, constitute the junction of the two plates. The northward movement of the Indian plate, its progressive underthrusting below the Tibetan plate and the shortening in the Himalayan region are about 2500 km or more, and this could not but cause a major displacement of the two sides of the junction in the Baluchistan area. Yet nothing of this sort exists and the coast is as smooth as any other on the Earth. The most enigmatic part of the suture concept is the area between the northern end of the Chaman Fault, and the western end of the Indus-Yarlung-Tsangpo Suture Zone in Ladakh. A number of faults do occur in the area but none has been recognized as joining the westward extension of the IYTSZ with the Chaman Fault. But far more difficult to explain is that the Indian plate seemingly jumped laterally from Ornach-Nal fault to move along the en-echelon Chaman Fault, a distance of about 50 km, without leaving any trace of a junction in the between the two. And if this happen, what is the origin and character of the Chaman Fault ***south*** of this point? In the south, the Chaman Fault starts at the triple junction of the Arabian Plate, the Eurasian Plate and the Indo-Australia Plate,which is just off the Makran coast of Pakistan.The Fault tracks northeast across Baluchistan and then north-northeast into Afghanistan, runs just to the west of Kabul, and then northeast ward across the dextral Herat Fault, up to where it merges with the Pamir Fault system north of the 38^{o} parallel, but does not join the IYTSZ, which ends to the east of the Nanga Prabat- Haramosh massif (Sarwar and DeJong, 1979, Fig. 1) well away from the Chaman Fault and there is a clear gap between the two. South of the triple junction, where the fault zone lies under sea and extends southwest to approximate 10^{o}N 57^{o}E, it is known as Owen Fracture Zone. However, the Owen Fracture Zone is dextral as is also suggested by its displacement of the Mid-Indian Ocean Ridge near the mouth of Gulf of Aden. The Owen Fracture Zone, too, stop short of the shore, and its place is taken by the northwest-southeast Murray ridge (Fig. 6) which reaches almost to the coast, east of Karachi.

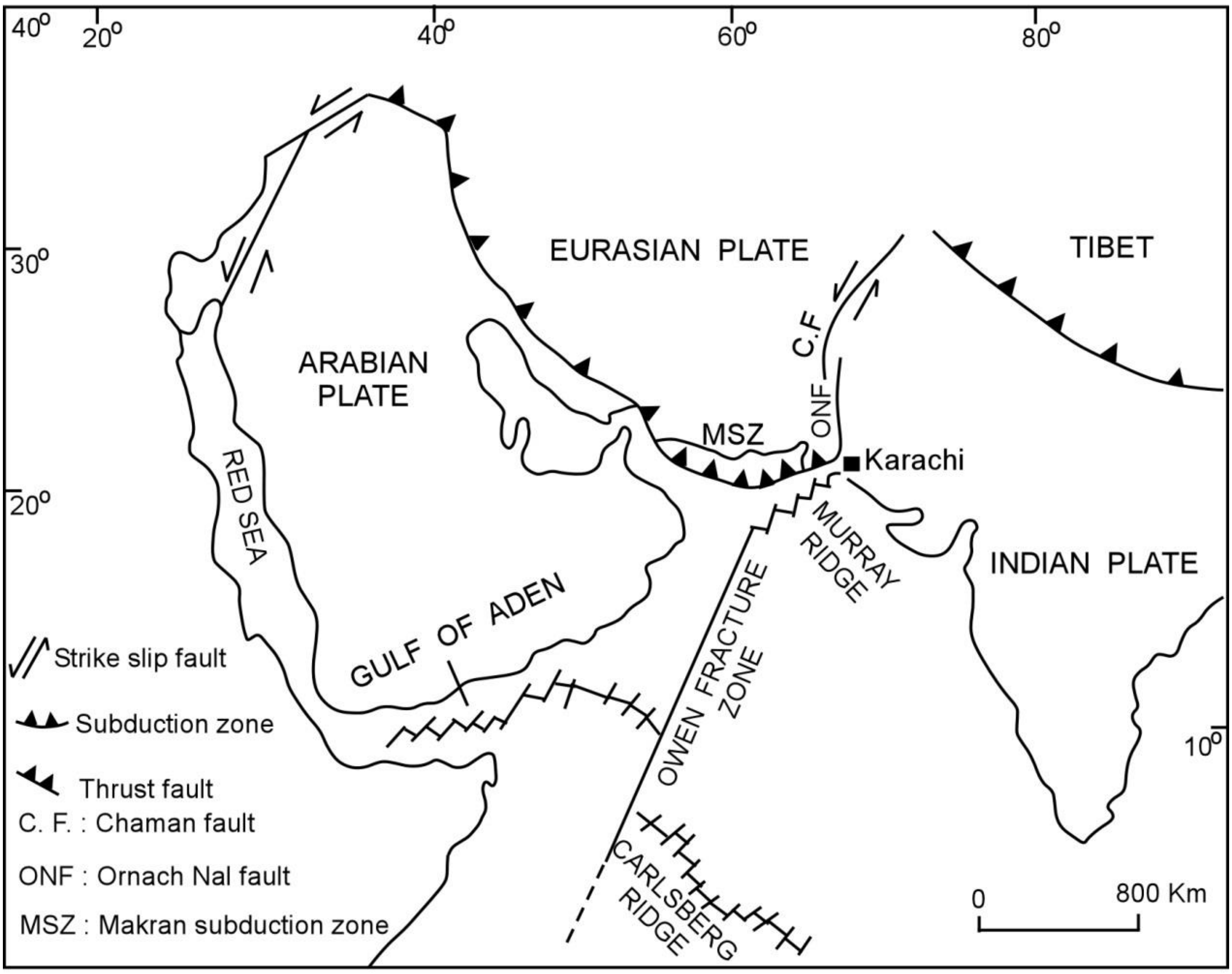

Figure 6) Map showing mid-oceanic ridge system of the Indian Ocean. Note Owen Fracture Zone stops short of the shire and its place taken by NW-SE Murray ridge.

Thus, an objective study of the feature leaves no doubt that on the west the Chaman-Ornach-Nal faults are not the junction of the two plates and on the east there is no feature that could be identified as the suture. This suggests that India had at no stage, broken off from the Asiatic continents to return to its ***original*** position along the sutures. This is not to speak of the scores of gulfs, deltas, marine erosion areas and other coastal features that ought to have developed on the opposite coasts in the course of about 250 Ma while India was roaming around as an independent sub-continent and would have obstructed the suturing. Instead, they seem to have disappeared to produce a smooth, straight suture in the west and the north, exactly at the original site on the coast that came into being in the Carboniferous.

7- Discussion

From the foregoing review, it is evident that the Chaman Fault does not have any characteristics supposed to be associated with so-called suture zones. The Chaman Fault has been considered as an active wrench fault and caused disastrous earthquakes. The global plate tectonics visualized it as the feature along which a northward migrating Indian plate joined the Afghanistan-Baluchistan section of the “Great Gondwanaland” supercontinent. If so, the Chaman Faults would not have come to an end in the middle of Baluchistan and would not have taken a sharp turn to the west. Instead, it would actually have continued to the end of the continental margin along the Arabian Sea, the situation as it obtains in the Baluchistan area is that there are scores of faults running north-south and then taking a sharp turn to the west (Fig. 3). On the contrary, this fits in well with the counterclockwise rotation brought about by the Baluchistan Orocline as envisaged by Carey (1976). In fact, India, Baluchistan and Afghanistan blocks were together along the faults on both sides of the so-called suture zone. Also, by comparing geological formations on both sides, the translational movement has been estimated to be of 300 km in Afghanistan (Auden, 1978) and decreased to only about 200 km in northern Baluchistan (Lawrence and Yeats, 1979). Thus, the translational movement along the Chaman fault decreases rapidly southward until the fault develops breaks along its length, splays and then abruptly come to end. The field evidence should be exactly the opposite if it was the line along which India has joined to Afghanistan-Baluchistan. Eastwards, the Ornach-Nal Fault develop en-echelon pattern, yet it, too, takes a turn to the west and runs parallel to the Makran coast. Had the Chaman-Ornach-Nal Faults been the suture line of two continental blocks, they would have been continuous and not en echelon. An earthquake along this coastal part of the Ornach-Nal Fault in 1943 brought up two lithospheric islands. If the Chaman Fault is not the suture zone between India and Baluchistan-Afghanistan where lays the margin of the Indian plate in the west? At its northern end, the Chaman Fault runs into the dextral Herat Fault, which in turn, runs into the Pamir region. It does not join the Indus-Yarlung-Tsangpo Suture Zone and as pointed out earlier, there is a gap between them.

On the other hand the Indus-Yarlung-Tsangpo Suture Zone exists only up to Rinbun, to the west-southwest of Lhasa (Fig. 2) and there rock formation passes into Jurassic slates and geosynclinals granites. This is very difficult to reconcile with the plate tectonic concept because there is no feature north of Assam in which this part of the Indian plate subducted. Stoneley (1974) admitted that the voluminous outpourings of magma were emplaced between Latest Cretaceous –Early Tertiary while the Indian continent was some hundreds of kilometers and in fact it was thousands of kilometers from the Eurasia. Yet the northern margin of the Indian plate is thermally metamorphosed by the outpouring of magma. It would have been impossible if the Indian plate did not form the southern margin of the Indus-Yarlung-Tsangpo Suture Zone at the time of the magma emplacement. The ophiolite emplacement took place in two phases and they are confined between steeply dipping Tibetan plate in the north and equally steeply dipping Indian plates in the south. If the plates have broken away after collision and joining together, the surfaces would not have been smooth or having almost identical slopes to this position. This bespeaks clearly of a rift valley and not of a suture through which oceanic crust was forced up by compression. Xiong Shaobai *et al*. (1984) have concluded form geophysical studies that the northern side rises evidently; the southern side subsides and forms deep trench, the drop being of the order of 5 km corroborating Stocklin (1983) and Kumar (1990) that a rift opened in the area in the Triassic and continued to deepen till eruptions occurred along in the Jurassic-Cretaceous. It has been dormant since and no subsequent seismic activity has been reported from the IYTSZ. Such activity would be inevitable if subduction was in progress, as advocated in the plate tectonic concept. The interpretation here that the so-called Indus-Yarlung-Tsangpo Suture Zone is, in fact, a rift valley, through which magma has erupted, thus appears to be justified. Moreover, recent geological investigation in the so called "Indus-Yarlung-Tsangpo Suture Zone" indicate that it is, in fact, a rift valley and its continuation in Tibet, on the tectonic map of China, is interpreted as an extensive syncline by the Chinese geologists. And if IYTSZ is a rift valley, as suggested above, all three other so-called suture zones Bongong-Nujiang, Jinshajing-Tungbianhe (Kokoxilo) and Jinsha-Tongbian (Lilien) exist in the Tibetan region, too, may be rift valleys. Thus, Tibet and Central Asia have been more or less continuously under tension, apparently accompanying the plateau uplift, tore it apart, extensively in the Quaternary in a north-south direction in general (Fig. 7), and is still strongly active.

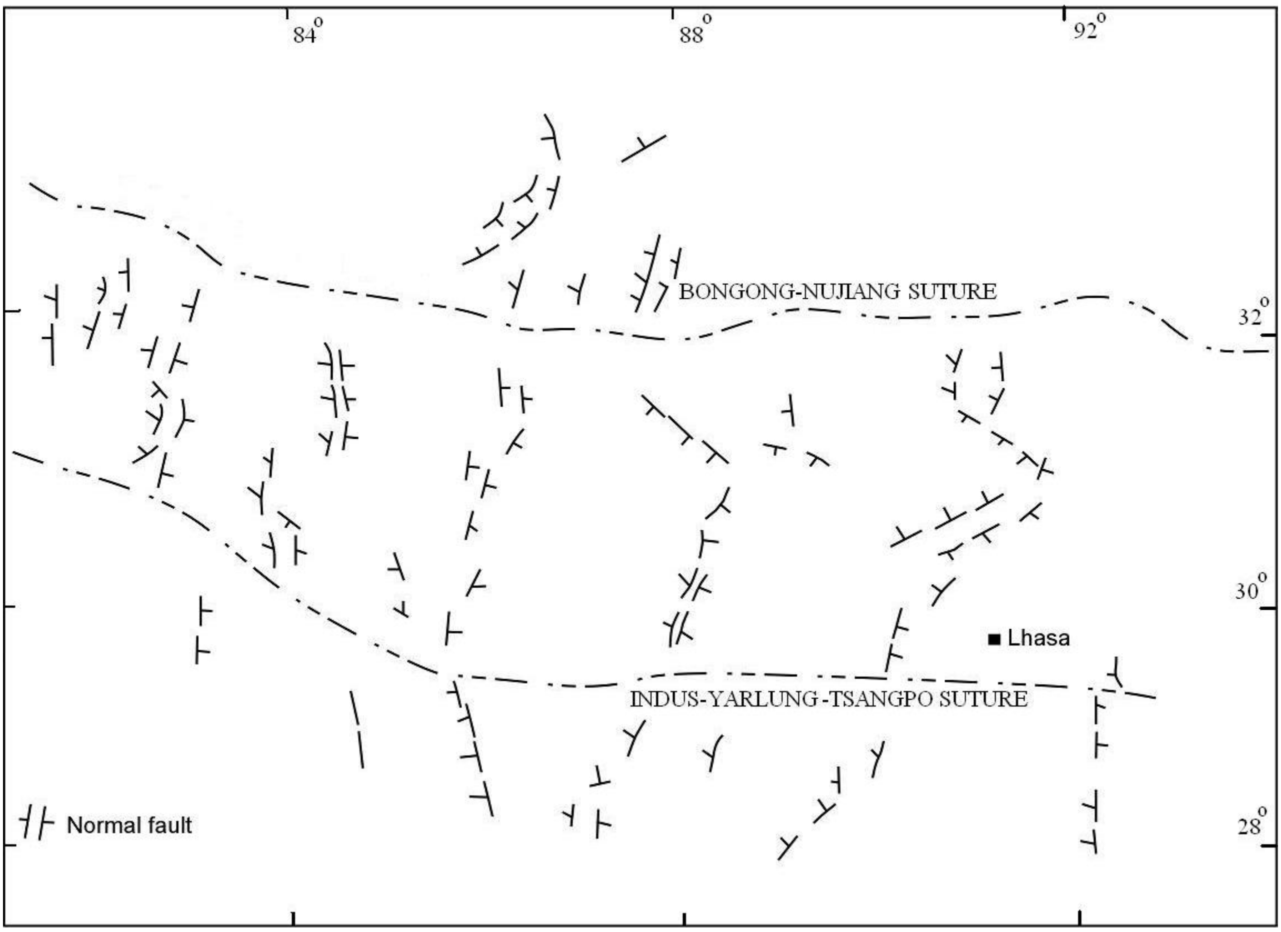

Figure 7) Quaternary rifts and normal faults in Tibet plateau seem to extend to the Himalayan region. These rift valleys and normal faults bespeak of tension over the entire area.

The plate tectonic concept envisages that the Indian plate was underthrust beneath the Tibetan plate (Zhao and Morgan, 1987; Najman *et al*., 2010) and that the underthrusting is still in progress at a rate 20 mm/year or more (Xu *et al*., 2015, and reference therein). This would mean that the Indian plate leap over the 8-20 km thick wall of ophiolites (Fig. 2), which must have appeared, if plate tectonic concept is valid for the area, very soon after the initial collision that intervenes between the two continental fragments, and on its northern side dips vertically to a depth of about 30-35 km to underthrust the Tibetan plate without leaving behind any trace of this activity on the surface to the north of the suture. On the contrary, the suture zone is cut by a number of Tertiary normal faults, NNE-SSW to NNW-SSE direction, extending over 1200 km from east to west in the Bongong-Nujiang region and form 450 km from north to south to the north of the Himalayan region (Fig. 7) indicating that the region is under east-west tension. The extensive Xidatan Fault carries clear evidence of a tensional state in its normal and strike slip faulting. "The large scale and steep sides of the tension gashes imply that large earthquake occurred on this fault in the past few hundred years" (Chang Chengfa *et al*., 1986, p.507). To suggest that the faulting is a result of north-south compression (Armijo *et al*., 1989; Zhang *et al*., 2004) is ridiculous since the area where the compression should be at its maximum is repeatedly rifted. While passing through Indus-Yarlung-Tsangpo Suture Zone these rifts are usually marked by intense uplift, whereas a few of the rifts show a slight dextral strike slip. Most of these rifts are seismically active, and about 440 medium to strong earthquakes have been recorded along them since 1911. On the other hand, vertical movement decreases towards the middle of the Tibetan plateau, both from east and the west. However, these faults are responsible for hundreds of hot- water springs. The Yangbajan Geothermal Power station works on four of these. Molnar and Lyon Caen (1989) reiterated, on the earthquake moment tensor analysis which show strike slip and normal fault activity throughout the Tibet plateau. Also relevant is the fact that Hou *et al*. (2006) and Xiao *et al.* (2017) have drawn attention to the north-south Quaternary rifts are extended through the Lhasa block, Indus-Yarlung-Tsangpo Ophiolite, Tethyan Himalayan Sequence and even a part of Greater Himalayan Crystalline Complex but does not seems to be extending into the Siwalik foreland system. This fact does not support the model of post-collision because it does not penetrate all the units in the orogenic belt. More important, if the Indian plate is underthrusting the Tibetan plates how is it that the thermally metamorphosed northern margin of the Indian plate is exposed along the Indus-Yarlung-Tsangpo Suture? Significant also is the fact that addition to thickness by subduction would require a low-angle movement of one plate below the other subduction is purportedly a ***high angle*** process. Dewey *et al*. (1989) based on data from Tibet, the Himalayas and China, discussed arguments for and against the underthrusting of Greater India beneath Eurasia and concluded that models advocating underthrusting and subduction were untenable.

The ophiolites emplaced in the two phases are significantly different in chemical composition and physical characteristics seem to have tapped different levels of mantle. Had they been formed of oceanic crust brought up by the collision of continents they would not have been intruded at the high temperature believed to have obtained. Deng Wanming (1984) admitted that the so-called ophiolites are in fact similar to tholeiites formed in mid-ocean ridge spreading areas or in other words they are not oceanic crust emplaced in the progress of continental collision, but are magma upwelling's from the mantle. Chang Chengfa *et al*. (1986) agreed that an oceanic crust developed in the area by Permian-Triassic rifting.The ophiolites of the Indus-Yarlung-Tsangpo Suture Zone, according to Bhat (1987), represent mafic-ultramafic diapirism following repeated rift re-activation.

The occurrence of Carboniferous fluvio glacial deposits with fauna and flora of Gondwana affinities over entire northern Tibet, right up to the Kun Lun, Qaidam, Qiangtang and Lhasa and Tarim blocks; and the continuity of geological formation across the suture belt suggests that neither the Indus-Yarlung-Tsangpo, nor the

Bongong-Nujiang, nor even the Kokoxilo and Lilien "suture zones" ever separated the northern continent from India. The close faunal affinities, at various taxonomic levels, suggest continental contiguity of these blocks with each other and with Greater Gondwana in Paleozoic time (Metcalfe, 2001; Xiaochi, *et al*., 2011). Xu *et al*. (2015) came out strongly against the Indus-Yarlung-Tsangpo Zone representing a suture, but puzzled as to where to place the junction of the two landmasses in terms of global plate tectonics. Thus Wang Naiwen (1984) stated that "it is unbelievable that Indus-Yarlung-Tsangpo/Zhangbo Zone is the suture between the North and South continental landmasses". The "evidence" for the Tethyan Ocean, therefore, represents pure superposition on the basis on computer-assisted re-assemblies of the contours along the Atlantic continental shelves (Dietz and Holden, 1970; Scalera, 2003). To justify extrapolation of this far-away data to the heartland of Asia, it was assumed arbitrarily that continents were rigid; without rigidity it was possible to swing open the Tethys, between Gondwana and Laurasia.

In view of the above arguments, it seems that field evidence is unequivocal that India and Tibet have never been separated, not at least from Devonian to the Jurassic and perhaps from the Cambrian to the present. The paleontological evidence, including the distribution of Permian, Triassic and Jurassic vertebrates, as well as typical Gondwana fauna and flora, leaves no option but to accept it, and so does the distribution of rock formations across Indus-Tsangpo Suture zone. Indeed, the presence of extensive Gondwana glaciations over the entire Tibetan plate, north of Indus-Tsangpo Suture belt, cannot be explained otherwise. Zheng Haixiang *et al*. (1984) agreed that "the data available indicate that the IYTS-belt was no means such a boundary", and that both sides of the TYTS-belt belonged to a unified sedimentary basin from the Triassic to the Cretaceous. Sakagami *et al*. (2006) very recently Shen *et al*. (2016) and Ernst (2016) pointed out that "In the Permian both flanks of Yarlu-Zhangbo River belonged to the same biographical terrain' with common brachiopod and other cold water fauna, whereas Tibetan bryozoans were closely related with those of Pamir, Afghanistan, Oman, Iran, Thailand, Malaysia and Australia and those from the north and south of Yarlung-Tsangpo area are identical. Similarly Xiaochi (2002), too, admitted that "the Permo-Carboniferous system occurring on both sides of Yarlung-Zhangbo River may be regarded as forming of a single platform domain".

It would therefore be appropriate to consider alternate possibilities for the origin of the Indus-Yarlung-Tsangpo Suture Zone. Indications from the field evidence referred to above suggest that it represent a rift valley. Gopel *et al*. (1984) believed that the so-called "suture" is in fact "a propagation ridge under slow spreading conditions"and not a suture zone. Wang Xibin *et al*. (1980) concluded that slow spreading and partial melting of the upper mantle had been responsible for the feature. And obviously "spreading centers" and "propagating ridges" are not compatibles from the suture zone concept. Xu Baowen *et al*. (1984), on the other hand, considered the Indus-Yarlu-Tsangpo Suture belt Triassic geosynclines. Thus, it would appear that a narrow rift valleys and tensional faults appeared in the region in the Late Permian to Early Triassic and sediments poured into it. It continued to deepen and when magmatic emplacement took place in the Jurassic and Cretaceous, marine conditions prevailed in the rift where magma outpouring occurred twice. These emplacements have been identified as "ophiolite" purely to fit in with the global plate tectonics concept, whereas, random distribution of ophiolites and volcanic arcs also strong points against plate tectonics. And if this identification of the feature with rift valley is accepted, it follows that the whole area was under tension.

8- Conclusions

The Indus-Tsangpo Suture concept based on paleomagnetic data and global plate tectonic models is negated by all available field evidences. If Greater India has moved from a southern hemisphere position, and re-attached itself to Eurasia, the suture should exist on all its three sides, without a break, from the Arabian Sea to the Bay of Bengal. Along the west this suture is thought to be represented by the Chaman Fault. However transcurrent movement along this sinistral active fault decreases from north to south, develops a number of breaks in Nushki area of Baluchistan. The en echelon Ornach-Nal Fault like all other faults in the area takes a sharp turn to the west and not a single fault cuts across the Makran coastal area. Accordingly, the Chaman Fault cannot mark the junction of two landmasses. Instead, it perhaps have been developed by the counterclockwise oroclinal rotation of India and also at its northern end it does not join up with the Indus-Tsangpo Suture but seems to be terminated by the Herat Fault.In the north, the Indus-Tsangpo Suture stops abruptly near Rinbun, west-southwest of Lhasa, whereas in Myanmar, no feature can be identified that could be consider as suture. In fact the suture in the region should be besides Assam and Bangladesh, and not within Myanmar, where it is being looked for. Moreover, magma emplacement took place in the Jurassic-Cretaceous, and again in Early Cretaceous, when Greater India should have been according to plate tectonicists, in the southern hemisphere. The two magmas differ chemically as well as in physical characteristics, have produced contact metamorphism. These magmas were not only in a molten state when emplaced but seem to have tapped two different depths in the mantle. Moreover, the emplacements are bounded on the two sides by steep faults, i.e. they fill a rift valley. Similar rifts exist in northern Tibet and beyond. They are progressively older northward, and their multiplicity is embarrassing for the plate tectonics supporters. The evidences and data seem to fit in with Stocklin's concept that a rift opened in the area in the Triassic and continued to deepen till eruptions occurred along it in the Jurassic-Cretaceous. It has been dormant since and no subsequent seismic activity has been reported from the belt. Such activity would be inevitable if subduction was in progress, as advocated by the plate tectonicists.The widespread Permo-Carboniferous glacial deposits in the North Himalayas, Lhasa, Qiangtang, Tarim, Tengchong in Yunnan continental fragments together with the occurrence of Permian, Triassic and Jurassic vertebrate faunal distributions confirm the conclusion that a land connection continued to exist over this time for free two-way traffic for faunal and floral elements.Thus, Tethys existed as an epicontinental sea which covered large areas of Eurasia from Cambrian onward and withdrew in the Jurassic-Eocene.

It is concluded that the Indus-Yarlung-Tsangpo Zone is a rift valley and not a suture zone. Available field evidences further favor that India has retained its present relationship with the northern continents and hence also with its western and eastern neighbors. On the other hand, it would appear that a vast area in central Asia from Chinese territory to Himalayan region had down wrapped continuously at least from Ordovician to the Eocene and collected immense quantities of sediments, which follows that the area was, then, under tension till not long ago. Obviously, the Plate tectonic concept does not readily qualify in this area to explain such phenomena and therefore alternative Expanding Earth model is more reasonable.

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