dislocation to a place like Pudhumadam coast may not be conducive for survival. On the other hand, fishes which get drifted to rich habitats will have the benefit of survival and establishment of new populations. Thus, it can be discerned that although fish populations may get dislocated periodically because of such unusual tsunami, they may also get redistributed in the vast stretches of the oceans. Unless they are dislocated to incompatible places, this in turn may help populations of different species of fishes to establish in different geographical locations of the oceans and thus expand their geographic distribution and survival.

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Structure and tectonics of Kutch basin and earthquakes

Several shortcomings ensuing from faulty interpretations significantly damaged the efficacy of a study of geology *vis-à-vis* seismicity in a recent paper by S. K. Biswas[1] on 'A review of structure and tectonics of the Kutch basin, western India, with special reference to earthquakes'. Beginning from the title itself, the author created an impression that the entire sedimentary ensemble in the Kachchh region represents a single-basin evolutionary history. Instead of taking note that barring the Jurassic ensemble, none of the other deposits are linked with any rifting process, he envisaged a basin evolutionary model (illustrated in figure 4), which is a gross misrepresentation of geology of the area.

A major slip-up in the paper is the assumption that the 'Kachchh rift' evolved within the Mid-Proterozoic Aravalli–Delhi fold belt that swings to E–W in the Kachchh region. This is fallacious, as no swing in the NE–SW Delhi trend is observed all along its length. There is also no outcrop of the Delhi–Aravalli rocks from the southernmost tip of the Aravalli Mountains, to provide information about any swing. Further, no westward swing is also implied in Krishnan's writings[2], which might have enthused the author's thoughts. It seems that the author is unaware of the suggestions[3] that the Kachchh faults are new features formed during the Reunion Plume outburst.

Talking about the basin architecture (without discriminating between basins formed during different geological events), the author mentions about the southward-tilting asymmetric rift basin. The ascribed geometry matches with the present-day architecture of the rocks caused by the Quaternary neotectonic deformation[4], and contradicts the author's own suggestion of westerly palaeoslope. An intriguing feature in the paper is the description of a median high (MH). Apart from the diverse nomenclature used ('median' in figures and 'meridional' in the text), the author never tried to precisely state what it truly is! Instead, he goes on making utterly confusing and mutually contradictory statements.

The author wrongly asserts that the positive Bouguer anomalies along the lineaments indicate that these are basement highs. First, it is not true that the positive anomalies form any linear pattern but instead have highly irregular and patchy occurrences[3]. Secondly, the basement highs (made of sialic rocks) are unlikely to produce gravity highs of the types mapped in the region.

The author's interpretations on rifting and faulting are marred by clumsy presentation. He has used abbreviations for faults and uplifts in figure 2, without mentioning them in the 'index' or 'figure caption'. In figure 3, one single fault is named NRFL on the top and KMF below. The statement that the basin contains footwall uplifts is contradicted by what is shown in figure 3, where the uplift is on the hangwall side. Further, identification of foot/hangwall is difficult because the fault NRFL/KMF in the uppermost part (in figure 3) is almost vertical. Similarly, his descriptions of fault movements are quite confusing. He mentions about E–W striking primary master faults having characteristics of strike-slip faults. He then talks of 'uplifts', 'upthrows', and 'horsting' and 'down tilting' along the same set of faults. To deepen the confusion further, the author continues with descriptions like 'strike-slip movement resulting inversion' and 'development of flower structures'. All these, according to him, are the result of 'convergent wrench movements' caused by 'transpressional tectonics'. Going through such a description is truly a bewildering experience.

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Response:

I am surprised to note A. B. Roy's comments on my paper, which are only derogatory remarks without logic and supporting data/evidence. It appears that he is not familiar with the geology of Kutch and the processes of tectono-sedimentary evolution of rift basins. Bias of plume-related tension fracturing in the Kutch[1] region prevented him in appreciating the facts discussed in the paper.

Rift basins are formed during crustal stretching and thinning. This causes the mantle to rise with increasing heat flow and thermo-tectonic movements may or may not be related to hotspot plume[2]. In most cases, primordial basement faults are reactivated as rift faults and remain active throughout the syn-rift sedimentation. Crustal cooling and thermo-tectonic adjustment of the crustal blocks control the post-rift stage sedimentation. The rift is finally aborted by tectonic uplift and structural inversion. Within the rift several horst-graben–half grabens are formed by activation of parallel faults. The grabens–half grabens are sedimentary sub-domains[3]. Rift-fill sediments are thus syntectonic deposits, as evident from varying thickness and facies of sediment packs across the faults. Kutch basin is a typical example of such riftogenic sedimentation. Thickness variation due to differential syn-tectonic subsidence is clearly shown in figure 3. Two main half-grabens, BHG and GOKHG occur respectively, to the N and S of the fault KMF with different thickness of the sediment fill, thicker in GOKHG due to greater subsidence along NKF. It is to be noted also that the Deccan Trap is present only on the southern flank of KMU and thins down towards its northern uptilted edge. This indicates that tilted KMU was already in position and KMF was active prior to the hotspot event. Deposition of Tertiary/Quaternary sediments in the half-grabens suggests subsidence in later tectonic cycles. Thus, the E–W Kutch faults, described here as primary or master faults are pre-existing basement faults reactivated during Jurassic rifting and subsequent tectonic cycles. They are not plume-generated faults as speculated by Roy[1]. KMF separates two half-grabens. BHG was normal faulted against it during rift stage and hence, KMU is the footwall. Similarly, Saurashtra horst is the footwall for GOKHG along NKF. If this is understood, where is the ambiguity? All abbreviations are mentioned in the text. NRFL is not a fault. It is a fault flexure as mentioned in the index of figure 3.

The basin was tectonically active throughout its history, maintaining the style of the rift framework. The Mid Jurassic and Early Cretaceous sediments represent respectively, the synrift and postrift sedimentation. The rift aborted in Late Cretaceous by regional uplift related to trailing edge uplift of the Indian plate[4]. Subsequent Tertiary–Quaternary deposition took place in the peripheral and structural lows within the uplifted rift framework in the same basin. This post-rift sedimentation was controlled by relative sea-level changes responding to eustasy and local tectonics. The basin fill consists of several cycles of sedimentation. Thus, the 'entire sedimentary ensemble' belongs to the same poly-history basin.

Both the cross-sections in figures 3 and 4 are drawn across the basin based on detailed geological map and subsurface data (seismic and drilling). The model presented in figure 4 shows fault-bounded basement blocks with thin sediment cover and conceptual sub-crustal projection constrained by geological, aftershock and seismic tomographic data. The rift geometry is comparable to classical models of rift basins[2,3]. Where is the scope for gross misrepresentation of geology?

It is true that there is no outcrop of Aravalli–Delhi fold belt beyond the southwestern tip of the Aravalli Range but its subsurface continuation across the Cambay rift extending into Kutch rift (figure 1) could be traced clearly in Bouguer anomaly and seismic maps. In fact, this trend is an important cross-trend in Cambay basin described as transfer zones[5]. The present courses of Banas and Saraswati rivers flowing across the Cambay graben into Rann of Kutch illustrate this curving trend.

Median high (mentioned in the text as meridional high in order to describe its orientation) is a well-established feature based on gravity and geological data[4,6]. Under 'Basin architecture', the basin configuration and first-order basement features are described. Palaeoslope is the original depositional slope during early rift stage, which indicates direction of marine transgression/regression and sediment transport. The basin asymmetry is due to tectonic tilt, which affected the palaeoslope and the resultant tectonic slope is towards the southwest. The south-tilted asymmetry is clearly illustrated in figure 3, as the sediment accommodation increases towards south, reaching maximum at the southern boundary fault, NKF. In gravity maps, basement highs and lows can be seen below the sediment cover due to density contrast, basic rocks only add to the value of the anomaly. Gravity highs (interpreted as basement highs[7]) and their linear trend are clearly seen in detailed (large-scale) Bouguer anomaly maps and profiles.

Changes in the kinematics of master faults with changing stress pattern during post-rift tectonic cycles have been discussed. In this case the faults were first activated as normal during rift stage, as reverse during aborting of the rift, as divergent strike-slip during the drift stage and as convergent strike-slip in the post-collision compressive stage, which is continuing in present Neotectonic cycle[8]. If this is understood without the bias of plume-induced tectonics then there should not be any confusion in understanding the tectonic evolution of the Kutch basin. Common terminologies related to rift and strike-slip tectonics have been used here and should not be confusing to anyone familiar with strike-slip tectonics.

As discussed under 'Igneous activity', the Reunion plume is responsible for late tectonic igneous activity, the Deccan Trap flows and related intrusions. Localization of the intrusive bodies along the master faults in narrow, linear zones further points to the existence of faults prior to the plume activity. The faults acted as conduits for intrusions. The suggestion of structure formation due to hotspot activity in this region located in the distal part of Reunion plume periphery, is thus unfounded and a sweeping generalization.

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