

„Images and photos are structured by the presumptions and perspectives of their creators“

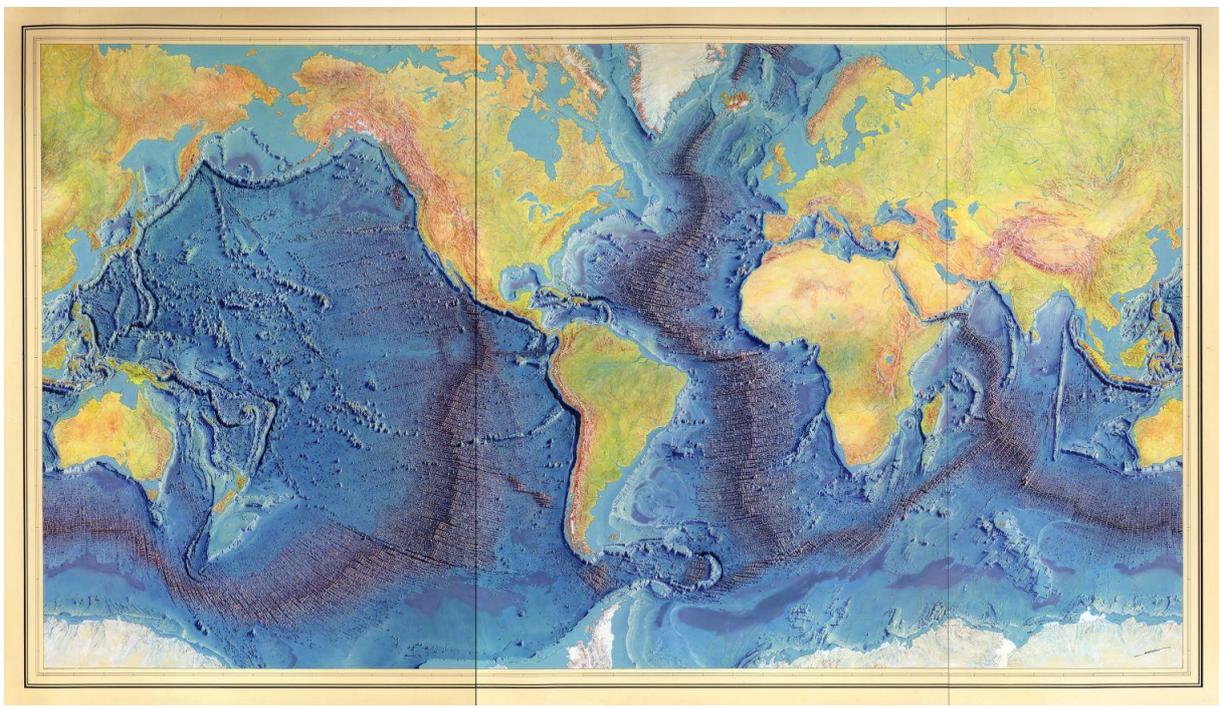
(E. Wolfrum & C. Arendes, 2006)

## Some reflections on the charts of the ocean floor:

### Do they hide more than they reveal?

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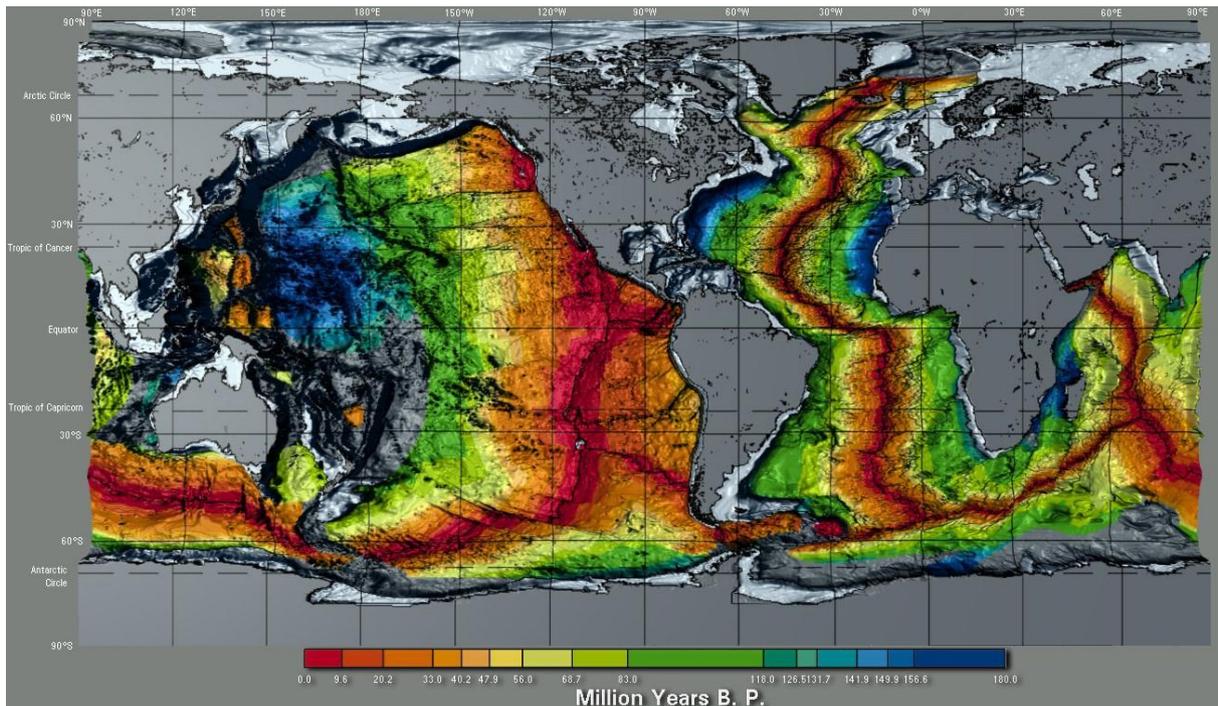
Who does not know the charts that suggestively present the world's ocean with its impressive bottom morphology (Fig. 1) and the crustal stripes showing progressively younger ages from the ocean margins to the mid-oceanic ridges (Fig. 2)?



*Figure 1. The chart of the World Ocean floor, known also as the Heezen-Tharp Chart, painted by Heinrich C. Berann (1977)*

Marie Tharp (1920-2006) and Bruce Heezen (1924-1977) undoubtedly did a remarkable job by creating the first chart of the world's ocean floor and soon after it was released (1977) it became an important pillar of the theory of plate tectonics, enunciated a couple of years earlier.

Thereafter it lasted twenty years until the first digital map appeared (1997) that presented the age of the ocean floor (Fig. 2).



*Figure 2. The crustal age of the ocean floor (Source: Dr. Peter Sloss, former NGDC, 1997)*

Taken together these two charts are strongly suggesting the infallibility of the plate tectonics theory and its explanatory power. Thus the bottom morphology presented by the first chart documents particularly well the existence of a world system of mid-oceanic ridges segmented by transform faults. Along these ridges new crust is continuously formed by outpouring of basaltic lava. As it cools it is breached amid and pushed sideways by the ascent of newly formed basaltic melts. In the end there occur on both sides of the ridge symmetrically arranged stripes of basalt whose ages increase gradually away from the ridge crest. This is exactly what the second chart illustrates.

However this situation would also agree well with the idea of an expanding Earth if it was not for the evident asymmetry of the Pacific. While the Atlantic and Indian Oceans are characterized by the mid-oceanic position of their ridges, the present Pacific ridge – labeled East-Pacific Rise –is not situated in the middle of the ocean but in the south-eastern part of it. Plate tectonics explains this by admitting subduction, a process by which (old) oceanic crust

buckles down beneath continents or island arcs in order to maintain a constant radius Earth.

Thus, by looking at the age chart we are tempted to admit the reality of subduction by logically considering that the centered position of the “mid”-ocean ridge of the Pacific was spoiled by differing rates of subduction along its borders. The impression is that along North America not only the eastern half of the ocean disappeared by subduction but also the ridge itself and parts originally situated west of it. Along South America “only” the older Mesozoic and (?)Pre-Mesozoic parts of the ocean disappeared while in the Western Pacific there still exist large areas of Mesozoic oceanic crust. That’s what the chart tells us. The subduction concept is further sustained by the fact that the centered position of the ridge in the Atlantic and Indian Oceans correlates well with the very limited extent of subduction zones along their borders, unlike the situation of the Pacific which is almost surrounded by assumed subduction zones in the so-called Ring of Fire.

Under the topic “Mid-ocean ridge” Wikipedia writes: “The mid-ocean ridges of the world are connected and form a single global mid-oceanic ridge system ...”. This impression is also created by looking at the age chart.

But is this all real? What if the data is presented in such a form as to conform to the theory?

The situation presented in both charts may grossly approach reality but *it is not reality*. In spite of the fact that the charts have been updated in recent years, data that tends to contradict the theory is underrated and plotted in such a mode as to remain unnoticed. Thus the impression is created that it is of only minor importance and does not really challenge the theory.

Let me try to explain: are the same rocks of different ages allocated different status when represented on a map? Two or more basalts may differ in age and some other characteristics but they are still equivalent. They are not basalts of first, second or third order.

But exactly this kind of rating is undertaken in the case of ridges and paleo-ridges when they are represented on the charts. Present-day ridges are clearly visible, paleo-ridges much less. Not to mention that many of them are still waiting to be plotted or even to be discovered.

There is however a problem. As conjectured by Hess (1959) and Menard (1959) long ago, ocean ridges are ephemeral features from a functional and geomorphological point of view. They may leave no traces on the ocean floor millions of years after cessation of crustal accretion. Thus they mostly cannot be represented on charts like that illustrated in Figure 1. Nevertheless there are other features that enable their identification, like gravity anomalies or the structural grain of magnetic anomalies within the appropriate basaltic crust.

Table I

	<b>Name / Location of Paleo-ridges</b>	<b>Time of activity (Ma)</b>	<b>References</b>
I	Labrador Sea & Baffin Bay, NW Atlantic	63 – 35	Srivastava & Arthur, 1989; Hosseinpour et al., 2013
II	Aegir, NE Atlantic	55 – 25	Greenhalgh & Kuszniir, 2007
III	Crozet/Conrad Rises, SW Indian	83 - 55	Cross et al., 2011
IV	Mozambique & W Somali Basins, W Indian	167.5 - 123	Coffin & Rabinovicz, 1988; Gaina et al., 2013
V	Mascarene Basin, W Indian	83 - 59	Royer et al., 1989; Gaina et al., 2013
VI	Wharton Basin, W Indian	136 - 43	Müller et al., 2000
VII	Tasman & Coral Seas, SW Pacific	83.5 - 52	Müller et al., 2000
VIII	Osborn Trough, SW Pacific	118-86	Worthington et al., 2006
IX	Nova - Canton Trough, SW Pacific	Middle Cretaceous	Mammerickx & Sandwell, 1986; Yamazaki & Tanahashi, 1992; Joseph, 1993
X	Line Islands, SW Pacific	Early Cretaceous	Winterer, 1976
XI	Chinook Trough, Central North Pacific	Late Cretaceous	Dickens & Owen, 1995
XII	Galapagos Rise, SE Pacific	? - 20	Mammerickx et al., 1980



*Figure 3. The Age Chart issued by the California Institute of Technology (2009), completed with the trend of twelve fossil ridges (I-XII) plotted by the author.*

This permits us to plot them on age charts. I show here a recent variant of a seafloor age chart on which I approximately plotted 12 paleo-ridges (Fig. 3). On the original chart the paleo-ridges are not shown although some of them may be inferred from the distribution of the differently colored stripes of oceanic crust. Table I lists the 12 paleo-ridges and the probable time of their activity according to different sources from the literature. Some of the paleo-ridges like those from the Labrador & Baffin Bay or from the Tasman & Coral Seas do not “disturb” very much the image created by plate tectonics, but the rest of them do. At least their traces and evolution may be explained differently. Thus, instead of merely assuming “global plate reorganization” and/or ad-hoc “ridge jumps” as a cause for their abandonment, it may be instructive to consider the general evolution trend of ridges, as proposed by Hess (1959) and Menard (1959). Frankel (2012) summarized Menard’s assumptions on the evolution of mid-ocean ridges as follows:

“Oceanic ridges start out as broad rises. They are seismically active, characterized by high heat flow and volcanic islands. They also seem to lack a central rift valley. As they age, they remain seismically active, a central rift valley forms, their flanks begin to subside, and some associated volcanic islands are truncated by wave action and become guyots. They eventually become narrower and narrower, and remaining volcanic islands become guyots and atolls...”

In Menard’s own words: “The proposed sequence of development from rises to ridges implies that oceanic rises are not permanent features.” (Menard, 1958). With this idea in mind we should be cautious to trace back what we see today. Even admitting that most segments of the present Mid-Atlantic Ridge were probably active since the initiation of rifting in the Proto-Atlantic basins, this assumption does not apply to the present ridges or rises from the Indian and Pacific Oceans.

### *Indian Ocean*

In Figure 4 I plotted three of the fossil ridges from the Indian Ocean on the chart to show that instead of arguing for local ridge jumps one may rather imagine a completely different ridge system during the Upper Cretaceous.

Indeed, the array of the three paleo-ridges strongly suggests that they probably met at a triple junction. Similarly an even older Jurassic-Lower Cretaceous ridge

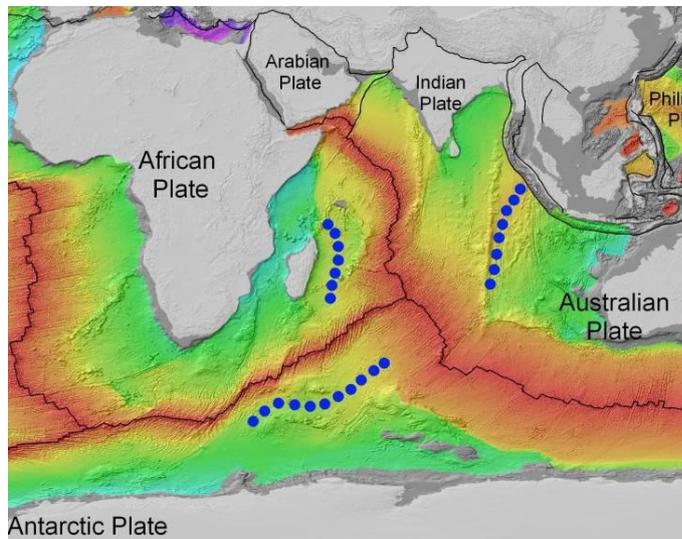


Figure 4. The age chart of the Indian Ocean (Detail from Elliot Lim, 2008) completed by the present author with three paleo-ridges (blue dots) active during the Upper Cretaceous. They possibly converged at a triple junction situated in the middle of a Paleo-Indian Ocean of reduced dimensions.

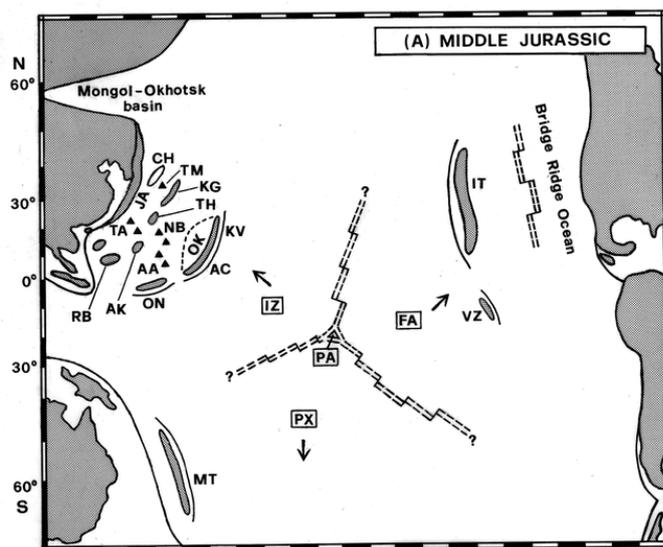


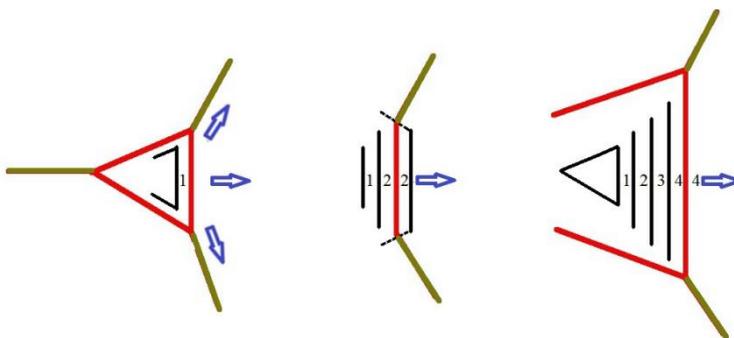
Figure 5. The “birth” of the Pacific Plate (PA) during the Middle Jurassic according to the plate tectonics theory (from Smith, 2007)

system different from that just mentioned may be inferred. And there is much evidence that almost every new ridge, if not an entire system, was initiated by the rising of a mantle plume. Thus, the Jurassic ridges probably occurred in connection with the plume that generated the Karoo large igneous province (LIP) (Gaina et al., 2013), the Upper Cretaceous ones are linked to the Marion hotspot (Storey et al., 1995) while the present Carlsberg ridge, that finally caused the cessation of the Cretaceous ridges, is a direct consequence of the activity of the Reunion hotspot (Collier et al., 2008).

## *Pacific Ocean*

The situation is much more complicated in the Pacific Ocean. To solve it in the spirit of plate tectonics, a rather disputable explanation has been spawned as regards the Pacific plate. Thus it was assumed that it “nucleated” at a ridge-ridge-ridge (RRR) triple junction (Fig. 5) in spite of the fact that *nowhere else on Earth has such a process been actually witnessed*. Moreover this assumption is at variance with at least two earlier tenets of plate tectonics, namely that RRR configurations are the most stable among triple junctions (Mitchell, 2010), and that ridges are situated over rising limbs of convection cells (Hess, 1962).

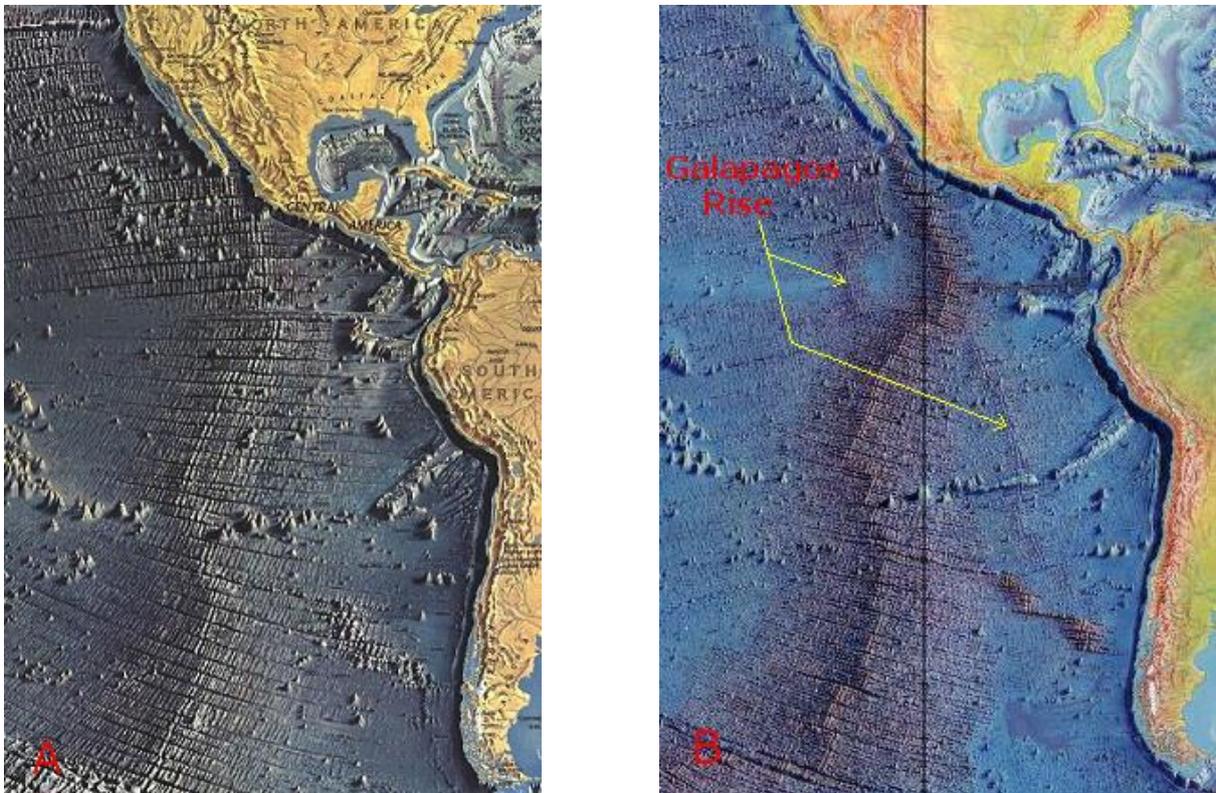
The assumption that the Pacific plate has come into existence at the triple junction of the inferred Farallon, Phoenix and Izanagi plates (FA, PX and IZ in Figure 5) automatically implies that the bordering ridges of the new plate were all moving radially outward to permit its growth (Fig. 6).



*Figure 6. Initial stages of the “birth” of a plate at a triple junction: all new ridges (shown in red) that delimit the plate migrate radially outward while all old ridges (in khaki) are forced to retreat.*

Such pre-conditions are extremely different from those that are now admitted by plate tectonics to prevail during the creation of so-called oceanic microplates. Therefore the presently existing Galapagos, Easter and Juan Fernandez microplates strung along the East Pacific Rise (EPR) (see Figure 3) cannot be regarded as today’s equivalents of the Pacific plate in its “nascent” state. As shown by many authors, these microplates all rotate; more than that – without rotation they should not have come into existence at all. However, rotation is also the reason why they should go extinct sooner or later (Schouten

et al., 1993; Searle, 2013). It is safe to admit that no oceanic microplate existed for longer than about 10 Ma. In the end “the microplate is transferred entirely to one of the adjoining major plates and ceases to exist as a separate plate” (Searle, 2013). As examples of “defunct microplates” in the eastern Pacific, Searle (2013) mentions the Mathematician Ridge situated west of the EPR and the Bauer Basin east of it.



*Figure 7. Different representations of the EPR and surroundings in accord with increasing data acquisition. A. Detail of the first edition of the Pacific sea floor chart (National Geographic Society, 1969). Galapagos Rise not figured; B. 1977 edition of the World ocean floor (Berann, 1977). Galapagos Rise is plotted on the chart and seen to be transected by the EPR.*

It should also be mentioned that, like in the Indian Ocean, indications of paleo-ridges particularly in the west-central Pacific (see Table I and Figure 3) can be interpreted as remnants of one or maybe more Pacific ridge systems that were altogether differently shaped than the presently functioning eye-catching one seen on the charts. Yet, even in the south-eastern Pacific there is not only the EPR and its branches, the Cocos and Chile Ridges, but at least one more ridge

(Galapagos Rise) that has been segmented by the EPR (compare Figures 7A and 7B). For this and many other reasons it is now clear that the EPR is a young oceanic ridge that initiated not earlier than about 18.5 Ma ago (Mammerickx et al., 1980). Thus emplacement *and* subduction of oceanic crust of pre-Miocene age thought to have been generated along the EPR are no longer up for debate. Why should one consider that the Galapagos paleo-ridge should be more appropriate to account for oceanic crust subducted under the American mainland?

Of course plate tectonicists would argue that their interpretation is founded on a sound base: the existence of magnetic lineations within the oceanic crust. However, my impression is that their model stands or falls with the accuracy of the basic assumption that the Pacific plate began its existence as a microplate somewhere in the middle of Panthalassa. As I tried to show, the arguments in favor of such an assumption are meager in spite of the seemingly conclusive image that emanates from the charts that I briefly discussed above. The alternative to this model, that should be thoroughly investigated in the future, is the existence in both the Indian and Pacific Oceans of paleo-ridges assembled into systems completely different from the presently active one. It may well be that, if correct, this model would make subduction superfluous, thus paving the way for alternative geotectonic hypotheses.

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