Inconsistencies of the plate tectonics rationale

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Abstract

The intention of the author is to show inconsistencies of the plate tectonics theory by focusing on appropriate case studies. A first step was done with the more general paper "Some reflections on the charts of the ocean floor: Do they hide more than they reveal?" (http://www.dinox.org/publications/Strutinski2015.pdf)

The first case study refers to the Iquique Ridge in the Southeast Pacific. It is argued that the ridge is not rigid in its frontal part adjacent to the Chile Trench, nor is it subducting. The physiographic chart clearly shows a pronounced curvature of the ridge, which is, beyond doubt, a secondary feature. The reason for its occurrence is seen in the deformation of the ridge by dragging along the left lateral Atacama Fault System (AFS), a component part of the Western South American Megashear (WSAM).

Case study Nr.1

"As the uncertainties in our data sets get smaller and smaller, I fully expect that we will start detecting the non-rigidity of the major plates …"

(Tanya Atwater, 2003)

The Iquique Ridge

The Iquique Ridge is a submarine ridge of the Southeastern Pacific, obliquely facing the Chile Trench at about 20^{0}S. Due to plate tectonics, the ridge – rigid as it is - is subducting together with the Nazca Plate under South America. The incidence angle between the Nazca and South American plates is considered to be near to orthogonal. Accordingly, Rosenbaum et al. (2005) give the positions of the ridge at 5 and 0 Ma as seen in Figure 1.

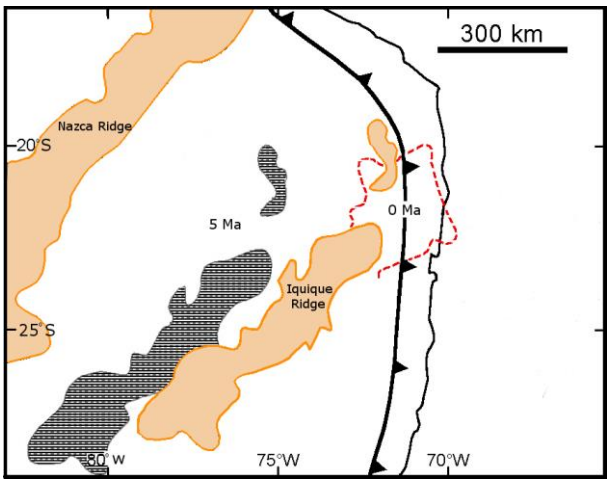


Figure 1. The Iquique Ridge, south of the Nazca Ridge, at 5 Ma (checkered) and 0 Ma, according to Rosenbaum et al. (2005)

According to their view the ridge began to subduct in recent time, less than 2 Ma ago. The "subducted" portion of the ridge is outlined on the map by the red dashed line. The authors came to their conclusion based on the absence of ore deposits "in the area where subduction of the Iquique Ridge takes place in northern Chile" (Rosenbaum et al. 2005). In their eyes this stands in opposition to the situation of the neighboring Nazca Ridge that started to subduct in the Middle Miocene (15-11 Ma) and was apparently responsible for the increase of metallogenic activity in the Peruvian Andes at about the same time. However this activity lasted only 8 Ma and then came to an end irrespective of the fact that subduction of the Nazca Ridge allegedly was assumed to continue.

I have a totally different story to tell about the Iquique Ridge, based on my hypothesis of shear belt tectonics and the characteristic morphology of the ridge as seen on the GEBCO World Ocean Map (M. Leier, 2007). It stands in opposition to the plate tectonic tenets regarding subduction and the rigidity of oceanic plates.

Quite differently from an individual fault plane, along which failure takes place instantaneously and that may be classified as brittle, along an entire shear belt deformation is brittle only on outcrop level. On a very large scale however, involving vast portions of the crust and over a long time span, deformation should be considered plastic, the more so as it is acknowledged that motion along shear faults takes place to a great extent by aseismic continuous and episodic creep (Wei et al., 2013).

In the laboratory many workers have reproduced the fracturing of rocks. In a seminal paper, Tchalenko (1970) described a series of vertical shear (strike-slip) experiments with clay and compared his results with situations in the field. He was able to show that the principle of simple shear is the same from the microscopic to the regional scale irrespective of the material involved. The last stage of development of one of his experiments is presented in Figure 2. As we can clearly see, during the shearing an anastomosing network of vertical faults was created, whereas the initially straight markers on the clay cake were distorted into drag folds, attesting plastic deformation.

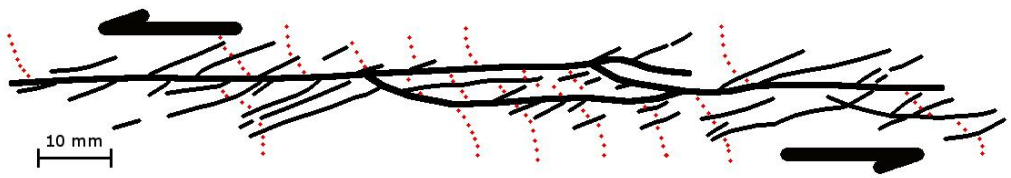


Figure 2. Experimentally created shear fracture (redrawn from Tchalenko, 1970). Markers (in red) have been deformed systematically and are an indication of the adjustment suffered by the clay. Their obvious drag to the right is a reliable indication of the sinistral character of the shear.

Let us now take a little step farther, trying to see what happens at a much bigger scale. Carey (1976) gives us a suggestive example by presenting the interaction between two creeping masses, differing by the speed of flow (Fig. 3). The two masses are a landslide and a glacier. In analogy with the fault example, the landslide flow is an almost instantaneous event, lasting hours, while the glacier flow takes place over years at speeds of one or a few meters per day. We can see the important changes in the distribution and form of the frontal part of the landslide carried by the creeping glacier.

Notwithstanding the fact that we are dealing with “solid materials” (rock and ice), the effect as a whole is of plastic deformation.

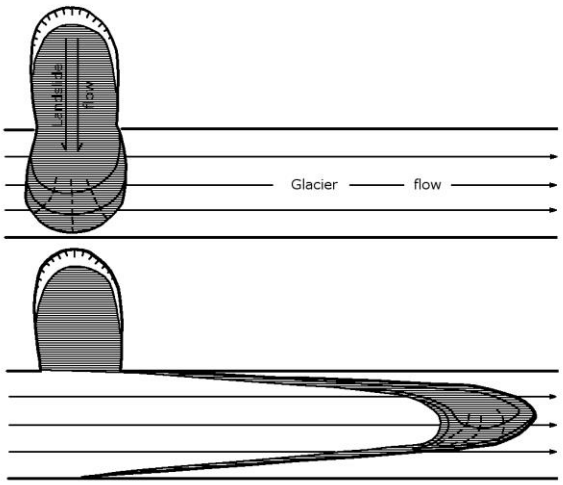


Figure 3. Plan view showing overprinting of fast by slower deformation. The horizontal lines represent flow-lines of different speeds. (redrawn from Carey, 1976)

Systems of faults like those that occurred during the experiment (Fig. 2) are well known in many regions of strike-slip faulting. To better show the analogy between the two different orders of magnitude, I have put side by side the rotated image of Figure 2 and a sketch map of the left-lateral Atacama Fault System (AFS) along the Coastal Cordillera of northern Chile (Fig. 4).

The AFS, exceeding 1100 km in length and reaching up to 50 km in width, was recognized for the first time as a strike-slip or transcurrent alignment by St.Amand & Allen (1960). It is supposed to have been active from the Middle Jurassic and to the Late Miocene (Brown et al., 1991). Since then until the Present most authors consider that it suffered mainly dip-slip brittle reactivations within an extensional environment (Chorowicz et al., 1996; Delouis et al., 1998; Cembrano et al., 2005; Gonzales et al., 2006). However, recent left-lateral horizontal offsets of at least minor extent (up to tens of meters) are attested by some authors (Brown et al., 1991; Delouis et al., 1998). Interestingly, this sense of displacement is opposed to the predicted one, if strain partitioning due to the inferred oblique subduction of the Nazca Plate would have been the cause (Armijo& Thiele, 1990; Delouis et al., 1998). As a matter of fact neither the sense of horizontal displacement on the AFS nor the extensional tectonic regime within the Coastal Cordillera favors the subduction assertion. Moreover, a close examination of the physiographic chart of the seafloor of the Nazca Plate in the region of the Iquique Ridge shows a striking curvature of the ridge that can hardly be interpreted as a primary feature (Figure 5), the more so as a similar curvature is observed to affect also the Juan Fernandez Ridge, situated some 1000 km more to the south. These features can be most properly interpreted as drag folds, comparable to those shown in figure 2, and formed by entrainment along the sinistral AFS.

This interpretation must be outrageous for any adherent of plate tectonics, because it clearly opposes at least two essential tenets of the theory: the rigidity of the oceanic crust right to the trench and the process of subduction itself. Not to mention collision. It is true that recently the rigidity of oceanic plates has been questioned on the ground of horizontal thermal contraction

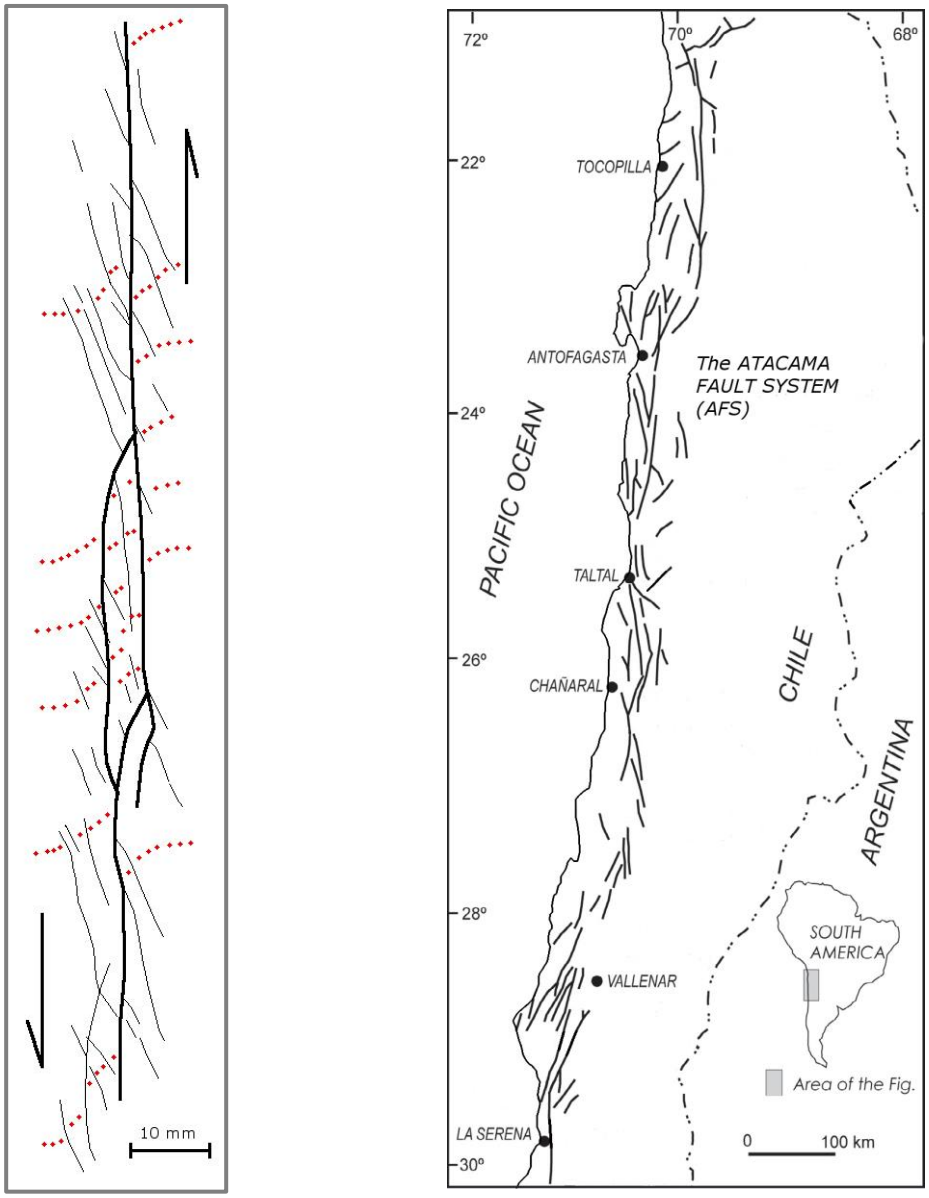


Figure 4. Comparison between two left-lateral strike slip alignments seven orders of magnitude apart. To the left – Tchalenko's experiment (see Fig. 2), to the right – the Atacama Fault System (redrawn from Maksaev et al., 2010)

(Kumar & Gordon, 2009; Kreemer & Gordon, 2014). However, here I imply that the oceanic crust of the Nazca plate has effectively been deformed by horizontal bending due to its vicinity to a shear belt, the AFS. The curvature can be seen on the chart, it is ***real*** and not only ***assumed*** like the flexural bending of the oceanic crust beneath trenches, which is the favored image of the plate tectonics theory. The adherents of this theory make the same mistakes as the former contractionists by assuming without any argument that some parts of the crust behave rigidly like vise jaws along their margins whereas others are deformable. Collision as a consequence of compression is an illusion and does not produce noteworthy deformation in rocks. It is an almost hundred years old wisdom that

deformation of the crust is almost entirely at the expense of shearing (Schwinner, 1924). Therefore I stated that in regard of the lithosphere ***rigid*** means merely ***temporary not subject to deformation*** (Strutinski, 1997). Rittmann (1942) also thought that orogeny has much less to do with different mechanical behavior, meaning different types of crust, but with specific conditions created in strictly delimited areas. The areas that are most prone to deformation are the shear belts developed along transcurrent systems. They are all characterized by lengths one or even two orders of magnitude larger than their breadths (England & Jackson, 1989).

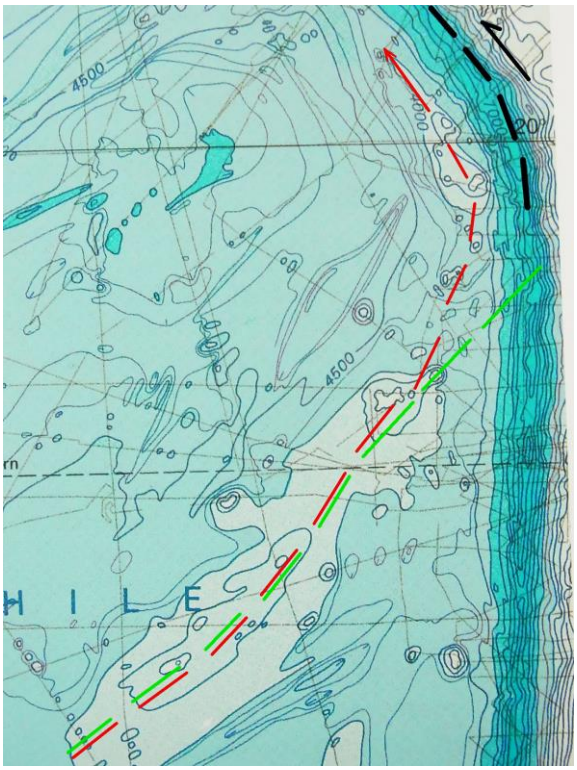


Figure 5. Physiographic map showing the curvature of the Iquique Ridge along the Chile Trench (from Leier, 2007). Green line – the axis of the originally straight ridge. Red line – the Actual curved axis. Black line – suspected axis of the northern prolongation of the sinistral Atacama Fault System

In my view the Pacific is surrounded not by subduction zones but by shear belts like the discussed AFS. The strike-slip movement may be "touchable" at the surface (e.g. AFS, San Andreas Fault, Philippine Fault, Semangko Fault) or not, but is still the principal type of movement irrespective of what fault plane solutions may suggest. It should be mentioned however that, by analyzing fault plane solutions, John Hodgson (1957) concluded almost sixty years ago that most of the earthquakes around the Pacific are triggered by strike-slip, not dip-slip. Even assuming that part of his data may have been erroneous (Isacks et al., 1968), we know today that to an important part displacement along strike-slip faults takes place aseismically (Wei et al., 2013) and therefore may remain unnoticed. The shear belts along the Pacific margin of South America are to a very large proportion "touchable" and not just imagined. From north to south the most important are: the Cauca-Romeral System (dextral), the AFS (sinistral), the Liquine-Ofqui System (dextral) and the Magallanes System (sinistral). Until recently I assumed that they all belong to a *single* shear belt that borders the margin between the Pacific and the South American continent. Between the dextral and sinistral shears highly deformed, elongated crustal slivers of continental or oceanic origin ("terranes") occur, which I supposed to be situated above an upper mantle current (an *asthenocurrent*, according to Strutinski & Puste, 2001; Strutinski et al., 2003) not larger than 100-200 km that creeps along the continental

block from south to north (Figure 6). The shear-wave splitting technique, based on the time-delay of split shear-waves on transition of anisotropic media, and the polarizations of the fast waves, provides valuable evidence in favor of my hypothesis. It clearly shows that flow within the mantle under 'subduction zones' is parallel and not orthogonal to them as it should be if subduction would be real. Kneller & van Keken (2007) assert accordingly:

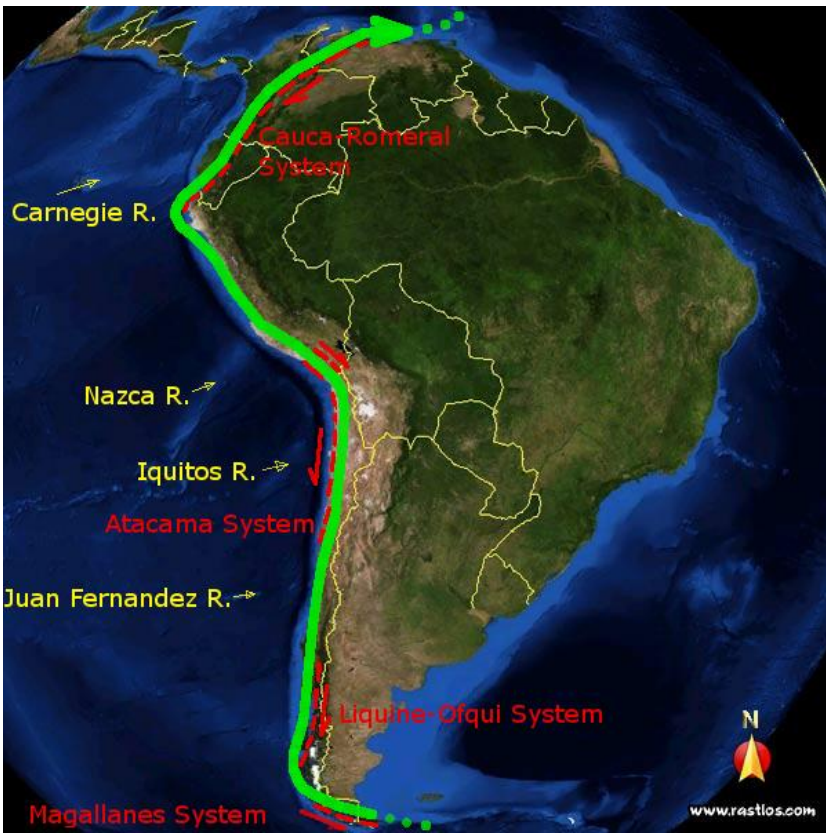


Figure 6. Shear belts along continental South America bordering the Pacific (in red). The sinistral (against the Pacific crust) and dextral (against the South American craton) shear belts delimit a "corridor" within which highly deformed, elongated crustal slivers are transported northward by an assumed *asthenocurrent* (in green) that essentially "follows" the outline of the continental margin. Background map from www.rastlos.com

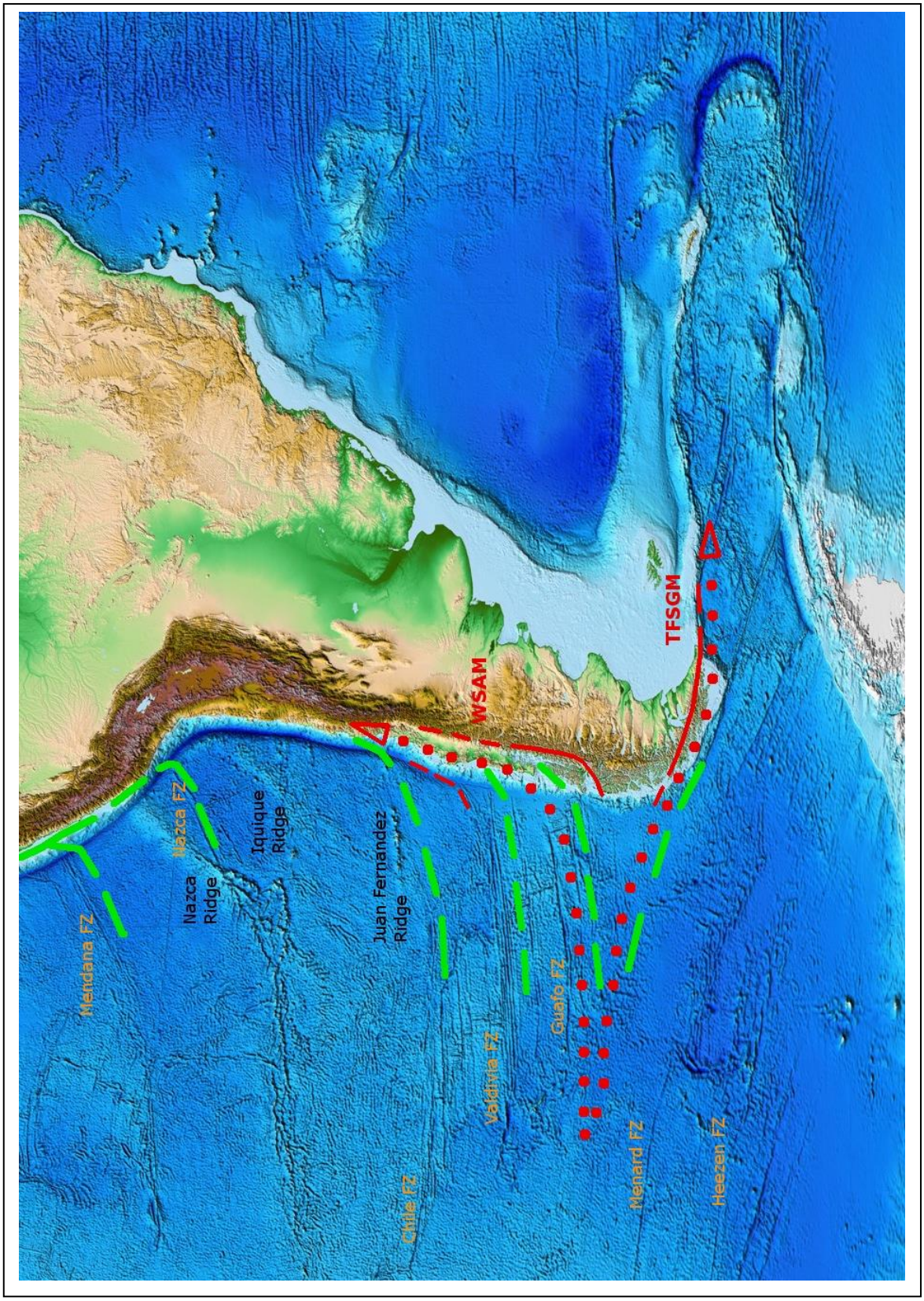
"Shear-wave splitting observations from most subduction zones show complex patterns of seismic anisotropy that usually have trench-parallel fast directions. These observations are unexpected, because models of two-dimensional wedge flow predict fast seismic anisotropy parallel to plate motion (trench-perpendicular)". Truly, the error of plate tectonics is this 90-degree difference!

However, as I remarked above, I recently changed my mind about the real situation in this sector of the Pacific border. I am herewith putting forward a new hypothesis that is more in consonance with the facts and according to which the Magallanes System does not belong to the *Western South American Megashear* (WSAM) but is part of another one that develops in a W-E direction towards South Georgia (*Tierra del Fuego – South Georgia Megashear*, TFSGM).

As surmised by different authors in the past (see for instance Jardetzky, 1954; Gilliland, 1964, 1973; Strutinski, 1994; Strutinski & Puste 2001) zonal motion due to Earth rotation may take part in differential movements within the upper mantle. Along the equator zonal motion is assumed to generate a mantle current relatively moving to the east as compared to the mid-latitudinal and polar zones. But even at mid-latitudes zonal motion takes place, even though at a much reduced speed. The motion is revealed spectacularly in the oceans by the thousands of kilometers long so-called transform faults, which probably have no genetic relationship to ocean spreading, contrary to what plate tectonics adherents assert following Wilson (1965). This seems particularly true for the 'transform faults' in the Central Atlantic and the entire Pacific basin. Instead, these faults appear to represent motion vectors of the creeping 'asthenospere'. As there is no indication of an asthenosphere under old shields, the term 'asthenosphere' is also misleading, like the term 'transform fault'. So, if we consider that the sub-oceanic 'asthenospere' is relatively moving east, we have to imagine what is happening to this W→ E movement when a 'wall' represented by a deep continental/cratonal root is encountered. The answer seems to be quite simple: the movement is deflected along the 'wall' and a *mantle contour current* (MCC) is created, in a similar way as water contour currents are generated along continental slopes. MCCs are fed by the sub-oceanic mantle material flowing east. But until the Present, they seemingly formed only along the eastern margin of the Pacific. However, they are strong enough to continue to flow *around* this ocean, so we find them along Alaska, the Aleutians, and bordering East Asia, Oceania and Australia. *These are the 'subduction zones' of the plate tectonics theory*. It is plausible that MCCs also exist under the West African –West European border but to this moment they probably were too weak to produce shearing within the overlying lithosphere. And without shearing there will be no trench, no volcanic arc, no accreted terranes and particularly no orogeny. However, ideas on an initiating 'subduction' west of Iberia already exist (Duarte et al., 2013) If we analyse the situation in the southeastern Pacific (Figure 7), it is obvious that the Guafo, Valdivia and Chile Fracture Zones ('transforms') are directed towards the north-east as they approach the continent, while the Menard and Heezen Fracture Zones are trending towards the south-east. What could be more appropriate as to infer that their trends indicate that mantle material feeds two different MCCs, namely a northerly flowing one giving birth to the WSAM and a southeasterly directed one that creates the TFSGM?

Shearing within a transcurrent system may be old (tens of millions of years), relatively young (millions of years), or just initiating. This topic I intend to discuss in another paper where I shall also allude to the connection between shearing and trench formation.

Figure 7.Two megashear systems (WSAM and TFSGM) above contour currents feeded by suboceanic 'asthenospheric'mantle. Green – motion vectors; red dotted – branching of the creeping mantle between Guafo and Menard Fracture Zones. Red lines represent (from south to north): Magallanes FS, Liquine-Ofqui FS and southern extension of the AFS. Background map: cut-out from ETOPO1 Global Relief Model (Amante, C. & Eakins, B.W., 2009)



Regarding the AFS and its role in deforming the “rigid” crust of the Iquique Ridge, it can be surmised that it must have been active since the initiation of the ridge some 50 Ma ago, as the “oroclinized” (=curved and elongated) portion of it measures at least 300 km. As I already mentioned, the Juan

Fernandez Ridge shows a similar bending, although differently oriented, because the orientation of the trench is different. This means that any connection between the bends and a change in plate motion should be excluded.

The fact that the Nazca Ridge to the north of the Iquique Ridge apparently has no curvature and abuts on the trench along a remarkably straight line may be interpreted by assuming a higher rigidity of the Nazca Ridge that did not permit bending but instead rupture along that line that parallels the direction of the shear belt. Farther to the north ridges, including the broad Carnegie Ridge, show again slight curvatures that are all in accordance with the left-lateral character of the implied shearing.

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