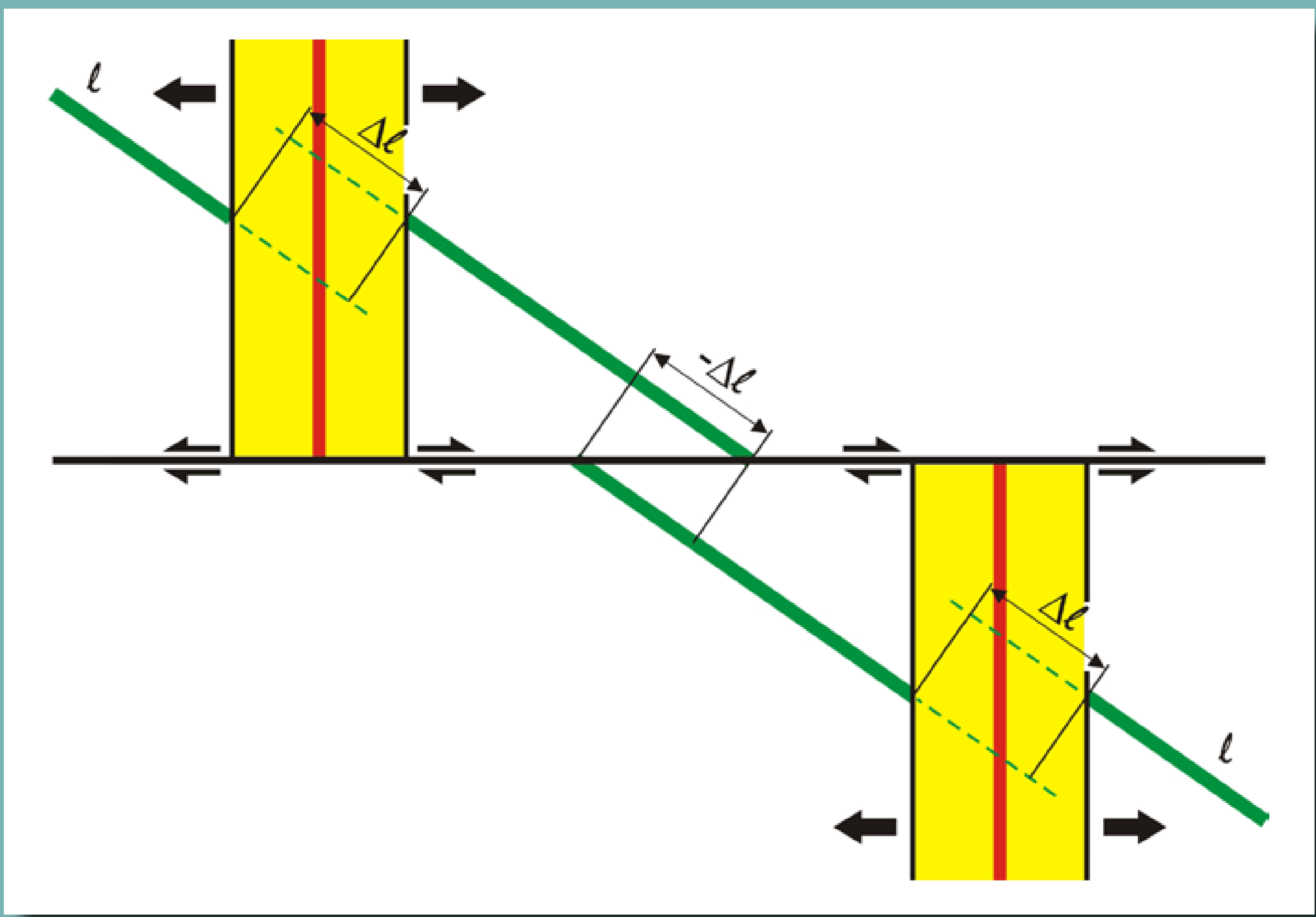
JAN KOZIAR

The Ripper–Perin expanding great circle, proving Earth expansion



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Introduction

The presented paper was sent in March 2014 to the *NCGT Journal* (New Concepts in Global Tectonics) under the title *"Null global impact of transform faults on the Ripper-Perin expanding great circle, proving Earth expansion".*

The NCGT Journal was founded for the purpose of exploring alternative theories to plate tectonics. So the journal is formally open to expanding Earth. However the journal is occupied mainly by modern-day fixists who reject spreading of the ocean floor. These workers have by now amassed a vast set of data in support of this rejection. However their position is only partially correct, in that the data they have assembled really do conflict with spreading as envisioned by plate tectonics – i.e. on a non-expanding Earth. But, as I argue elsewhere, these same data are actually concordant with spreading on an expanding Earth, an even further substantiate the reality of expansion. But modern-day fixists reject the spreading as such.

Unfortunately the problem was not yet explained sufficiently by expansionists and my paper became a casualty of this situation. It was rejected on the grounds that it accepts the spreading of the ocean floor[1].

However the rejection revealed a very important current problem – that of the correct understanding of sea-floor spreading. This problem is much more important than the content of the rejected and now presented paper. The latter only supplements the earlier-discovered expanding great circle, discussed previously by several other authors.

I explained the spreading problem provisionally in a letter to the editor of the *NCGT Journal*, referring to my paper of 1985 (*Development of the oceans as a manifestation of the expansion of the Earth*) in which the process of general stretching of the lithosphere is discussed among other things. The process of general stretching of continental margins and tearing away micro-continents, presented there, is indicative for spreading on the

[1] **One reviewer wrote:**
Koziar relies on the standard plate-tectonic seafloor-spreading model and magnetic-stripe chronology. He completely ignores the extensive geological and geophysical counter-evidence that has been presented in the NCGT newsletter/journal, showing that the age, composition and structure of large areas of the ocean crust are incompatible with the spreading hypothesis. This is unacceptable.
Second reviewer wrote:
Global expansion and lithospheric spreading are regarded [in the paper – JK] *established facts without any need of further treatment. But without lateral 'crustal' separation* [spreading – JK], *the paper is virtually without substance. In conclusion,* ***I cannot recommend this paper for publication.***

expanding Earth and it removes the bulk of arguments against spreading put forward by contemporary fixists. The paper is accessible at **www.wrocgeolab.pl/oceans.pdf**.

I also informed the *NCGT Journal* editor that I will write a separate paper about spreading. The paper is now under preparation and entitled *"Spreading of the ocean floor on the expanding Earth"*. It will be accessible on my website at the address: **www.wrocgeolab.pl/spreading.pdf**.

Apart from that I have decided to publish the rejected paper directly on my website (**www.wrocgeolab.pl/circle.pdf**). As I have already mentioned, the paper is less important than the emerging spreading problem. But the Ripper-Perin expanding great circle alone is a very important and simple proof of the Earth expansion. Because its earliest version (the Ripper expanding great circle) was questioned by Dooley in 1983, it was necessary to explain just why Dooley's criticism fails, and this is what I have done in the paper.

In the now-presented version the title has been shortened, and the cover and this introduction added. Apart from this, no changes have been made.

J. Koziar
August, 2014

Acknowledgments

I thank Steven Athearn for turning my attention to Ripper's and Dooley's papers and for the English correction of this paper. I also thank Professor Cliff Ollier for delivering the copy of Ripper's paper.

The Ripper-Perin expanding great circle, proving Earth expansion

Abstract. Despite Dooley's criticism, the expanding Ripper-Perin great circle remains a valid proof of the expansion of the Earth. Among three other expanding great circles the Carey one is a part of his Pacific Paradox which is also a proof of Earth expansion, whereas the other two – the Le Pichon one and the plate tectonics one are only good confirmation of the process of expansion.
Key words., Expanding great circles, transform faults, expanding Earth.

CONTENTS

1. Introduction[1]

There are several proofs of the expansion of the Earth:

1. Growth of the Pacific (Carey's test), Carey (1958, 1976)
2. Elongation of plate boundaries, Carey (1958, 1976)
3. Mutual moving apart of hot spots, Stewart (1976)
4. Deep mantle roots of plates, Carey (1983), Kremp (1990)
5. Carey's "gaping gores" (artificial openings at underestimated curvature of the globe), Carey (1958), Van Hilten (1963)
6. Carey's Arctic Paradox, Carey (1976)
7. Ripper's and Perin's growing perimeters of the Earth, Ripper (1970), Perin (1992, 2003)

The first four of these proofs were presented by me in a Polish paper (Koziar, 2004) and now they are accessible in English[2]. The sixth proof (Carey's Arctic Paradox) is demonstrated in another paper of mine (Koziar, 2014)[3].

Ripper's and Perin's growing perimeters of the Earth (expanding great circles) are very similar to each other. The first of them was criticized by Dooley (1983) and this criticism was not riposted by Ripper.

The main goal of the present paper is to show that Dooley's criticism did not actually undermine Ripper's expanding great circle and thus also Perin's later one.

Additionally, three other expanding great circles are presented in this paper. The last one, the plate tectonics expanding great circle, is a new one.

The text may seem to be too detailed but the topic is fundamental so it is better to say more than leave some things unclear. The majority of the considerations concerns oceanic ridges and transform faults between their sections. This has another advantage because today's geological thought is disproportionately concerned with the fictitious zones of plate convergence (subduction). The well-proved and fundamental process of oceanic floor spreading seems to be less important for contemporary geotectonics. Thus some laymen interested in geology are familiar with subduction but know relatively little about the spreading of the ocean floor at oceanic ridges.

2. The Ripper-Perin expanding great circle

a. The Ripper expanding great circle

Ripper (1970) found the great circle (Fig. 1) which crosses only zones of plate divergence and avoids the zones of supposed subduction (except for the Crete trough). In this way it proves the expansion of the Earth.

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[1] March 2014

[2] www.wrocgeolab.pl/handbook.pdf

[3] www.wrocgeolab.pl/geodesy2.pdf

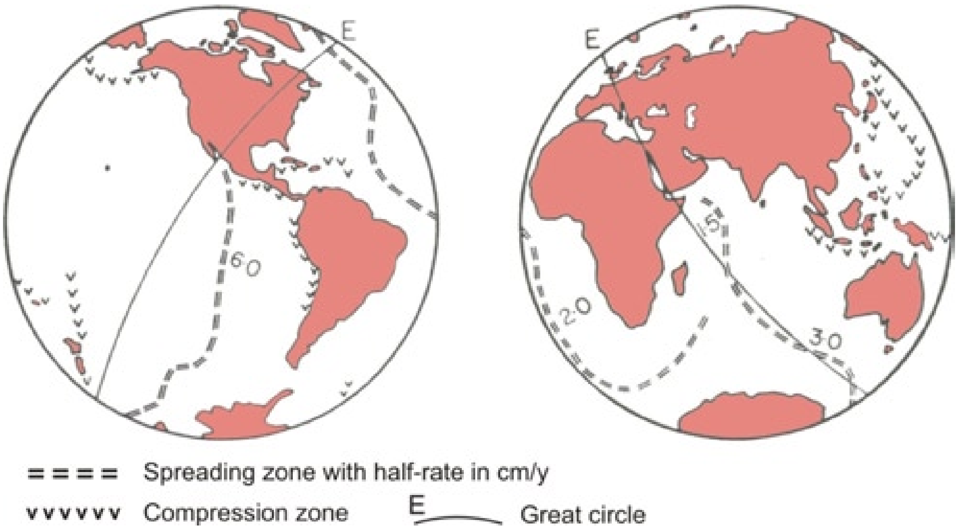


Fig. 1. The Ripper expanding great circle (explanation in text)

Dooley (1983) tried to undermine Ripper's proof pointing out that any great circle which is elongated at a spreading zone can lose this elongation at crossing a transform fault. This critique is presented in full below. Ripper is not known to have respond to this critique.

b. The first Perin expanding great circle

Several years later Perin (1994, 2003) analyzed a very similar great circle (Fig. 2) but did not refer to either Ripper's paper or Dooley's criticism. He probably did not know them. The problem would remain rather unexplained because the author died in 2009.

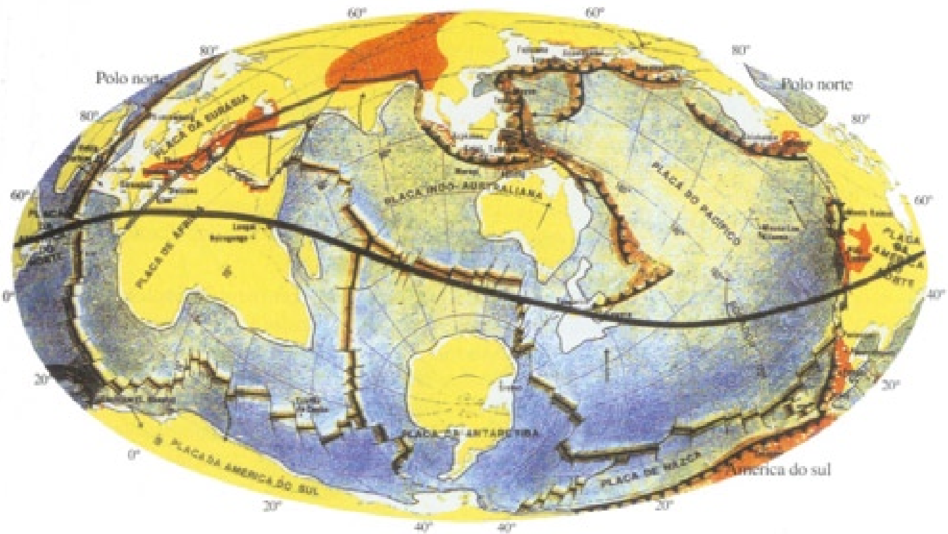


Fig. 2. The first Perin expanding great circle

Perin's great circle fits better the determined goal because it avoids the Crete trough with supposed subduction.

c. The second Perin expanding great circle

Later, Perin (2006, †2012) traced another great circle (Fig. 3) which should fulfill the requirements presented above.

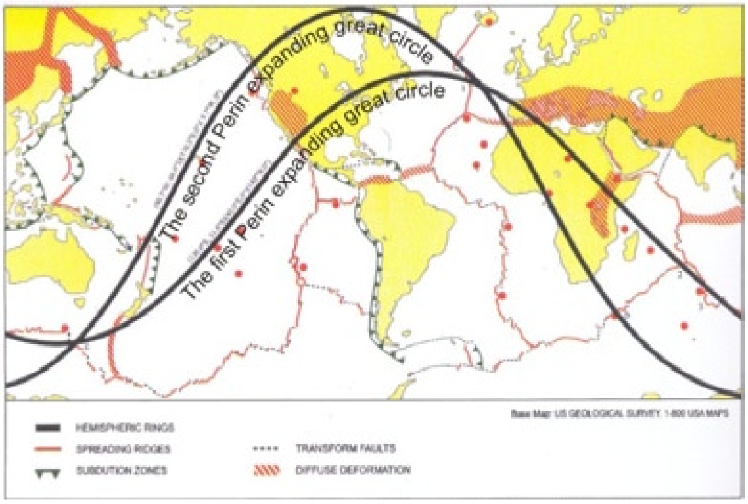


Fig. 3. *The first and the second Perin expanding great circles*

However its crossing the Fiji – Samoa region can be questioned by supporters of plate tectonics and so it will not be considered further in this paper.

d. The Ripper–Perin expanding great circle

As was mentioned, the Perin first circle differs very little from the Ripper one but is more precise. Thus we will consider it alone as a proof of the Earth expansion. However because of Ripper's priority, we will call it "the Ripper – Perin expanding great circle".

3. Dolley's criticism of the Ripper expanding great circle

Usually the proofs of the Earth expansion are ignored by supporters of the plate tectonics paradigm or criticized superficially. The latter is what happened to Ripper's expanding great circle. The critique was done by Dooley (1983), who based it on a hypothetical situation presented in Fig. 4 (also Dooley's Fig. 4).

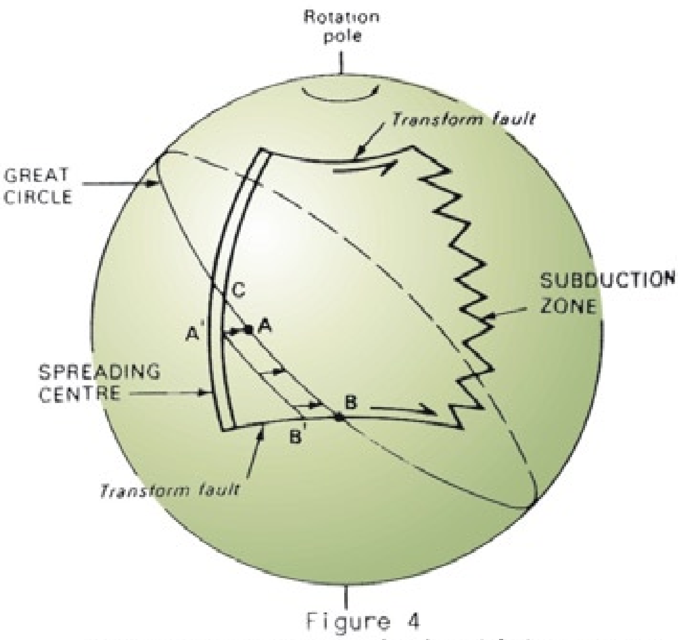


Figure 4
Example of a great circle which appears to be expanding on a constant-sized globe.

Fig. 4. *Dooley's scheme, questioning Ripper's expanding great circle (explanation in text)*

Dooley wrote:

> *"..it is proposed to show that the existence of an apparently extending great circle does necessarily prove expansion of the Earth. This may be seen by reference to Figure 4 which illustrates a hypothetical Earth with one moving plate. The plate moves eastwards (i.e. Eulerian rotation about the geographical pole) from a spreading centre to a subduction zone, both shown as lying along meridians; the north and south boundaries of the plates are transform faults lying along parallels of latitude. The Earth is taken constant size.*
>
> *A great circle is shown intersecting the spreading zone at A and one transform fault at B; it does not intersect the subduction zone. Thus the great circle would appear to be lengthening , and hence to imply an expanding Earth.*
>
> *This apparent paradox can be understood if we consider the movement of the actual segment CB of the crust, now forming part of the great circle. Moving backwards in time it would have been at A'B', which is shorter than CB. If pegs had been driven into the crust at A' and B', they would have moved to A and B, the segment AC is new crust.*
>
> *Thus the paradox arises from confusion between lengthening of a segment (or segments) of crust which now forms part of the great circle, and increase in the perimeter of the great circle itself.*
>
> *As Ripper's great circle crosses several expansion zones and* ***transform faults*** *[bold J.K.] obliquely, the situation depicted in figure 4 can well be applied."*

The segment AC is certainly not new crust, as Dooley insisted, but really the great circle on Dooley's figure does not change its length (see section 6 of this paper). However globally, transform faults do not counterbalance the lengthening of the Ripper – Perin great circle caused by the dilatational zones it crosses. Thus the circle in fact proves the expansion of the Earth. To show that, a more detailed analysis must be done.

4. Analysis of the change of the length of a great circle crossing a transform fault

a. Sense of the change

Real planar or linear geological structures change their length on a fault if they cross it at an angle different from a right angle. They may be lengthened or shortened as may be seen on layers of a normal (Fig. 4a) and reverse (Fig. 4b) fault, respectively.

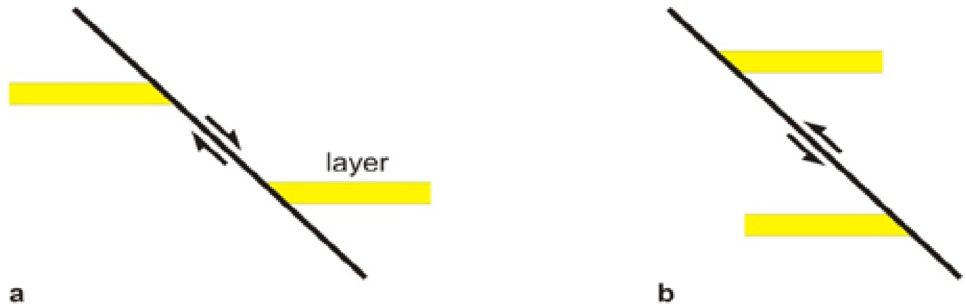


Fig. 5, a *– a normal fault lengthens a horizontal structure,*
b *– a reverse fault shortens a horizontal structure*

However the usual terms "normal" and "reverse" are not good for a general definition of cases of lengthening and shortening. The above terms are fitted to almost horizontal layers and faults with significant vertical translation. Both type of faults act in opposite way for a vertical structure, for instant a dike. The normal fault shortens the dike (Fig. 5a) and the reverse fault lengthens the dike (Fig. 5b).

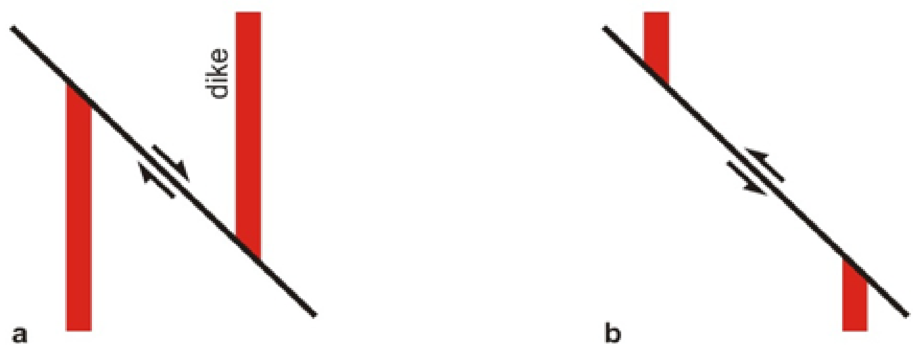


Fig. 6, a *– a normal fault shortens a vertical structure,*
b *– an inverse fault lengthens a vertical structure*

Thus it is necessary to find another and general definition combining shortening and lengthening of being deformed structure (in our case a straight line[4]) with its geometrical relation to relative movement on a fault. Such a definition will be useful also for transform faults. For instance such a definition may combine shortening or lengthening of a straight line with direction of its inclination relative to arrows of shear movement on faults. Thus:

A. The lengthening of a straight line on a fault occurs if the line is tilted against the arrows of shear movement (Fig. 7).

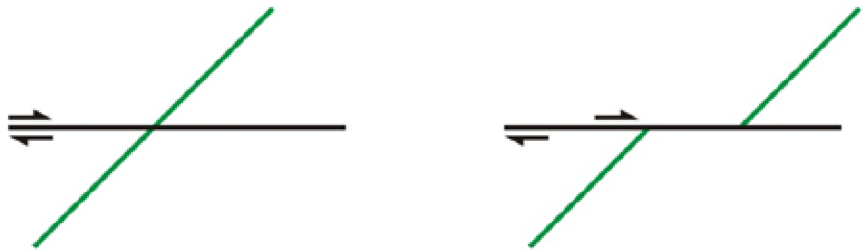


Fig. 7. *Relation between lengthening of a deformed straight line, its inclination to the fault, and direction of movement of the fault (explanation in text)*

B. The shortening of a straight line on a fault will happen if the line is tilted concordantly with the a arrows of shear movement (Fig. 8).

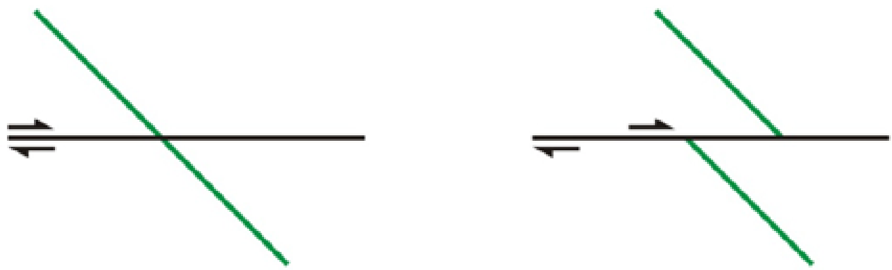


Fig. 8. *Relation between shortening of deformed straight line, its inclination to the fault, and direction of a movement of the fault (explanation in text)*

Of course a line perpendicular to the fault is neither lengthened nor shortened.

However the best solution is to define of the angle of inclination of a straight line to the fault in relation to the shear movement on the latter and then combine the lengthening or shortening of the line with the size of this angle ($< 90^0$ or $> 90^0$). Thus:

The angle of inclination (α) of a straight line to the fault is the one which is pointed by the arrows of the shear movement on the fault (Fig. 9). Then:

A. the lengthening of a straight line on a fault will happen if α is an acute angle (Fig. 9a)

B. the shortening of a straight line on a fault will happen if α is an obtuse angle (Fig. 9b)

[4] By shortening or lengthening of a straight line (a great circle) will be understood shortening or lengthening of the distance between its any two points situated on opposite sides of deformation .

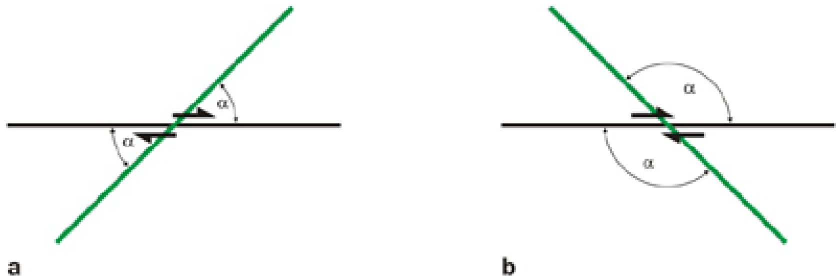


Fig. 9. *Definition of the angle of inclination of a straight line to a fault (explanation in text)*

In the next section we will consider the size of change of length of the deformed line expressed by a mathematical formula. Due to the above definition of α, the lengthening will be expressed as a positive increment and the shortening as a negative increment.

b. Size of the change

Now we shall determine the size of the change of the length of a straight line (a great circle on a globe) on a transform faults (in general – on strike slip faults). First, we will consider a case of lengthening (Fig. 10).

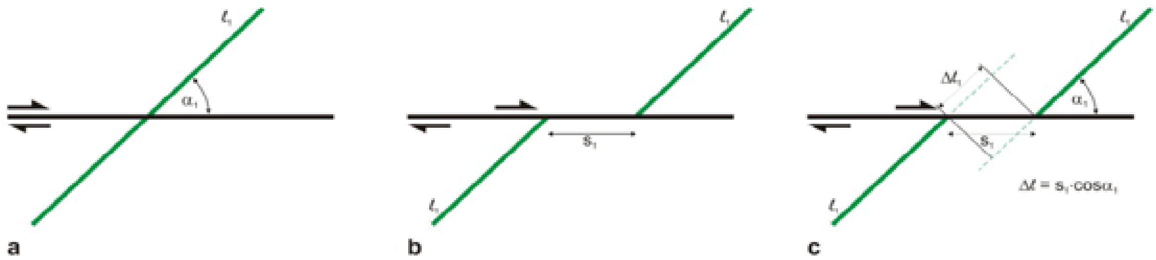


Fig. 10. *Size of the lengthening of a straight line on a fault (explanation in text)*

The angle α_1 in Fig. 10a is an acute one. Thus the slip s_1 on the transform fault (Fig. 10b) produces the lengthening of the line l_1 by the distance Δl_1 (Fig. 10c). Δl_1 is related to s_1 and α by the formula: $\Delta l_1 = s_1 \cdot \cos\alpha_1$. Because for α between 0^0 and 90^0 $\cos\alpha_1$ is positive, Δl_1 is also positive.

Now we will consider a case of shortening (Fig. 11).

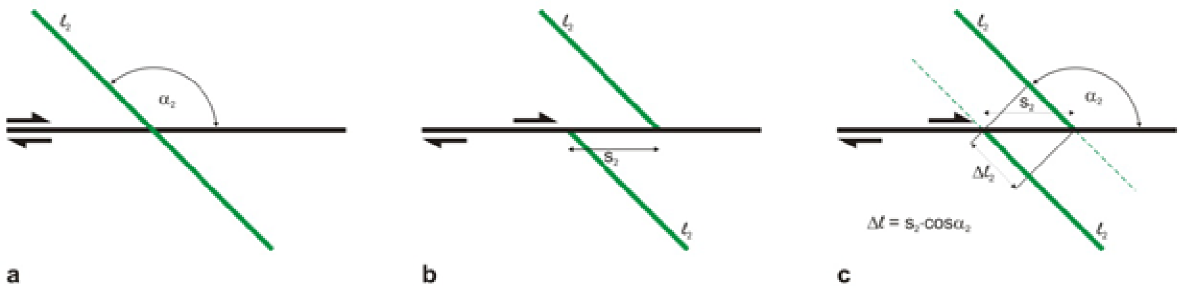


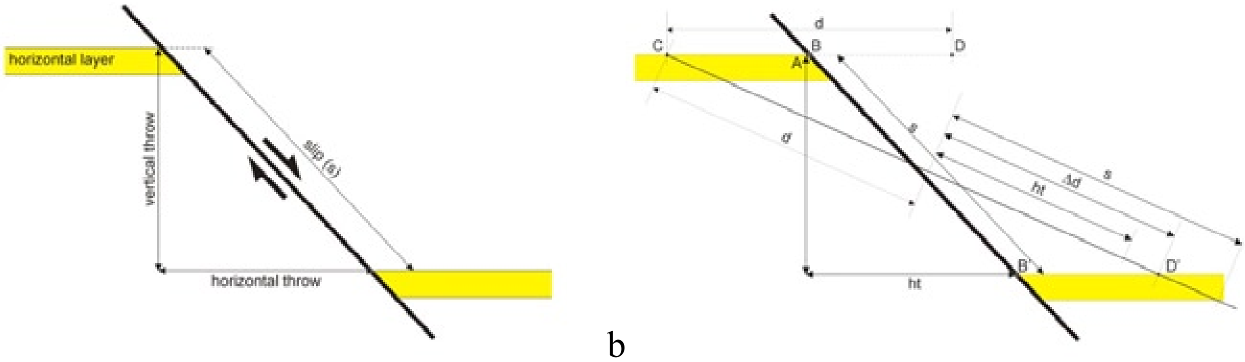
Fig. 11. *Size of the lengthening of a straight line on a fault (explanation in text)*

The angle α_2 in Fig. 11a is obtuse. Thus the slip s_2 on the transform fault (Fig. 11b) produces shortening of the line l_2 by the distance Δl_2 (Fig. 10c). Because for α_2 in the range between 90^0 and 180^0, $\cos\alpha_2$ is negative, the Δl_2 is also negative.

Of course for $\alpha = 90^0$ $\cos \alpha = 0$, thus $\Delta l = 0$.

c. Global meaning of the change of distances on strike slip faults

However the question arises: what does the change Δl really mean? Its positive value (lengthening) corresponds exactly to a horizontal throw on a normal fault, cutting a horizontal layer (Fig. 12a).



a b

Fig. 12. Meaning of the change of distances on a fault (explanation in text)

But the change of a distance Δd (Fig.12b) between points lying on the layer on both sides of fault (and in the same vertical plane parallel to the slip) differs from Δl. The biggest difference is for points A and B previously close to each other, but on both sides of the fault. Their resulting Δd (BB') is exactly equal to the slip. To the points C and D lying previously at some distance from the fault, the resulting Δd is lesser than the slip but still larger than the horizontal throw i.e. Δl. The difference between Δd and Δl is becoming smaller with growing distances from the fault and both increments become equal for the points laying in infinity.

Infinity is an uncomfortable quantity for practical issues. But we have here a paradoxical situation - the infinity which appears on a local scale disappears on a global scale. This is because geodesic on a sphere (great circle) has a finite length in contrast to a straight line.

Thus, let us consider a round wire ring of length l and radius $R = l/2\pi$ (Fig. 13 a). The ring is treated here as a great circle determining a sphere S of the same radius R. Let's now assume that a shearing force acts on the ring at the point P lying in the plane tangent to the sphere but the force acts at acute angle to the plane of the ring.

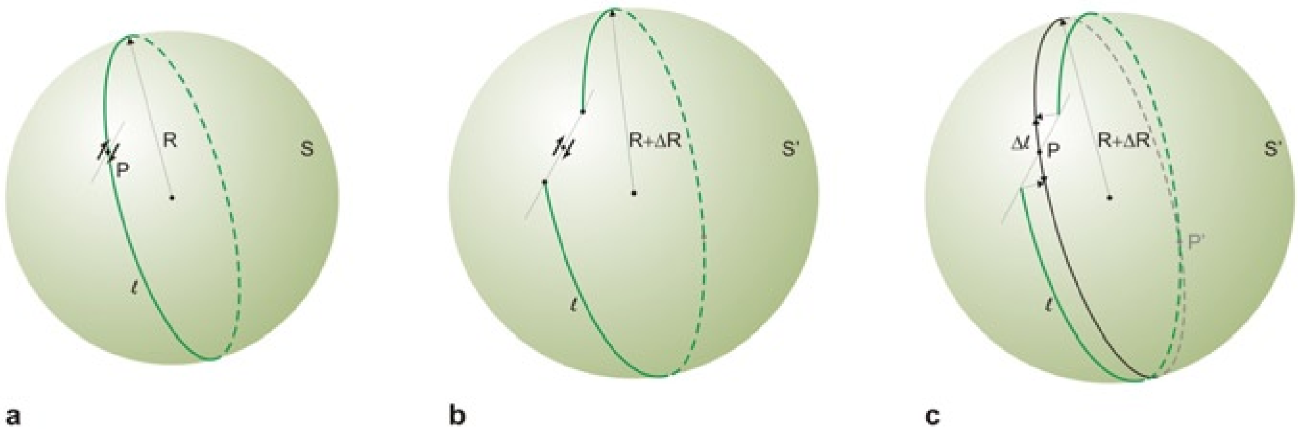


Fig. 13. *Global meaning of the change of distance on a strike slip fault (explanation in text)*

The force causes the disruption and deformation of the ring as is shown in Fig. 13b. The created loop now determines a new sphere of radius R+ΔR. To determine the increment Δl of the perimeter of the new sphere we project the ends of the loop on the median circle (Fig. 13c) which crosses the loop at antipodal point P' (relative to point P). The distance between the projected ends of the loop is the Δl we were looking for. The increment in the radius of the new ring and thus the sphere is $\Delta R = \Delta l / 2\pi$.

In geology, the deformation marked in Fig. 13 is a strike slip fault and R is the radius of the Earth. In such a way humble strike slip faults gain a global meaning.

Of course, the loop may be lengthened or shortened in other places and only the sum of these deformations gives the real change of the R. But that is just our goal.

Let's return to Fig. 12a. The horizontal throw of a fault is determined by an orthogonal projection of the slip on one of prolongations of the disrupted layer.

Similarly, the lengthening of a straight line or a great circle on a strike slip fault is equal to an orthogonal projection of the slip on one of the prolongations of the disrupted line (as in Fig. 13c) or on any line between them and parallel to them.

The shortening of a straight line or a great circle on a strike slip fault is equal to the orthogonal projection of the slip on one of the ends of the disrupted line (as in Fig. 13c) or on any line between them and parallel to them.

5. Lengthening of a great circle crossing a spreading zone

In contrast to the case of crossing the transform faults, a great circle crossing spreading zones can only be lengthened and this is obvious. But as regards the size of lengthening on a spreading zone we can be easy misled by our intuition as is shown below.

a. Apparent lengthening

Let us examine three cases of crossing of a great circle over a spreading zone: perpendicular to the spreading axis (Fig. 14a), oblique (Fig. 14b) and parallel (Fig. 14c).

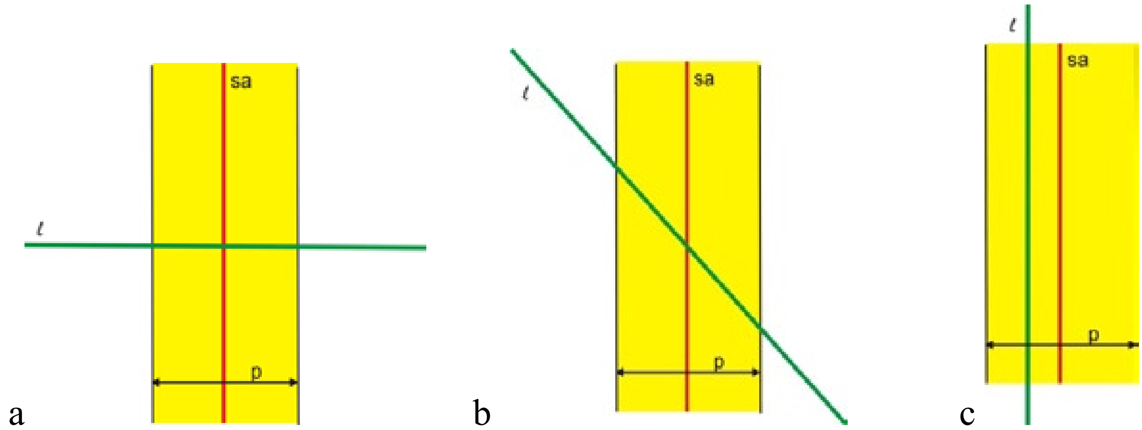


Fig. 14. *Apparent lengthening of a great circle on a spreading zone (explanation in text)*

In all the figures a pull apart distance (p) was taken as perpendicular to the spreading axis (sa).

At the first approach it seems that the lengthening of the straight line l is smallest in the case (a) the bigger in the case (b) and the biggest in the case (c). In the latest case it seems that it is even infinite, what should be immediately suspected. And rightly, because the real situation is quite the opposite: the biggest lengthening is in the case (a), smaller in the case (b) and even zero in the case (c). To see it, we should start from the initial situation when the pull apart distance is zero. Similarly we dealt earlier in the case of the transform (strike slip) fault, starting from the situation when the slip distance was zero.

b. Real lengthening

The pull apart force which acts at a spreading axis is not always perpendicular to this axis. Thus we will consider a general case. Let us consider (Fig. 15a) a spreading axis (sa) with oblique pull apart force (F_{pa}) crossed obliquely by a great circle (l). The acute angle included between the pull apart force and the great circle is α[5].

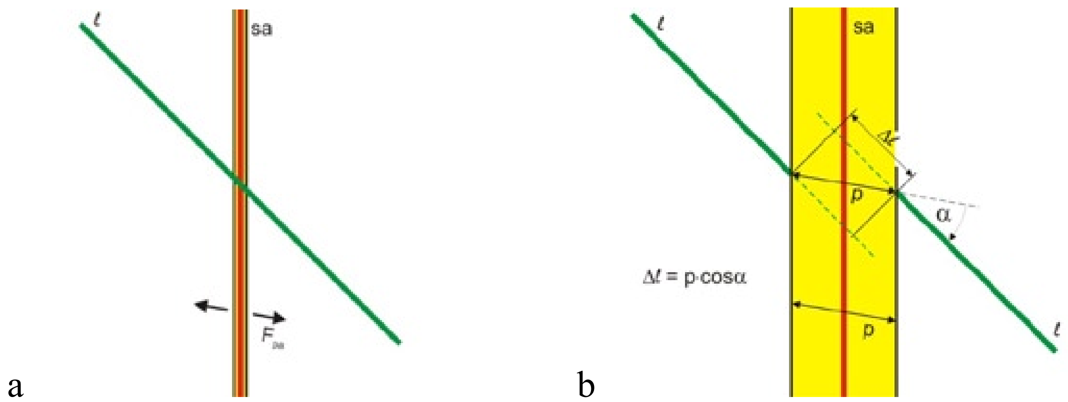


Fig. 15. *Real lengthening of a great circle on a spreading zone – the first case (explanation in text)*

[5] The angle included between the pull apart force and spreading axis is taken here as 80^0. The angle included between the great circle and spreading axis is taken 45^0. Thus the angle included between the pull apart force and the great circle is 35^0.

After opening a spreading zone along the distance (p) – Fig. 15b, the great circle is torn and shifted also along the distance (p). The increment in the length of the great circle (Δl) is equal to $p \cdot \cos\alpha$. As may be seen the essential factor is the angle between the great circle and pull apart distance, not between the great circle and the spreading axis.

When a great circle crosses a spreading axis and the pull apart force in opposite way (Fig. 16a) then (Δl) is also positive (Fig. 16b) and expressed by the same formula $p \cdot \cos\alpha$. This is different from what we found in the case of transform faults.

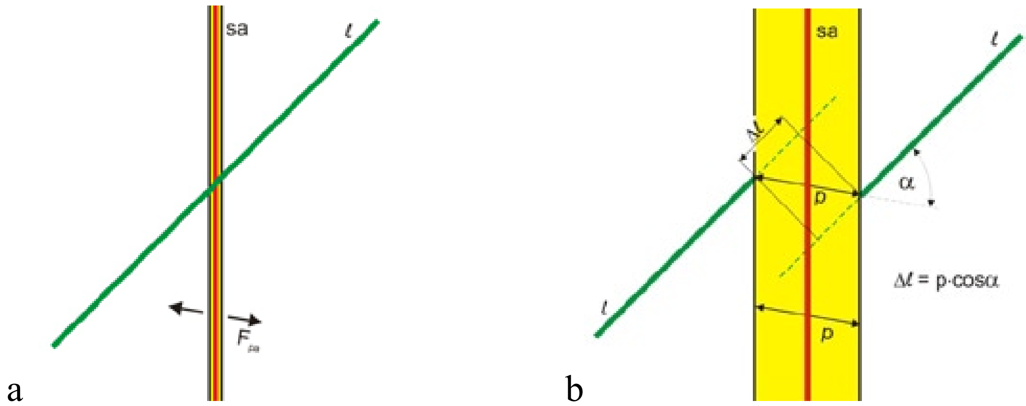


__Fig. 16.__ Real lengthening of a great circle on a spreading zone – the second case (explanation in text)

If α is zero then $\Delta l = p$ and is maximum. If α is 90^0 then $\Delta l = 0$, as was mentioned before.

c. Rate of the lengthening

The rate of the two-sided spreading v_s is the pull apart distance p divided by the time increment Δt in which the p was created, that is the age of the border of the spreading zone:

$$v_s = p/\Delta t$$

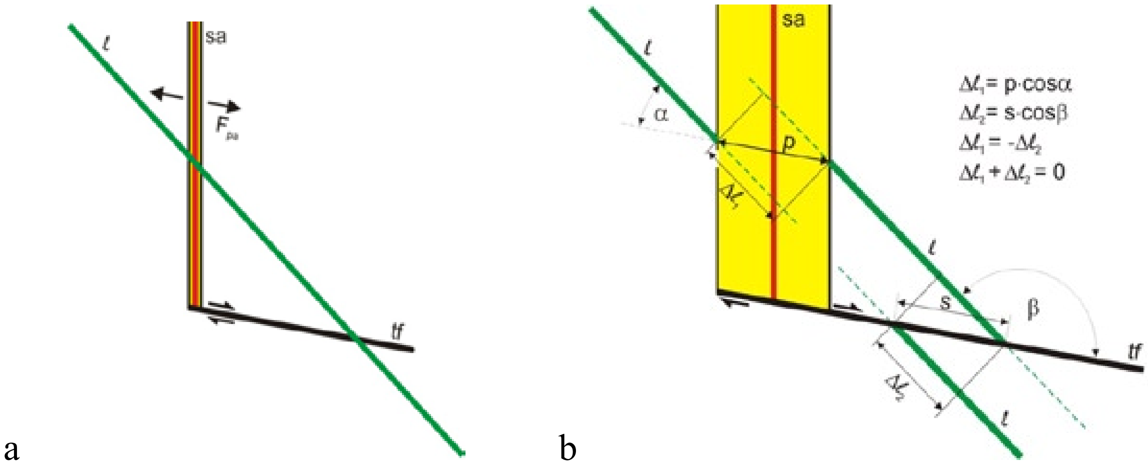
Analogically the rate of the lengthening of the great circle at its crossing of spreading zone is $v_l = \Delta l/\Delta t$, thus $v_l = v_s \cdot \cos\alpha$.

6. Great circle crossing a spreading zone and its transform fault (Dooley's case)

In reality spreading axes are densely offset by transform faults. Pull apart forces and pull apart distances are concordant with slips on these faults.

a. Local confirmation of Dooley's result

Let us consider a spreading axis offset by a transform fault (tf) and a great circle crossing both structures (Fig. 17a). This is exactly the case considered by Dooley (Fig. 4). The slip (s) along the transform fault is tantamount with opening of the spreading zone along the distance (p) – Fig. 16b. What is more, the pull apart distance is always equal to the slip. Because p = a and cosα = -cosβ thus $\Delta l_1 = -\Delta l_2$ and thus $\Delta l_1 + \Delta l_2 = 0$.



a b

Fig. 17. Great circle crossing a spreading zone and its transform fault (explanation in text)

So the length of the great circle is not changed, which is in accord with Dooley's result but only on a local scale. We will return to this situation later.

b. Simple explanation of Dooley's result

The spreading zone and the transform fault in Fig. 17 constitute a border between two plates. The area to the right of the spreading zone and the area below the transform fault belong to the same plate and there is no deformation between them. Thus the parts of the great circle, lying on this plate do not change their mutual position.

We will note this feature again when we examine cases of a great circle crossing assumed zones of plate convergence (section 15).

c. Comparison with a landslide

The situation presented in Fig. 17 is analogous to that in the case of landslides. To make this clear we can present this figure in another form (Fig. 18) which should be imagined in vertical position.

The spreading axis from Fig. 17a is now a breakaway fault (Fig. 18a) and the spreading zone from Fig. 17b is now a breakaway gap (Fig. 18b). The transform fault from Fig. 17 is now a surface of rupture or a slip surface. The green line is now not a section of a great circle but some geological object. Its lengthening and equal shortening by the mobile

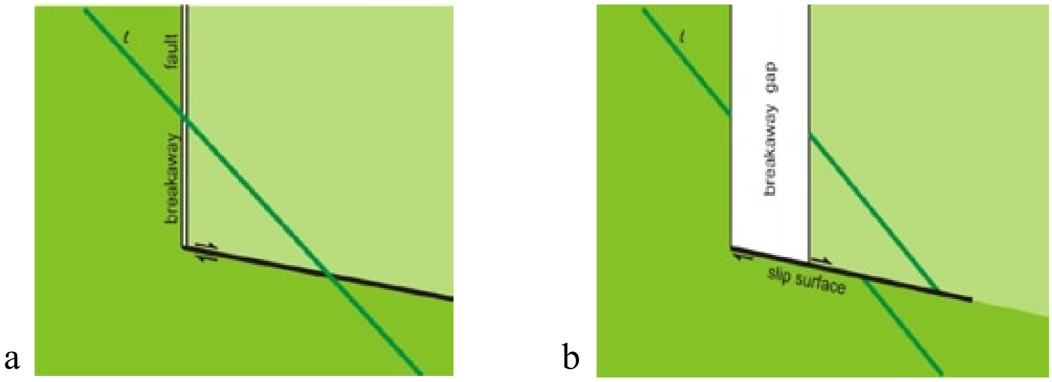


Fig. 18. *Comparison a spreading zone and its transform fault with a landslide (explanation in text)*

(light green) part of the structure is quite a local process and the sections of the green line in a stabile part (dark green) of the structure are not changed. In reality the whole landslide is a local process. The whole break away gap at the rear part of the landslide is compensated by overthrust in the front part (Fig. 19).

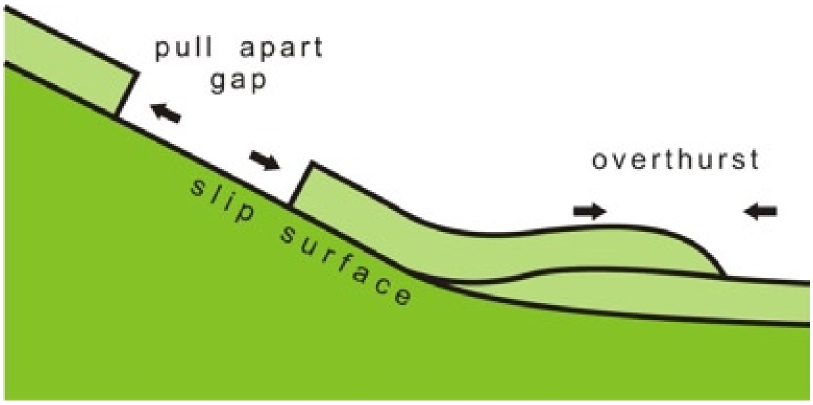


Fig. 19. *Idealized landslide. Compensation of a pull apart gap by overthrust*

d. Problem of hypothetical compensation of spreading zones

In fact, relations analogous to landslides are assumed in plate tectonics. At the beginning of the paradigm the whole mantle convection was considered as a driving mechanism of plates (Holmes, 1942; Dietz, 1961; Hess, 1962). Then the gravitational concept appeared (Van Bemmelen, 1965a, 1965b, 1966; Elsasser, 1967, Isacks et al. 1968; Wilson, 1969; Isacks and Molnar, 1971; Jacoby, 1973) in which the weight of the lithospheric slab was considered as a driving force, whereas the mantle reacted only passively. In the following years plate tectonics returned to large scale convection currents with their convections cells. The model of the mantle conveyer belt, with passively carried plates, became the most successful "driving mechanism" in the field of popularization of plate tectonics. However insurmountable problems with this hypothesis, caused a return in 1990s to the old concept of the gravitational plate movement. Today, the so called "pull slab" and "ridge push" is to be the driving mechanism of plates (Fig. 20).

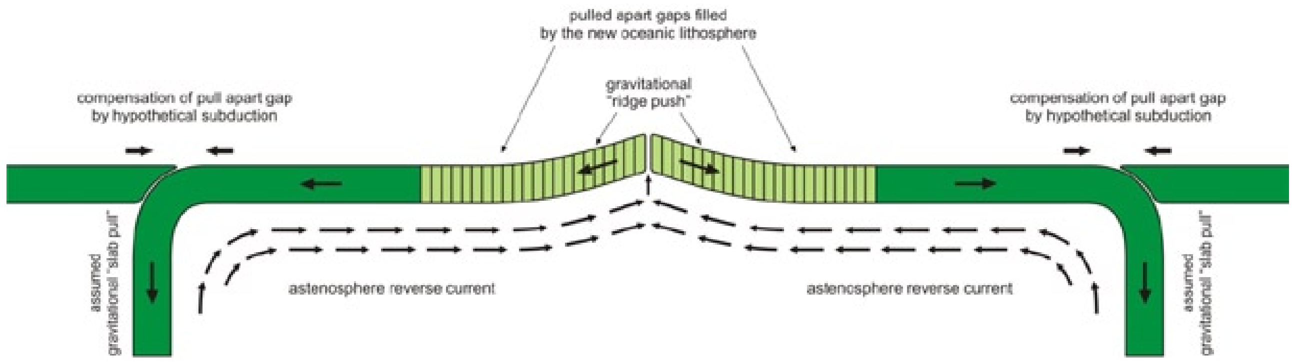


Fig. 20. *"Pull slab" and "ridge push" as a new version of driving mechanism in plate tectonic (explanation in text)*

As is visible in this figure, the asthenosphere does not carry actively plates "on its back" but passively moves in opposite direction. Thus it hampers the movement of plates. What is more, the plates with continents at their assumed leading edges (South and North America, Australia) have no "slab pull" but despite of this the spreading at the opposite sides of these plates is active. What is worse, the North America plate is not driven by slab pull along its Pacific border but even blocked there by the Pacific plate along transform faults (tangential movement border).

Thus this modern hypothetical gravitational mechanism does not so much explain the motions of plates as it illustrates the size of crisis of the problem of the driving mechanism in the framework of plate tectonics.

To compare a landslide with the present model of plate motion in plate tectonics we should put Fig. 18 back to horizontal position. Then on Dooley's scheme (Fig. 4) spreading zone can be treated as a breakaway gap of a gigantic landslide, whereas transform faults as its flanks.

However, no matter how the driving force is explained in plate tectonics, the movement is to be compensated in this paradigm and so the movement should have only a local meaning though the scale of it is usually big.

It can be demonstrated that the zones of so-called subduction do not compensate the spreading of the ocean floor at oceanic ridges (Koziar and Jamrozik, 1994[6]; Koziar, 2003[7]; Koziar, 2011[8]) but this is not the goal of this paper. The present goal is to show that the spreading along the Ripper-Perin great circle is not compensated.

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[6] www.wrocgeolab.pl/margins1.pdf
[7] www.wrocgeolab.pl/margins2.pdf
[8] www.wrocgeolab.pl/tsunami.pdf (not ready yet)

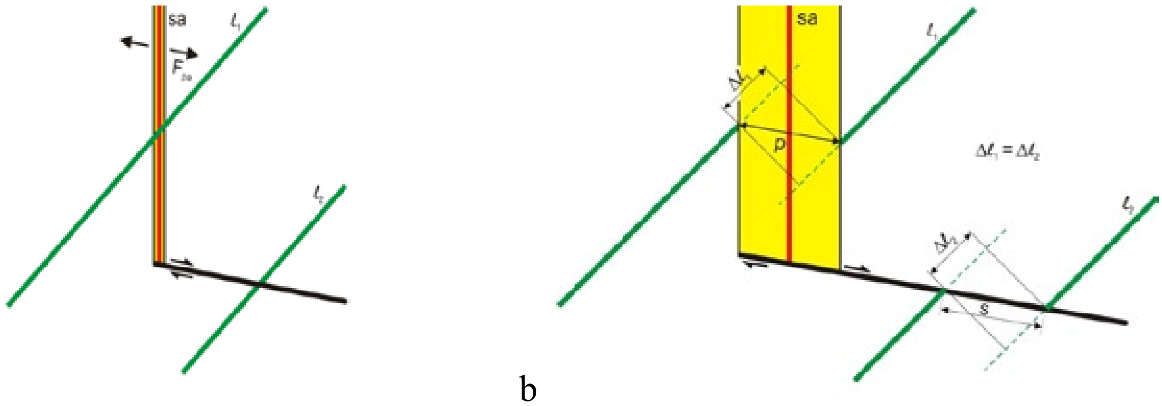
7. Two quasi-parallel great circles: one crosses only the spreading zone and the other only its transform fault

a. Definition of the quasi-parallel great circles

Under the name "quasi-parallel great circles" we will understand two great circles which intersect each other at a very small angle and their considered sections are near their equator. In such a situation their parallelism is almost the same as parallelism of two straight lines on a plane.

b. Analysis of the case

Let us consider the initial stage of the situation presented in the title of this chapter (Fig. 21a).



a b

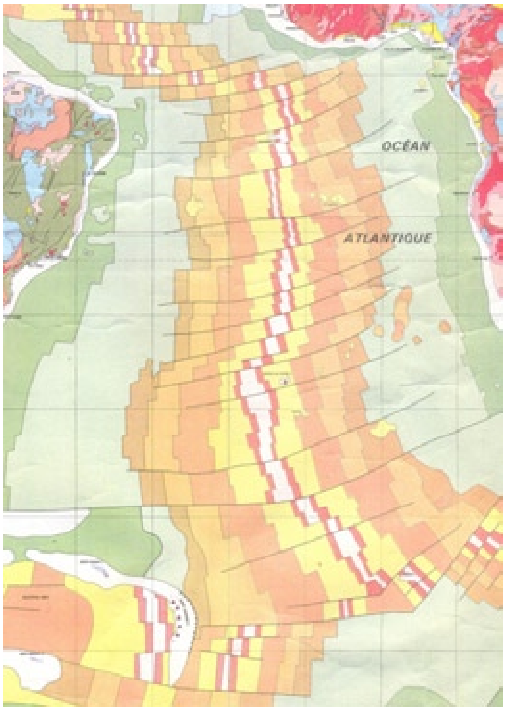
Fig. 21. *The case of two quasi-parallel great circles (explanation in text)*

After a slip (s) along the transform fault (Fig. 21b) both great circles are elongated by the same increment. Thus the situation is quite opposite to that in the former case.

8. Universality of transform faults between two spreading zones

In the four sections that follow the cases of transform fault between two spreading zones will be considered. At the beginning, the ubiquity of such cases should be stressed. Such a situation is almost universal. There are uncountable instances of such relations on all oceanic ridges. As examples, the section of the Atlantic Ridge (Fig. 22a) and the sections of the Indian Ocean ridges (Fig. 22b) are presented.

It must be noted here that not the whole line cutting the ridges, visible in the figures, are transform faults, but only their sections between spreading axes (see paragraph 13). Thus, in fact, the transform faults are very short. Some longer examples are visible in the southern part of the Atlantic (Fig. 22a).

a 

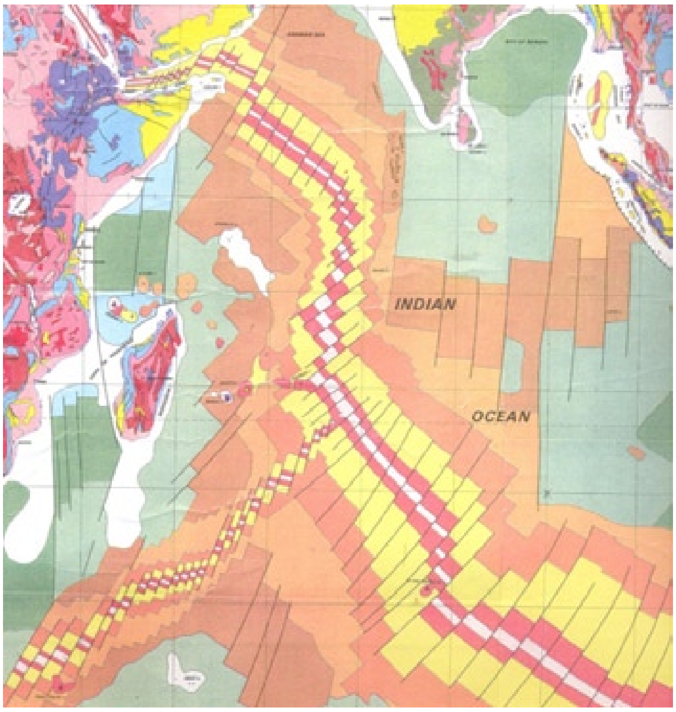
b 

Fig. 22. *Abundance of transform faults between two spreading zones,*
a *– south Atlantic example,* ***b*** *– Indian Ocean example*

All these transform faults, together with associated spreading axes, constitute the oceanic ridge or (more precisely) the border of the adjacent lithospheric plates.

9. Great circle crossing two spreading zones and their transform fault

This case is presented in Fig. 23. For simplicity, a transform fault perpendicular to spreading axes is used here as well as in subsequent schemes. The change carries with it the necessity of making the great circle less sloping than in previous figures in order to avoid ending of the increment Δl on the spreading axis[9] as the latter would suggest some rule which does not exist.

Now, to make the analysis it is enough to use the results of the previous analyses.

[9] The present angle between the great circle and the spreading axis is taken as 55^0. Thus the angle between the great circle and the transform fault (pull apart force) is as previously 35^0.

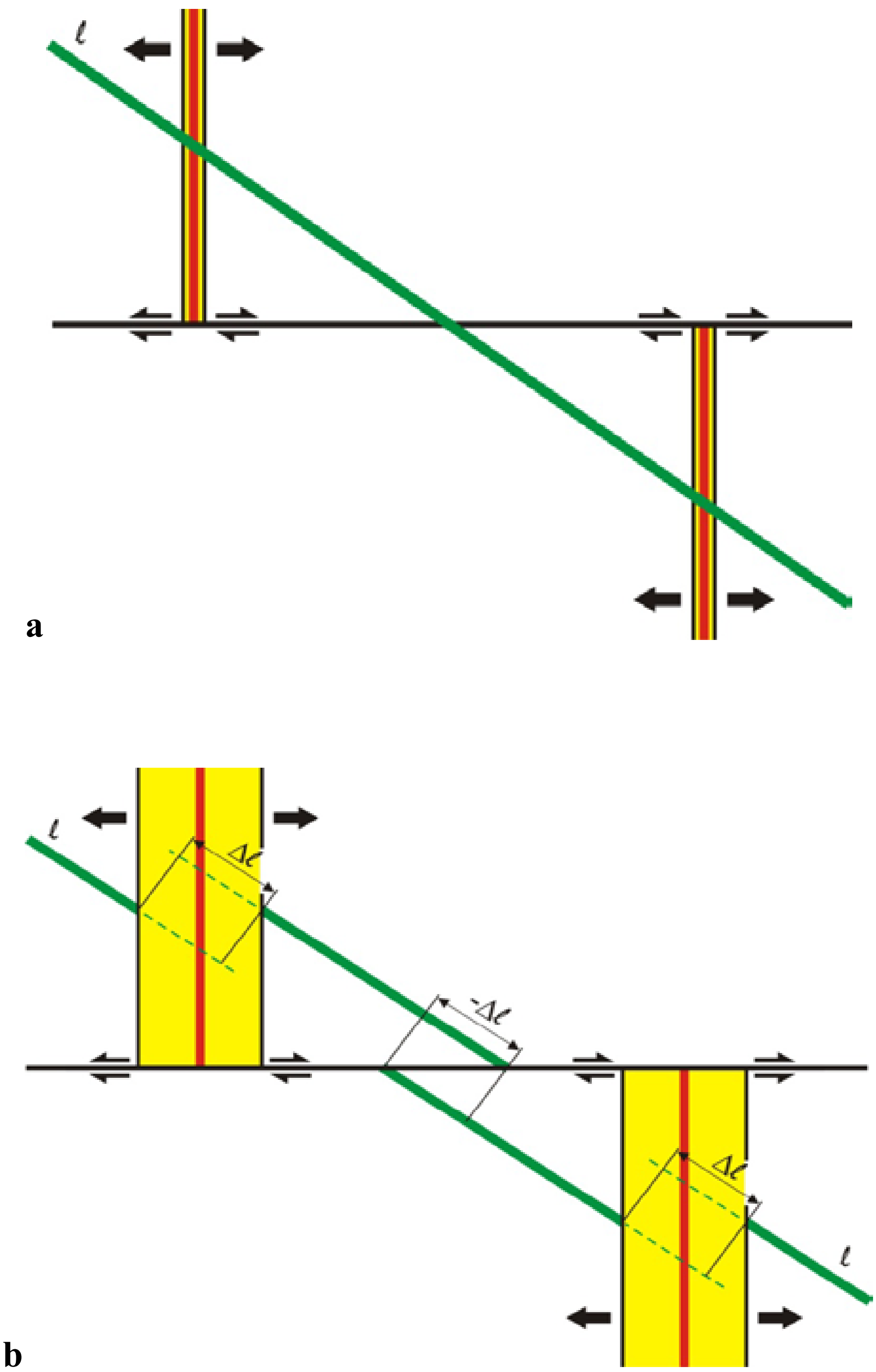


Fig. 23. *Lengthening of the great circle crossing two spreading zones and their transform fault (explanation in text)*

The great circle crossing the upper spreading zone gains an increment Δl as in Fig. 15. Then, crossing the transform fault, it loses this increment according to Figs. 11 and 17. However crossing the lower spreading zone the great circle recovers its former increment. Thus this great circle is lengthened on the oceanic ridge (border of adjacent plates) as the latter would be if it were a continuous spreading zone without any transform fault.

10. Great circle crossing only a transform fault between two spreading zones

The case is presented in Fig. 24.

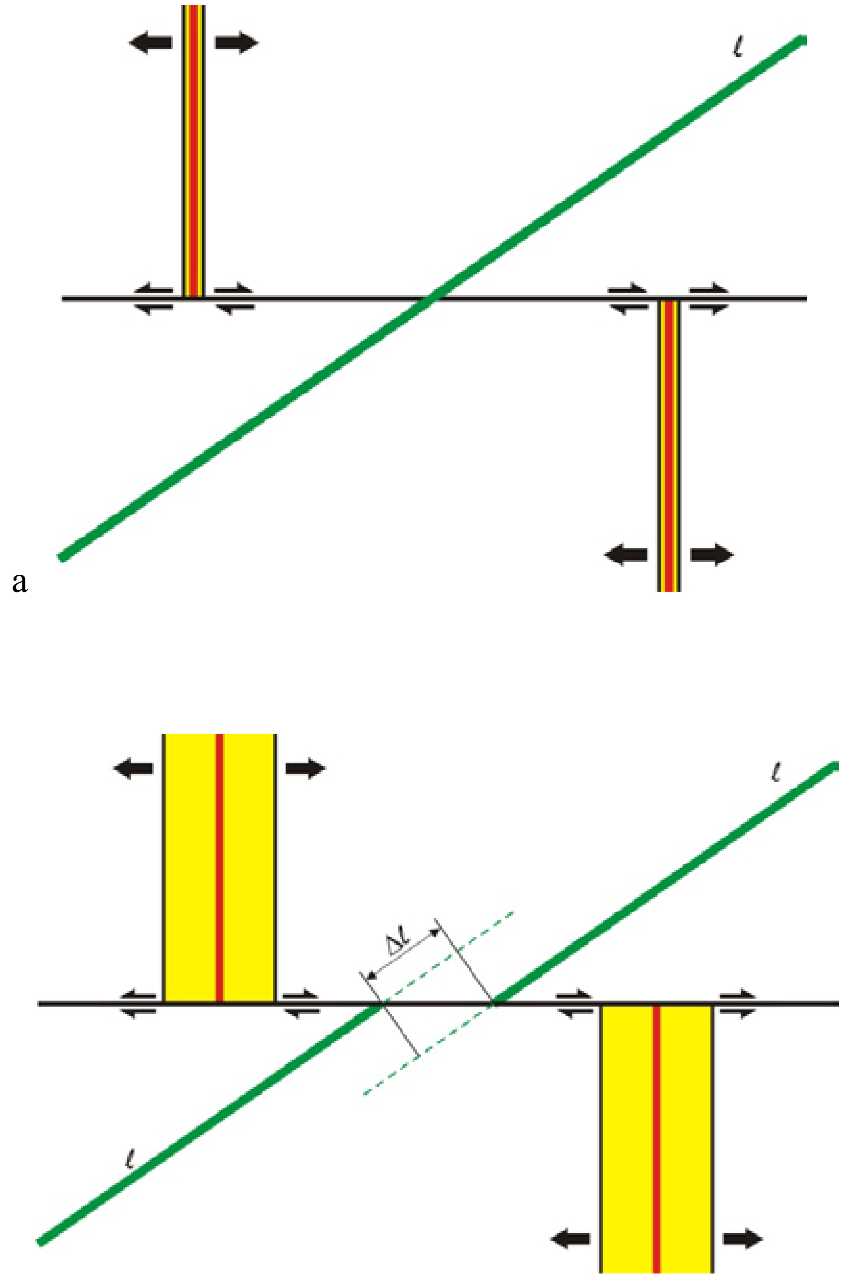


Fig. 24. Lengthening of the great circle crossing only a transform fault between two spreading zones (explanation in text)

In this case the great circle, crossing the transform fault, gains the same increment Δl as it would in a parallel cross of the upper or lower spreading zone (see Fig. 21). Thus the conclusion is the same as in the former case: the great circle is lengthened on the oceanic ridge (border of adjacent plates) as the latter would be if it were a continuous spreading zone without any transform fault.

11. Great circles and transform faults – an example how Nature does not cheat and permit cheating

The results obtained above may be used for some personifications of Nature. Let us assume that somebody, summing up the lengthening of great circle on oceanic ridges, meets the situation presented in Fig. 23 and wants to count the elongation twice. Nature does not allow to cheat itself by the reduction process on the transform fault. Alternatively, let us assume that somebody, in a similar manner, meets the situation presented in Fig. 24 and neglects the lengthening. This time Nature does not allow him to be cheated by the lengthening process realized on the transform fault.

12. Summary of the impact of transform faults on great circles at oceanic ridges

Summing up the results of analyses carried out in sections 4 – 9 we can conclude:

1. Transform faults between two spreading zones are almost universal
2. They act on the great circles as if the oceanic ridge were constituted by a continuous spreading zone without any transform fault
3. Thus, each great circle is lengthened in the system of spreading zones and their transform faults.

13. Neutrality of flow lines

In Figs 22 a and b, long lines are visible generally perpendicular to oceanic ridges and reaching far beyond them. They can be easy confused with transform faults by a person (even a geologist) not well trained in geotectonics. Thus Dooley's statement that:

> *"Ripper's great circle crosses several expansion zones and* ***transform faults*** *[bold J.K.]"*

may be applied just to them. So, it is worth explaining these structures and their relation with great circles.

The lines are produced by transform faults but cover with them only on a short section between two spreading axes (Fig. 25).

Beyond these axes both wings of faults move away in mutual concordance, without any relative slip. These relations are already visible in figs 23 and 24. Thus the seismic activity is only on the real transform faults between spreading centres. Beyond them the lines are aseismic.

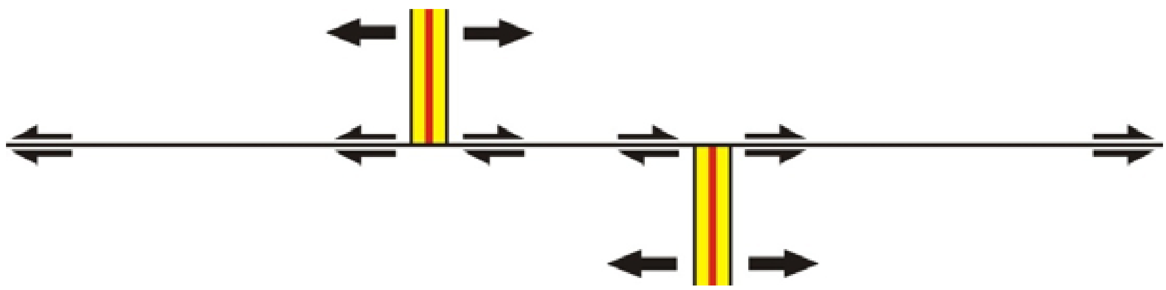


Fig. 25. Disappearance of relative motion on a transform fold line beyond spreading axes

These lines are called ”fracture zones” or “flow lines” and are very important at any reconstruction of oceanic, and even adjacent continental lithosphere.

Because the flow lines are without any relative slip, they have null impact on great circles crossing them.

14. Wilson's prediction and its failure

a. Wilson's prediction

Transform faults were defined and called in this way by J. Tuzo Wilson in his very important paper (Wilson, 1965). The author considered in theoretical way different combinations of zones of spreading and assumed zones of convergence (island arcs and fold belts) linked by a dextral transform faults. He obtained six cases (Fig. 26). When using a sinistral fault the number of cases is doubled.

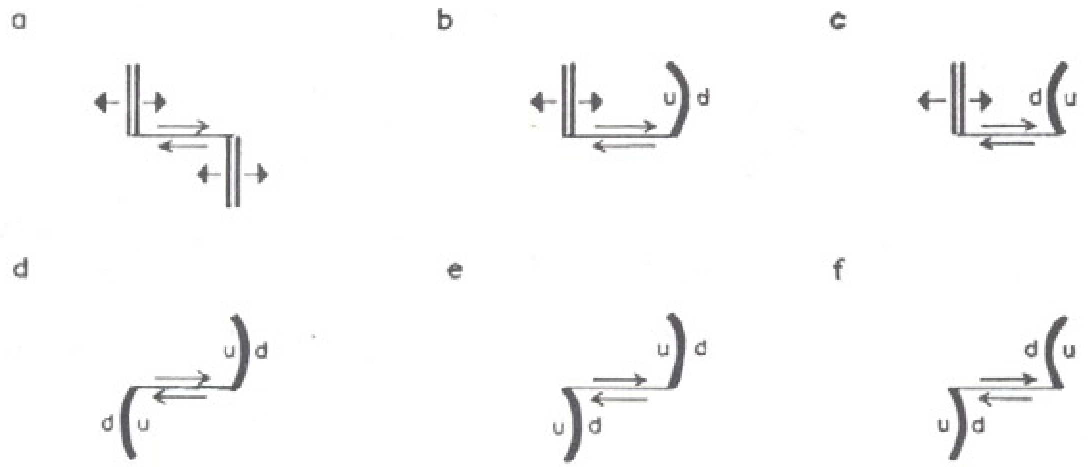


Fig. 26. Wilson's six combinations of spreading zones and assumed zones of plate convergence linked by dextral transform fault

Taking into account the overwhelming majority of theoretical cases with zones of assumed convergence (5 to 1) we should expect the adequate majority of such cases in the real world (if the theoretical basis is correct).

b. Failure of Wilson's prediction

Unfortunately, in the real world the situation is quite the opposite, with much greater preponderance of the first case (in both dextral and sinistral version) over the remaining cases. As was mentioned earlier, the cases of transform faults linking two spreading zones are numerous and almost exclusive.

Wilson tried to find examples with the assumed convergence but was not very successful. What is more, some of them appear to be false. One of his examples is the Owen fault (Fig. 27 a – east part) which should link the west end of the Carlsberg Ridge with the west end of the Hindu Kush Mts. However the fault does not reach the Hindu Kush Mts. and is only a flow line (Fig. 24b). Another of Wilson's examples is the Dead Sea-Jordan River fault which should link the north end of the Red Sea with the west end of the Armenian Taurus (Fig. 27a – west part). However the fault does not reach the Taurus and this fold belt does not end at the predicted point but continues to the west into the Turkish Taurus. The Dead Sea – Jordan fault links most probably the end of the Red Sea with tensional structure of the Levantin Basin (of Mediterranean Sea). Thus it is the first case of Fig. 26 (two divergent zones), only in its sinistral version.

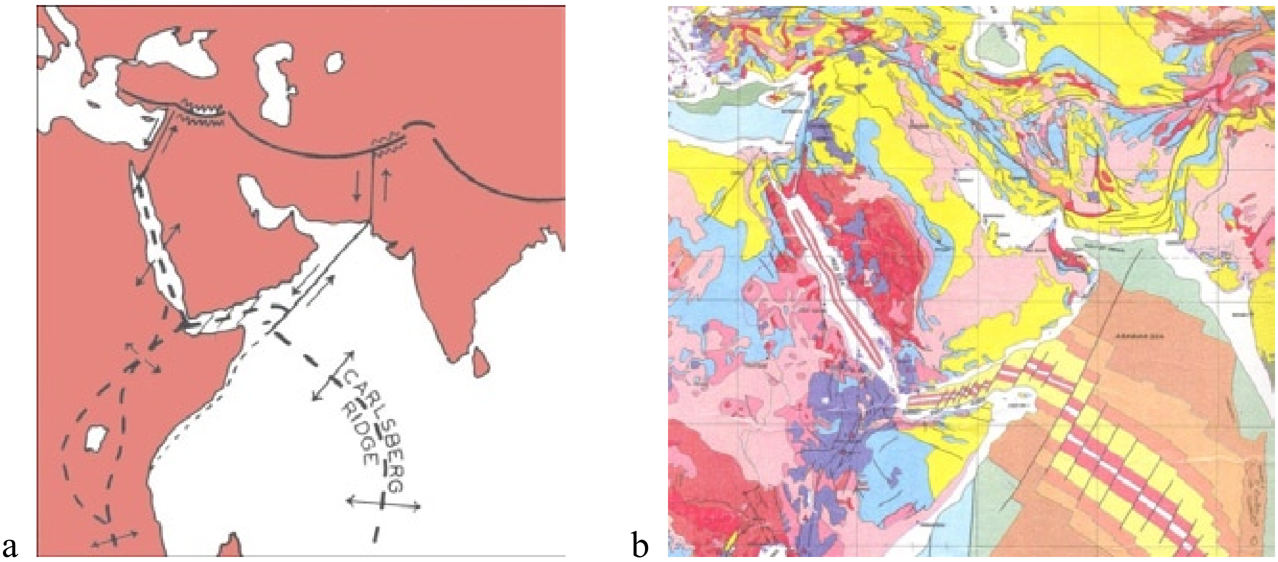


Fig. 27. *Assumed connection of spreading zones with fold belts (eastern hemisphere). Explanation in text*

The next of Wilson's examples are two faults bordering the Drake Passage (Fig. 28 a). However the northern fault is not confirmed, while the southern one links in fact the south-west offspring of the South Atlantic Ridge with back-arc spreading of the Southern Antilles arc (Fig.22 a).

The next examples are two faults bordering the Caribbean Sea (Fig. 28a). Only the northern one, linking the spreading center at the Cayman Trough with the West Indian Arc (Fig. 28 b), can be in accordance with Wilson's interpretation. However it is collinear with the Puerto Rico trench and only together with it, is perpendicular to the West Indian arc. It does not fit the plate tectonics paradigm very well. The last of Wilson's examples is the connection of the West Chile Ridge with southern Andes (Fig. 28a) and it was latter confirmed (Fig. 28c). Thus, only two items of Wilson's examples have survived up to now. However one further example has appeared which was not known in the time of Wilson's paper – the connection of the east end the Galapagos Rift with the Middle America Trench (Fig. 28b).

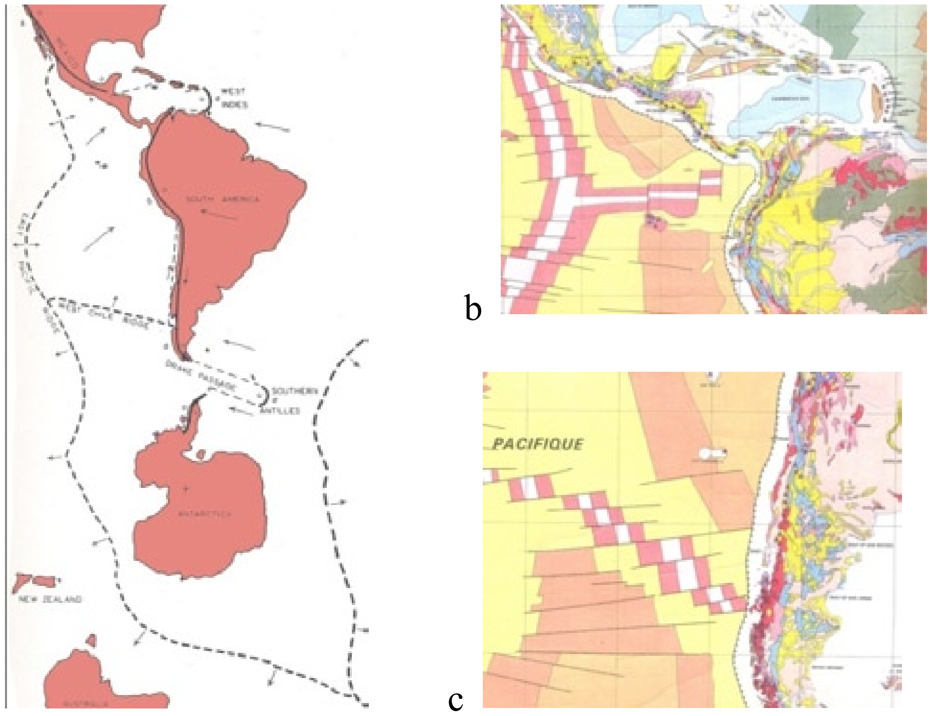


Fig. 28. *Assumed and real connection of spreading zones with oceanic trenches (western hemisphere). Explanation in text*

The next of Wilson's examples are two faults bordering the Drake Passage (Fig. 28 a). However the northern fault is not confirmed, while the southern one links in fact the south-west offspring of the South Atlantic Ridge with back-arc spreading of the Southern Antilles arc (Fig.22 a).

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Thus only three real situations fit Wilson's prediction presented in Fig. 26 b – f, while uncountable examples fit the situation presented in Fig. 26 a (in dextral and sinistral version).

None of these features intersect the Ripper expanding great circle or the similar but more refined the Ripper – Perin expanding great circle.

c. Global significance of the failure of Wilson's prediction

In the plate tectonics paradigm there is a strict symmetry between the zones of plate divergence and the zones of plate convergence. The same amount of lithosphere produced at the zones of divergence must be consumed at the zones of convergence. Thus the total length of these two types of zones should be comparable and transform faults linking them should be ubiquitous.

Since long ago critics of plate tectonics have pointed out (i.e. Ollier and Pain, 2000) that the total length of zones of assumed subduction is about three times shorter than the total length of oceanic ridges. This fact itself raises doubts about plate tectonics. In this paper the almost total absence of transform faults linked with the assumed zones of subduction has been stressed. This is another strange feature of the plate tectonics paradigm.

15. Great circle crossing an island arc within the same plate

There is one more issue that remains to be settled. This is a great circle crossing an island arc but being not shortened, even if we assume that the latter is a zone of shortening. There are two such cases presented below. They are not applicable to the Ripper – Perin expanding great circle but to another one presented at the end of this paper.

a. Great circle crossing an island arc along its chord

If a great circle crosses an island arc along its chord (Fig. 29) it does not change its length, because on the outward sides of the chord is the same rigid plate. The rule is valid no matter what happens inside the arc.

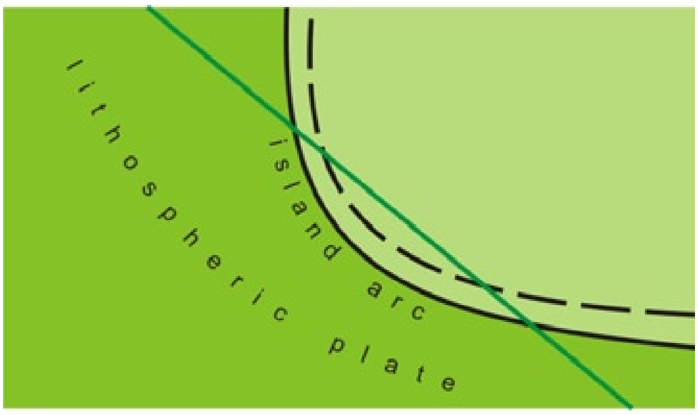


Fig. 29. Great circle crossing an island arc along its chord (explanation in text)

b. Great circle crossing an island arc along the section, linking oceanic and continental parts of the same plate

If a great circle crosses an island arc along the section linking oceanic and continental parts of the same plate (Fig. 30) it does not change its length, because on the outward sides of the section there is the same rigid plate. The rule is valid no matter what happens along this section.

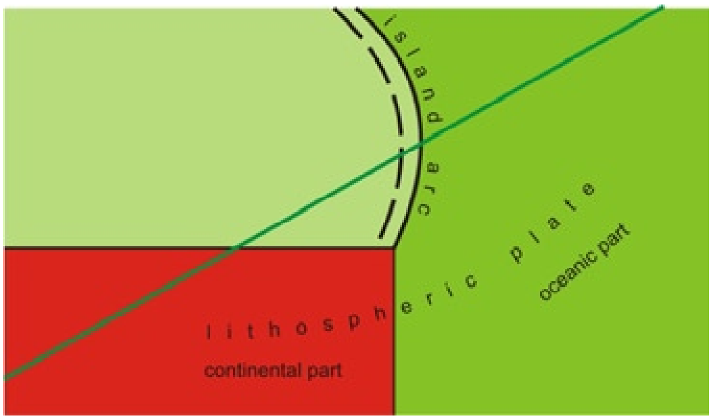


Fig. 30. Great circle crossing an island arc along the section, linking oceanic and continental parts of the same plate (explanation in text)

16. Validity of the Ripper-Perin expanding great circle as a proof of Earth expansion

Dooley (1973, 1983) did not demonstrate the incorrectness of Ripper's great circle as an expanding great circle and thus as a proof of the expansion of the Earth. He only undermined it by showing possibility that the great circle, though avoiding the zones of assumed subduction, can lengthen at spreading zones yet be reduced on transform faults.

It was demonstrated in this paper that transforms faults at oceanic ridges don't reduce the length of any great circle. It was also demonstrated that there are only few cases of linking spreading zones with assumed zones of subduction but they do not interfere with the Ripper great circle and with more modern and precise the Ripper – Perin great circle.

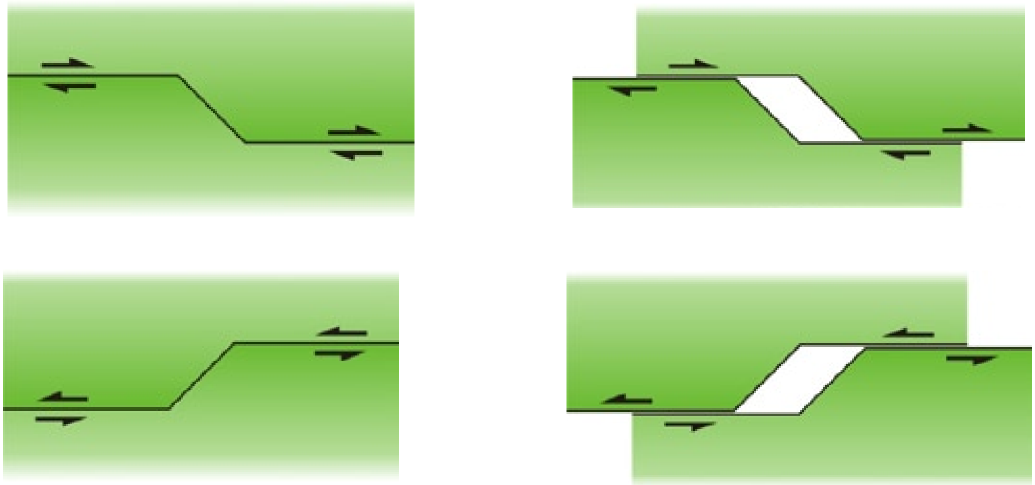
Thus the Ripper – Perin great circle is a really expanding great circle and as such is a valid proof of the expansion of the Earth.

17. Carey's transform faults

a. Transform faults at Carey's rhombochasms

J. Tuzo Wilson twice referred to Carey's early works, in his seminal paper on transform faults. However he did not notice the very important structures defined by Carey already in 1950s, and called rhombochasms. Carey (1958, p. 192) wrote:

"Rhombochasm (from Greek ρομβοσ a rhombus, χαο to yawn) will be used for a parallel-sided gap in the sialic crust occupied by simatic crust, and interpreted as a dilatation. In dextral (Fig. 31a[10]) *and sinistral* (Fig. 31b) *rhombochasms, the blocks have moved apart with a right hand or left hand lateral component respectively.*



a

b

Fig. 31, ***a*** *– dextral rhombochasm,* ***b*** *–sinistral rhombochasm*

These "right hand or left hand lateral components" are the dextral or sinistral transform faults, respectively. Thus in fact Carey is a discoverer of the transform faults though he did not call them so and did not concentrate on them. Carey tried to apply the rhombochasms and associated transform faults in many places on the Earth but he nowhere linked the latter with assumed zones of convergence (as Wilson did) since he understood that the Earth is expanding.

b. "Pull apart" tensional structures or "rhombochasms"?

Unfortunately Carey's term "rhombochasm" has not become widespread in literature. However the relevant structures were noticed later, especially by sedimentologists involved in tectonics. They called them "pull apart basins". But this term is not good. All tensional structures are "pull apart", so this term tells nothing about the geometry and the special mechanism of development of the structure. Next, the term "rhombochasm" consists of only one word and is easy to be supplemented by the additional term "dextral" or "sinistral" as Carey did. In case of term "pull apart" it would be uncomfortable and incomprehensible. Apart from that rhombochasms (as tensional gaps) can be filled not only from above (basins) but also from below (magmatic structures). Thus the term "rhombochasm" is more general. All the sections of oceanic ridges bordered by two transform faults are magmatic rhombochasms in Carey's. Thus the term is especially useful for these ridges. At more detailed investigation of the ridges (and now we have reached the stage) it would be convenient to call their particular sections as rhombochasm

[10] Fig. 31 has been developed by the present author.

with some proper name or with only number or a letter. It would be analogous to the treatment of fractures zones.

There is only one little problem. Rhomb is a leaned square thus it is a very regular figure. Carey's rhombochasms are in fact parallelograms. However this latter term is uncomfortable. Thus the former term may be kept, the more that another name for a parallelogram is rhomboid.

18. Rate of expansion of the Ripper–Perin expanding great circle

Ripper could not calculate the rate of expansion of his great circle because of the lack of proper data in 1970 – the year of his publication. He only referred to the value of the two-sided spreading rate on the Atlantic Ridge which according to Le Pichon (1968) was 2 cm/year.

Perin possessed already the proper data and he used them. Below (Fig. 27) there are five points for which he made calculations (Perin, 2003), according to the principle presented in the section 5c of the present paper.

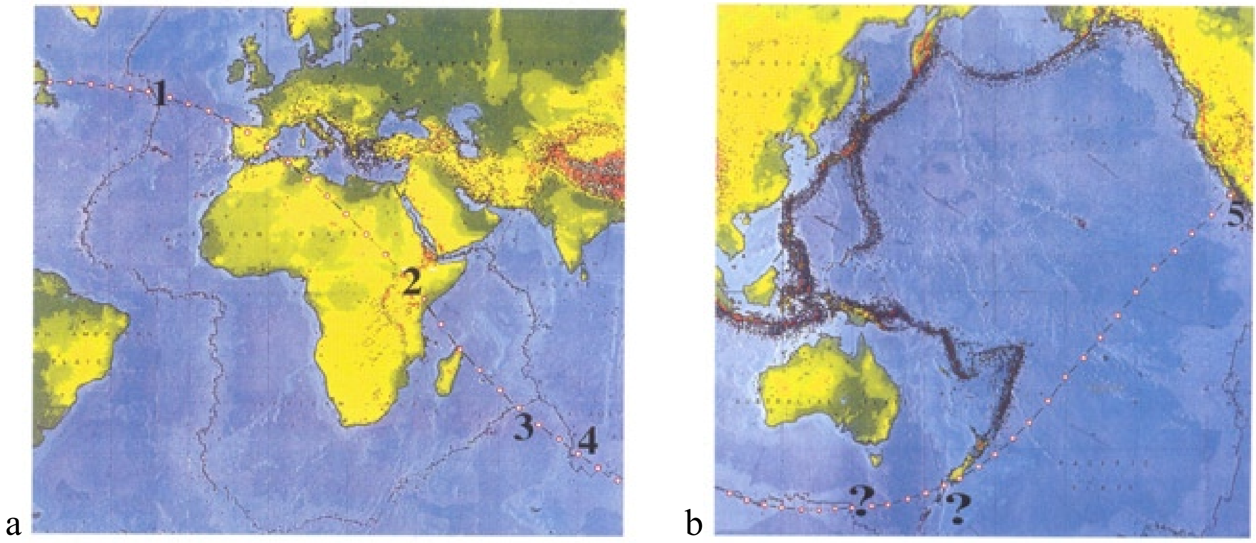
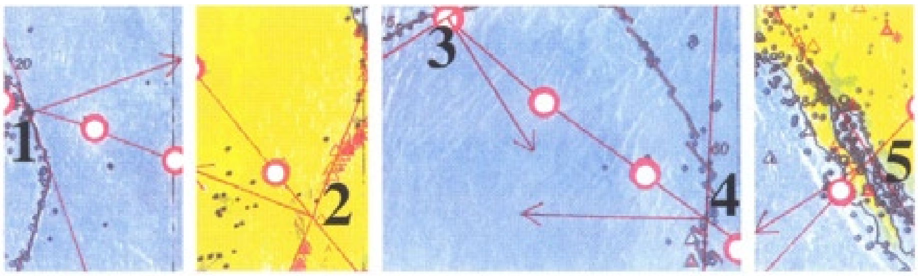


Fig. 32. *Points of crossing of axes of plate divergence by the first Perin expanding great circle (after Perin, 2003)*

The results are given in Fig. 33. The sum of these local rates is 77.8 mm/year.

In his next papers (Perin, 2006, †2012) Perin confirmed this result and made analogical calculation for his second ring (see Fig. 3). The result was almost the same – 79.40 mm/year. Perin rounded these values to 79 mm/year. According to the explanation given in section 2 we consider only his first great circle. The rate of growth of the Earth radius implied by Perin's result is only 1.24 cm/year. However the rate calculated with use of several independent methods (see the next section) is between 2.0 – 2.5 cm/year. Thus the Ripper-Perin great circle must be significantly elongated also beyond Perin's points of calculation in areas inaccessible for his method. The first of such place is an area to



Point	Expansion	Angle	Cos	Ring Growth
1	20.0 mm/y	39° 02′	.78	15.6 mm/y
2	<1.0 mm/y	30° 01′	.87	Negligible
3	15.0 mm/y	18° 03′	.95	14.5 mm/y
4	60.0 mm/y	37° 02′	.80	48.0 mm/y
5	<1.0 mm/y	07° 12′	.99	Negligible

Fig. 33. *Rates of plate divergence at points of crossing of axes of the divergence by the first Perin expanding great circle (after Perin, 2003)*

the south of New Zealand where the great circle crosses the tensional Solander Trough. The second is the Mexican tensional Basin and Range province and US tensional Rio Grande rift. For the northern (US) part of the basin and range province the rate of extension is measured by satellite geodesy and is 1 cm/year (Harrison and Douglas, 1990). But the most suspected section for diffuse extension is the longest oceanic part of the Ripper- Perin great circle between California and New Zealand.

Thus we may conclude that the Ripper-Perin expanding great circle being a good proof of the Earth expansion is not a good base for calculation of the rate of this expansion.

19. Rate of growth of the Earth radius

The tables of the rate of growth of the Earth radius, presented below, have been published (Koziar, 2011[11]).

a. Rate of growth of the Earth radius based on geological data

Table I presents the values of contemporary rate of growth of the Earth radius calculated with use of different geological methods. The first result (Koziar, 1980)[12] is based on the most reliable method, that is, on measured increments of the surface areas of oceanic and continental lithosphere. The fourth result (Koziar, 1996) is based on reinterpretation of Le Pichon's (1968) measurements of spreading rates along the equator. The topic is discussed in the present paper in the next section. The possibility of casual coincidence of both results is near zero. Even closer to zero is the possibility of casual coincidence of all the results.

[11] www.wrocgeolab.pl/geodesy1.pdf
[12] www.wrocgeolab.pl/floor.pdf

b. Rate of growth of the Earth radius based on space geodesic data

Table II presents the values of contemporary rate of growth of the Earth radius calculated using different space geodesy methods. The possibility of casual coincidence of all these results is near zero. But the possibility of their coincidence also with geological results is practically equal to zero and can be treated as an independent proof of the expansion of the Earth.

Table I. Present rates of the growth of the Earth's radius obtained by geological methods

Author	Year	Rate [cm/yr]	Method
Koziar	1980	2.59	Increase in the Earth's surface area (Phanerozoic)
Blinov & Schuber	1984	≅ 2.0	Increase in the Earth's surface area (Cenozoic)
Maxlow	2002	2.2	Increase in the Earth's surface area (from the Archean)
Koziar[1]	1996	2.7	Increase in the Earth's circumference
Koziar	this paper	>2.0	ratio of the lengths of Atlantic Ridge and the shore of Africa

[1)] correct interpretation of the result obtained by Le Pichon (1968)

Table II. Present rates of the growth of the Earth's radius obtained by space geodesic methods

Author	Year	Rate [cm/yr]	Method
Blinov[1]	1987	2.43	Doppler Surveying (general uplift)
Carey[2]	1988	2.08 ± 0.8	SLR (chord analysis)
Maxlow[3]	2000	>1.8	VLBI (general uplift)
Koziar[4]	this paper	>1.0	VLBI (fictitious baselines contraction)

[1)] correct interpretation of the results obtained by Anderle and Malyevac (1983)
[2)] W.D. Parkinson's calculations
[3)] correct interpretation of the results obtained by Robaudo and Harrison (1993)
[4)] correct interpretation of the results obtained by Heki et al. (1989)

20. Other expanding great circles

a. The Le Pichon expanding great circle

One of the main goals of Le Pichon's (1968) paper is:

> *"to test whether the more uniformly distributed data on sea-floor spreading now available are compatible with a non-expanding earth"(p. 3661).*

Undertaking this task, Le Pichon distinguishes himself positively from other founding fathers of plate tectonics, such as Jason Morgan and Dan McKenzie, who simply ignored the expanding Earth alternative and took the non-expanding Earth assumption as something self-evident.

Trying to prove that the Earth is not expanding Le Pichon considered many great circles, but the essential one lies approximately along the equator of the Earth, and can be called by his name. In fact, Dooley (1983) so labels it.

In Le Pichon's understanding, his circle proves that the Earth is not expanding. In fact it is a good confirmation of the expansion, as will be shown below.

Le Pichon started with the strange assumption that unevenly distributed spreading zones (and they are such) should be connected with uneven expansion resulting in a non-spherical shape of the Earth. Because the shape is not such, the spreading must be compensated in some zones of convergence and thus the Earth is not expanding.

However, the quite non-hypothetical gravitation, not hypothetical subduction, is the factor which keeps spherical shape of the Earth. This was pointed out already by Ripper (1970). Carey (1996) also pointed out that all rigid cosmic bodies are rounded off by gravitation if their radius and mass are bigger than respectively: 200 km and 10^{19}kg. Corresponding Earth parameters are far beyond these values.

Specifically, Le Pichon pointed out a big dominance of the meridional routes of oceanic ridges above the latitudinal ones. This is tantamount to the big dominance of the latitudinal spreading above the meridional one. He (p. 3674) summing up spreading rates along his great circle: at the mid-Atlantic ridge 4 cm/year, at the Carlsberg ridge 1.5 cm/year and at the East Pacific rise 12 cm/year (Fig. 34).

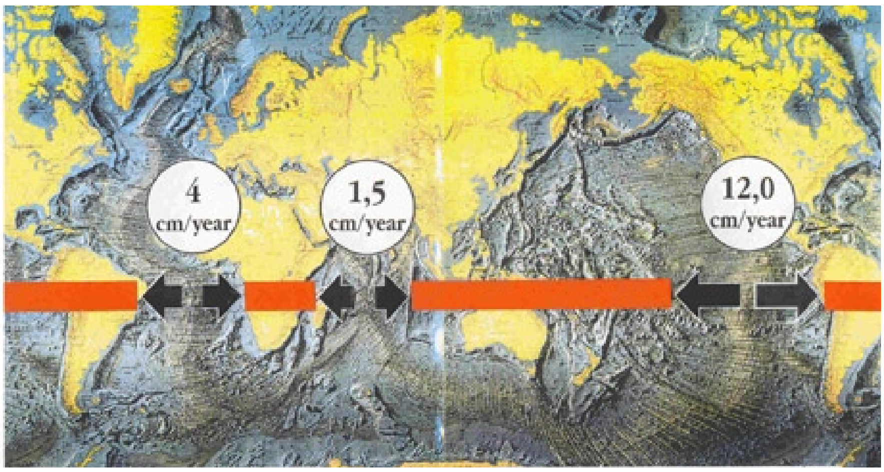


Fig. 34. *The Le Pichon expanding great circle (explanation in text)*

Then he rounded the sum to 17 cm/year and obtained the increment 270 km in the equatorial radius for the last 10 Ma. Because according to Le Pichon *"some of the great circles of longitude would not have expanded"* thus the calculated 270 km should make a big equatorial bulge. Because *"It is unacceptable /…/ we have to assume some compensating large –scale process of earth's surface shortening by compression or thrust to maintain the nearly spherical surface of the earth. The expansion hypothesis then loses most of its appeal*."(p. 3674).

Carey (1976, p. 18) wrote *"What Le Pichon found unacceptable, was not the expansion model, but a Le Pichon model of expansion constrained by his 'plate tectonics' parameters."* Then he pointed out that Le Pichon did not take into account many zones of meridional elongation beyond spreading zones as between both Americas and between South America and Antarctica. He also pointed out the elongation indicated by spreading ridges. Because the ridges are really mainly meridional this elongation is mainly meridional too. This elongation of ridges Carey noticed already in 1958 and pointed out that it results from expansion of the Earth. In fact it is one of the proofs of this expansion (see the introduction to this paper).

__Fig. 35.__ Enlargement of the Atlantic oceanic border of the African plate relative to its parent continental border

The elongation is best visible on the mid-Atlantic ridge (Fig. 30).

I counterpoised (Koziar,1991; 1996) this elongation to Le Pichon's "proof" and simultaneously juxtaposed the rate of the radius growth of the Le Pichon's great circle which is 2.7 cm/year with the rate of the Earth radius 2.59 cm/year obtained by differentiation of my function of the growth of the Earth radius (Koziar, 1980)[13]. The function was based on increments of the surface areas of the lithosphere throughout the Phanerozoic. Thus the recent rate of the growth of the Earth radius was obtained in a quite independent and firmer way. Both values are presented in the Table I in the first and fifth position respectively. As was mentioned, the probability of casual coincidence of the two results is almost zero.

The Le Pichon expanding great circle cannot be treated as an independent proof of Earth expansion because

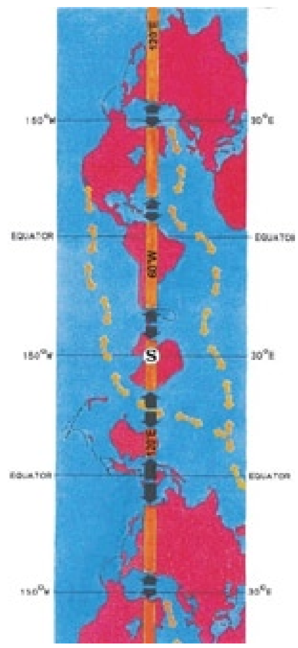
[13] www.wrocgeolab.pl/floor.pdf

the demonstration of its lengthening is based on another independent proof (Fig. 35). However, it is the only great circle which enables us to calculate accurately its own rate of expansion. In fact, Le Pichon already did this in 1968, but he did not treat the obtained value as linked with the real process.

b. The Carey expanding great circle

The Carey expanding great circle (Fig. 30; Koziar, 1993[14] ; Koziar, 2004[15]) is a derivative of Carey's proof of growth of the Pacific (Carey's test, or Carey's Pacific Paradox) and thus a proof of the expansion of the Earth (Carey, 1958, 1976). Growth of the Pacific can be proved from only three growing gaps along the Pacific perimeter, the growth of which is non controversial even in plate tectonics. These are: Middle America, South America – Antarctic, and the Antarctic – Australian gaps. Such a proof I called "Carey's test strengthened" (Koziar, 1993). The growth of the Arctic gap is also evident, though plate tectonics tries to ascribe to it some shortening. However all Arctic oceanic basins are dilatational and there are no signs of structures interpreted in plate tectonics by subduction. The most that can be claimed is that the Arctic gap is not currently growing but is certainly not decreasing.

a



b

Fig. 36. The Carey expanding great circle, a – 3D presentation, b – Mercator development (explanation in text)

The most controversial is the Asia – Australian gap. According to plate tectonics a big shortening occurs there. However we can apply here the Ripper-Perin method to show that the shortening does not take place. Between Arnhem Land in Australia and Okhotsk in eastern Siberia a straight line can be drawn (Fig. 37) which does not cross

[14] www.wrocgeolab.pl/Pacific.pdf
[15] www.wrocgeolab.pl/handbook.pdf

any hypothetical zone of subduction. Thus the line is an abstract “bar” which makes impossible any convergent movement between Asia and Australia in terms of plate tectonics itself. There is no need to point out some divergence here, and in the Arctic gap too, because the non controversial divergence in the remaining three gaps means that the entire Carey great circle expands.

The Carey expanding great circle was called by me (Koziar, 1993) “Carey’s test simplified”.

The Carey expanding great circle is the best answer to Le Pichon’s conviction that there is no substantial growth of meridional great circles and that Le Pichon’s great circle is a proof of the non-expanding Earth. As was noted the Le Pichon expanding great circle is not treated here as an independent proof the expansion of the Earth but it is a good supplement to the Ripper-Perin expanding great circle and the Carey expanding great circle which are such proofs.

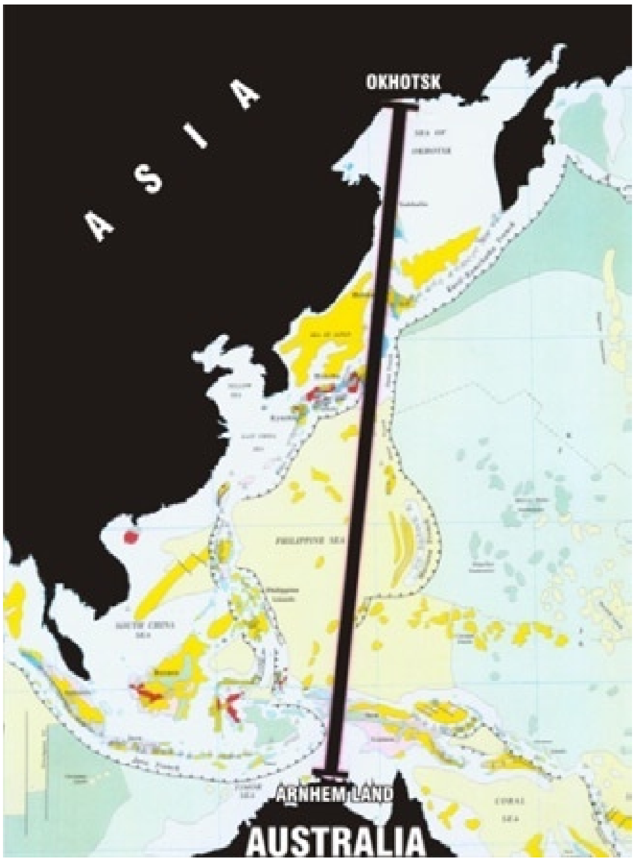


Fig. 37. Arnhem Land – Okhotsk “bar” preventing Australia and Asia from coming closer (explanation in text)

c. The plate tectonics expanding great circle

One more expanding great circle can be defined in addition to the earlier ones. This circle should cross Australia and South America. Then it should cross only the zones of divergence beyond the Pacific and zones of supposed convergence, also beyond the Pacific, but in such a way which does not shorten its length. However the circle has no necessity to omit the zones of the supposed convergence between Australia and South America. This is because these two continents are moving apart according to plate tectonics itself. Thus such great circle is expanding as a whole on the basis of the plate tectonics itself.

Such a circle has coordinates of its main points: (0^0,25^0N), (90^0E, 0^0), (180^0, 25^0S), (90^0W, 0^0) – Fig. 38, which by chance coincide with the special values of geographical longitudes (0^0, 90^0E, 180^0 and 90^0W) which were established by convention.

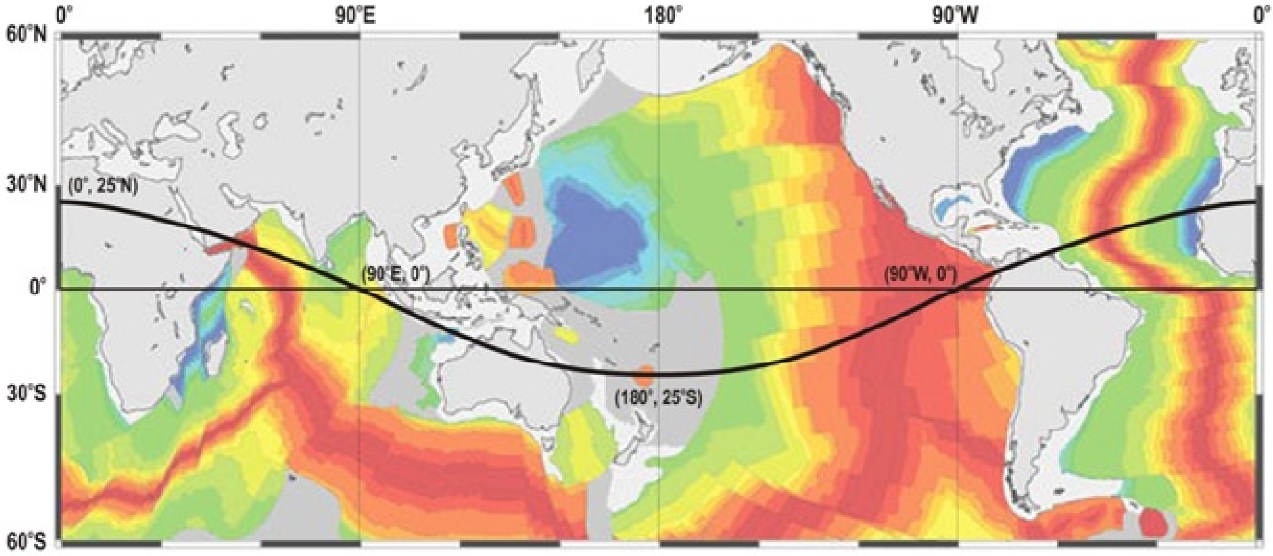


Fig. 38. *The plate tectonics expanding great circle – location (explanation in text)*

As can be seen, the new great circle occupies an intermediate position between Ripper-Perin's and Le Pichon's ones.

The requirements given earlier determine the position of the presented great circle very precisely. The circle cuts almost tangentially the Indonesian arc in the eastern hemisphere and passes the southern end of the Lesser Antilles arc in the western hemisphere. The reduction of the angle included between the plane of the great circle and the plane of the equator results in deeper entering the circle into the Indonesian arc and its slipping out from the oceanic part of the Australian plate. The enlargement of this results in deeper entering the circle into the Lesser Antilles arc and its slipping out from the South America continent. The same effects result from shifting the points of the intersection of the great circle with the equator to the East and to the West, respectively.

The almost tangential cutting into the Indonesian arc does not change the length of the great circle because outside the arc the circle runs through the same rigid oceanic part of the Australian plate (see paragraph 15a and Fig. 29). Similarly, cutting into the southern end of the Lesser Antilles arc does not change the length of the great circle because its outer parts runs through the same rigid South American plate – partly continental to SW, and partly oceanic to NE (see paragraph 15b and Fig. 30).

Between Sumatra and Sri Lanka the great circle runs through the supposed diffuse border between the Indian and Australian plates which in this part is assumed to be compressional. However the direction of the supposed compression is almost perpendicular to the circle (Wiens et al., 1984), so it cannot shorten the latter.

Thus the expansion of the non-Pacific section of the great circle is out of the question. Whereas expansion of the section between Australia and South America results from plate tectonics and space geodesic calculations (Fig. 33).

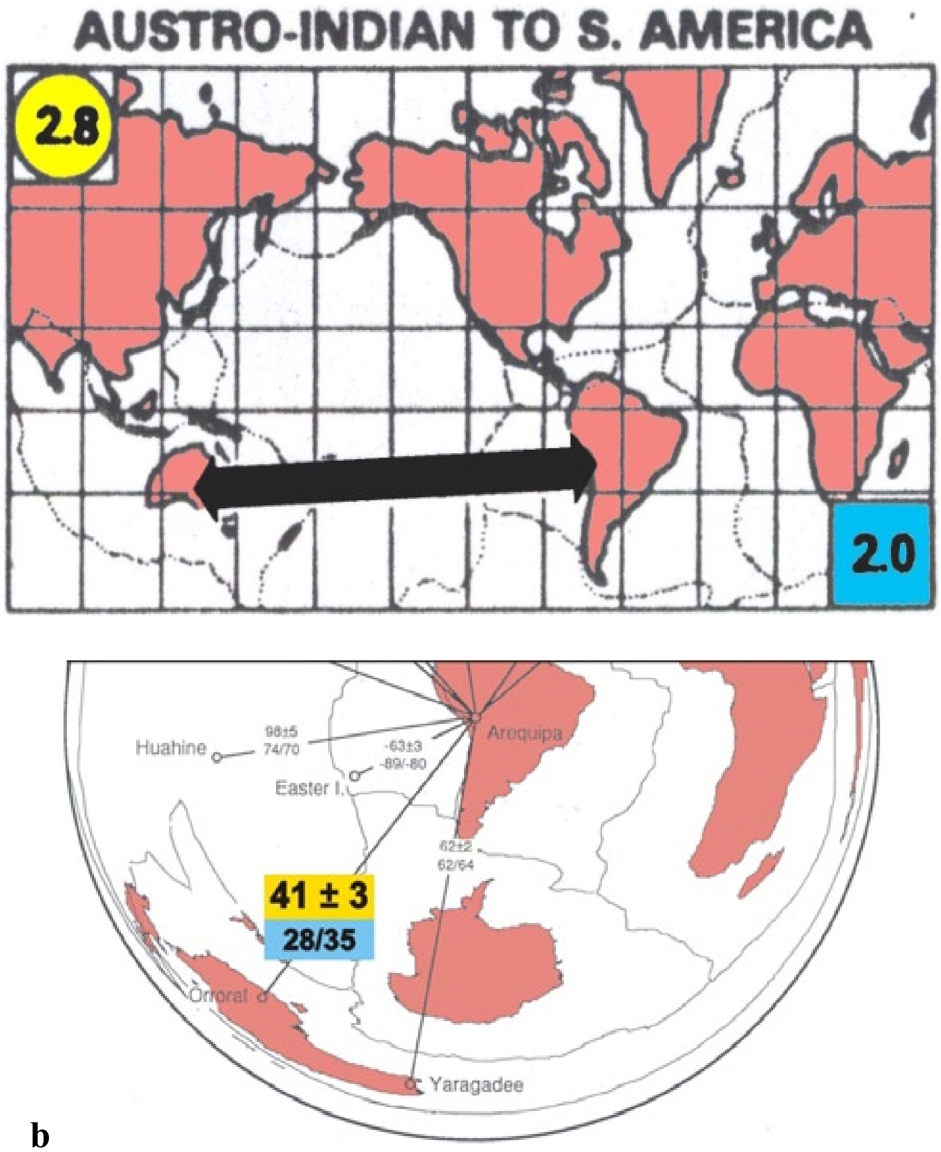


Fig. 39. *Rates of expansion of the South Pacific,*
a *– 2.8 cm/year by space geodesy, 2.0 cm/year by plate tectonics (Christodulidis et al., 1985),*
b *– 41 mm/year by space geodesy, 28/35 mm/year (two different calculations) by plate tectonics (Smith et al., 1990)*

Both kinds of the presented calculations have been made between two sites of space geodesic measurements: Arequipa (Peru) and Orroral near Canberra (Australia). Of course, Arequipa lies behind the Peruvian oceanic trench with its hypothetical subduction. One may question that the Andes themselves are a zone of some shortening (Arequipa lies on the western slopes of Andes). However this objections concerns only space geodesy calculations connected strictly with the site. Whereas plate tectonics calculation treated the site as lying on the rigid South American plate.

The line connecting the two geodetic sites is close to the determined great circle (Fig. 34) and so it is appropriate to project the lengthening of the former onto the latter. Thus the whole great circle is expanding.

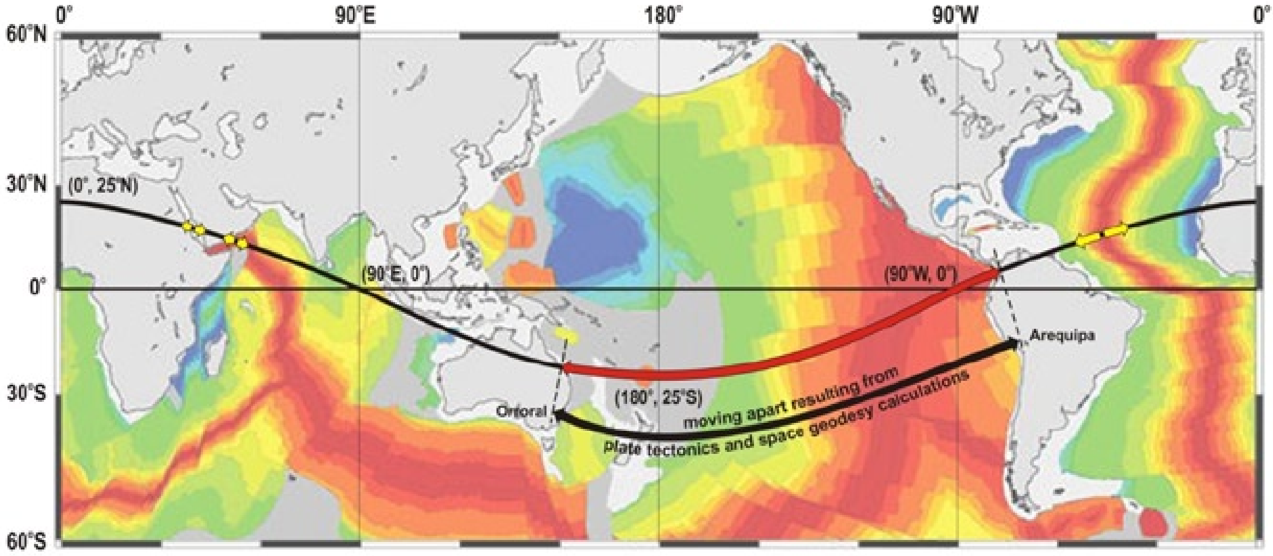


Fig. 40. *The plate tectonics expanding great circle – Pacific section of expansion and non-Pacific axes of expansion (explanation in text)*

The moving apart of Australia and South America, presented above, is independent of whether hypothetical subduction occurs at South American and Kermadec – Tonga trenches. However the fundamental reason for subduction is the assumption that the Earth is not expanding, as Le Pichon (1968, p. 3673) wrote:

> *"If the earth is not expanding, there should be other boundaries of crustal blocks along which surface crust is shortened or destroyed".*

Thus, if the Earth **is** expanding there is no reason for such speculative subduction. As was mentioned in section 6b, the direct analyses of the zone of hypothetical subduction, that is - island arcs and active continental margins, reveal that the latter are also the zones of plate divergence, similarly to oceanic ridges though at much smaller rates.

The plate tectonics expanding great circle cannot be regarded as a proof of the expansion of the Earth, because its expansion results from false plate tectonics rules of plate movement[16]. Though Australia and South America really are moving apart, the plate tectonics expanding great circle only demonstrates that the plate tectonics paradigm is internally contradictory.

A reader can be disappointed at the old dates of the papers quoted in Fig. 33, but they are valid. More recent space geodesy analyses have shifted focus from the mutually relative movement of plates to their movements in the so-called "absolute reference frame". These movements confirms in turn Carey's Arctic Paradox which is one of the proofs of the expanding Earth (Koziar, 2011[17]).

[16] The rules are Eulerian ones which as such are right but their application to plate movements is wrong.

[17] www.wrocgeolab.pl/geodesy1.pdf

21. Summary

Ripper (1970) introduced a great circle of the Earth as a proof of Earth expansion. Dooley (1983) questioned this proof pointing out the possibility that transform faults crossing the circle can reduce the enlargement of the latter which is gained at crossing the spreading zones. Perrin (1993, 2003) introduced a very similar but more precise great circle which is called (in this paper) the Ripper-Perin expanding great circle. Detailed analysis of impact of transform faults on great circles and the distribution of the former structures, carried out in this paper, revealed that they have no global impact on the Ripper expanding great circle as well as on the more modern and precise the Ripper-Perin one. Thus the latter is a valid proof of Earth expansion.

Apart from these great circles there are also three others: Le Pichon's, Carey's and the one derived in this paper from plate tectonics itself. The Carey one is a part of his Pacific Paradox which is a proof of the Earth's expansion. The other two can be only regarded as a good confirmation of the process of expansion of our globe.

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