JAN KOZIAR

A new reconstruction of GONDWANA on the expanding Earth

Wrocław 1991
Digital edition – Wrocław 2012

Front cover

The reconstruction of Gondwana supercontinent on the geologic globe at scale 1:15 000 000 (85 cm in diameter).

The gaping gores growing towards the perimeter of the reconstruction result from enlarged radius of the Earth in relation to original radius. This is the so-called Van Hilten's "orange peel effect".

The background of the cover presents fossil leaves of the Upper Paleozoic fern called glossopteris – the floristic icon of the Gondwana supercontinent.

The original work was financed from grants 2094/W/ING/91 and 1017/S/ING/ 91/VIII, 1.

Comments (2012)

An original Polish version of this present English translation was published in 1991 in the volume of Acta Universitatis Wratislaviensis, no. 1375, in the series: Geology – Mineralogical Works, pages 357–396.

The volume was edited as a preconference book of the jubilee conference entitled "30 years of the Department of Physical Geology of Wrocław University" in which I was then employed. The conference was organized under the direction of the founder and director of the department, Professor Józef Oberc – supporter and promoter of an expanding Earth theory. In the introduction to the volume he wrote :

> *"A part of the scientific works of the Department is concerned with geotectonics and within that frame is the subject of the expansion of the Earth. The development of the latter has much promise for the future".*

Today the investigations are continued at the Wrocław Geotectonic Laboratory, founded by myself.

The preparation of the paper and its publication were in the times when neither author nor publishers used computer techniques. Using such technical possibilities today I decided to prepare the paper again at a higher level. The original figures were black-and-white and are now in colour. All figures of other authors reproduced here have been re-drafted by me. This information is omitted in the captions to avoid frequent repetition.

In this new edition more subheadings have been added as well as contents, a cover (because the paper is presented now as a separate brochure) and copy of a cover of the volume in which the original paper was published. The original text was not changed apart from shortening the title[1], re-writing the Abstract in a more modern way and removal of some small technical faults.

Taking advantage of the passage of time and the progress of my own investigations, some footnotes have been added which comment on parts of the text and point to later papers. This list of papers is placed after the original bibliography. To avoid misunderstanding each footnote is provided with the present date (2012).

At the end of the paper two photos of Gondwana imposed on a geological map of Africa are presented as well as two schemes of geotectonic development of the eastern and western hemispheres. These are schemes of development of Indian Ocean and the Pacific respectively. The illustrations are closely connected with the paper and were displayed on a poster in the Department of Physical Geology, in the days following original publication.

The reconstruction of Gondwana presented here has stood the test of time and is confirmed by my later reconstructions on big geological globes which I have constructed, using precise oceanic isochrons.

This reconstruction of Gondwana is a key to a proper reconstruction of the entire globe.

Jan Koziar

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[1] The original title was: "A new reconstruction of Gondwana on the expanding Earth, on the background of the hitherto existing reconstructions". The shortening was made according to pertinent suggestion of the proofreader of the translation – Professor Cliff Ollier.

On the following page is a copy of the front cover of the volume of Acta Universitatis Wratislaviensis in which the original paper was published.

PRACE GEOLOGICZNO-MINERALOGICZNE XXIX

30 LAT ZAKŁADU GEOLOGII FIZYCZNEJ INSTYTUTU NAUK GEOLOGICZNYCH UNIWERSYTETU WROCŁAWSKIEGO

WROCŁAW 1991
WYDAWNICTWO UNIWERSYTETU WROCŁAWSKIEGO

Abstract

The new reconstruction of Gondwana on the expanding Earth is presented, based on a new connection of Africa and Antarctica. The continents were joined along the south-east cratonic edge of Africa and cratonic edge of East Antarctica, marked by the Transantarctic Mountains. The clue for finding this connection was starting the assembling of Gondwana from closing the south Pacific, in concordance with the tectonic development and paleobiogeography of the latter.

In the new reconstruction the concave arc of the Eastern Ghats of India is connected with Antarctica's Queen Maud Land not with Enderby Land as in plate tectonics reconstructions.

The new reconstruction submits to van Hilten's "orange peel effect" which is an artefact resulting from the expansion of the Earth.

Of previous reconstructions the most similar to the new one is that of Klaus Vogel.

The angular size of the reconstructed Gondwana exceeded 1800 of central angle (in a circle) on a smaller Earth. Thus the Late Paleozoic glaciation of the supercontinent was not only a circum-polar one. It had to develop on high plateaus which crossed the snow limit even at the equator.

Gondwana (including India), before its break up, was connected with Laurasia. The Tethys zone was only an epicontinental sea with local deep rifts.

In Precambrian time the Antarctic-Australian block was connected with southeast and east borders of the Siberian shield along the line: Enderby Land – Queen Mary Coast – western coast of Australia.

Acknowledgments

(1991)
I would like to thank Professor Józef Oberc and Dr Jerzy Głazek for comments that improved the paper.

(2012)
I also thank Professor Cliff Ollier for proofreading this English translation of the original paper.

Contents

I. Beginnings of the concept of Gondwana supercontinent

1. Components of Gondwana

The concept of existence of an old southern super-continent started with Blanford's paper (1875). He saw in the past a vast area of land comprised of India, South Africa and Australia. His vision was based on the geographical range of the glossopteris flora. Neumayr (1887) added South America to this area and Blanford (1896) added Antarctica. Suess in 1885 introduced the name Gondwana Land, initially only for South Africa, Madagascar and India, but in 1888 added Australia, and in1909 added the whole of Africa up to the Atlas, South America and the Arabian Peninsula.

2. Relation of Gondwana to Laurasia

In the beginning it was believed that Gondwana was isolated from the northern super-continent Laurasia by the Tethys Sea, but after the World War I the Godwanan flora, fauna and similar sedimentary formations were discovered in the eastern part of Laurasia. But already Frech (1902) included Indonesia and Indochina in Gondwana, while Abendanon (1919) placed between Australia and south-east Asia an Aequinoctia (Tropic Continent), which linked both areas in the Paleozoic. So, it appeared that Gondwana was connected with Laurasia.

3. Land-bridge theory and problem of South Pacific Land

The Gondwana supercontinent was at first linked with the land-bridge theory of sunken former bridge lands and continents. A continuous continental area was seen not only in today's Indian Ocean and Atlantic but also in the South Pacific where geological connections between Australia, New Zealand and South America are not less visible than in other regions. A former South Pacific Land was assumed there on the basis not only of biogeographical and palaeobiogeographical premises but also sedimentological ones. For instance Burkchard (1903) found in the southern Andes a Jurassic formation of conglomerates which were accumulated from the site of the present Pacific.

4. Developed land-bridge theory

Continental data proving the young Meso-Cenozoic age of the oceans were collected also in relation to north Atlantic and north Pacific. As a result the developed land-bridge theory comprised the all oceans. According Haug (1900) there was a Pacific Continent besides Gondwana and the already mentioned Laurasia. They all together were regarded as covering the whole Earth, separated only by narrow geosynclinal zones.

II. Theoretical problems

1. Contradiction between land-bridge theory and theory of isostasy

At the very beginning the land-bridge theory met a serious obstacle in the form of the theory of isostasy. According to the latter continents cannot sink, which leads to the theory of permanency of the oceans. Thus a very big contradiction in the geological sciences appeared.

2. Local solution of contradiction between land-bridge theory and theory of isostasy

A solution of this contradiction was given by Wegener's theory (1912) which explained the former connection between continents by their mutual drifting apart. This did not collide with isostasy and explained better the phenomena which the land-bridge theory had tried to explain. Wegener made also the first mobilistic reconstruction of Gondwana in the frame of his Pangaea.

However, Wegener did not solve the contradiction between the land bridge theory and theory of isostasy globally, but only in reference to the Atlantic and Indian Oceans. Wegener could not explain connections across the Pacific. On the contrary the problem became even more difficult because this solution assumed a bigger size of former Pacific (Panthalassa). No wonder that specialists on the Pacific and its surroundings still tried to explain its origin according to the land-bridge theory, as did Gregory (1930).

3. Global solution of contradiction between land-bridge theory and theory of isostasy

Not long after Wegener two German geologists Lindemann (1927) and Hilgenberg (1933) applied his solution to the contradiction problem globally, by what is equivalent to significant expansion of the Earth. Hilgenberg was the first to make a global reconstruction, closing the Pacific just as Wegener closed the Atlantic and Indian Oceans. Hilgenberg's Pangaea – the name introduced by Oberc (1986) – covers the whole globe, and such a continuous continental shell was assumed by the consequently developed land-bridge theory.

Today investigators of trans-Pacific connections such as Avias (1977), Shields (1983) and Davidson (1983) treat these connections as Wegener treated the Atlantic, moving the continents apart. Growth of all oceans means the expansion of the Earth.

However the basis of the theory is much wider and here is no place to discuss it.

III. Rank of certainty of connections of Gondwana's components

Starting from Hilgenberg's publication all the reconstructions of Gondwana can be divided into two big groups: the first assumes a constant size of the Earth and the second takes into account its expansion. Before presentation of the two groups the rank of certainty of different connections will be discussed. This is independent of global geotectonic context.

Since Wegener's time the connection between Africa and South America (Fig. 1a) has been completely non-controversial.

According to present knowledge, especially after the precise setting of isochrons between Australia and Antarctica (Weissel and Hayes, 1972), the connection between these continents is very reliable (Fig. 1b). The connection of Madagascar with India (Fig. 1c) is also reliable. However the connection of Madagascar with Africa is controversial. There are two possible locations of this island: northern and southern (Fig. 1d). A recent investigation (Coffin and Rabinowitz, 1987) seems to point to the northern location.

The position of India in relation to Africa is determined in great measure by the two possible positions of Madagascar mentioned above, so it is reliable to the same degree.

The least reliable is the position of the Australian-Antarctic block in relation to other elements of Gondwana.

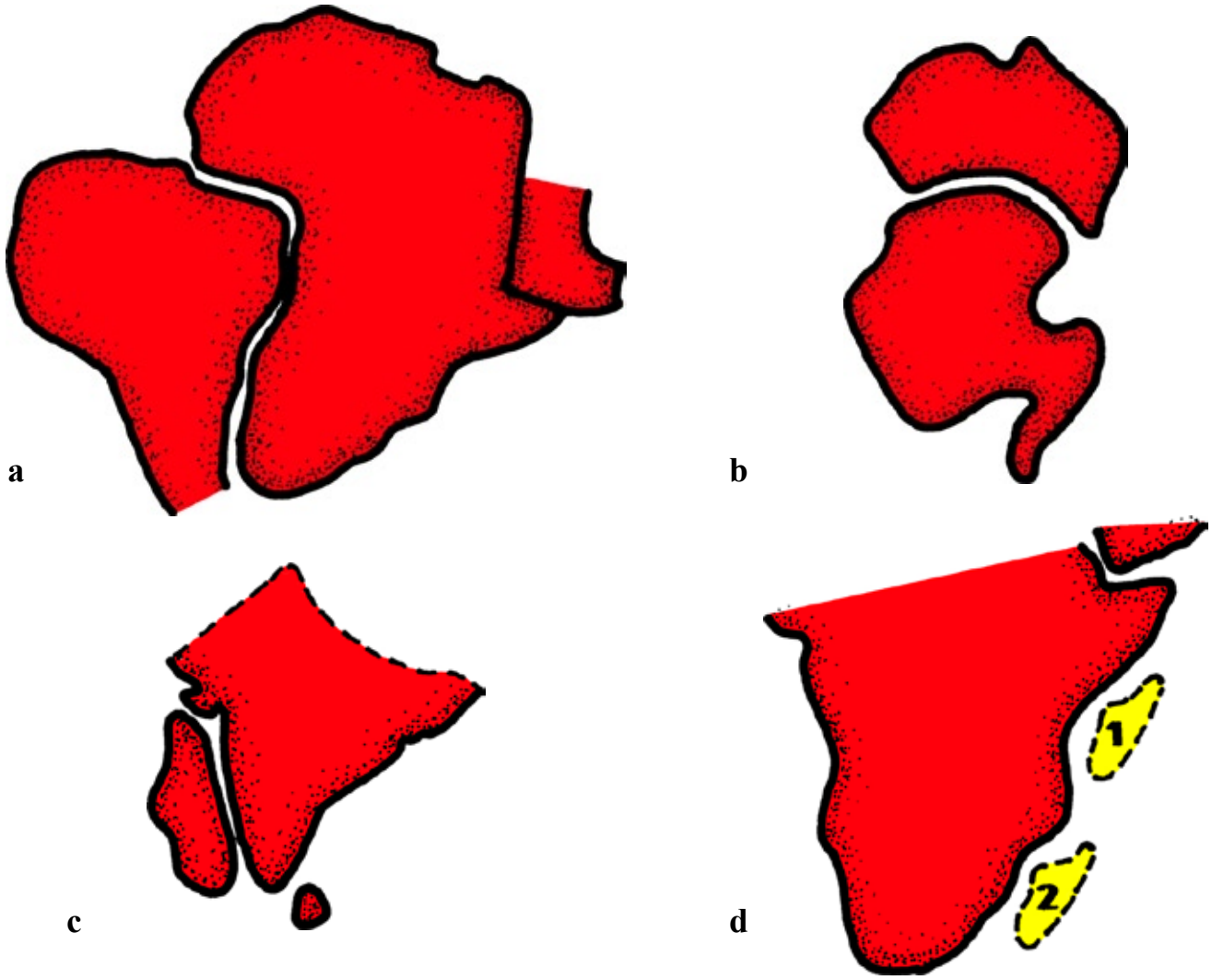


Fig. 1. Connections of the units of Gondwana
a – African – South American block (West Gondwana)
b – Australian – Antarctic block (East Gondwana without India and Madagascar)
c – Madagascar – India block (Lemuria, as a part of the East Gondwana)
d – two controversial positions of Madagascar in relation to Africa:
1 – northern position, 2 – southern position

IV. Mobilistic reconstructions assuming constant size of the Earth

It should be explained that using above the adjective "mobilistic" is necessary to differentiate these reconstructions from stabilistic ones made also on a non-expanding Earth, which were the land-bridge reconstructions.

Of the reconstructions fitting this description, given in the heading, only the most important ones will be discussed. The first was the well-known Wegener reconstruction in the framework of his Pangaea.

1. Du Toit's Gondwana

The next one was Du Toit's (1937) reconstruction (Fig. 2).

It has survived up to today, with only little changes, entering the canon of plate tectonics (see below).

Fig. 2. Du Toit's Gondwana (1937)

2. Subsequent mobilistic, non-expanding Earth reconstructions of Gondwana

King and Downard (1964) modified a little Du Toit's Gondwana rotating Australian-Antarctic block sinistraly and slightly, relatively to Africa and India.

In 1970 Smith and Hallam made a computer reconstruction of Gondwana according to the program looking for the best fit along the 500 fathom isobaths (Fig. 18a). The result was almost identical with Du Toit's.

In the same year Dietz and Holden (1970) made a reconstruction of Gondwana in the frame of their Pangaea (Fig. 20a) which was also similar to Du Toit's one.

3. Norton and Sclater's Gondwana

Norton and Sclater's (1979) reconstruction of the Indian and Atlantic Oceans, using isochrons, again obtained a Gondwana (Fig. 3) similar to that obtained by Du Toit.

It should be emphasized that this method gives reliable results only in places where the connections were earlier established, i.e. in the southern Atlantic and the south-eastern Indian Ocean. In the south-western Indian Ocean the development of oceanic lithosphere is less readable, which allows some freedom in connections of Antarctica with Africa and India.

Summing up, all later reconstructions on a non-expanding Earth did not go much further than Du Toit's result obtained in 1937. The solution obtained by Norton and Sclater is treated as a model in plate tectonics. It is also used in the multistage global reconstruction made by Scotese et al. (1988).

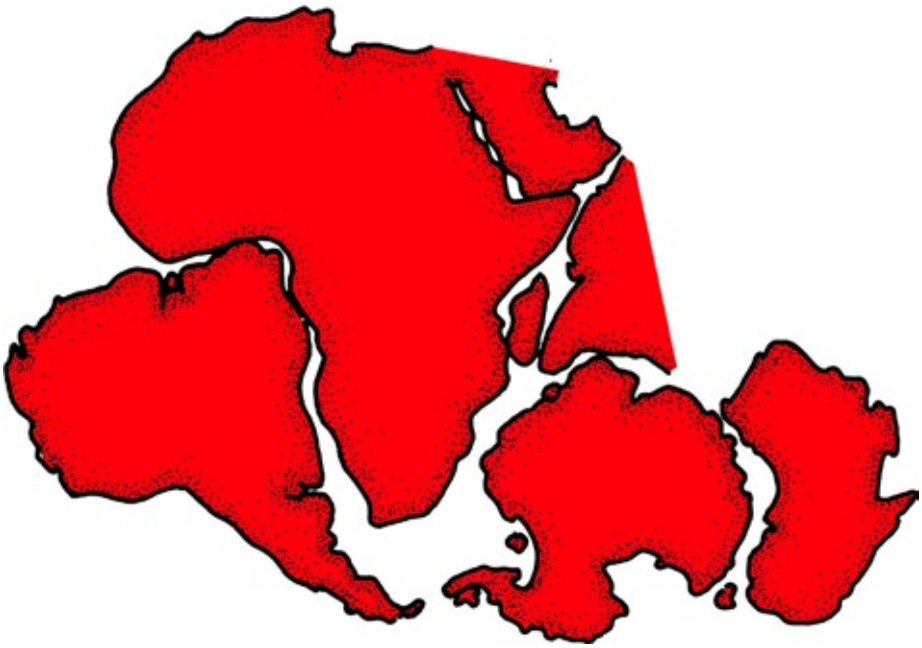


Fig. 3. Norton and Sclater's Gondwana of (1979)

V. Previous reconstructions of Gondwana on the expanding Earth

In this group of reconstructions some progress is visible. These reconstructions are more difficult to make because they must to take into account the change of the area and curvature of the Earth's surface. Apart from that all continental borders should touch with other ones because in this case Pangaea covered the whole Earth. There are no outer borders (like the perimeter of the non-expanding Earth Pangaea) which do not contact with others and there is no inner opening of the hypothetical Tethys "Ocean" which exists in the post-Wegener non-expanding Earth Pangaeas.

The distinctive feature of reconstructions of Gondwana on the expanding Earth is closure (elimination) of all oceanic basins of the southern hemisphere, including the south Pacific.

1. Hilgenberg's Gondwana

The first such reconstruction was made by Hilgenberg (Fig. 4), connecting the western borders of South America with Antarctica (Fig. 4 a and b). Australia was placed on the southern side of these connected continents, which was not followed by any later reconstructions. Yet the connection between Australia and Antarctica is, apart from slight dislocation, in accordance with present data. (Fig. 4b and c – compare with Fig. 1b). The position of India is not much different from the present one. It is, as in Wegener's reconstruction, connected with Asia. Madagascar is connected with Africa in the area of Mozambique (Fig. 4d).

2. Australia as a keystone of the northern circum-Pacific zone

In 1962 Brösske (Fig. 5a) and Barnett (Fig. 5b), independently of each other, connected Australia with South America (the change of orientation of the Australian-Antarctic block is 180^0 in relation to Hilgenberg's reconstruction). Simultaneously they moved it high in northern Pacific, making it the "keystone" of the northern part of the circum-Pacific zone. In relation to the subsequent results of other authors it should be treated as a successful pioneering solution. While Barnett connected correctly Antarctica with Australia,

Fig. 4. Hilgenberg's (1933) Gondwana
a – connection of western coast of South America with Antarctica
b – connection of Australia with Antarctica
c – connection of Australia with Asia
d – connection of India with Asia and Africa

Brösske rotated it by 180^0 (Fig. 5c). However the latter author applied for the first time location of the longer axis of east Antarctica between India and Australia. It gives a long distance between the latter two elements and the possibility of a connection of the long border of east and south-east Asia also with the long Antarctic-Australian section of Gondwana's border. This solution was applied later by Vogel (1983) who, however, connected correctly Antarctica with Australia (Fig. 5d) and connected the opposite margin of Antarctica to Asia.

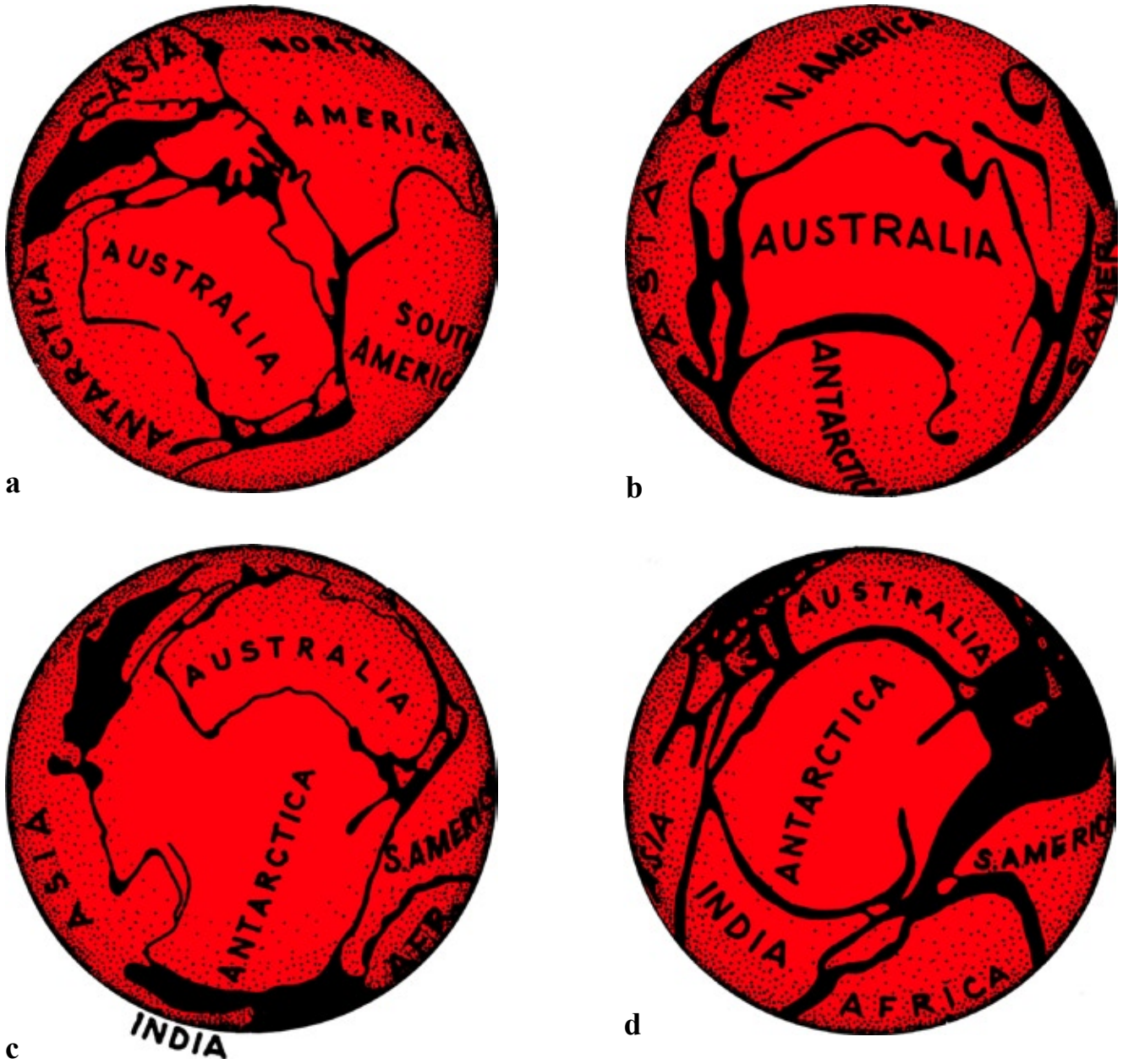


Fig. 5. Australia as a keystone of the northern circum-Pacific zone

a – Brösske's reconstruction (1962)
b – Barnett's reconstruction (1962)
c – Brösske's reconstruction (1962) with jamming of Antarctica between Australia and India
d –Vogel's reconstruction (1983) with jamming of Antarctica between Australia and India, and a correct connection of Australia and Antarctica, which causes the 1800 rotation of the latter in relation to the Brösske's reconstruction (Fig. 4c)

3. Attempts at connection of Antarctica with west border of South America

The common feature of all three above reconstructions is the connection of Antarctica with the south-west border of South America. More radical variants of such connection result in northward pushing of Australia out from the Arica bending (Stille's nomenclature) of the western coast of South America. This occurs in reconstruction by Creer (1965) – Fig. 6a, Bevis and Paine (1983) – Fig. 6b, and Carey (1988) – Fig. 6c.

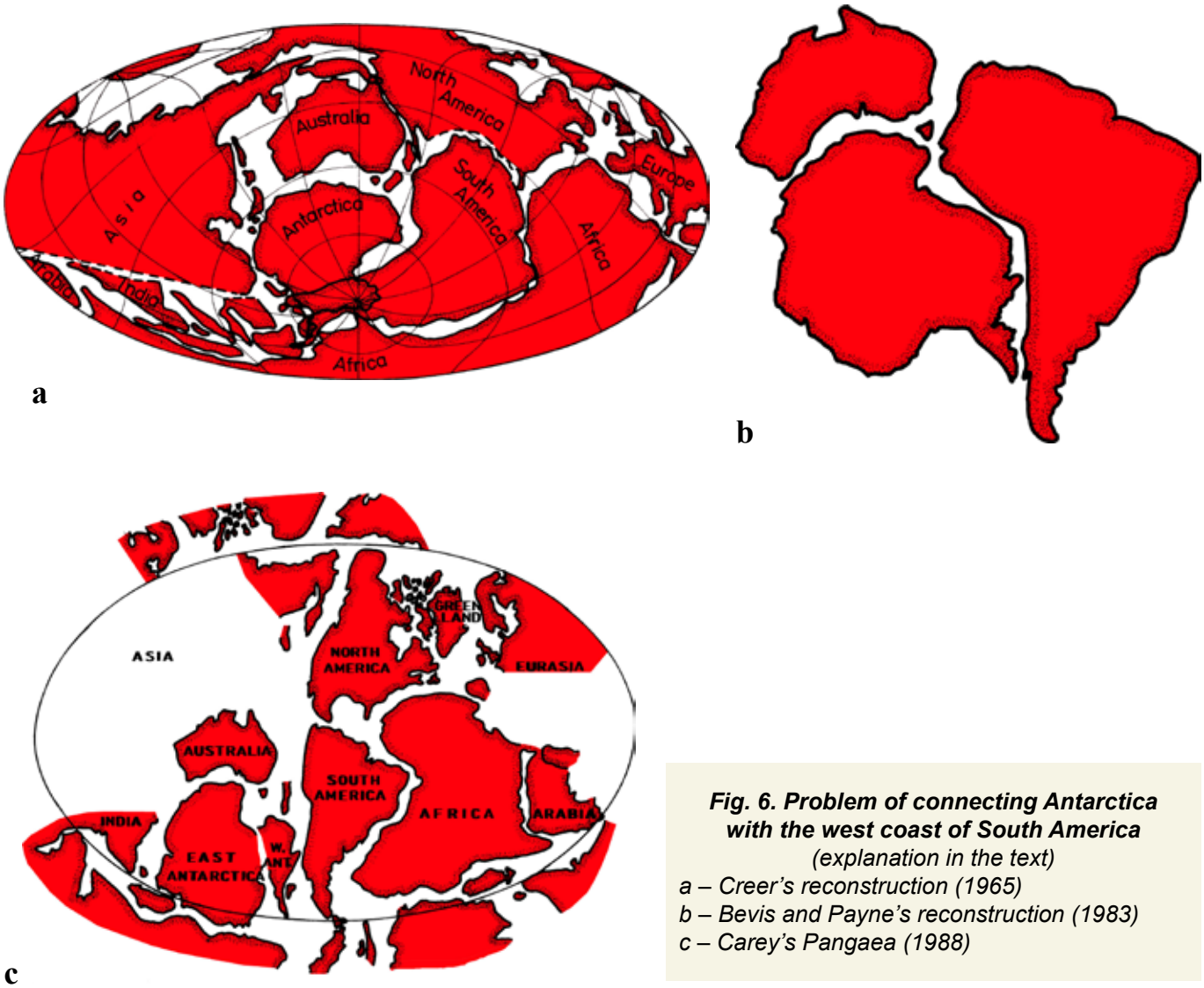


Fig. 6. Problem of connecting Antarctica with the west coast of South America
(explanation in the text)
a – Creer's reconstruction (1965)
b – Bevis and Payne's reconstruction (1983)
c – Carey's Pangaea (1988)

4. Barnett's second Gondwana

In 1969 Barnett published a new reconstruction (Fig. 7) in which Antarctica does not touch the south-west border of South America at all, being located between Australia and Africa.

But Australia is superimposed on Western Antarctica in this reconstruction, what does not fit with the situation proved at present (compare with Fig. 1b).

Fig. 7. Barnett's second Gondwana (1969)

5. The school of longitudinal closing of the Pacific

A certain confusion was triggered by the evocative connection of north-western vertex of Australia with the concave eastern margin of India, geologically justified by Ahmad (1961). Such connection makes it impossible for Australia to play the role of "the keystone" of the northern Pacific. In this situation the only way to close this part of Pacific is by connection of the eastern borders of Asia with the western borders of North America. Such a solution was applied by Carey (1983) – Fig. 8a, and Shields (1983) – Fig. 8b.

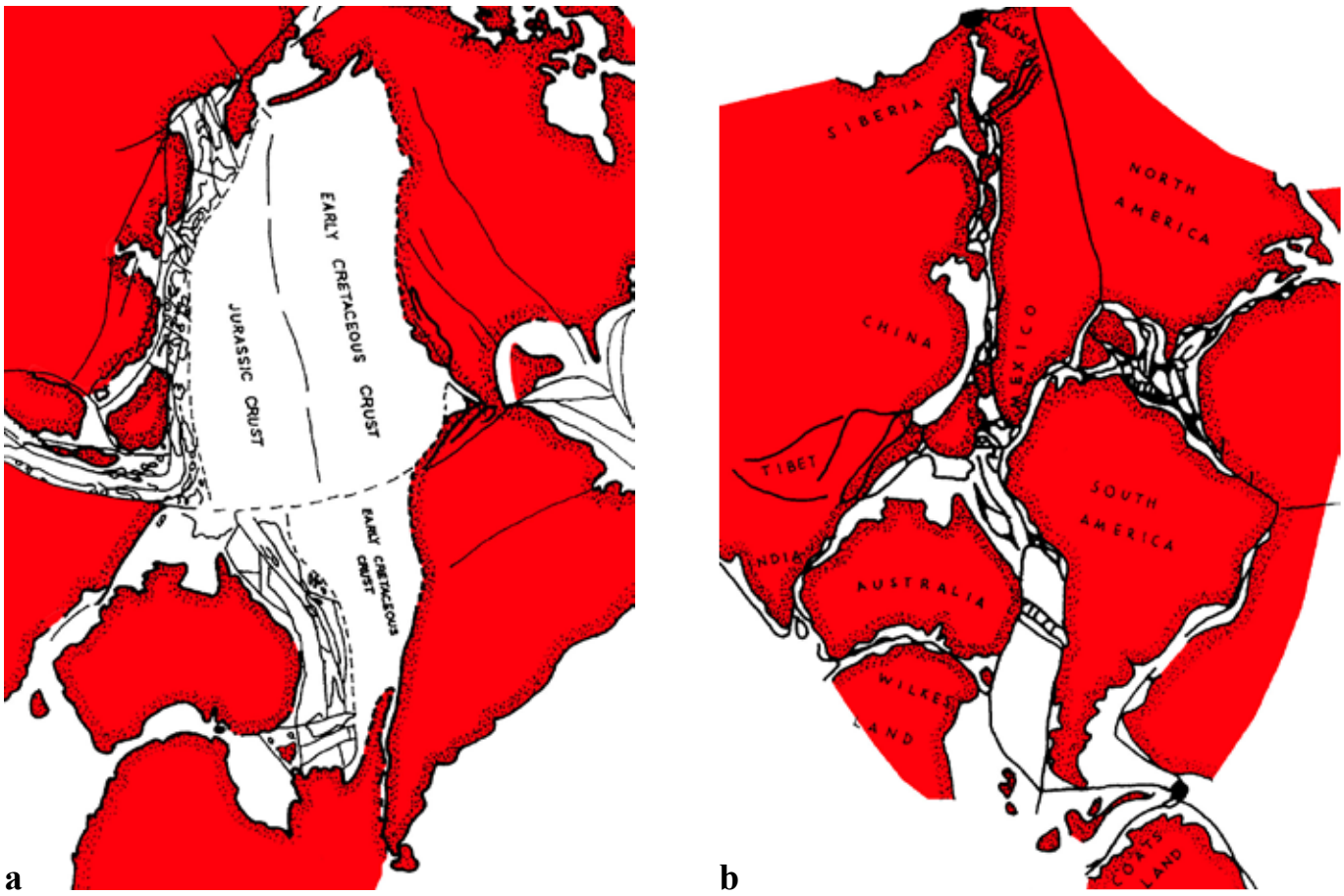


Fig. 8. Connections of Australia with India, "the school of longitudinal closing of the Pacific"
a – Carey's reconstruction (1983)
b – Shields' reconstruction (1983)

The above connection of India with Australia is a starting point of the so called "school of longitudinal closure of Pacific", distinguished by Vogel (1983). In another reconstruction (Fig. 6c) Carey pushed Australia from India to the north-east direction, preserving however a longitudinal plan of the reconstruction of the Pacific.

6. Vogel's Gondwana

The most advanced reconstruction is that of Vogel (1983). Its important feature is correction of Brösske's error (wrong turning of Antarctica through 180^0), which makes possible the best use of Australia as the "keystone" of the northern Pacific. He obtained a connection of the assembly: Madagascar–India-Antarctica–Australia which is correct, as I will show later. However the connection of the assemblage with the Africa – South America block should be judged critically. Vogel used the southern connection of Madagascar with Africa (Fig. 9) which, writing with Schwab he tried to justify in a separate publication (Vogel and Schwab, 1983).

Fig. 9. Connection of India and Madagascar with Africa in Vogel's (1983) reconstruction

But according the newest analysis of the ocean floor (Coffin and Rabinowitz, 1987), Madagascar occupied a northern position. Southward shift of Madagascar caused, on the one hand, a shift of Antarctica towards the western border of South America, and, on the other hand, an excessive southward shift of India from Asia. This compelled Vogel (oral information) to assume that India later drifted northward towards Asia. This introduces some eclecticism to the theory of the expanding Earth (convergent movement).

VI. A new reconstruction of Gondwana on the expanding Earth

I am an expansionist, and have demonstrated the expansion of the Earth in several publications and many lectures. The aim of this paper is not to fully document the expansion of the Earth, but to touch on those problems of this process which are directly connected with Gondwana.

A key for a new reconstruction of Gondwana was finding a new connection of Antarctica with Africa. The essential step was starting the reconstruction with a closure of the south Pacific. That is opposite to conventional way of shifting Australia and South America in opposite directions. There are direct data in the area of the South Pacific showing mutual moving apart of South America and Australia.

Trans-Pacific connections interpreted in a framework of the land-bridges theory were mentioned earlier. In time, they were supplemented by other data pointing to an opening of the Pacific.

1. Progressive development of Pacific basins

The Pacific does not have such a distinct geometrical connection between its borders as Atlantic, but they are visible in the South Pacific between Australia and South America. The connections become clearer if the isochrons of the oceanic lithosphere and the oceanic ridge are taken into account. So the isochron dividing the lower and upper Cretaceous lithosphere, juxtaposed with the west border of both Americas and with Pacific Ridge (Fig. 10), gives a clearer picture of progressive development of the Pacific than in the case of the Indian Ocean.

Enlargement of the Pacific, and thus expansion of the Earth, results independently from elongation of the whole circum-Pacific zone, as was shown by Carey already in 1958. This results particularly from elongation of three sections A, B and C of this zone (Fig. 11).

These enlargements are integral parts of plate tectonics. Thus the latter is internally contradicted. I pointed this out in an earlier paper (Koziar, 1985) [2].

[2] Progressive development of the Pacific is also described in my later paper "Development of the Pacific and its significance to contemporary geotectonics" (1993).
The paper is accessible: www.wrocgeolab.pl/Pacific.pdf *(Footnote 2012)*.

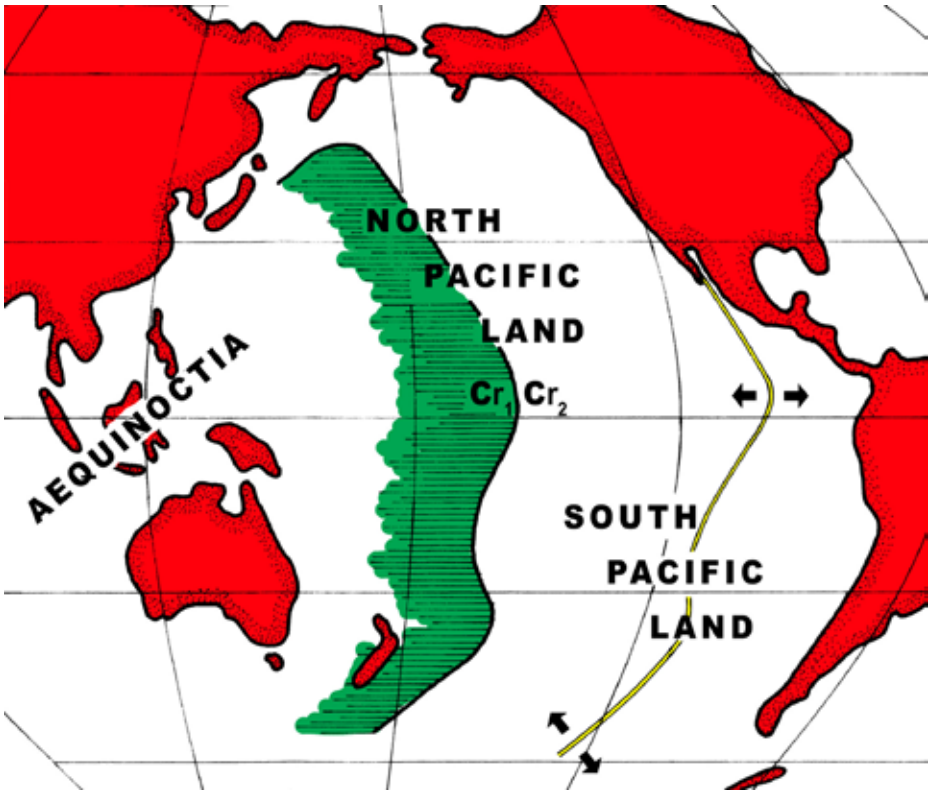


Fig. 10 . Hypothetical land-bridges of classic geology inside of the Pacific
Cr_1/Cr_2 – isochron dividing lower and upper Cretaceous lithosphere in the Pacific

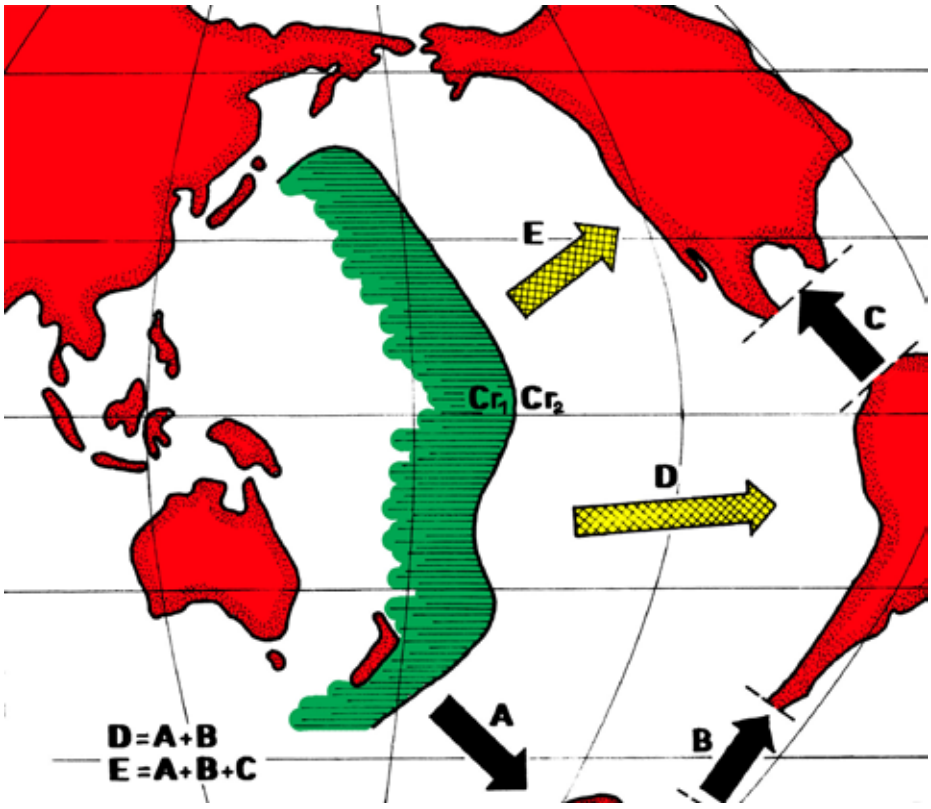


Fig. 11. Expansion of the area of the Pacific as a consequence of the recorded enlargement of the southern and eastern sections of circum-Pacific zone

2. Retrogressive closing of the South Pacific

Let us consider the South Pacific. The sum of the vectors A and B (Fig. 11) gives vector D that is moving South America away from Australia. That is true independently of the spreading of oceanic lithosphere in the South Pacific and its alleged compensation in the South American and Kermadec-Tonga trenches.

Incidentally, analysis made independently of plate tectonics, shows directly that the zones of alleged subduction are zones of a regional tensional regime (Tanner, 1973, 1983; Carey, 1973; Chudinov, 1981; Koziar and Jamrozik, 1991)[3].

It is impossible to reconstruct zones A and B without moving South America and Australia closer together. This is visible for instance on one of the plate tectonics reconstructions (Le Pichon, 1968). The moving apart of both continents results also from plate tectonics calculations made according to Euler's theorem (Minster and Jordan, 1978; De Mets et al., 1990). Space geodesy measurements (Christodoulidis et al., 1985; Smith et al., 1990) confirm directly expansion of the South Pacific.

Thus, pushing South America closer to Australia (Fig. 12) is justified.

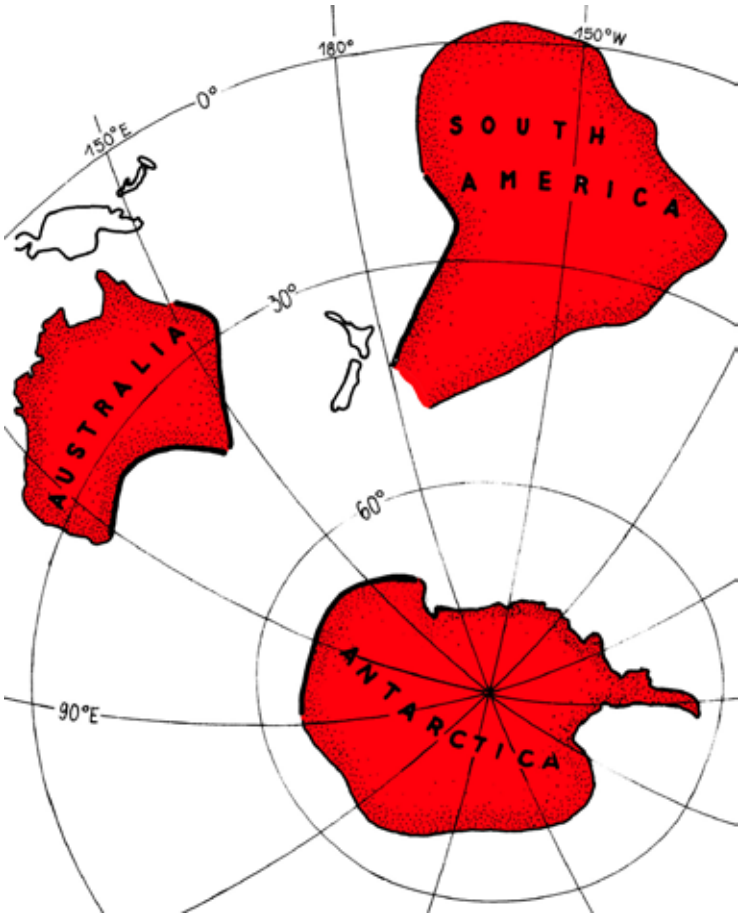


Fig. 12. Closing of the South Pacific
Pushing of South America closer to Australia, according to relations presented in Fig. 10 and 11

3. Disclosure of a new connection of Antarctica with Africa

After pushing Africa closer to previously shifted South America (Fig. 13) a distinct geometrical connection is revealed between the cratonic edge of south-east Africa and the inner cratonic edge of Antarctica, separating Precambrian East Antarctica from Meso-Cenozoic West Antarctica. The latter is outlined both morphologically and geologically by the Transantarctic Mountains.

[3] See also: Koziar and Jamrozik, 1994; www.wrocgeolab.pl/margins1.pdf
Koziar, 2003; www.wrocgeolab.pl/margins2.pdf (*Footnote 2012*).

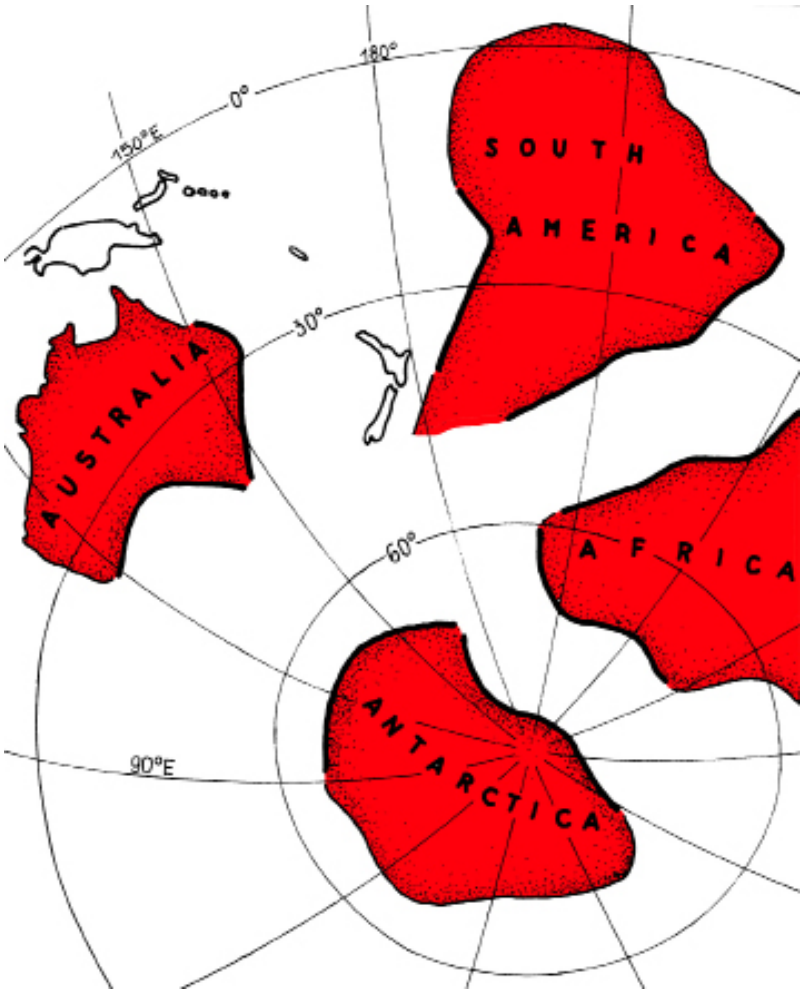


Fig. 13. Pushing Africa closer to South America according to the well known connection of these continents

In the south-west part of Africa a cratonic edge was marked. Antarctica is outlined on its cratonic edges

In finding similarity of the above edges some experience was helpful which I have gained from intracontinental reconstructions, mainly in the Tethys zone and in the area of the West Siberian basin. These are reconstructions taking perforce into account borders of older and more compact crustal units within continental areas, not reconstructions of a geographical kind which take into account exclusively isobaths along continental slopes. All the reconstructions of Gondwana discussed earlier have just such a geographical character.

4. Subsequent pushing close of the Gondwana's continents

Further pushing together the continents of Fig. 13 can be done by pushing them to meet at the present position of one of them. The configuration which is most similar to their present set is given by pushing them to the present position of Antarctica (Fig. 14).

Within South America the Guyana Shield was pushed closer to the Brazilian Shield, reducing the younger depression of the upper Amazon. The southern tip of South America, being composed of younger Meso-Cenozoic formations, was also reduced. On the other hand the Paleozoic core of New Zealand was added to East Australia. The configuration obtained can be dated as upper Paleozoic[4].

[4] As it is seen, the new connection of Antarctica with Africa allows coherent closure of the whole continental southern hemisphere on a smaller Earth. This is not the feature of other reconstructions of Gondwana, including the younger ones. *Footnote 2012*.

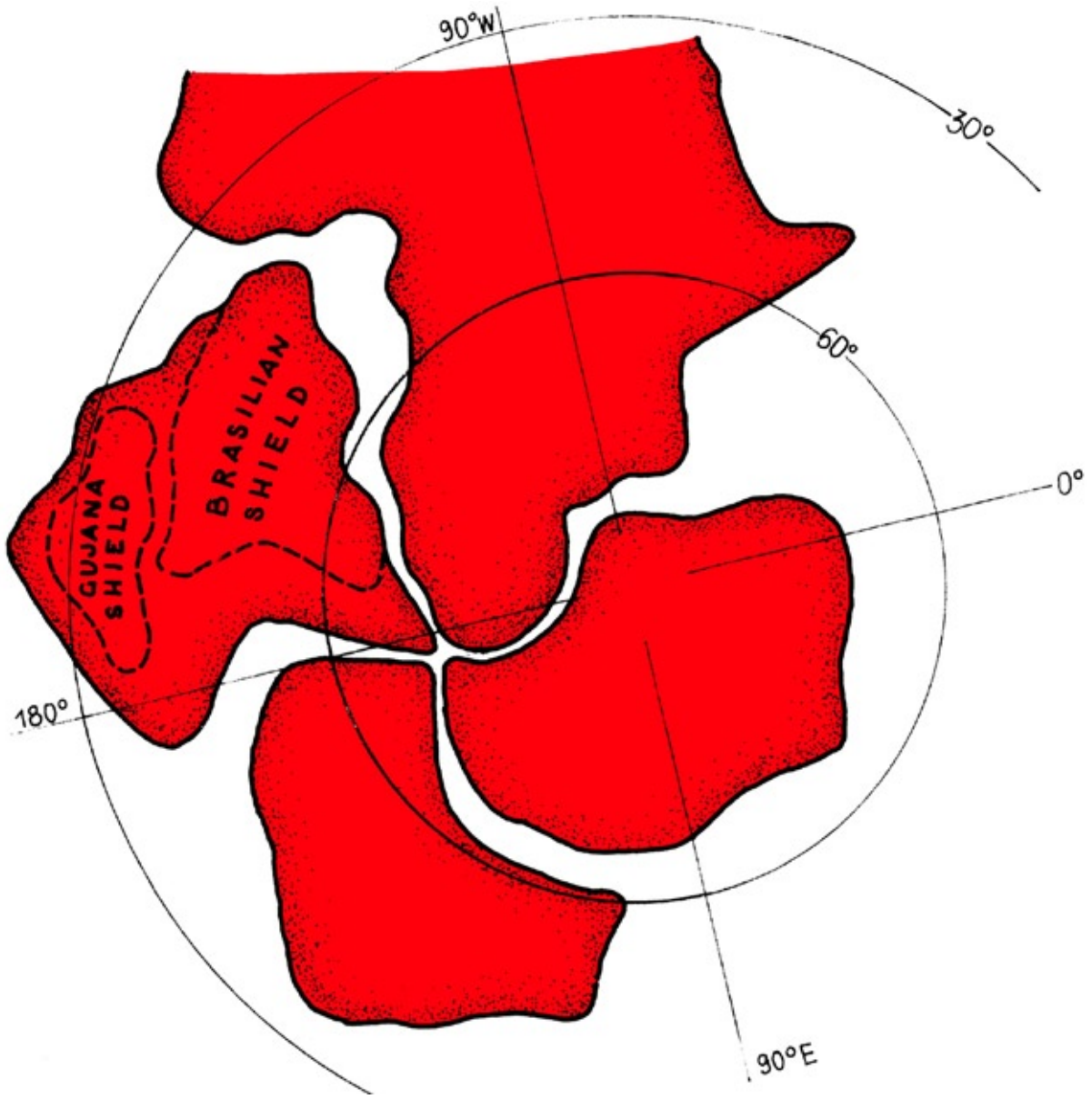


Fig. 14. A new reconstruction of Gondwana
Pushing close to the Antarctic craton the other continents that are parts of Gondwana, in relation to Fig. 13

5. Orange peel effect

The pushing together was conducted on a present size globe and hence there apper openings which grow towards the borders of Gondwana (gaping gores – Carey, 1976) appeared. This phenomenon is a manifestation of Van Hilten's (1963) "orange peel law", that is, the peel is put together on a sphere of bigger size than the original sphere (Fig. 10a and b).

According to the above relationship the openings are closed on a sphere of about half the present radius (Fig. 16).

The central point of this reconstruction was covered with the pole of the geographical graticule, and Africa was put on the meridian 20° E, according to its present position.

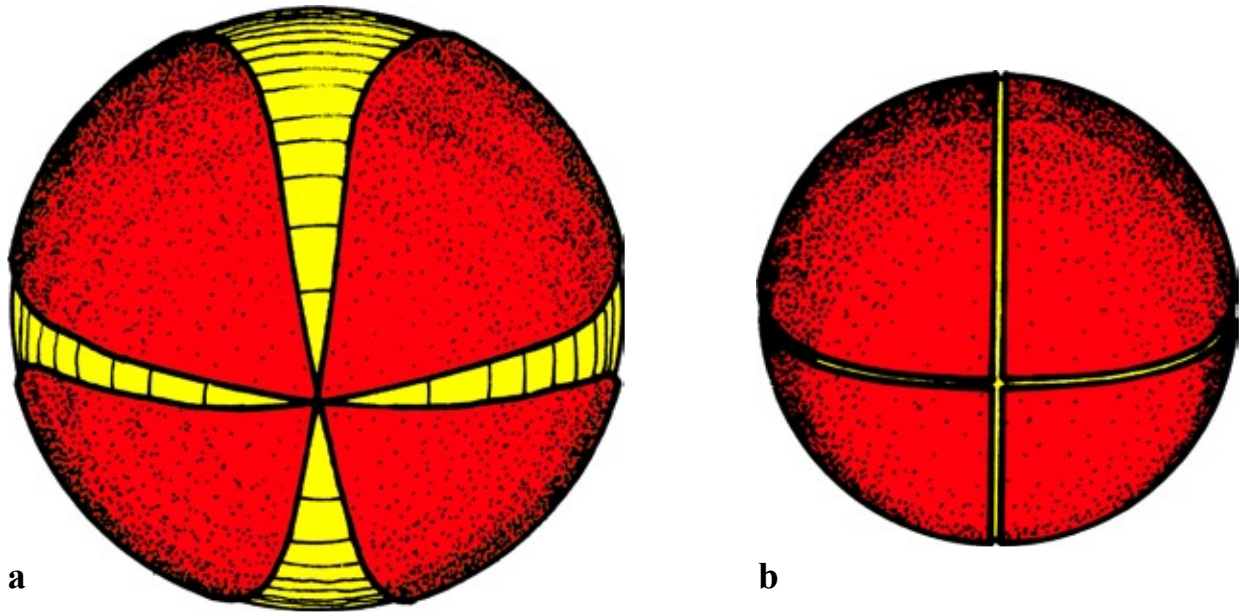


Fig. 15. Illustration of van Hilten's "orange peel effect"
a – assembling of an orange peel on a sphere greater than the original orange results in artificial gaping gores (the expression of Carey, 1976)
b – correct assemblage of the peel back on the original orange eliminates former gores

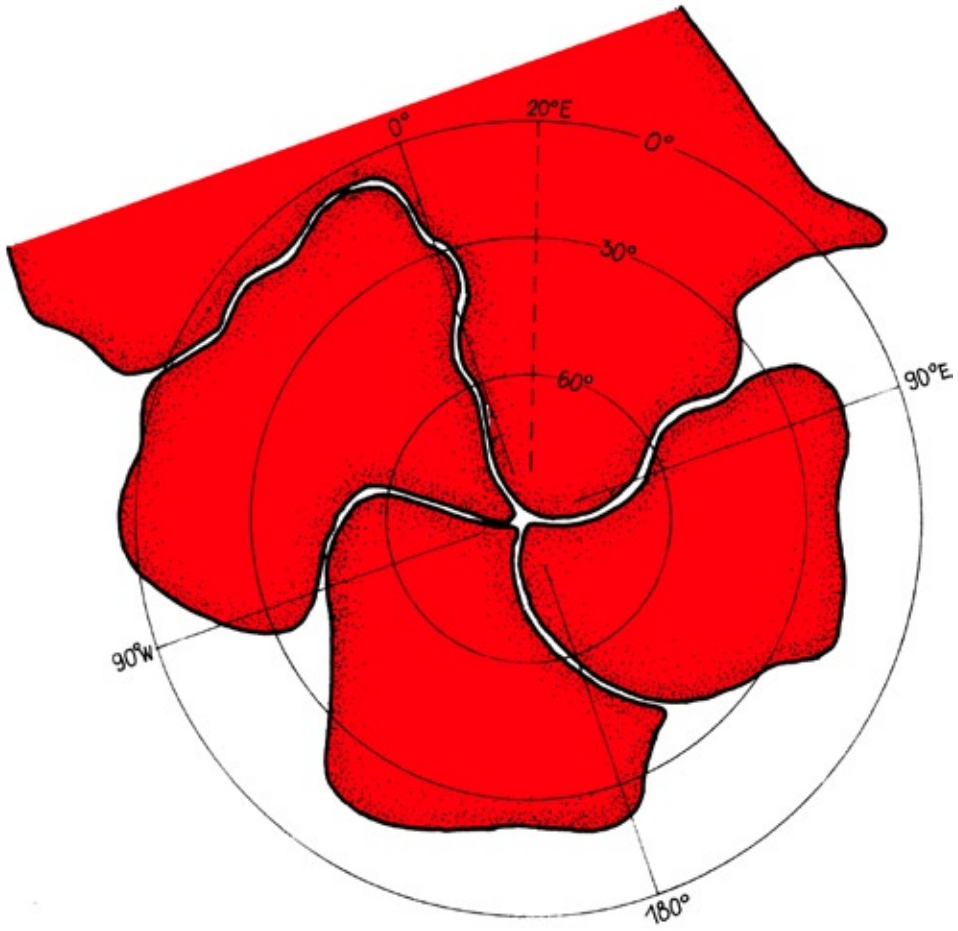


Fig. 16. Gaping gores visible between Gondwana's continents (Fig. 10) disappear when assembling this supercontinent on a globe half the diameter

6. Location of India and Madagascar

The connection of Antarctica with Africa eliminates the southern position of Madagascar (see Fig. 1d) and determines the location of the India-Madagascar block in the position shown in Fig. 17a.

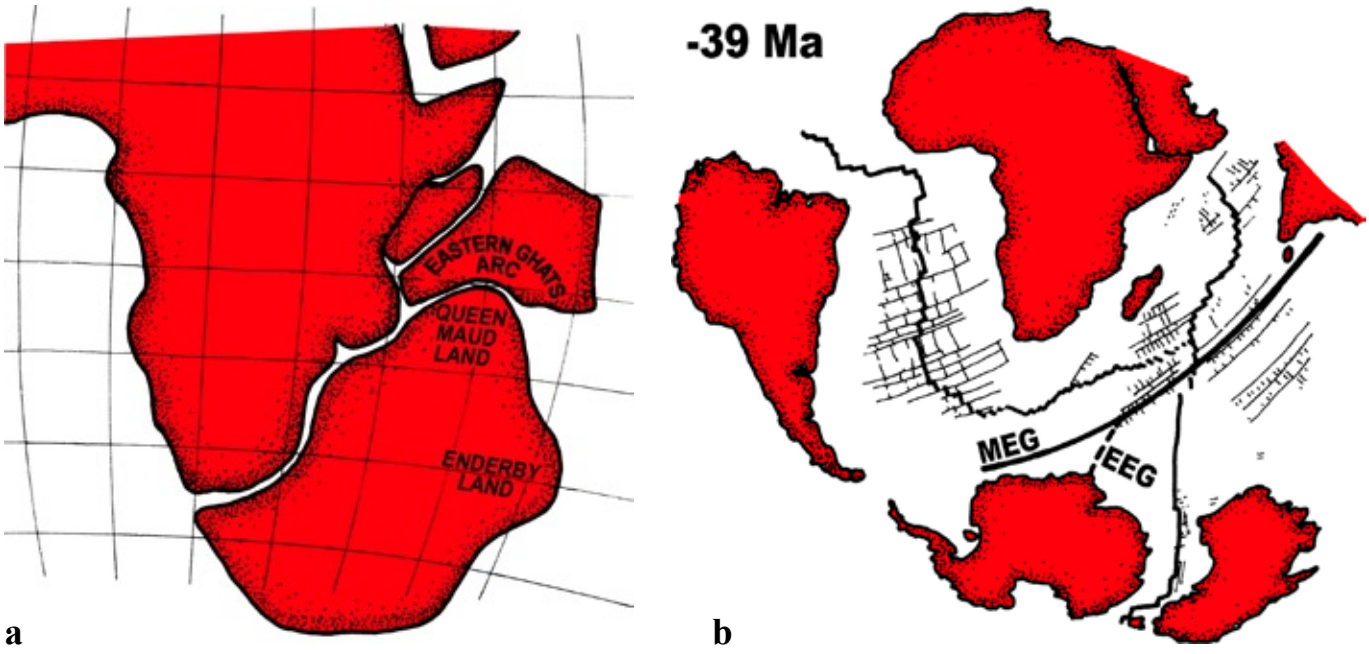


Fig. 17. Connection of Indian peninsula with Antarctica

a – connection of the India-Madagascar block with Africa and Antarctica, determined by the newly found connection of the latter pair of continents

b – intermediate stage of Norton and Sclater's (1979) reconstructions, dated Lower Oligocene (-39 Ma). MEG – line correlating Queen Maud Land with Eastern Ghats arc; EEG – line correlating Enderby Land with Eastern Ghats arc

On the reconstruction of Norton and Sclater (Fig. 17b) it can be seen that the reconstructed set of isochrons correlates better the India's East Ghats arc with Queen Maud Land than – as the authors assume – with Enderby Land.

7. Similarity to other reconstructions

I shall not discuss obvious and non controversial similarities.

In my reconstruction the India-Madagascar block is situated relative to Africa as in plate tectonics reconstructions (compare with Fig. 3). The connection of India with Antarctica is as in Vogel's reconstruction (compare with Fig. 5d), but obtained in a different way. The connection of Australia with South America is as in reconstructions of Brösske (Fig. 5a), Vogel (Fig. 5d), Barnett (Fig. 7) and Shields (Fig. 8b).

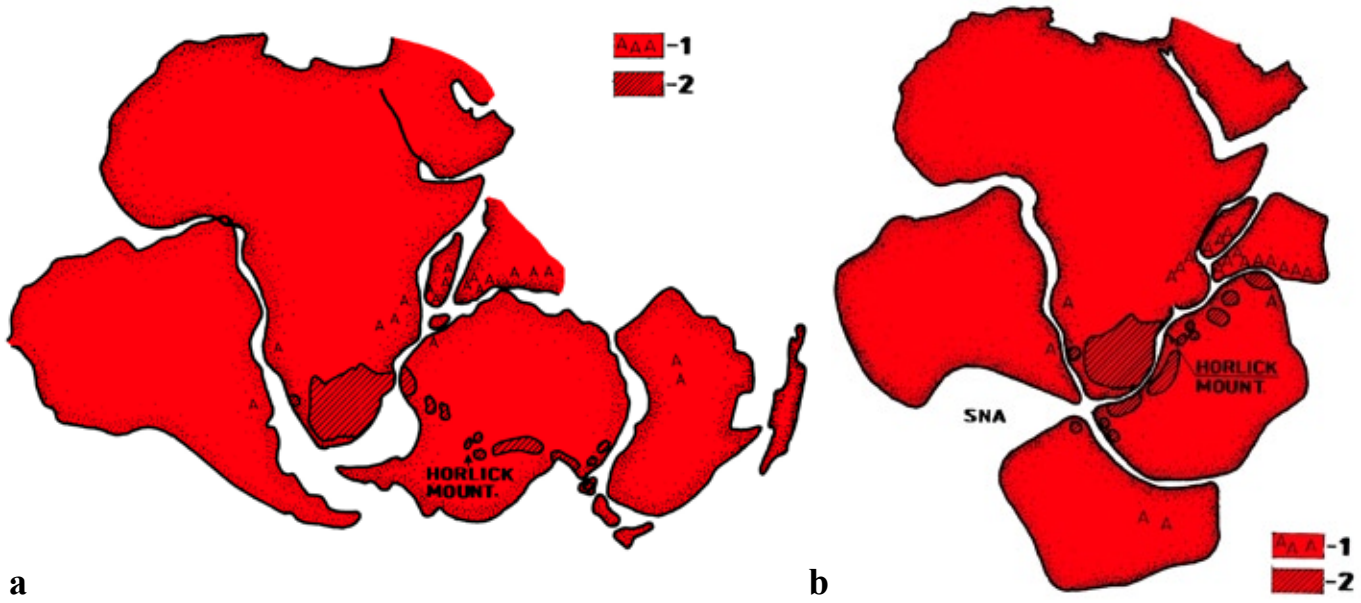
My reconstruction is very similar to Barnett's Gondwana (Fig. 7). Even there all southern continents meet at their tips, setting a central point of reconstruction. Similarly the pairs: Africa and Australia on one hand and South America and Antarctica on the other hand occupy opposite locations. However Antarctica does not reach back to the central point of Gondwana with the Palmer Peninsula (Antarctandes) as in Barnett's reconstruction, but with Cape Adare. This is the essential difference. Apart from that, in my reconstruction, the correct connection of Australia with Antarctica is preserved, which is not the case with Barnett's.

The central point of Gondwana can be described as a conjunction of four capes: Adare (Antarctica), Howe (Australia), Horn (South America – despite southern shortening of the continent) and Good Hope (Africa).

VII. Particular problems

1. Geological data

The geological data will be discussed with reference to the paper by Smith and Hallam (1970). The authors demonstrate the areas of anorthosites and dolerites as rocks correlating separate elements of Gondwana (Fig. 18a).



a b

Fig. 18. Connection of East and West Gondwana on the background of geological data

a – reconstruction of Smith and Halam (1970) with occurrences of Precambrian anorthosites (1) and Mesozoic dolerites (2) drawn by the authors. Upper Carboniferous flora from the Horlick Mts in Antarctica reveals the biggest connection with India and Africa (Plumstead 1962)

b – present reconstruction: SNA – spherical non-adjustment (gaping gore) summed up on the border of Australia and South America, in order to maximally liken the reconstruction to the former one (a); 1 and 2 – explanation as above. Note well that in this reconstruction the early Paleozoic condensation of continents is preserved, in spite of the fact that the dolerites are younger. However, this does not radically influence the outline of their occurrence

In the present reconstruction (Fig. 18b) the degree of correlation among anorthosites neither increases nor decreases, while dolerites fall into a much more compact area, especially when taking into account their appearance on the Indian peninsula.

The present reconstruction explains some puzzling connections found by Plumstead (1962) for the Permian-Carboniferous flora of the Horlick Mts. (central Transantarctic Mts.). The flora reveals the biggest similarities to those of Africa and India and not to those in South America and Australia, as should be the case in accordance with the reconstruction of Smith and Hallam (Fig. 18a).

Finally, the new reconstruction – like some others on an expanding Earth – explains many connections across South Pacific and is in accordance with the development of this part of the Pacific Ocean.

In this paper the paleomagnetic data are not discussed, as their interpretation depends in part on an assumed Earth's size.

2. Early plan of break-up of Gondwana

In the reconstruction thus obtained the Samfrau geosyncline does not run, as previously depicted (Fig. 2), on the edge of Gondwana but cuts across it (Fig. 19), dividing it into two sub-assemblies: South America – African and Australia – Antarctic. They, as is known, have separated first.

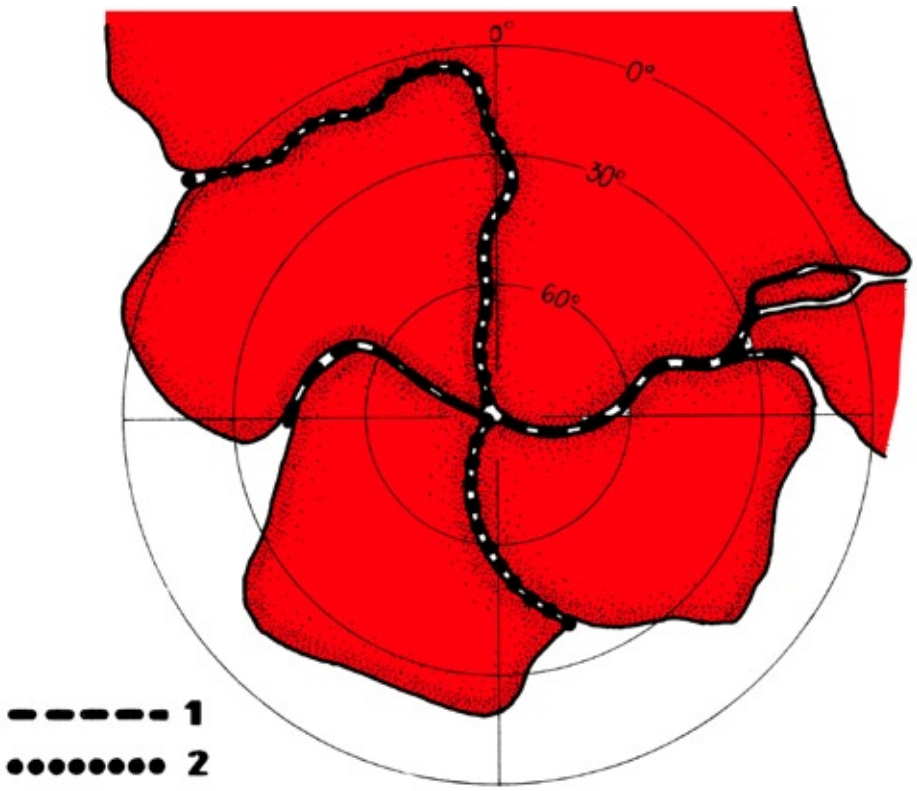


Fig. 19. Inner rifts of Gondwana

1 – Samfrau rift (compare with Fig. 2)
2 – young rifts of Gondwana

The small India-Madagascar block has separated earlier from both sub-assemblies, which justifies the introduction of a fork of the Samfrau rift (Fig. 19). The later southward shift of Madagascar, concurrently with a northward shift of India, creates an inconsistent pattern of movements (Vogel and Schwab, 1983). This can be explained by a sauthward pull of Madagascar exerted by Antarctica through oceanic lithosphere. This implies a temporary healing of the Samfrau rift[5].

Such a process is possible. The development of the northern Atlantic rifts is an example. Greenland was connected with Europe in the Upper Cretaceous while the north Atlantic rift was being developed between Greenland and North American continent in the Baffin Sea. At the beginning of the Tertiary the old Caledonian rift between Europe and Greenland was reactivated while the Baffin rift died out and was consolidated. In the Cenozoic, the pulling out of Greenland from Europe has involved compaction of the lithosphere of the Baffin Sea and Davies Strait.

The younger Gondwana rifts, along which the previously-formed large blocks began to break away, take on a new meaning. These are the South Atlantic and Australia-Antarctica rifts. On the new reconstruction they lie on a continuous line and cross the Samfrau rift at the central part of Gondwana. This was probably an old line of weakness, highly predisposed to break, which happened later after its division by the Samfrau rift. The difference is not only in age. The Samfrau rift was transformed into fold belts[6]. Younger rifts did not develop such structures.

[5] I withdrew later from that explanation. In Upper Jurassic – Lower Cretaceous time Madagascar was separating southward from Africa together with India and Antarctica. The bigger stretching of lithosphere between India and Siberia shield than between Africa and Europe results from that (see part VI of the present paper). In that time a tear of lithosphere began to develop in the place of the present day Tibet. Then the giant diapir of asthenosphere had been developed there which thrusted the Himalayas southward by gravitational spreading (tectogenesis), then uplifted them (orogenesis). The scheme of the tension-diapir-gravitational mechanism of fold belts was introduced to geology by Carey (1976), then developed by: Koziar and Jamrozik (1985), Carey (1996); Koziar (2005 a,b). A similar scheme which connects the development of mountains (not only originated from fold belts) and gravitational tectonics directly with vertical motions on an expanding Earth has been developed by Ollier and Pain, 2000; Ollier, 2003; Ollier, 2005). *Footnote 2012.*

[6] It concerns only South America – Australian section of the Samfrau rift. According to later investigation the Transantarctic

3. Problem of late Paleozoic glaciation of Gondwana

This problem was put forward at the beginning of the concept of supercontinent the Gondwana. In the framework of the land-bridge theory the continent was of gigantic size and, generally stretching across the southern hemisphere, it crossed the equator and also the southern pole. Upper Carboniferous tillites at the bottom of the so-called "Gondwana series" were similarly widespread. This required an almost global glaciation, not only circum-polar. On the other hand life still existed on Earth and even warm climate. So a contradiction appears in the recorded data.

Wegener's break-up of Gondwana could solve the contradiction since the area of this super-continent turned out to be much smaller than in the land-bridge interpretation and it was therefore possible to squeeze glaciated areas into one hemisphere far from the equator. But Wegener's Gondwana (together with its tillites) spreads across both sides of the equator and barely reaches the southern pole. Later reconstructions separated Gondwana from Asia and located it entirely in the southern hemisphere. In spite of this, Gondwana deposits on the Arabian Peninsula are still near the equator. What is more, the tillites were later discovered in Tibet, so they still cross the equator.

Thus the problem is difficult to avoid. The reconstructions on the expanding Earth still have this problem. They indeed make Gondwana much smaller than in the land-bridge theory, but the Earth is also smaller so the proportion of the area of Gondwana to the area of an ancient hemisphere is greater than in mobilistic reconstructions on a non-expanding Earh. Specifically – the area of Gondwana is greater than the area of the Earth hemisphere at the end of Paleozoic. The glaciation at this time had to cross the equator. So, how to make it agree with survival of the life on the Earth and particularly with the existence of organisms living in tropical temperatures?

There is nothing to do but accept that the Late Paleozoic glaciation was the one of high continental plateaus, which exceeded the line of year-round snows even in the equatorial zone. In deep rifts crossing the plateaus and on lowlands quite different climatic conditions prevailed. The glaciers of the equatorial Andes and Kilimanjaro can serve as a model for such a condition, with tropical flora at their feet. Thus the Late Paleozoic glaciation was more a function of altitude than distance from the equator.

The elements of Gondwana are of cratonic character and this can explain their predisposition to significant elevation. Northern continents are labile in the Paleozoic and – as paleogeography shows – often flooded by seas[7]. So, they did not jut much out of the sea[8].

Glaciations are connected with Gondwana throughout all the Paleozoic (Caputo and Crowell, 1985), which supports the above explanation.

Mountains are not a fold belt but the mountains of pure tension origin, being an uplifted flank of the West Antarctic Rift (Van der Beek et al., 1994; Feraccioli and Bozo, 1999*). Footnote 2012*.

[7] It was probably connected with northward asymmetric expansion of the Earth in the late Precambrian and Paleozoic. This asymmetry was opposite to present southward asymmetric expansion recognized by Carey (1976). This new direction of asymmetrical expansion started at the beginning of the Mesosoic and disrupted Gondwana supercontinent. Of course, gravitation preserves the spherical shape of the Earth in spite of its asymmetrical expansion. *Footnote 2012*.

[8] It should be explained additionally that uplifting of continental cratons on the expanding Earth, relative to a mean seas level, is less connected with their absolute uplift, relative to the center of the Earth, than with the drop of mean sea level connected with rifting, that is - with horizontal mutual moving apart of the cratons. It was a very effective mechanism in the past when continental cratons dominated over deep and narrow rifts and the hydrosphere had much less volume. In this situation every paroxysm of expansion could trigger almost global glaciation on immediately emerged high plateaus along with even global tropical climate in the deep widened rifts with lowered water level. Atmospheric pumping of the sea water from rifts to high glaciers makes this differences even more extreme. With time, glacial and water erosion can finally fulfill the rifts and bring the glaciations to the end. The next paroxysm of expansion will repeat the whole cycle.
The longer ago the more sensitive was this mechanism. The so called "snow ball glaciations" in the Precambrian (plate tectonics has difficulties with explaining them) are of this origin. The presented mechanism explains the paradox that life easy survived old global glaciations. The paradox exists only on a non-expanding Earth.
It should be also explained that the Plio-Pleistocene uplift of many mountains especially old fold belts in Asia, grouped by the common name "Neotectonic Period" (Ollier and Pain, 2001) is connected with rarefaction and swelling of the underlying mantle. This uplift is of different character than that described above, but it is also connected with stretching of the lithosphere and expansion of the Earth. *Footnote 2012.*

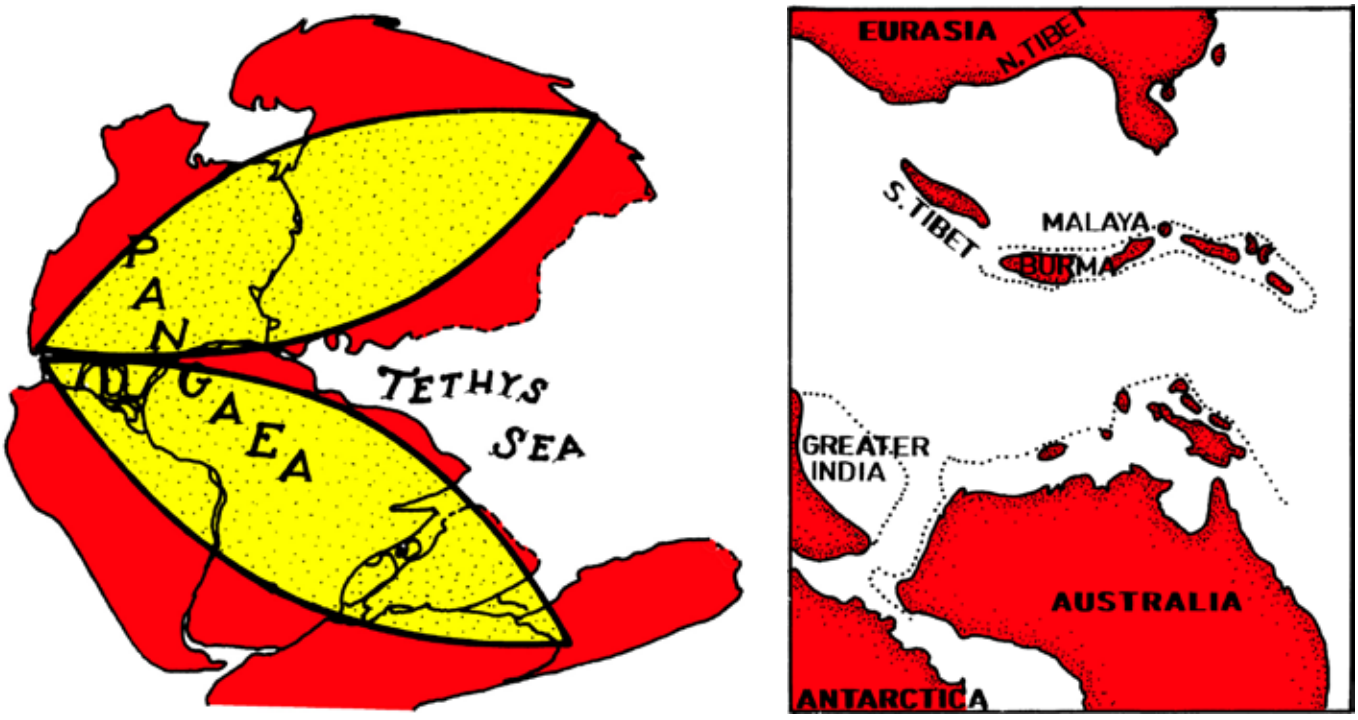
VIII. Gondwana and Eurasia

1. Contact of Gondwana with Eurasia

In the beginning, the floristic and faunistic separation of Gondwana and Eurasia had been assumed, but was soon obliterated by later discoveries. Wegener took these latter into account in his reconstruction, treating the border zone – the Tethys – as an epicontinental sea and preserving a connection of India with Asia. However, he was compelled to stretch India significantly which is not justified geologically. Wegener's Pangaea is stretched in its peripheral parts which is easy explained as an effect of putting it together on a too big globe.

2. Problem of the Tethys "Ocean"

Later reconstructions of Pangaea, made on a present-size globe, have not applied such unexplained stretching (and later contraction) of the continents and thus a wide Tethys Ocean appears, open to the east. Its shape is not derived from geological data of the Tethys zone, but from a reconstruction that reassembles continents on a too-big globe. Such a speculative origin of the recent concept of Tethys is emphasized by Crawford (1979). This can be demonstrated by van Hilten's (1963) "orange peel law" (Fig. 20a).



a **b**

Fig. 20. Problem of the Tethys "Ocean"
a – interpretation of the Dietz and Holden (1970) reconstruction, according to Van Hilten's "orange peel effect"
b – attempt to explain old geological connections between Asia and Gondwana with the help of the terranes concept (Audley-Charles, 1988)

However geologic data from the Tethys zone are in contradiction with the 'wide – Tethys Ocean' reconstructions. Well-known critics of plate tectonics – Meyerhoff and Meyerhoff (1972, 1978) pointed out that India had not drifted to Asia. In the latter paper they wrote:

For 104 years or more (Mallet,1873; Oldham, 1883), field geologists and paleontologists working in India and contiguous areas of southern Asia and Soviet Union have published a cumulative body of tectonic, lithostratigraphic, and biostratigraphic evidence demonstrating that peninsular India has been an integral part of Eurasia since Precambrian time. The continuity of lithostratigraphic and biostratigraphic units and floral and faunal zones – westward into Pakistan, Iran, Iraq, and the Arabian peninsula; northward into Pakistan, Iran, Iraq, and western interior China; and eastward into Burma and China – is firmly established by lithofacies and paleontological correlation.

The authors summed up about 2000 geologic and palaeontologic publications from the period 1883–1977 which recorded adjoining of India to Asia since the Middle Proterozoic.

The data were ignored for many years by supporters of plate tectonics. Finally, the problem became too serious to be passed over. Now, they tried to explain it by the fashionable concept of terranes[9]. According to this idea, the Asiatic parts related to Gondwana were to drift to Asia even before India (Fig. 20b).

The plate tectonics reconstructions refer to an old image about the origin of the Himalayas as developing from a vast Tethys geosyncline. The extreme size of the orogen pointed to an extreme size of the geosyncline and an extreme pushing of India towards the rest of Asiatic continent. However later investigations (Gansser, 1964; Petrushevski, 1970) have revealed that Himalayas are not the product of a geosyncline but are a marginal part of the India craton thrusted southward. The Indus ophiolites are still treated as remnants of a vast Tethys Ocean, but detailed investigations (Bhat, 1987) showed that they are a product of intracontinental rifting. Stöcklin (1983), an investigator of the South Asiatic regions, emphasized that lack of traces of the assumed Tethys Ocean in the Himalayas confirms expansion of the Earth.

Ahmad (1983), an expert in the eastern part of the Tethys zone, carried out an extensive critique of the concept of the Tethys Ocean. He pointed out that this water body was an epicontinental sea in the Late Paleozoic and Early Mesozoic. In other words Asia and Gondwana were close to each other at this time.

It is not a goal of this paper to discuss the development of the Tethys zone. At the end however, the scheme of separation of Gondwana from Eurasia and particularly Gondwana from East Asia will be shown.

3. Mesozoic connection of East Gondwana with Asia and the embryonic Pacific plate

The border of the new Gondwana with south-east Asia comprises: Enderby Land and part of Wilkes Land on Antarctica, and the west coast of Australia. That is as in Vogel's reconstruction (Fig. 21).

In the new reconstruction the whole assembly: Madagascar – India – Antarctica – Australia is shifted northward along the Africa border towards Asia (the northern location of Madagascar is true) in comparison with Vogel's reconstruction. So it is easier to connect it with Asia.

Relation of particular elements of the East Gondwana to Asia and the Jurassic embryonic Pacific is shown in Fig. 22.

The elements of the above scheme are located in such a way to best illustrate the relations of the East Gondwana to its Asia/old-Pacific and African neighbours. Specifically, present positions of Africa and Eurasia were applied to maximize resemblance of the scheme shown to the known, present arrangement of the main continental masses.

South-east widening of the east section of the Tethys zone[10], presented in the above figure, can be deciphered both in the Mediterranean section (Koziar and Muszyński, 1980) and Near East section. Admittedly in the latter there is preponderance of fold belts over evidently tensional openings of the Black and Caspian Seas, but such belts are also explained by tension (Koziar and Jamrozik, 1985a and 1985b)[11].

[9] Critical discussion of theory of terranes is in: Koziar, 2006. The paper shows that the extremely complicated solutions proposed by the theory in the framework of plate tectonics are very simple on the expanding Earth. *Footnote 2012.*

[10] West section of the Tethys zone is Central America. *Footnote 2012.*

[11] www.wrocgeolab.pl/Carpathians.pdf ; See also the final part of the footnote 5.

Fig. 21. Connection of East Gondwana with Asia. Vogel's (1983) reconstruction

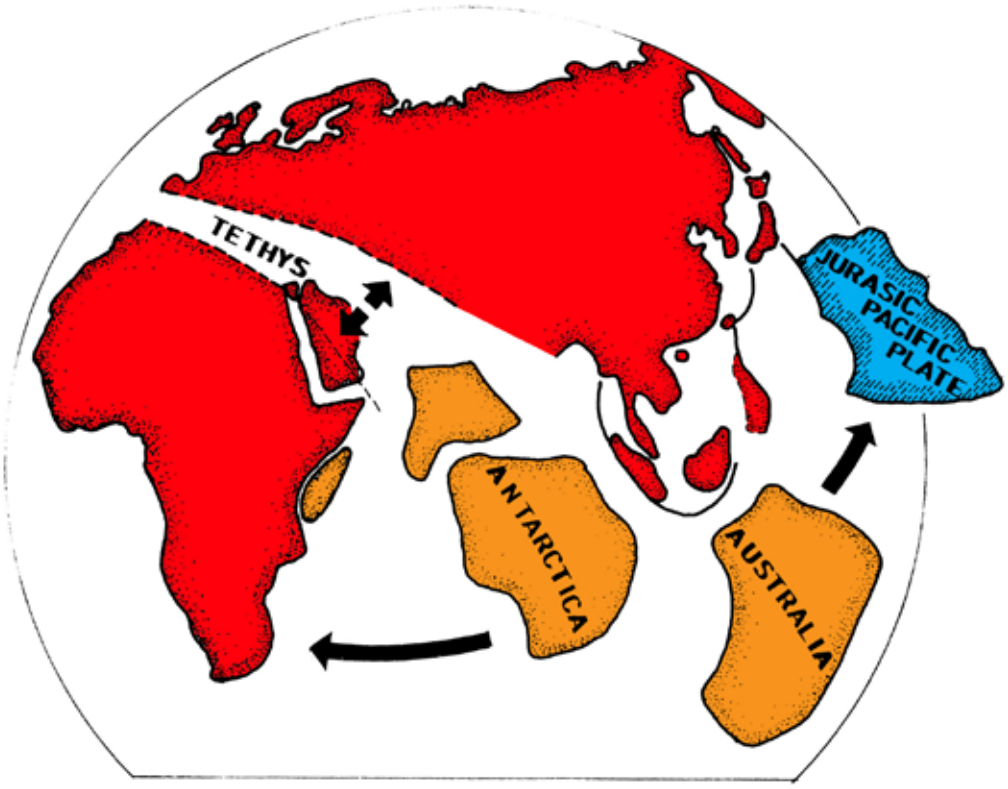


Fig. 22. Scheme showing relationship of East Gondwana with south-east Asia and the Jurassic embryonic Pacific plate

The orange marked elements are not in their present day positions. Antarctica is a keystone between south Africa and south-east Asia

The tension causes upper mantle diapirism and gravitational tectonics. The latter results in compression only in shallow horizons and on the borders of diapirs.

In Fig. 22 the Tethys zone gains a new geotectonic meaning, going beyond previous paleographic definitions. Namely, it is a zone of a wide opening between Africa and Eurasia growing to the South-East. In the South-East it comprises the whole Indian Ocean apart its Australia-Antarctic segment[12].

[12] „Southern Ocean" of Australians. *Footnote 2012.*

According to the new reconstruction, Antarctica is a keystone of the south-east ending of the Tethys zone as an element stuck originally between southern Africa and south-east Asia. The northward travel of India is connected with the northward moving away of the whole Asia (together with India) from Africa. There is no collision of India with Asia. In other words India is an element of Gondwana which still has not broken away from Asia, not one that has joined it from afar.

Incidentally, this mechanism of India's 'traveling' is a simple solution to the mentioned contradiction between its northern shifting and its permanent connection with Asia.

4. Late Precambrian connection of East Gondwana with the Siberian Shield

The connection of East Gondwana with Asia can be traced going deep into the Asian continent and far back in geological time. It is possible to reconstruct the Late Precambrian connection of this part of Gondwana with the east Siberian core of Asia – so-called Angaraland (Fig. 23).

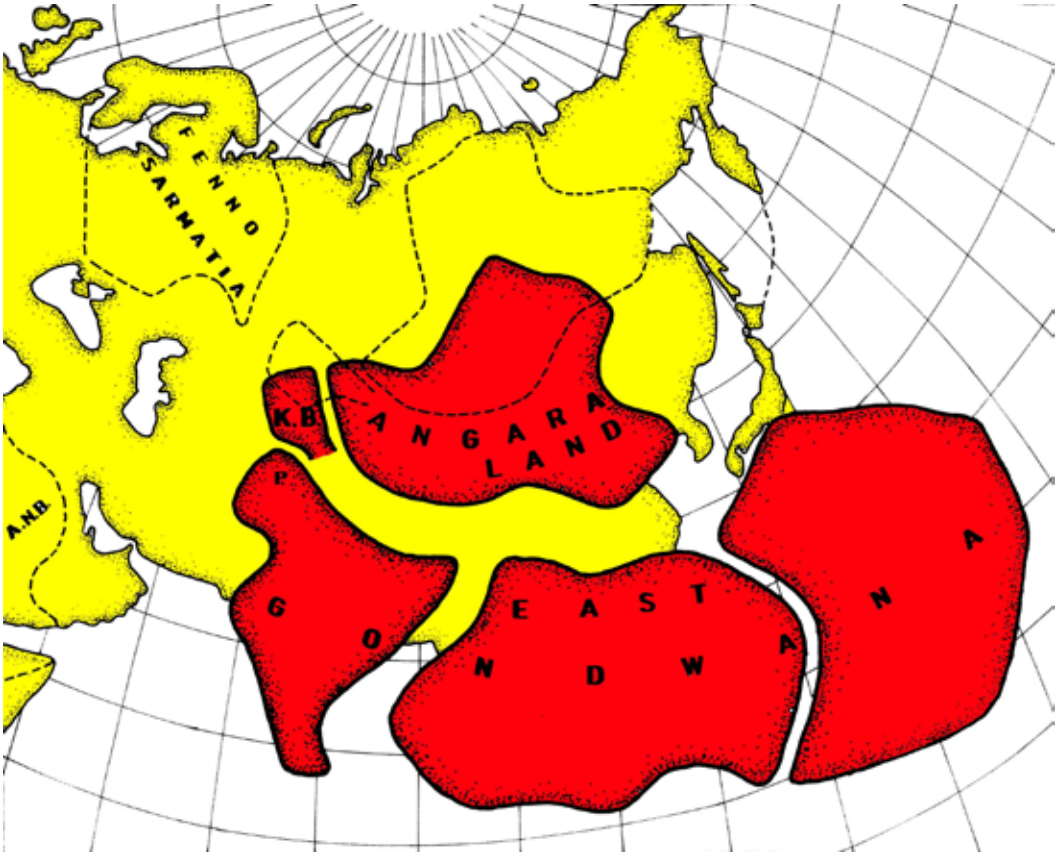


Fig. 23. Late Precambrian reconstruction of connection of East Gondwana with Angaraland

Enderby Land continues to move back across the today Tonkin Bay and Sichuan Basin to the south-east bending of Angaraland.

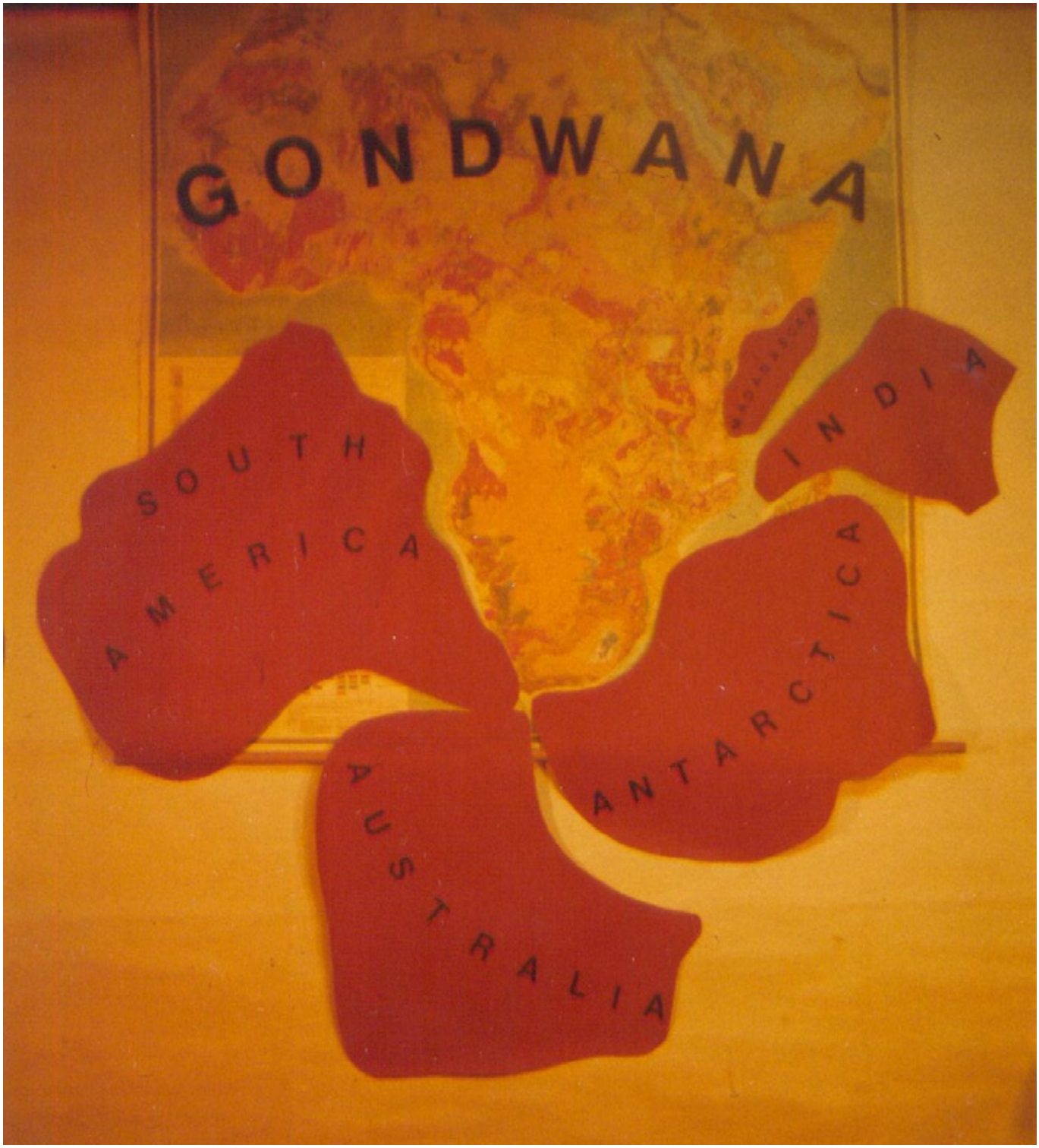
The presented connection is in harmony with intensive tensional tectonics recorded in the whole area of central, east, and south-east Asia. This is recorded both in shallow and deep structures (Ma and Wu, 1987; Zorin, 1981; Dewey, 1983). The last author compared tensional development of the Tibetan plateau with analogous development of the Nevada Basin and the Altiplano in Andes. The reconstruction is also in harmony with dextral shift of the Siberian Shield relative to the southern part of Asia. This is well displayed on the contact of the Altai with the Kazakh block (Koshkin, 1969). The shift, together with significant movement away of the east edge of the Siberian craton from south-east Asia, is tantamount to intensive stretching of the whole East Asia margins. The old material which the margins contain could fill the gap visible in Fig. 23 between Australia and the Siberian Shield.

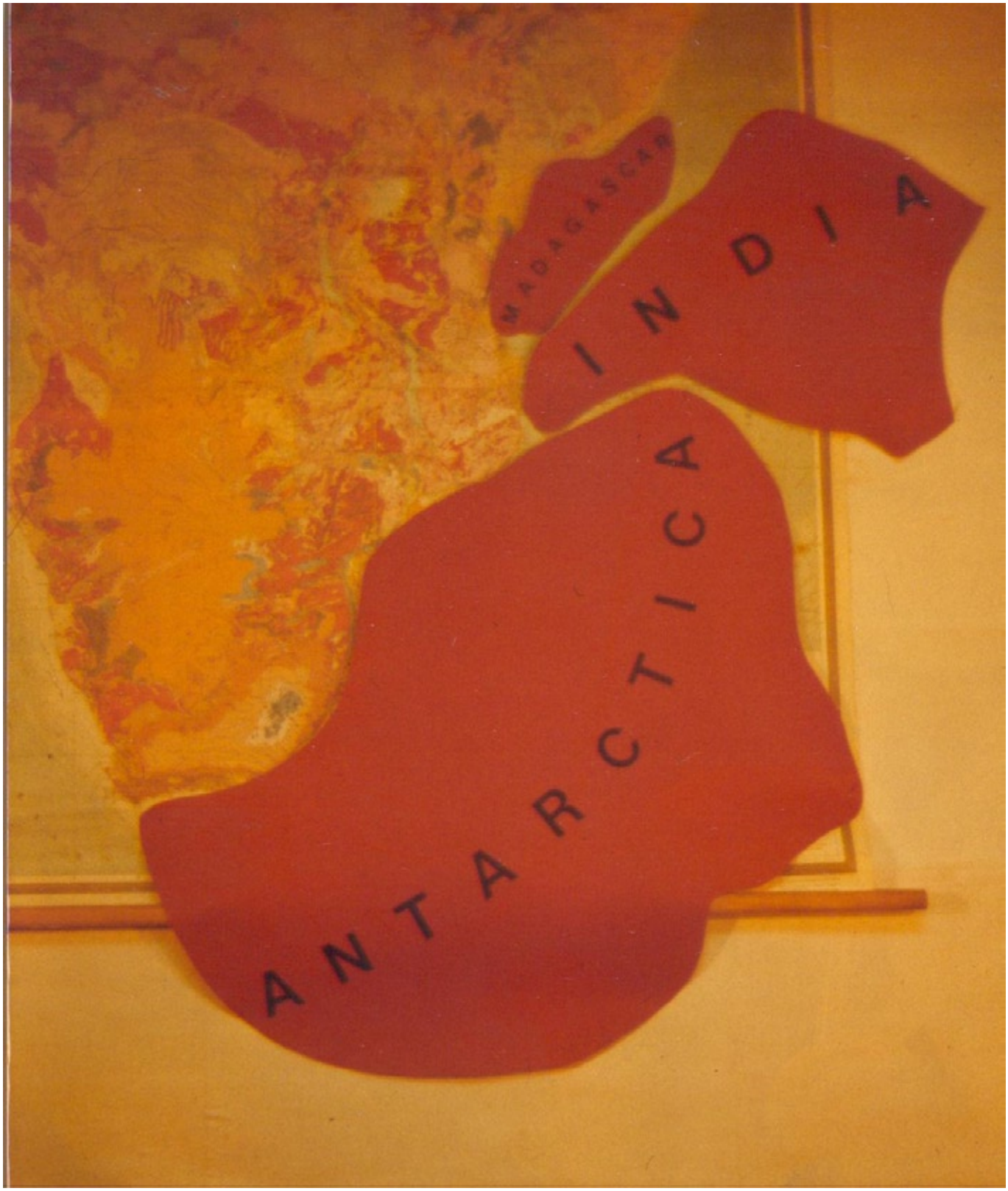
The configuration is also in harmony with general development of the Pacific (compare with Fig. 11), the northern part of which is closing by movement of Alaska into the Verkhoyansk Mountains bay. Eastward, in turn, the whole assembly can be connected with the East European craton, as marked in the figure.

■ ■ ■

(2012)

Below are two diagrams of elements of Gondwana, superimposed on a geological map of Africa, as well as two schemes of geotectonic development of the east and west hemispheres – that is, schemes of the development of the Indian Ocean and the Pacific, respectively. The figures, previously unpublished, are strictly connected with the paper and were made near the time of its original publication.




MADAGASCAR
INDIA
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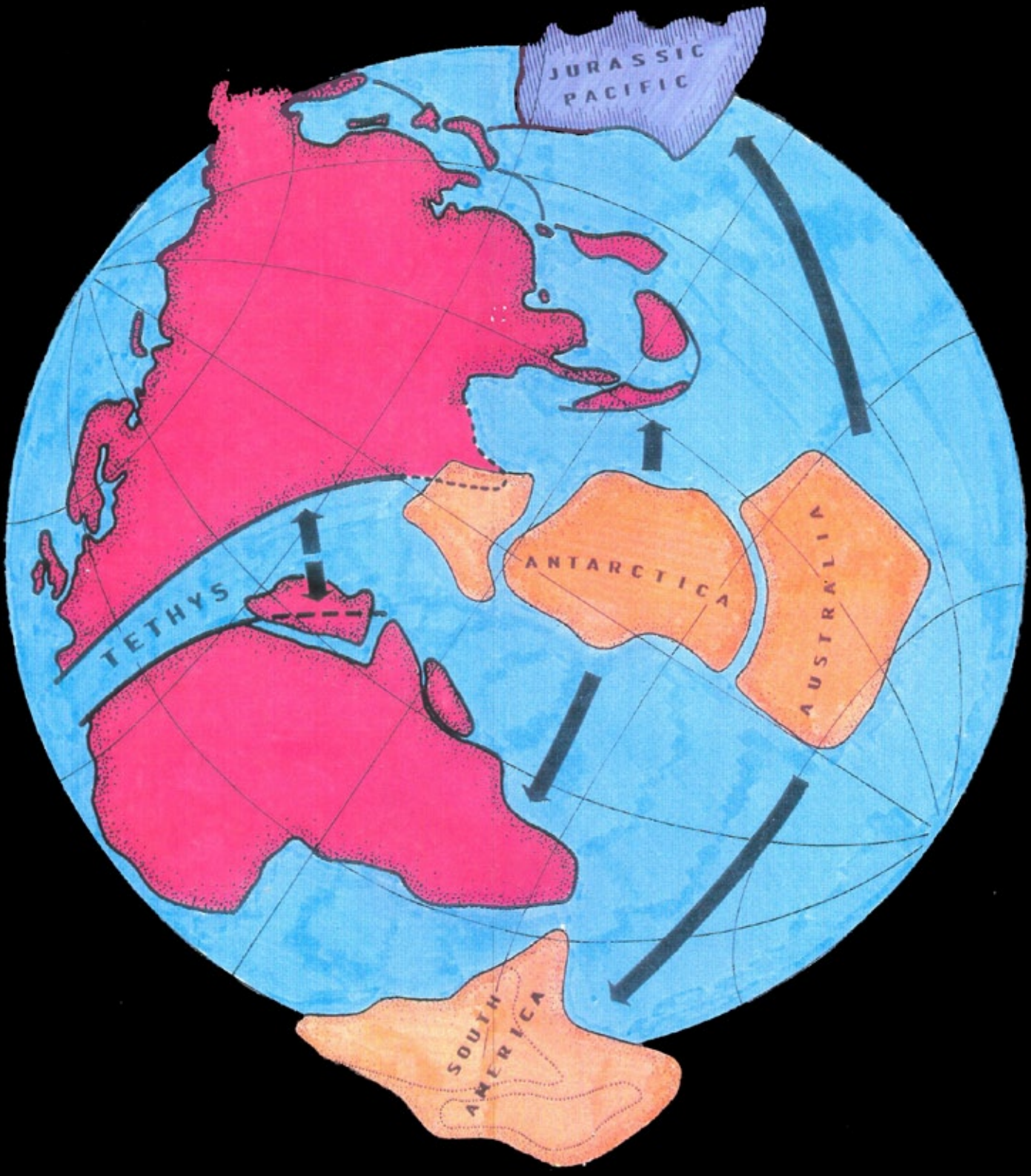
Idealized scheme of the development of the Indian Ocean



J. Koziar 1992

Idealized scheme of the development of the Pacific

J. Koziar 1992

References

Abendanon E.G., 1919. Aequinoctia, and old Paleozoic Continent.
3. Geol., 5, p. 562–573.

Ahmad F., 1961. Palaeogeography of Gondwanaland with special reference to India.
Mem. Geol. Surv., India, v. 90, pp. 142.

Ahmad F., 1983. Late Palaeozoic to Early Mesozoic paleogeography of the Tethys region.
In: Carey S.W. (ed.): Expanding Earth Symposium. Sydney 1981,
University of Tasmania, p. 131–145.

Audley-Charles M.G., Ballantyne P.O., and Hall R., 1983. Mesozoic-Cenozoic rift-drift sequence
of Asian fragments of Gondwanaland.
Tectonophysics, 155, p. 317–330.

Avias O.V., 1977. Facts and arguments about Permo-Triassic opening of a Neo Pacific Ocean
in Earth expansion hypothesis.
In: International Symposium on Geodynamics in South-West Pacific.
Noumea (New Caledonia) 27 August – 25 September 1976. Editions Technip, Paris, p. 381–386.

Barnett C.H., 1962. A suggested reconstruction of the land masses of the Earth as a complete crust.
Nature, 195(4840), p. 447–448.

Barnett C.H., 1969. Oceanic rises in relation to the expanding Earth hypothesis.
Nature 221, p. 1043–1044.

Bevis M., Payne B., 1983. A new Palaeozoic reconstruction of Antarctica, Australia and South America.
In: Carey S.W. (ed.): Expanding Earth Symposium Sydney 1981,
University of Tasmania, p. 207–214.

Bhat M.I., 1987. Spasmodic rift reactivation and its role in the pre-orogenic evolution
of the Himalayan region.
Tectonophysics, 134, p. 103–127.

Blanford H.F., 1875. On the age and correlation of the plant-bearing series of India and the former
existence of an Indo-Oceanic continent.
Quart. J. Geol. Soc. 31, London, p. 519–542.

Blanford W.T., 1895. On the papers by Dr. Kossmat and Dr. Kurtz, and on the ancient geography
of Gondwana-Land.
Geol. Surv. India. Rec., 29, p. 52–59.

Brösske L., 1952. Wächst die Erde mit Naturkatastrophen? Die Expansions – Theorie.
«Sanus» L. Brösske abtlg.
Verlag, Düsseldorf-Benrath, pp. 103.

Burkhardt C.,1903. Beiträge zur Kenntniss der Jura – und Kreideformation der Cordillère.
Paleontographica, 1, p. 125–128.

Caputo M.V. and Crowell J.C., 1985. Migration of glacial centers across Gondwana during
Paleozoic Era. Geol. Soc. Am. Bull. 96, p. 1020–1036.

Carey S.W., 1958. A tectonic approach to continental drift.
Symposium continental drift. Hobart, p. 177–355.

Carey S.W., 1983. Tethys, and her Forebears.
In: Carey S.W. (ed.): Expanding Earth Symposium Sydney 1981,
University of Tasmania, p. 169–187.

Carey S.W., 1988. Theories of the Earth and Universe. A history of dogma in the Earth sciences.
Stanford University Press. Stanford, California, p. 1–413.

Christodoulidis D.C., Smith D.E., Kolenkiewicz R., Klosko S.M, Torrence M.H. and Dunn P.O., 1985.
Observing tectonic plate motions and deformations from satellite laser ranging.
J. Geophys. Res., 90 (B11), p. 9249–9263.

Coffin M.F. and Rabinowitz P.D., 1987. Reconstruction of Madagascar and Africa:
Evidence from the Davie fracture zone Western Somali Basin.
J. Geophys. Res. 92 (B9), p. 9385–9406

Crawford A.R., 1979. The myth of a vast Oceanic Tethys, the India-Asia problem and Earth expansion.
Petroleum Geol. 2, 1, p. 3–9.

Creer K.M., 1965. An Expanding Earth?
Nature, 205 (4971), p. 539–544.

Chudinov Y.V., 1981. Razširienije Ziemli i tektoničeskije dwiženija: O naprawlieni dwiženij
v okrainno-okieaničeskich zonach. *(Expansion of the Earth and tectonic movements.
About the directions of motions active continental margins),*
Geotektonika 1, p. 19–37.

Davidson O.K., 1983. Tethys and Pacific stratigraphic evidence for an expanding Earth.
W: Carey S.W. (ed.): Expanding Earth Symposium, Sydney 1981,
University of Tasmania, p. 191–197.

De Mets C., Gordon R.G., Argus D.F. and Stein S., 1990. Current plate motions.
Geophys. J. Intl., 101, p. 425–478.

Dewey D.F., 1988. Extensional collapse of orogens.
Tectonics 7, p. 1123–1139.

Dietz R.S. and Holden J.C., 1970. Reconstruction of Pangaea: breakup and dispersion
of continents, Permian to Present.
J. Geophys. Res. 75, 26, p. 4939–4956.

Du Toit A.L., 1937. Our wandering continents, an hypothesis of continental drifting.
Olivier Boyd, Edinburgh, pp. 366.

Frech F., 1902. Lethea geognostica.
Theil. Lethea palaeozoica, Bd.2, Lief. 3–4. Die Days, Stuttgart, pp. 354.

Gansser A., 1964. Geology of the Himalayas.
Interscience, London, pp. 289.

Gregory D.W., 1930. The geological history of the Pacific Ocean.
Quart. J. Geol. Soc, 86, London, p. 2–136.

Haug E., 1900. Les Geosynclinaux et les Aires continentales.
Soc. Geol. France Bull. Ser.3, 28, p. 617–711.

Hilgenberg O.C., 1933. Vom wachsenden Erdball.
Giesemann und Bortsch, Berlin – Pankow, pp. 55.

King L., Downard T.W., 1964. Importance of Antarctica in the hypothesis of continental drift.
In: Antarctic Geology, ed.: R.J. Adie, N. Holland, Publishing Company – Amsterdam, p. 727–735.

Koshkin W.O., 1969. Centralno-kazachstanskij sdvig *(Central Kazakh fault)*.
Geotektonika 1, p. 52–67.

Koziar J., 1980. Rozwój oceanów jako przejaw ekspansji Ziemi *(Development of the oceans as an manifestation of the expansion of the Earth).*
Geologia 8, Katowice, p. 109–114; www.wrocgeolab.pl/floor.pdf

Koziar J. and Jamrozik L., 1985a. Tension-gravitation model of the tectogenesis.
Proceeding reports of the XIII-th Congress of KBGA, Poland – Cracov,
Inst. Geol. Warszawa, p. 195–199; www.wrocgeolab.pl/Carpathians.pdf

Koziar J., Jamrozik L., 1985b. Application of the tension-gravitation model of the tectogenesis to the Carpathian orogen reconstruction.
Proceeding reports of the XIII-th Congress of KBA Poland – Cracov,
Inst. Geol. Warszawa, p. 200–203; www.wrocgeolab.pl/Carpathians.pdf

Koziar J. and Jamrozik L., 1991. Tensyjno-grawitacyjny model subdukcji *(Tension – gravitational model of subduction).* In print[13].

Koziar J. and Muszyński A., 1980. Correlations of extension of the Mediterranean and the Black Sea (in Bulgarian).
Rev. of the Bulgarian Geol. Soc. 41/3, p. 247–2597

Le Pichon X., 1968. Sea – floor spreading and continental drift.
J. Geophys. Res., 73, p. 3661–3697.

Lindemann B., 1927. Kettengebirge, Kontinentale Zerspaltung und Erdexpansion.
Verl. von G. Fischer, Jena, pp.186.

Ma X. and Wu D., 1987. Cenozoic extensional tectonics in China.
Tectonophysics 133, p. 243–255.

Meyerhoff A.A. and Meyerhoff H.A., 1972. The new global tectonics: major inconsistencies.
Am. Assoc. Petrol. Geol. Bull., 56, p. 269–336.

[13] Already published:
Koziar J. and Jamrozik L., 1991. *Tensyjno-grawitacyjny model subdukcji.*
W: J. Skoczylas (red.), Streszczenia referatów, tom I. Polskie Towarzystwo Geologiczne – Oddział w Poznaniu i Instytut Geologii Uniwersytetu im. Adama Mickiewicza w Poznaniu, Poznań, s. 34–39.
***Tension-gravitational model of subduction*.**
In: J. Skoczylas (ed.), Lecture summaries, vol. I. The Polish Geological Society – Poznań Branch and the Institute of Geology of the Adam Mickiewicz University in Poznań, Poznań, p. 34–39. Footnote 2012.

Meyerhoff H.A. and Meyerhoff A.A., 1978. Spreading history of the eastern Indian Ocean and India's northward flight from Antarctica and Australia: Discussion.
Geol. Soc. Am. Bull., 89, 4, p. 637–649.

Minster J.B., Jordan T.H., 1978. Present-day plate motions.
J. Geophys. Res. 8, p. 5331–5354.

Neumayr M., 1887. Erdgeschichte.
3d. II, Leipzig, pp. 879.

Norton J.O. and Sclater J.G., 1979. A model for the evolution of the Indian Ocean and the breakup of Gondwanaland.
J. Geophys. Res. 84, B12. p. 5003–6830.

Oberc J., 1986. Ziemia – mobilizm i ekspansja *(Earth – mobilism – expansion)*.
Problemy nr 10, p. 23–24 and 33–36.

Petrushevskij B.A., 1970. O tektoniceskoj prirodie Gimalajev (*About tectonic nature of the Himalayas)*.
Biul. MOIP, 1, p. 5–30.

Plumstead E.P., 1962. Geology fossil floras of Antarctica.
Trans-Antarct. Exped. 1955–58, Sci. Rep. (9), p.154.

Scotese C.R., Gahagon L.M. and Larson R.L., 1988. Plate tectonics reconstructions of the Cretaceous and Cenozoic ocean basins.
Tectonophysics, 155, 1–4, p. 27–48.

Shields O., 1983. Trans-Pacific biotic links that suggest Earth expansion.
In: Carey S.W. (ed.): Expanding Earth Symposium, Sydney 1981.
University of Tasmania, p. 199–205.

Smith A.G. and Hallam A., 1970. The fit of the Southern Continents.
Nature 225, p. 139–144.

Smith D.E., Kolenkiewicz R., Dunn P.O., Robbins J.W., Torrenco M.H., Klosko S.H., Williamson R.G., Pavlis E.C., Douglas N.B. and Fricke S.K.,1990.
Tectonic motion and deformation from satellite laser ranging to LAGEOS.
J. Geophys. Res., 95, (B13), p. 22013–22041.

Stöcklin J., 1983. Himalayan orogeny and Earth expansion.
In: Carey S.W. (ed.): Expanding Earth Symposium, Sydney 1981,
University of Tasmania, p. 119–130.

Suess E., 1885. Das Antlitz der Erde.
Bd. I, Teil 2, Vienna, p. 311–778.

Suess E., 1988. Das Antlitz der Erde.
Bd. II, Vienna, pp. 703.

Suess E., 1909. Das Antlitz der Erde.
Bd. Ill, Teil 2, Vienna, pp. 789.

Tanner W.F., 1973. Deep-sea trenches and the compression assumption.
The American Association of Petroleum Geologists Bulletin, 57, 11, p. 2195–2206.

Tanner W.F., 1983. Diapirism, grabens and horizontal tension.
In: Carey S.W. (ed.): Expanding Earth Symposium, Sydney 1981,
University of Tasmania, p. 227–232.

Vogel K., 1983. Global models and Earth expansion.
In: Carey S.W. (ed.): Expanding Earth, Symposium, Sydney 1981,
University of Tasmania, p. 17–27.

Vogel K. and Schwab M., 1983. The position of Madagascar in Pangaea.
In: Carey S.W. (ed.): Expanding Earth Symposium, Sydney 1981,
University of Tasmania, p. 73–76.

Wegener A., 1912. Die Entstehung der Kontinente.
Geol. Rundsch. 3, Heft 4, p. 276–292.

Weissel O.K. and Hayes D.E., 1972. Magnetic anomalies in the southeast Indian Ocean.
In: Hayes D.E. (ed.): Antarctic Oceanology II: The Australian-New Zealand Sector,
Antarctic Res. Ser., 19, Washington D.C., p. 165–196.

Zorin J.A., 1981. The Baikal rift: an example of the intrusion of asthenospheric material
into the lithosphere as the cause of disruption of lithospheric plates.
Tectonophysics, 73, p. 91–104.

Items published after the present paper and referenced in footnotes

Carey S. W., 1996. Earth-Universe-Cosmos.
University of Tasmania, pp. 231.

Feraccioli F. and Bozo E., 1999. Inherited crustal features and tectonic blocks of the Transantarctic
Mountains: An areomagnetic perspective (Victoria Land, Antarctica).
J. Geophys. Res., v. 104, p. 25 297– 25 319.

Koziar J., 1993. Rozwój Pacyfiku i jego znaczenie dla współczesnej geotektoniki.
W: J. Skoczylas (red.), Streszczenia referatów, tom II. Polskie Towarzystwo
Geologiczne – Oddz. w Poznaniu i Instytut Geologii Uniwersytetu im. Adama Mickiewicza
w Poznaniu, Poznań, s. 45–56.

Development of the Pacific and its importance to the contemporary geotectonics.
In: J. Skoczylas (ed). Lecture summaries. vol. II. The Polish Geological Society - Poznań Branch and the Institute of Geology of the Adam Mickiewicz University in Poznań,
Poznań, p. 45–56. www.wrocgeolab.pl/Pacific.pdf

Koziar J. and Jamrozik L., 1994.Tension-gravitational model of island arcs.
In: F. Selleri, M. Barone (eds.), Proceedings of the International Conference "Frontiers
of Fundamental Physics" (Olympia, Greece, 27–30 September, 1993).
Plenum Press, New York and London, p. 335–337. www.wrocgeolab.pl/margins1.pdf

Koziar J., 2003. Tensional development of active continental margins.
In: K. H. Jacob (ed.), Materials of the International Conference „Erdexpansion – eine Theorie
auf dem Prüfstand" (24–25 May, 2003, Ostbayern Schloss Theuern (NRF).
Technische Universität, Berlin, p. 27–35. www.wrocgeolab.pl/margins2.pdf

Koziar J., 2005a. Tensyjny rozwój orogenów śródlądowych. Część I, Mechanizm.
W: J. Skoczylas (red.), Streszczenia referatów, tom XIV. Polskie Towarzystwo Geologiczne – Oddz. w Poznaniu i Instytut Geologii Uniwersytetu im. Adama Mickiewicza w Poznaniu, Poznań, s. 131–156.

Tensional development of the intracontinental fold belts. Part I, Mechanism.
In: J. Skoczylas (ed.), Lecture summaries, vol. XIV. The Polish Geological Society – Poznań Branch and the Institute of Geology of the Adam Mickiewicz University in Poznań, Poznań, p. 131–156.

Koziar J., 2005b. Tensyjny rozwój orogenów śródlądowych. Część II, Przykłady regionalne.
W: J. Skoczylas (red.), Streszczenia referatów, tom XIV. Polskie Towarzystwo Geologiczne – Oddz. w Poznaniu i Instytut Geologii Uniwersytetu im. Adama Mickiewicza w Poznaniu, Poznań, s. 157–196.

Tensional development of the intracontinental fold belts. Part II, Regional examples.
In: J. Skoczylas (ed.), Lecture summaries, vol. XIV. The Polish Geological Society – Poznań Branch and the Institute of Geology of the Adam Mickiewicz University in Poznań, Poznań, p. 157–196.

Koziar J,. 2006. Terrany, czyli geologia w krainie duchów.
W: J. Skoczylas (red.), Streszczenia referatów, tom XV. Polskie Towarzystwo Geologiczne – Oddz. w Poznaniu i Instytut Geologii Uniwersytetu im. Adama Mickiewicza w Poznaniu, Poznań, s. 47–98.

Terranes or the geology in a wonderland.
In: J. Skoczylas (ed.), Lecture summaries, vol. XV. The Polish Geological Society - Poznań Branch and the Institute of Geology of the Adam Mickiewicz University in Poznań, Poznań, p. 47–98.

Ollier C.D. and Pain, C.F., 2000. The Origin of Mountains.
Routledge, London, pp. 345.

Ollier C.D., and Pain, C.F., 2001. The Neotectonic Period.
New Concepts in Global Tectonics, v. 20, p. 14–16.

Ollier C.D., 2003. The origin of mountains on an expanding Earth and other hypotheses.
In: G. Scalera & K-H. Jacob, Why expanding Earth?
INGV Publisher, Roma, p. 129–160.

Ollier C.D., 2005. Mountain building and orogeny on an expanding Earth.
Boll. Soc. Geol. It. Volume Speciale 5, p. 169–176.

Van der Beek P., Cloetingh S. and Andriesen, P., 1994. Mechanisms of extensional basin formation and vertical motions at rift flanks: Constraints from tectonic modeling and fission-track thermochronology.
Earth and Pl. Sc. Lett., v. 121, p. 417– 433.