# THE PRE–, SYN–, AND POST-COLLISIONAL EVOLUTION OF TECTONOSTRATIGRAPHIC TERRANES WITH SPECIAL REFERENCE TO THE IAPETUS OCEAN OR PALAEO-PACIFIC SUTURE

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Debido a la rotación excéntrica del globo terrestre, dirigida hacia el oeste alrededor del centro gravitatorio del sistema Tierra-Luna (–Sol), el manto inferior se traslada hacia el este con relación al sistema convectivo del sistema manto superior-corteza (principio del engranaje hipocicloide). Encima de las anomalías gravitatorias del manto inferior, la forma del Océano Pacífico y los estados individuales del Ciclo de Wilson describiendo con una secuencia progresivamente más antigua tanto la apertura y el cierre de un océano (etapa rift/Mar Rojo, etapa Atlántico, etapa Pacífico, etapa colisional) como la evolución embrional y geosinclinal de una cintura orogénica, siendo trasladadas hacia el este en relación con la corteza terrestre (dando la vuelta alrededor del globo en 200 a 250 millones de años), efectuándose así los megaciclos tectónicos globales.

Los continentes migran hacia el oeste alrededor del Océano Pacífico tanto en su parte norte como en el sur. En el oeste del Océano Pacífico chocan entre sí, añadiendo continuamente segmentos al cinturón de orógenos colisionales (principio del cierre de cremallera) que se hace más antiguo hacia el oeste. Desde el Pérmico este cinturón se arrolló, aproximadamente una vez y un tercio, en forma de espiral en el hemisferio norte alrededor del núcleo cratónico de Laurasia.

Después de que el Océano Pacífico recorriese la mitad de la corteza terrestre, el Pacífico aparece («se levanta») de nuevo en el oeste. Los continentes que antes chocaron en sucesión en el oeste del Océano Pacífico, se separan de nuevo en la posición de Mediterráneo, con lo cual los márgenes septentrionales anteriores de los continentes del hemisferio sur quedan enganchados a los continentes del hemisferio norte en forma de terrenos tectono-estratigráficos, que después circulan alrededor del Océano Pacífico en su lado norte.

En el hemisferio norte, desde el Pérmico, el margen tipo Cordillera en el noreste del Océano Pacífico pasa a un margen tipo arco de islas del Pacífico Noroeste. Ambos tipos de márgenes son segmentos de la vuelta más antigua de la espiral del cinturón de orógenos colisionales.

En el hemisferio sur, desde el Pérmico, los continentes en la posición de la Antártida han girado unos 120° en el sentido de las agujas del reloj. El margen tipo Andino en el sureste del Océano Pacífico resulta de un margen pasivo tipo Africa oeste y pasa a un tipo colisional en el oeste del Océano Pacífico. El margen tipo arco de islas en el suroeste del Océano Pacífico proviene de un margen pasivo tipo Africa Norte/Antártida Oeste, que todavía pueda llevar fragmentos de las partes australes del cinturón orógenos colisionales, cuyos partes mayores migran por el norte alrededor del Océano Pacífico (vuelta más antigua de la espiral del cinturón de orógenos colisionales; terrenos tectono-estratigráficos).

La historia de la tierra parece estar subdividida en ciclos alternantes de crecimiento de Pangea norte/desintegración de Pangea sur y crecimiento de Pangea sur/desintegración de Pangea norte. En el hemisferio en que Pangea crece se forma continuamente una cintura orogénica de montañas colisionales al oeste y detrás de la forma del

Océano Pacífico, migrando hacia el este y envolviéndose alrededor de un núcleo cratónico en forma de espiral con doble enrollamiento, que se alimenta de la espiral más antigua que está desintegrándose simultáneamente en el hemisferio opuesto.
La cadena de montañas colisionales de los Apalaches-Caledonides no se formó por el cierre de un Océano proto-Atlántico, sino que es un fragmento del cinturón espiral de orógenos colisionales con doble enrollamiento de la Pangea sur del Proterozoico tardío y Paleozoico temprano y medio (hemisferio sur) que marca la huella de la forma del Océano Pacífico Paleozoico u Océano Iapeto migrando hacia el Este.

*Palabras clave: Terrenos tectono-estratigráficos, Ciclo de Wilson, Megaciclos tectónicos globales, Deriva Oeste/Deriva Este, Pangea, Pangea Norte, Pangea Sur, Gondwana, Océanos intra-Pangea, Océano Pacífico/Tethys, Océano Iapeto, Márgenes continentales, Colisión, Espiral del cinturón de orógenos colisionales.*

Due to the westward directed off-centre rotation of the spinning Earth around the gravitational centre of the Earth-Moon (–Sun) system the lower mantle is displaced eastwards in relation to the convecting upper mantle-crust system (principle of hypocycloid gearing). Above gravity anomalies in the lower mantle the shape of the Pacific and the individual states of the Wilson Cycle describing both the opening and closing of an ocean (Rift/Red Sea state, Atlantic state, Pacific state, Collisional state) and the embryonic, geosynclinal evolution of an orogen, are displaced eastwards in relation to the Earth's crust (once around the globe in 200 to 250 m.y.), thus causing the Global Tectonic Megacycles.
The continents migrate westwards around the shape of the Pacific in the north and south. They collide to the west of the Pacific continuously adding segments to a collisional mountain belt (zip fastener principle) which becomes older towards the west. Since the Permian this belt has lapped some 1 1/3 times around the cratonic nucleus of Laurasia in the northern hemisphere in the form of a spiral.
Following half an east drift lapping of the Earth's crust by the shape of the Pacific, the Pacific appears («rises») again in the west. In the Mediterranean setting the continents that previously had collided sequentially to the west of the Pacific separate again, whereby the former northern margins of the southern continents remain attached to the northern continents in the form of tectonostratigraphic terranes, that later migrate around the shape of the Pacific in the north.
In the northern hemisphere, since the Permian, the Cordilleran-type margin NE of the Pacific develops into the NW-Pacific island arc-type. Both types are remobilized segments of the older lap of the collisional mountain belt spiral.
In the southern hemisphere, since the Permian, the continents have rotated clockwise through approximately 120° in the Antarctica setting. The Andean-type margin SE of the Pacific evolves from a passive West Africa-type and develops into a collision-type to the west of the Pacific. The SW-Pacific island arc-type margin evolves from a passive North Africa-/West Antarctica-type that still might carry fragments from the southern parts of the collisional mountain belt, the main parts of which migrate around the shape of the Pacific in the north (older lap of the collisional mountain belt spiral; tectonostratigraphic terranes).
The Earth's history appears to be subdivided into alternating North Pangaea growth/South Pangaea breakup cycles and South Pangaea growth/North Pangaea breakup cycles. In the hemisphere of the Pangaea growing a collisional mountain belt continuously forming to the west and behind the eastward migrating shape of the Pacific winds around a cratonic nucleus in the form of a two-lap spiral which feeds on the older spiral disintegrating simultaneously in the opposite hemisphere.
The Appalachians-Caledonides orogenic belt did not result from the closure of a proto-Atlantic Ocean but is a fragment from the Late Proterozoic and Early to Middle Palaeozoic two-lap South Pangaea collisional mountain belt spiral (southern hemisphere) marking the trail of the eastward migrating shape of the Palaeozoic Pacific or Iapetus Ocean.

*Key words: Tectonostratigraphic Terranes, Wilson Cycle, Global Tectonic Megacycles, West Drift/East Drift, Pangaea, North Pangaea, South Pangaea, Gondwana, Intra-Pangaea Oceans, Pacific/Tethys, Iapetus Ocean, Continental margins, Collision, Collisional mountain belt spiral.*

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The model presented in this paper integrates most of the present-day plate tectonic models. However, in order to eliminate major inconsistencies in the present concept, a new dynamic aspect is introduced: The eastward displacement of the shape of the Pacific in relation to the Earth's crust. It has also been found convenient to give new connotations to some terms already introduced: *Pangaea* is used for all continental crust, past and present. *Tethys* is taken as synonymous with the Pacific. The circum-Pacific ring of subduction zones separates a *Pacific or Tethys area* with mainly active continental margins from a *continental or Pangaea area with Intra-Pangaea Oceans* (Atlantic, Red Sea/Indian Ocean, Arctic Ocean etc.) with mainly passive continental margins. The Pangaea area is subdivided into a *North Pangaea area* and a *South Pangaea area* with the northern and southern continents distributed broadly over the northern and southern hemispheres.

## EASTWARD DISPLACEMENT OF THE SHAPE OF THE PACIFIC IN RELATION TO THE EARTH'S CRUST AND THE LATE PALEOZOIC-MESOZOIC-CENOZOIC COLLISIONAL MOUNTAIN BELT SPIRAL OF THE NORTH PANGAEA

Five observations indicate an eastward displacement of the shape of the Pacific (not the Pacific crust) in relation to the Earth's crust:

1. The arrangement of ocean-types in the evolutionary sequence of the Oceanic or Wilson Cycle (Argand 1924, Wilson 1966, Dewey and Burke 1974) describing the opening and closing of an ocean with subsequent collision of the continental margins and collisional mountain building (Rift/Red Sea state and Atlantic state with mainly passive continental margins; Pacific state with mainly active continental margins; Collisional/Himalayas state) from east to west (younger to older) through 360° around the globe (Fig. 1).

Rift oceans of the Red Sea-/Indian Ocean-/SW-Pacific backarc basin-type will be dis-

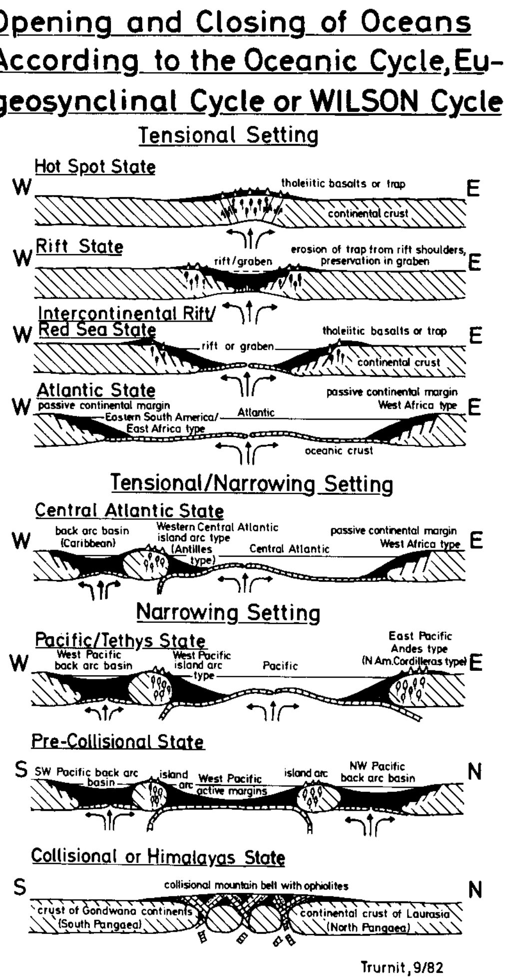



Fig. 1.–The Oceanic, Eugeosynclinal or Wilson Cycle (Mediterranean/Caribbean-type rift states not shown).

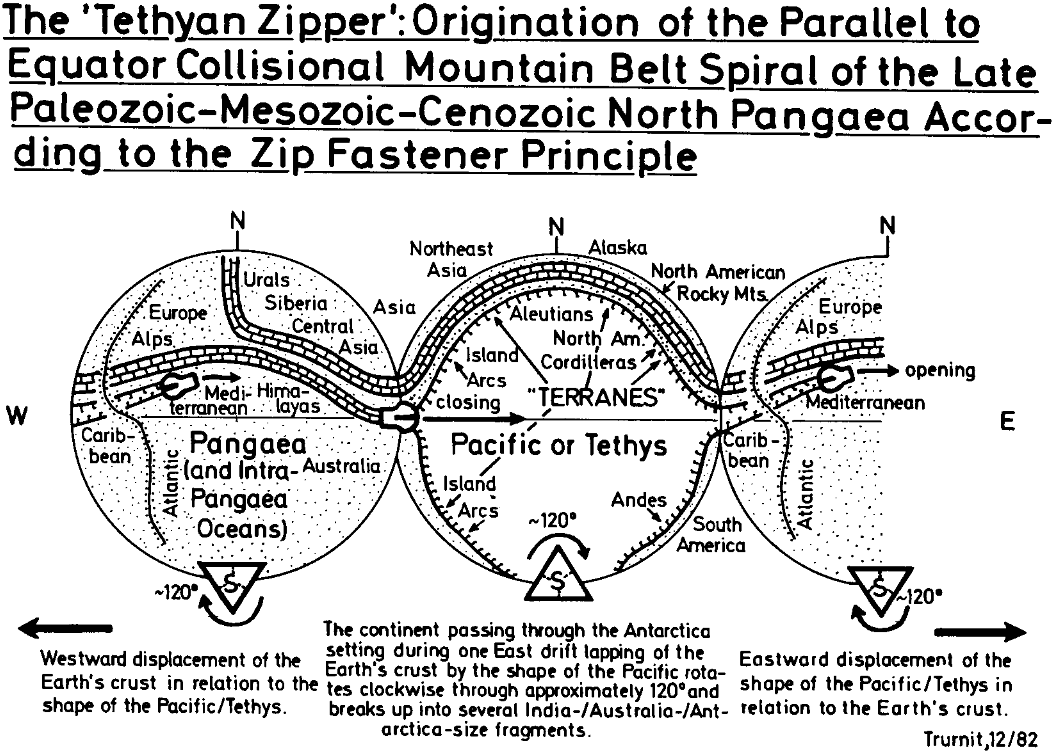



Fig. 2.—Eastward displacement of the shape of the Pacific/Tethys in relation to the Earth's crust. Opening of Mediterraneans/Caribbeans to the east of the Pacific (rift propagation towards the east) and continuous eastward growth of a collisional mountain belt to the west of the Pacific by sequential collision of the continents from the northern and southern hemispheres according to the zip fastener principle. The northern margins of the southern continents are left with the older lap of the two-lap North Pangaea collisional mountain belt spiral in the form of tectonostratigraphic terranes after the opening of a Mediterranean (lateral continental growth). Some 120° clockwise rotation of the continents from the Pangaea breaking up while passing through the Antarctica setting during one east drift lapping of the Earth's crust by the shape of the Pacific (equatorial view).

placed west in relation to the shape of the Pacific or Tethys to become a North or a South Atlantic (i.e. will occupy a progressively westerly setting in the Pangaea area during the course of their evolution) and will finally be absorbed by the shape of the Pacific advancing from the west. The continental or Pangaea area continuously opens at the Pacific bow in the east in the Mediterranean and Caribbean settings (rift propagation towards the east) and continuously closes again at the Pacific stern in the west (sequential collision) between the continents in the Asia and Australia settings (zip fastener principle) (Fig. 2). For an individual continent the Pacific «rises» (appears) in the west and «sets» (disappears) in the east. The Pacific retains approximately the same size; it does not shrink. What is lost at the stern in the west from the shape of the Pacific/Tethys through collision between the island arcs and continents of the northern and southern hemispheres, is added at the bow in the east by the opening of a series of Mediterraneans and Caribbeans, withdrawal of the continents in the North and South America settings towards the poles, and by the incorporation of a succession of Atlantics (rift oceans). Plate tectonic characteristics, like the ocean states of the Wilson Cycle, move eastwards across the Earth's crust with the angular velocity of the shape of the Pacific. The identity of an ocean will slowly be transferred east to the neighbouring ocean (West Pacific to the East Pacific; East Pacific to the Atlantic; Atlantic to the Red Sea/Indian Ocean; Indian Ocean to the SW-Pacific backarc basins).

2. A second observation is the contrast between the gentle inclinations of the subduction zones at the Andeans-type continental margins east of the Pacific and the steep inclinations of the subduction zones at the island arc-type continental margins west of the Pacific (Uyeda 1981). The oceanic crust of the Pacific, as it descends into the interior of the Earth along the circum-Pacific ring of subduction zones, should be attached to the lower mantle running ahead of the oceanic crust with east drift. Therefore the downward dipping slabs of the oceanic crust should be pulled towards the east. During backarc basin opening an island arc migrates oceanwards towards the east (trench suction).

3. A third point is the phenomenon of the «exotic, suspect, displaced, allochthonous or tectonostratigraphic terranes» (Jones *et al.* 1978, 1983; Coney *et al.* 1980, Saleeby 1983, Hallam 1986) that were first recognized in the Cordilleras of western North America and later on, also in the remainder of the circum-Pacific Region, with the exception of the western margin of South America. The terranes along the north Pacific rim to a large extent arrived at their present position from

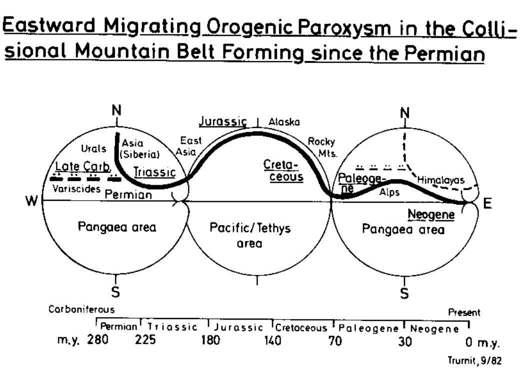



Fig. 3.–Eastward advancing states of orogenic activity (e.g. collision or orogenic paroxysm, post-collisional movements) in the Late Palaeozoic-Mesozoic-Cenozoic collisional mountain belt (equatorial view).

more southerly latitudes. Continents of the southern hemisphere which had previously collided sequentially to the west of the Pacific with the continents of the northern hemisphere, should after half an east drift lapping of the Earth's crust by the shape of the Pacific have separated again from the northern continents in the Mediterranean and Caribbean settings to the east of the Pacific, leaving their former northern margins in the form of tectonostratigraphic terranes attached to the northern continents (lateral continental growth) which migrated afterwards around the shape of the Pacific in the north (Fig. 2).

4. The fourth observation is the colli- sional mountain belt that starts to the west of the Pacific and extends west from New Guinea/Indonesia via the Alpine mountain ranges of South Asia and Europe (Alpine collision; closed Neo-Tethys), the North American Rocky Mountains/Cordilleras (Laramide or Late Kimmerian collision), the mountain ranges of Alaska and some of NE-Asia and via some East Asiatic mountains, parts of Southern and Central Asia (Indosinian or Early Kimmerian collision; closed Paleo-Tethys) to the Urals (Stöcklin 1977; Sengör 1985a, b, 1986, 1987; Searle *et al.* 1987). This belt is divided into segments by the ocean states of the Wilson Cycle and becomes progressively older towards the west (Fig. 3). Since the Permian it has wound approximately 1 1/4 to 1 1/3 times around the Earth, i.e. the cratonic nucleus of Laurasia, in the form of a spiral (Fig. 4). The ophiolites in the suture zones of the collisional mountain belt should mark the trail of the eastward migrating shape of the Pacific (modern Tethys).

5. The fifth and final observation indicating an eastward displacement of the shape of the Pacific in relation to the Earth's crust, is lateral continental growth by cyclically repeated orogenic events taking place at different times for the individual longitudes and continental margins. Examples are the Late Carboniferous Variscan «orogeny» succeeded by the Late Cretaceous/Paleogene Alpine collision in Europe, the Permian collision of the Southern Urals succeeded by the Tertiary Iranides collision, the Triassic Indosinian collision of Central and South Asia (closed Palaeo-Tethys) succeeded by the Neogene Hi-

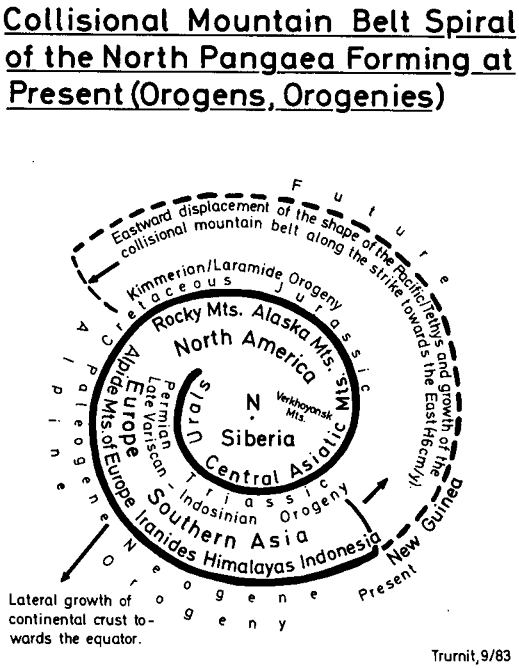



Fig. 4.–Collisional mountain belt spiral of the Late Palaeozoic-Mesozoic-Cenozoic North Pangaea or Laurasia (North Polar View).

malayas collision (closed Neo-Tethys), the Late Cambrian/Early Ordovician Ross collision followed by the Late Devonian/Early Carboniferous Borchgrevink collision in Antarctica, the Cambrian Delamerian-Tyennan collision succeeded by the Devonian Tabberabberan collision in East Australia, the Ordovician-Silurian Taconian collision (closed Palaeo-Iapetus Ocean) followed by the Early Carboniferous Late Acadian collision (closed Neo-Iapetus Ocean) in Eastern North America and Western Europe (Figs. 2, 4) and others.

While the sum of the orogenic states of an orogeny (pre-collisional Andean-/Cordilleran-type east of the Pacific; pre-collisional island arc-type and syn-collisional Himalayas-type to the west of the Pacific; post-collisional-type be-tween North and South Pangaea) will last one east drift lapping of the Earth's crust by the shape of the Pacific, a certain orogenic state (e.g. collision) will be repeated after the collisional mountain belt or the shape of the Pacific have lapped the Earth once.

## THE CONTRIBUTION OF TIDAL FORCES TO GLOBAL TECTONICS AND PLATE MOVEMENTS

The eastward displacement of the shape of the Pacific in relation to the Earth's crust and the high probability of its coupling to the angular velocity of the lower mantle and its gravity anomalies, demands slightly higher angular velocities of the Earth's solid inner shells (outside the core) around the Earth's spin axis, as compared with those of the solid outer shells (Eddington 1923, Joly 1923, Jardetzky 1952, Nadai 1952, Tanner 1962, Gilliland 1964, Bostrom 1971, Danes 1971, Roeder and Nelson 1971, Knopoff and Leeds 1972, Nelson and Temple 1972, Cullen 1973, Moore 1973, 1975; Jordan 1974, Uyeda and Kanamori 1979). This behaviour of the Earth appears to be caused by the off-centre rotation of the spinning Earth around the gravitational centre of the Earth-Moon (–Sun) system, which moves west through the lower mantle around the Earth's spin axis with the angular velocity of the Earth's tidal bulges. According to the principle of hypocycloid gearing, the outer circumferences of the solid inner shells are rolling off in the inner circumferences of the solid outer shells (kinematics of the hypocycloidal movement), whereby the direction of displacement of the inner shells in relation to the outer shells is opposite to the off-centre rotation and the amount of displacement between neighbouring shells depends on the difference between their radii or circumferences (Fig. 5) (Lehmann, 1979, Trurnit 1984 c, d; 1985 a, b, d; 1986 a, b, c; 1987 a, b, c).

The mass «m» in Fig. 5 is hypothetical. Other combinations are thinkable. e.g. one mass each in the upper and lower mantle (Trurnit 1984c), one mass in the upper mantle and two antipodal masses in the lower mantle (Trurnit 1984d), no mass at all and the pattern of gravity anomalies caused by a stable convective configuration in the upper and lower mantle.

It has long been observed that the secular change of the geomagnetic non-dipole field drifts west in relation to the Earth's crust (approximately 1500-1800 years duration for one westward directed revolution around the globe; Runcorn, 1982). This is consistent with the westward rotation of a fluid body being

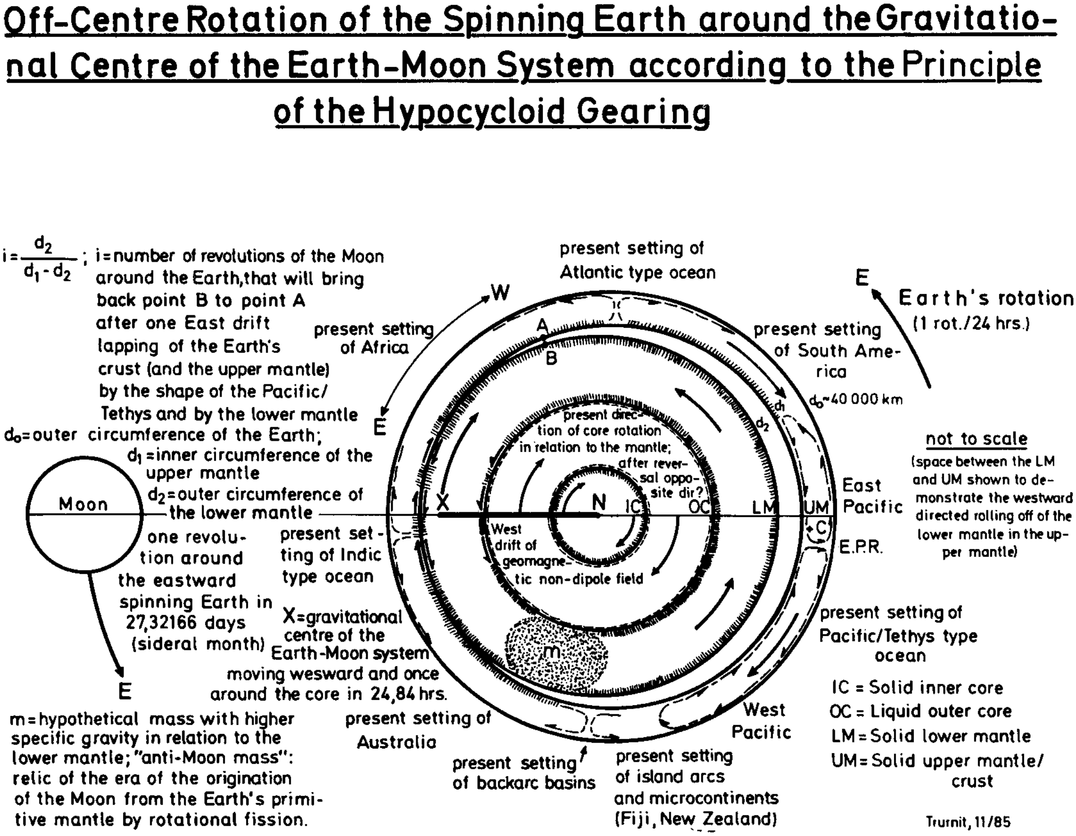



Fig. 5.–The Earth shown as a gigantic hypocycloid gearing: explanation for the eastward displacement of the shape of the Pacific/Tethys and for the west drift of the geomagnetic non-dipole field in relation to the Earth's crust (only one of several possibilities shown) (North polar view). Reversals of the geomagnetic field could be explained by the following sequence of events: After termination of a blocking of the hypocyloid gearing along a subduction zone, at a point of the upper mantle/lower mantle boundary or the mantle/core boundary and a slight speedup of the Earth's rotation back to its preblocking angular velocity, the solid inner core (IC) should tilt through 180° in the liquid outer core (OC) around an axis positioned approximately in the Earth's equatorial plane. A termination of blocking with subsequent 180° tilting of the solid inner core should only shift this axis around the Earth's rotational axis somewhat towards the east but should not influence considerably the orientation of the Earth's rotational axis in space. After a tilting the Earth's solid inner core rotates faster (east drift of the geomagnetic non dipole field in relation to mantle and crust). A reversal, however, should not have occurred yet (−x−=+). The inner core is then slowed down constantly by the westward directed off-centre rotation of the Earth around the gravitational centre of the Earth-Moon (−Sun) system until the angular velocity of the inner core in relation to the outer core and/or mantle slowly has dropped down to zero. Shortly afterwards the angular velocity of the inner core will slowly speed up again in a negative sense, i.e. it will again start lagging behind in relation to mantle and crust. During this period the geomagnetic non-dipole field will reverse and will afterwards again drift west in relation to mantle and crust (see test with threefold cardanically suspended wheel, Physical Department, Deutsches Museum, München, F.R.G.).

subjected to a westward directed off-centre rotation and could be an indication for the Earth's liquid outer core and solid inner core rotating west in relation to the Earth's mantle and crust.

## GLOBAL TECTONIC MEGACYCLES

The Earth's history is subdivided by, and the Earth's crust is subjected to, a series of 360° Global Tectonic Megacycles (Gastil

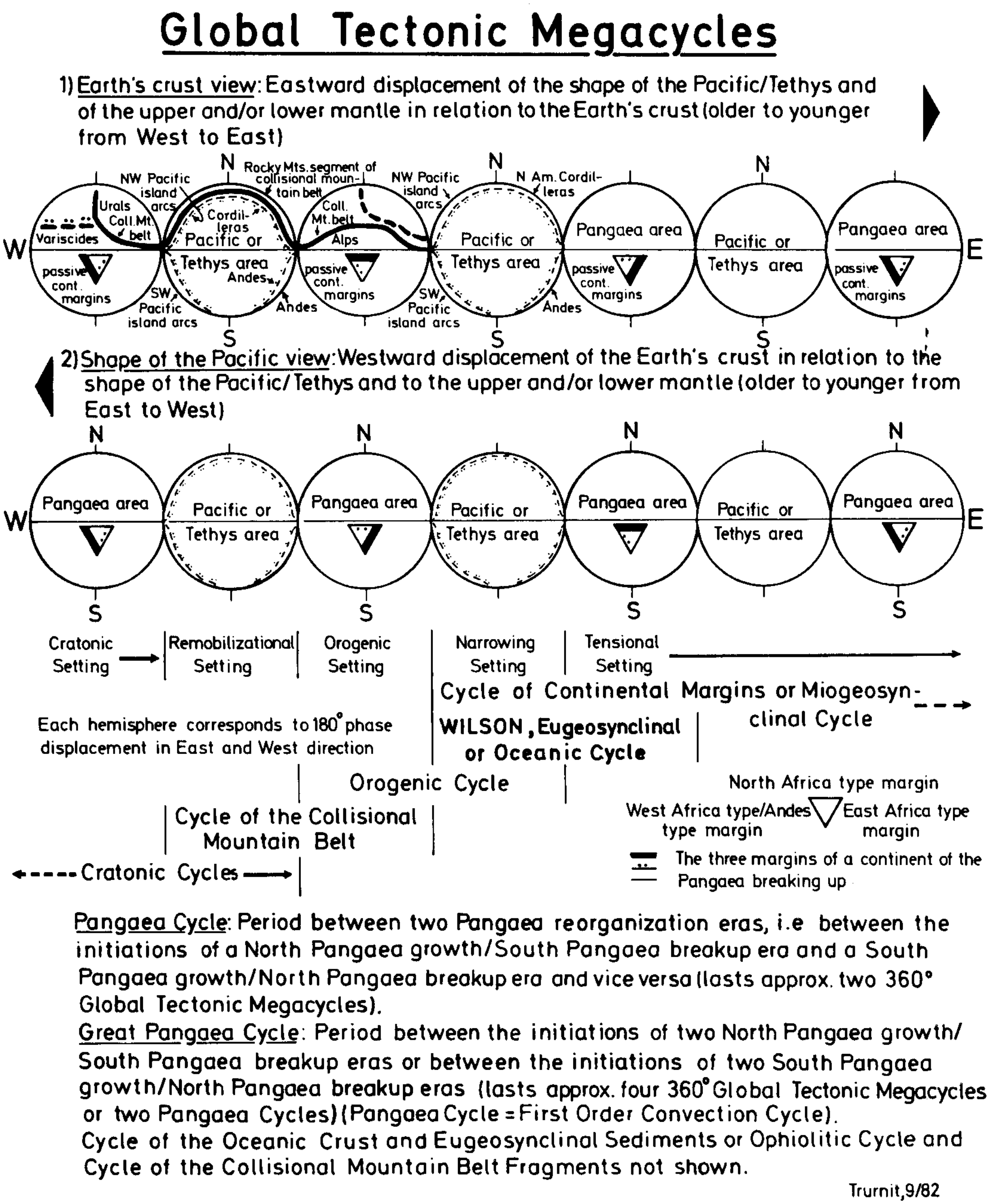



Fig. 6.—Evolutionary sequence of the Global Tectonic Megacycles migrating east with the shape of the Pacific and the lower mantle in relation to the Earth's crust (convecting upper mantle-crust system) (equatorial view); some 120° clockwise rotation of the continents in the hemisphere of the Pangaea breaking up while passing through the Antarctica setting during one east drift lapping of the Earth's crust by the shape of the Pacific.

1960, Sutton 1963, Walker 1976, Williams 1981, Stockwell 1982, Salop 1983, Trurnit 1984 a-d, 1985 a-e, 1986 a-c, 1987 a-c; Benkö 1985, Schmidt and Baumann 1985, Nance *et al.*

The Succession of Plate Tectonic Settings During the Cycle of Continental Margins or Miogeosynclinal Cycle

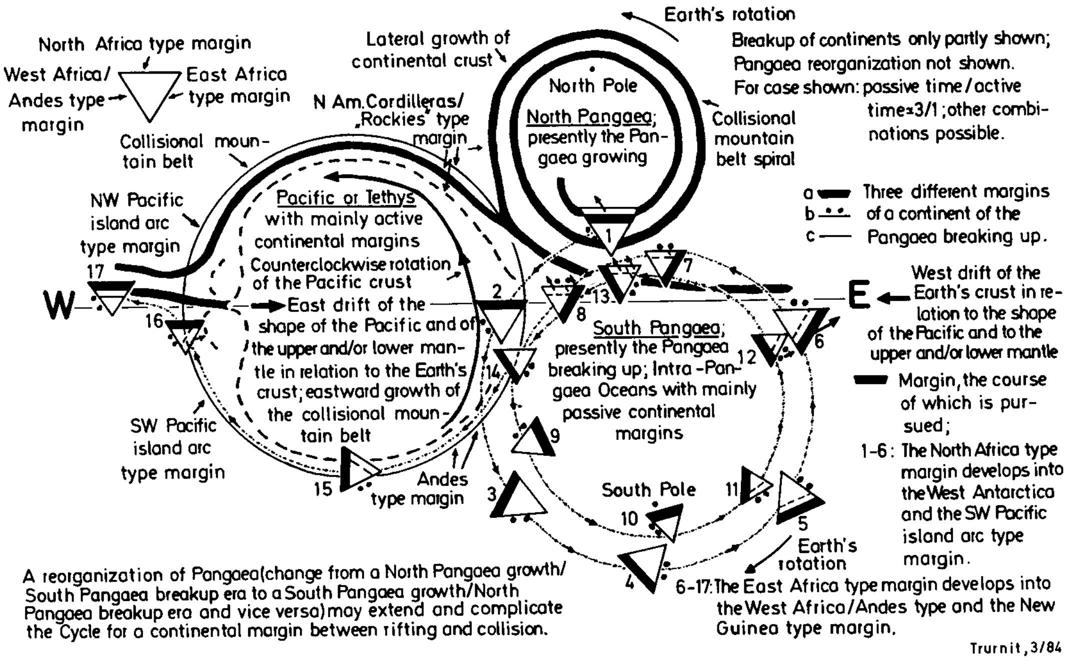



Fig. 7.–The Cycle of Continental Margins or Miogeosynclinal Cycle (combined equatorial, North Polar and South Polar views; Pacific area, North Pangaea area, South Pangaea area).

1986) arranged in series from east to west from the younger to the older evolutionary states, overlapping each other by 180° each (by definition) and advancing east across the Earth's crust with the angular velocity of the shape of the Pacific (Fig. 6): The *Oceanic Cycle, Eugeosynclinal Cycle or Wilson Cycle* (180° Red Sea/Rift state and Atlantic state with mainly passive continental margins; 180° Pacific state with 90° Cordilleran-/Andean-type margins east of the Pacific and 90° island arc-type margins west of the Pacific; terminated with the Collisional/Himalayas state; Fig. 1), the *Orogenic Cycle* (180° Pacific state; 180° collisional mountain belt state), and the *Cycle of the Collisional Mountain Belt* (Figs. 2-4). This series is headed in the east by the *Cycle of Continental Margins* or *Miogeosynclinal Cycle* (Fig. 7) and is succeeded in the west by the *Cratonic Cycles,* both types with a length and duration of more than 360°.

One east drift lapping of the Earth's crust by the shape of the Pacific/Tethys or any one of the three 360° Global Tectonic Megacycles during the younger history of the Earth lasted approximately 200 to 250 m.y., taken from the differences in age between the overlapping segments of the first completed lap and the second, still incompleted lap of the Late Palaeozoic - Mesozoic - Cenozoic collisional mountain belt spiral in Asia (Figs. 2-4; calculated with 250 m.y.: some 16 cm/y or 0.44 mm/d east drift at the equator or growth of the collisional mountain belt towards the east).

Pangaea (all continental crust, past and present) consists of a North Pangaea and a South Pangaea (a North and a South Pangaea collisional mountain belt spiral) roughly distributed in the northern and southern hemispheres, whereby simultaneously and alternately one is always growing while the other is

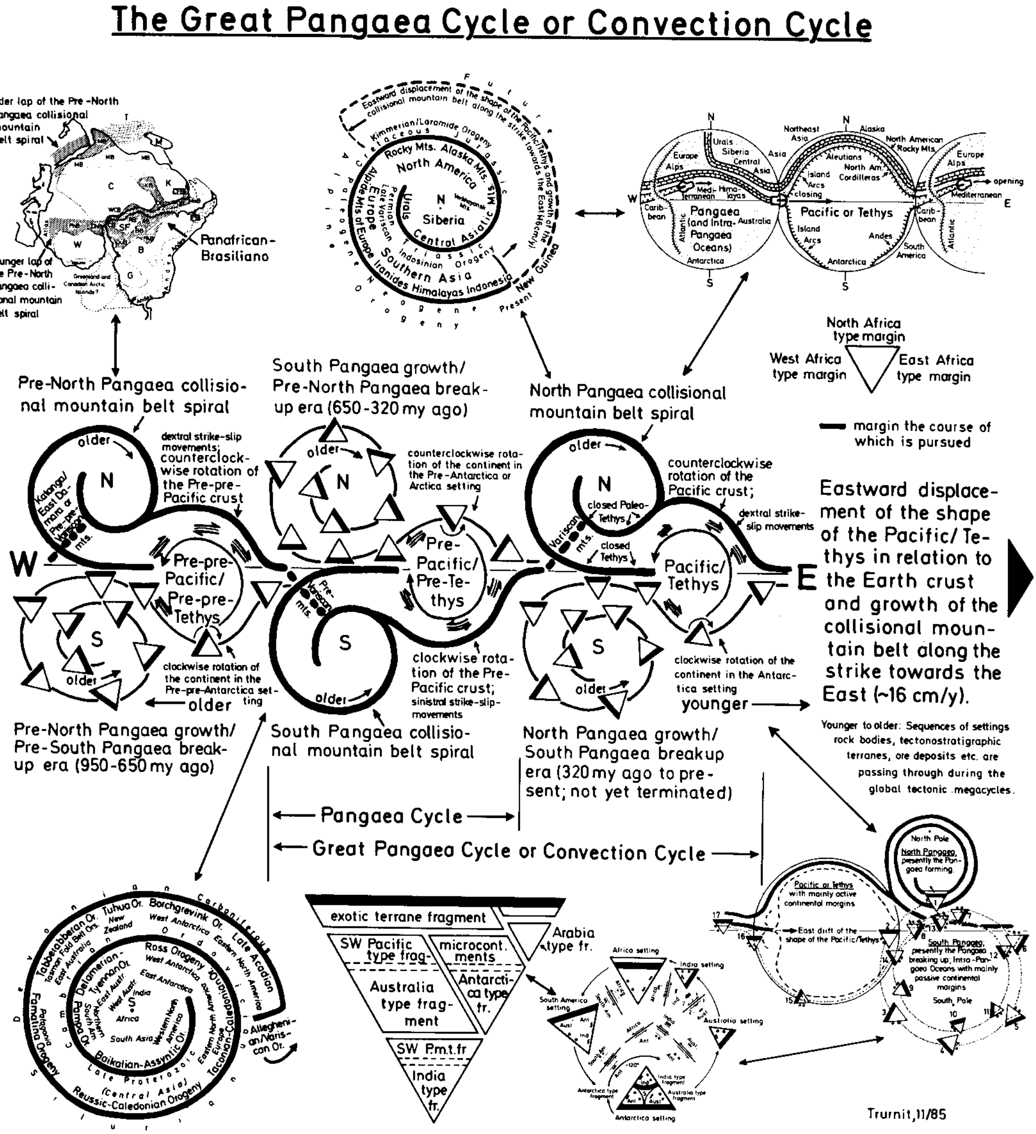



Fig. 8.—The Great Pangaea Cycle or Convection Cycle: Two Global Tectonic Megacycles of 360°/200 to 250 m.y. duration (Oceanic Cycle or Wilson Cycle, Orogenic Cycle, Cycle of the Collisional Mountain Belt, etc.) make one Pangaea Cycle; two Pangaea Cycles amount to one Great Pangaea Cycle or Convection Cycle. Pangaea Cycle and Great Pangaea Cycle are comparable to the 11 year and 22 year sunspot cycles (magnetic solar cycles).

breaking up. Since the Permian, a North Pangaea has been growing and feeding on the last South Pangaea breaking up simultaneously (Figs. 2, 4, 7). During the Late Proterozoic and Early to Middle Palaeozoic (approximately from 650 m.y. to 320 m.y. ago), a South Pangaea has been growing, while a pre-North Pangaea was breaking up. The Earth's history appears to be subdivided into alternating North Pangaea growth/South Pangaea breakkup eras and South Pangaea growth/North Pangaea breakup eras (Fig. 8). Approximately two neighbouring cycles of the three 360° Global Tectonic Megacycles, two East drift lappings of the Earth's crust by the shape of the Pacific or some two laps of the collisional mountain belt spiral correspond to one *Pangaea Cycle* between two Pangaea reorganization eras. Two Pangaea Cycles correspond to one *Great Pangaea Cycle* or *Convection Cycle* (Figs. 7, 8). The Pangaea Cycle is comparable to the 11 year sunspot cycle (magnetic solar cycle), the Great Pangaea Cycle to the 22 year sunspot cycle that is antisymmetrical about the equatorial plane.

The North Pangaea area and the South Pangaea area are comparable to a pair of cogs rotating against one another (Figs. 7, 8). However, in relation to the Earth's crust, the continents or plates remain more or less fixed to their longitudes on which they only move polewards and towards the equator (pendular movement), while the shape of the Pacific moves eastwards between them. Antarctica has moved southwards from lower latitudes during the Cretaceous/Tertiary along the longitudes of South America only on a grid related to the shape of the Pacific. On a grid related to the Earth's crust, it has come from a position on the equator west of the East Pacific Rise.

Each reorganization of Pangaea disrupts the series of Global Tectonic Megacycles. It causes fragmentation of the previously grown collisional mountain belt spiral and rotations of the resulting continents and continental fragments (Figs. 2, 6-8). The way in which the Variscan mountain belt of Europe connects at approximately right-angles the Urals with the Appalachians - Caledonides (Figs. 3, 6, 8) points to an interruption of the collisional mountain belt during the period of reorganization from a North to a South Pangaea growth and vice versa, by mountain ranges made up of island arc-type margins or a combination of island arc-type margins and Cordilleran-/Andean-type margins, which are not joined together on a parallel with equator basis. The Late Palaeozoic scenario for the Variscan mountain belt is a reflected image of today's West Pacific setting with the South Pangaea collisional mountain belt spiral having just been completed (Late Acadian collision between North America and Europe) and the Palaeozoic Pacific/Iapetus Ocean in a state of reorganization. In the southern hemisphere, the Marathon-Quachita-Alleghenian belt is arranged from South to North up to the equator in a setting comparable with the present-day NW-Pacific island arcs and backarc basins. In the northern hemisphere the European Variscan belt is arranged from the equator towards the North in a setting comparable with the present-day SW-Pacific island arcs and backarc basins. The opposite side of the belt (in Europe some-where South of the Moldanubian Region) must have been a Cordilleran-/Andean-type of setting east of the Pacific. Dextral strike-slip must have sheared off a large amount of this former eastern part (today's southern part) of the Variscan belt during the northward migration of Laurentia (North America and Europe) in the Late Carboniferous and Permian (collision of Laurentia with Kasakhstania/Siberia; initiation of the North Pangaea collisional mountain belt with the formation of the Urals).

*Pendular movements and rotations of continents*

During one east drift lapping of the Earth's crust by the shape of the Pacific the continents of the northern and southern hemispheres move differently, in that their margins pass through different sequences of plate tectonic settings:

In the hemisphere of the Pangaea growing (since the Permian the northern hemisphere) the continents always face the equator or the Pacific with their collisional mountain belt margin. Otherwise a collisional mountain belt spiral would not form. As the continents move around the shape of the Pacific in the North, they are subjected to a pendular movement (alternating clockwise and counterclockwise rotations combined with movements between high and low latitudes). The continent in the North America setting rotates clockwise after the opening of a respective North Atlantic and a respective Mediterranean/Caribbean and the continent in the setting of Alaska/East Asia rotates counter-clockwise (opposite rotations during a South Pangaea growth era). Since the Permian, the Cordilleran-type margin east of the Pacific develops into the NW-Pacific island arc-type. Both types at present are remobilized segments of the older lap of the North Pangaea collisional mountain belt spiral. The Late Jurassic onesided Nevadan and Sevier «orogenies» of Southwestern North America should represent the embryonic or pre-collisional Cordilleran and NW-Pacific island arc-states, east, in front and ahead of the two-sided, Late Cretaceous Laramide collision to the west of the Late Mesozoic Pacific/Tethys.

In the hemisphere of the Pangaea breaking up (since the Permian the southern hemisphere) the continents rotate through approximately 120° in the Antarctica setting (clockwise during the breakup of a South Pangaea —Permian to present; Figs. 2, 6-8; counterclockwise during the breakup of a North Pangaea – Late Proterozoic and Early to Middle Palaeozoic). Since the Permian, the Andean-type margin east of the Pacific evolves from a passive West Africa-type and develops into a collision-type margin to the west of the Pacific. The SW-Pacific island arc-type margin evolves from a passive North Africa-/West Antarctica-type that still might carry fragments from the southern parts of the collisional mountain belt (e.g. Atlas; parts of the northern Andes of Columbia and Venezuela; West Antarctica; New Zealand) the main parts of which migrate around the shape of the Pacific in the form of «exotic, suspect, displaced, allochthonous or tectonostratigraphic terranes» in the north together with the collisional mountain belt forming at present.

### *Breakup of continents*

In the southern South America and Antarctica settings, a South America-type continent breaks up into several fragments (Fig. 9). Generally accepted and visible evidence of these events only is the separation of Australia from Antarctica during the Tertiary. Apart from this breakup, one of the three margins of a South America-or of an Africa-type continent is scaled off twice during one east drift lapping by the shape of the Pacific or one 360° Global Tectonic Megacycle: Firstly the North Africa-type margin during its separation from the collisional mountain belt in the Mediterranean setting. Major parts of this margin remain attached to the collisional mountain belt of the Pangaea growing (tectonostratigraphic terranes). Only relics of the belt remain with the newly formed passive North Africa-type margin (Atlas, parts of the Northern Andes, West Antarctica). Secondly, the East Australia/SW-Pacific island arc-type margin (former North Africa-type margin). With the SW-Pacific island arcs and microcontinents (e.g. New Zealand, Fiji) most relics of the old collisional mountain belt lap are finally integrated into the new or younger lap of the belt. The SW-Pacific island arcs and microcontinents from one continent are pushed north into the collisional mountain belt to the west of the Pacific by the succeeding continent: Those of East Africa by India, those of India by Australia, those of Australia in future by Antarctica, etc. If a fragment of the old lap of the collisional mountain belt spiral once again fails to be incorporated into the new lap of the spiral, it will become an exotic splinter of orogen at a passive East Africa-type margin (Cape Folded Belt of South Africa – foreland belt of the Indosinian orogen; the Sierra de la Ventana in Argentina). There it has to wait until it is again the turn of the margin to collide to the west of the Pacific.

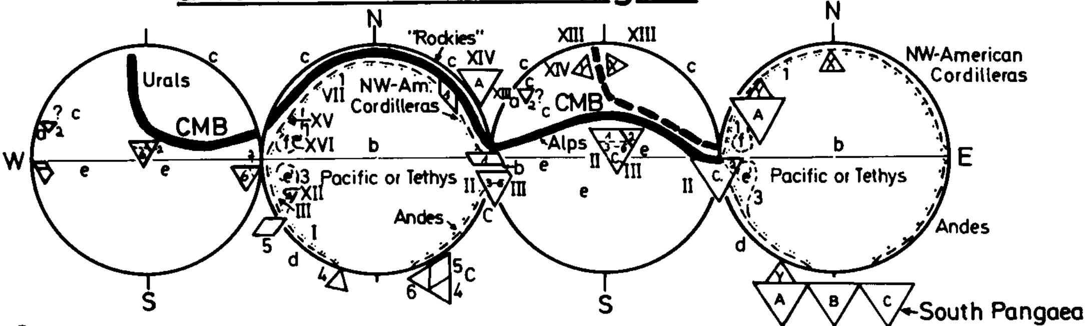
### *The Cycle of Continental Margins or Miogeosynclinal Cycle*

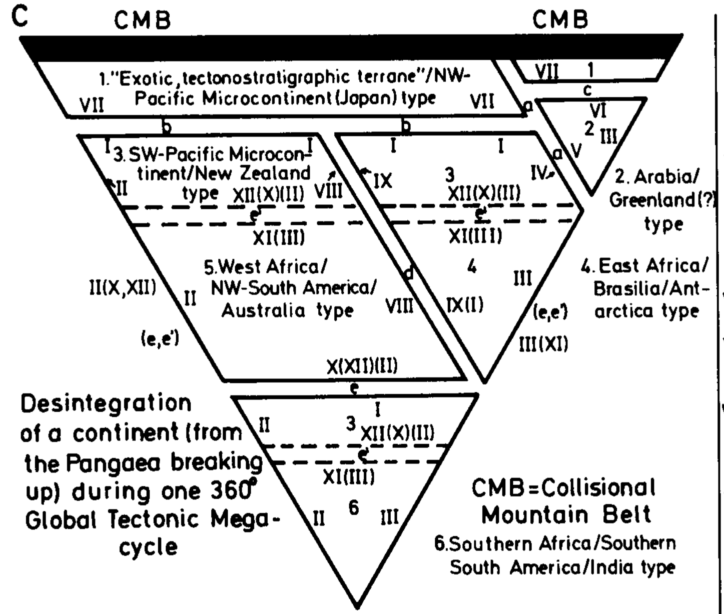
Less than one third of all continental margins become active and collide to the west of the Pacific during one Oceanic, Eugeosynclinal or Wilson Cycle (Figs. 1, 6). Together with their miogeosynclinal sediments they are subjected to the *Cycle of Continental Margins* or *Miogeosynclinal Cycle* (Figs. 6, 7). Depending on the plate tectonic setting of a new rift or opening ocean, there is a wide range of possibilities for the duration of a Cycle of Continental Margins. Generally, a Cycle of Continental Margins of a continent from the Pangaea growing has to be distinguished from that of a continent from the Pangaea breaking up.

→

Fig. 9.—Types of oceans, continents/continental fragments/microcontinents/terranes and continental margins that form during a 360°/200 to 250 m.y. Global Tectonic Megacycle or one east drift lapping of the Earth's crust by the shape of the Pacific (equatorial view); Pacific/Tethys and collisional mountain belt shown according to Fig. 6 (1); sequences of settings that the continents and their fragments pass through according to Fig. 6 (2).

# Types of Oceans, Continents/Continental Fragments and Continental Margins




## Types of continental margins

I. North Africa/Northern South America/West Antarctica/Southwest Pacific Microcontinent or Island Arc (Pacific side) type
II. West Africa/Andes/New Guinea type(X,XII)
III. East Africa/East Arabia/East Greenland(?)/SW-Pacific backarc basin (continental side) type(XI)
IV. African Red Sea/NE-South America type
V. Arabian Red Sea/Greenland Labrador Sea(?) type
VI. Arabian Persian Gulf/North Greenland(?)/Arctic A(?) type
VII. Northern Mediterranean/NE-Pacific/Exotic tectonostratigraphic terrane/NW-Pacific Island arc-Microcont.(Pacific side) type.
VIII. Australia(Antarctica side) type
IX. Antarctica(Australia side) type
X. Australia(India side) type(XII)(II)
XI. India(Australia side) type(III)
XII. SW-Pacific Microcontinent or Island Arc (backarc basin side) type(X)(II)
XIII. Eastern North America/Northern Europe and Northern Asia/Arctic B type
XIV. Western Europe/Northern North America/Arctic C type
XV. Northwest Pacific backarc basin (continental side) type
XVI. Northwest Pacific Microcontinent or Island Arc (backarc basin side) type

## Types of continents and continental fragments

A. North America type
B. West Gondwana (South America/Greenland?/Africa/Arabia/Tibet etc./South China/Madagascar) type
C. East Gondwana or Wegneria (India/Australia/New Zealand/Antarctica) type
X. Asia (Kasakhstania/Siberia) type
Y. Europe type
(AY=Laurentia; AYX=Laurasia or North Pangaea; BC=Gondwana; ABC=South Pangaea)

1. "Exotic tectonostratigraphic terrane"/NW-Pacific Microcontinent (Japan) type
2. Arabia/Greenland(?) type
3. Southwest Pacific Microcontinent (New Zealand) type
4. East Africa/Brasilia/Antarctica type
5. West Africa/Northwestern South America/Australia type
6. Southern Africa/Southern South America/India type

## Ocean types

a) Red Sea/Baffin Bay(?) type
b) Mediterranean/Caribbean/Pacific type
c) Persian Gulf/Arctic/North Atlantic type
d) Southeast Indian Ocean type (Ocean between Antarctica and Australia)
e) Bay of Bengal/Arabian Sea/Indian Ocean/South Atlantic type
e') Southwest Pacific backarc basin type
f) Northwest Pacific backarc basin type

◀ West drift of the Earth's crust (continents, oceanic crust) in relation to the shape of the Pacific and to the upper and/or lower mantle.

East drift of the shape of the Pacific and of the upper and/or lower mantle in relation to the Earth's crust; eastward growth of the collisional mountain belt. ▶

Trurnit, 3/84

In the hemisphere of the Pangaea growing (today's northern hemisphere), one of a continent's three margins, the newly formed passive northern Mediterranean-type margin, is soon converted into an active Western North America-/Cordilleran-type which afterwards develops into a NW-Pacific island arc-/East Asia-type margin before it is again integrated into the collisional mountain belt. During this period it is either facing the equator or the Pacific. The remaining two margins stay passive (pendular movement between an Arctic-type and a North Atlantic-type of setting) up to the next Pangaea reorganization era.

In the hemisphere of the Pangaea breaking up (today's southern hemisphere) only one of a continent's three margins (West Africa-type) will be converted into an active margin with a subduction zone (Andean-type) during one east drift lapping of the Earth's crust by the shape of the Pacific, while the remaining two (the North Africa-type; the East Africa-type) still retain their passive states.

A passive margin that originated in a West Antarctica-/SW-Pacific backarc basin-type of setting will need 2 to 2.5 east drift lappings by the shape of the Pacific to terminate its Cycle of Continental Margins in the collisional mountain belt to the west of the Pacific. If it is involved in a Pangaea reorganization before becoming active, it has a good chance of being forced to remain in an Arctic-/North Atlantic-type of setting (on the northern hemisphere during a North Pangaea growth era; on the southern hemisphere during a South Pangaea growth era; e.g. today's western margin of North America during the Late Proterozoic/Palaeozoic) for the period of one Pangaea Cycle, before another opportunity arises after the subsequent Pangaea reorganization for it to take up its interrupted course towards collision to the west of the Pacific. In the event of the margin under consideration being involved in an active state in a Pangaea reorganization, it will be incorporated into a Variscan-type of mountain belt.

### *The Cycle of the Oceanic Crust and Eugeosynclinal Sediments or Ophiolitic Cycle*

The greatest part of the oceanic crust exists at most for one Oceanic, Eugeosynclinal or Wilson Cycle (Figs. 1, 6) at the Earth's surface (200 to 250 m.y.) between its generation along the mid-oceanic ridges and its disappearance in the subduction zones. Only a small percentage is incorporated as ophiolites into the collisional mountain belt originating to the west of the Pacific. Oceanic crust, however, does not simply pass through the Oceanic Cycle. It is subjected to the *Cycle of the Oceanic Crust and Eugeosynclinal Sediments* or *Ophiolitic Cycle*. During the tensional part of this cycle the oceanic crust is joined to the passive margins of the continents (being subjected to the Cycle of Continental Margins and in the hemisphere of the Pangaea breaking up rotating through approximately 120° during one East drift lapping by the shape of the Pacific) up to that setting, where the West Africa type margin is converted into an Andean-type. Around the margins of the Intra-Pangaea Oceans (Atlantic, Red Sea/Indian Ocean, etc.) the oceanic crust in the hemisphere of the Pangaea breaking up is subducted successively into the Antilles-type, the South Sandwich-type and into the Indonesia-type of subduction zones and, after having become part of the Pacific following the conversion of the West Africa-type margin into an Andean-type, finally into the Andean-type subduction zone (sequence of plate tectonic settings: east of Australia, east of India/east of Africa, east of South America, north of Antarctica – South Atlantic/Indian Ocean; west of Australia, west of India/west of Africa; west of South America; Figs. 2, 6-9). In the remaining circum-Pacific subduction zones, oceanic crust will be subducted which has mainly been generated west of the East Pacific Rise. In the hemisphere of the Pangaea growing the oceanic crust not subducted in the Pacific area (NW-Atlantic, Arctic Ocean) should be subducted into an Antilles-type subduction zone of greater extent than the present zone and in an Arctic setting into a Verkhoyansk-/South Anyuy-type of subduction zone (Verkhoyansk and South Anyuy mountains of NE-Asia) which does not exist at present. Thus, the Cycle of the Oceanic Crust and Eugeosynclinal Sediments or Ophiolitic Cycle is interposed between the Oceanic, Eugeosynclinal or Wilson Cycle and the Cycle of Continental Margins or Miogeosynclinal Cycle. From its duration it is connected to the Oceanic Cycle, from the sequence of its plate tectonic settings, to the Cycle of Continental Margins.

With regard to the formation of oceanic crust, the ophiolites from the backarc basins of the West Pacific appear to be much younger compared to the ophiolites from the Pacific crust (less than 0.25 of an Oceanic Cycle before collision).

The oceanic crust from the Intra-Pangaea Oceans (including backarc basins of the West Pacific) and the oceanic crust from the Pacific might possibly pass each through a separate and independent convective cycle. Masses in the hypocycloid gearing Earth (Fig. 5) would not be required in such case and the Pacific crust might even belong to the lower mantle cooling in its own convective system at the Earth's surface. In that case the rotating Pacific plate (counterclockwise during a North Pangaea growth era – Premian to present; Saint Amand 1961; Benioff 1962; Allen 1965; Trurnit 1984c, 1986a; clockwise during a South Pangaea growth era) should have a counterflow above the lower mantle-core boundary (Hawaiian islands hot spot track). Answering that question depends, amongst other things, on finding out how the West Africa-type margin is converted into an Andean-type (rupture of the passive margin or «collision» of the Antilles-type and South Sandwich-type island arcs with the West Africa-type margin; Dietz 1963; Dewey 1969; Dewey and Bird 1970; Burke *et al.* 1984).

## THE REASSEMBLY OF GONDWANA AND OF SOUTH PANGAEA AND THE LATE PROTEROZOIC AND EARLY TO MIDDLE PALAEOZOIC COLLISIONAL MOUNTAIN BELT SPIRAL OF SOUTH PANGAEA

The continents and continental fragments India, Australia/New Guinea, New Zealand with its surrounding plateaus and Antarctica formed the megacontinent of East Gondwana during the Mesozoic (Figs. 9, 10). It broke up during the Late Cretaceous/Tertiary while passing through the southern South America and Antarctica settings (Figs. 2, 6-9). Between South America and East Gondwana lay a proto-South Atlantic Ocean. The proto-North Atlantic, if it existed at all, should have merged into the Cordilleras/Rocky Mountains of today's Western United States territory and into the Arctic Region (Columbia River Line?). During the Early Mesozoic there existed a West Gondwana megacontinent (South America/Greenland(?)/Africa/Arabia and attached to it from today's South to today's north along the east coast of Africa Madagascar, China, Tibet, etc., the latter two of which were lost to smaller Asia or Kasakhstania/Siberia after the Triassic Indosinian collision). Between West Gondwana and East Gondwana lay a pre-pre-South Atlantic. The pre-pre-North Atlantic merged into the Verkhoyansk and South Anyuy Mountains of NE-Asia (around the Kolyma block of Gondwana descent; Churkin and Trexler 1980) and into the Arctic Region (Fig. 10).

A correct reconstruction of the Late Proterozoic and Early to Middle Palaeozoic South Pangaea, of the Mesozoic Gondwana and of its collisional mountain belt spiral has to observe the following conditions:

1. The collisional mountain belt has to become progressively older from east to west.
2. The younger lap of the collisional mountain belt spiral has to face the equator, the older lap the South Pole.
3. The collisional mountain belt during the whole of its eastward growth had to be orientated parallel with the equator or in the southern hemisphere alongside the Palaeozoic Pacific or Iapetus Ocean.
4. The continents of the South Pangaea and of Gondwana, roughly triangular in shape, during the Mesozoic-Cenozoic during each east drift lapping by the shape of the Pacific or Tethys have each rotated clockwise through approximately 120° while passing through the Antarctica setting. Through reverse rotations of the megacontinents, continents and continental fragments to their Early Mesozoic and Palaeozoic orientations one arrives at the correct reassembly of Gondwana and South Pangaea with its collisional mountain belt spiral (Figs. 2, 6-10).

Due to the rotations of West Gondwana and East Gondwana and of their fragments during the Mesozoic and Cenozoic and the northward migration of Laurentia (North America and Europe) during the Late Carbo-

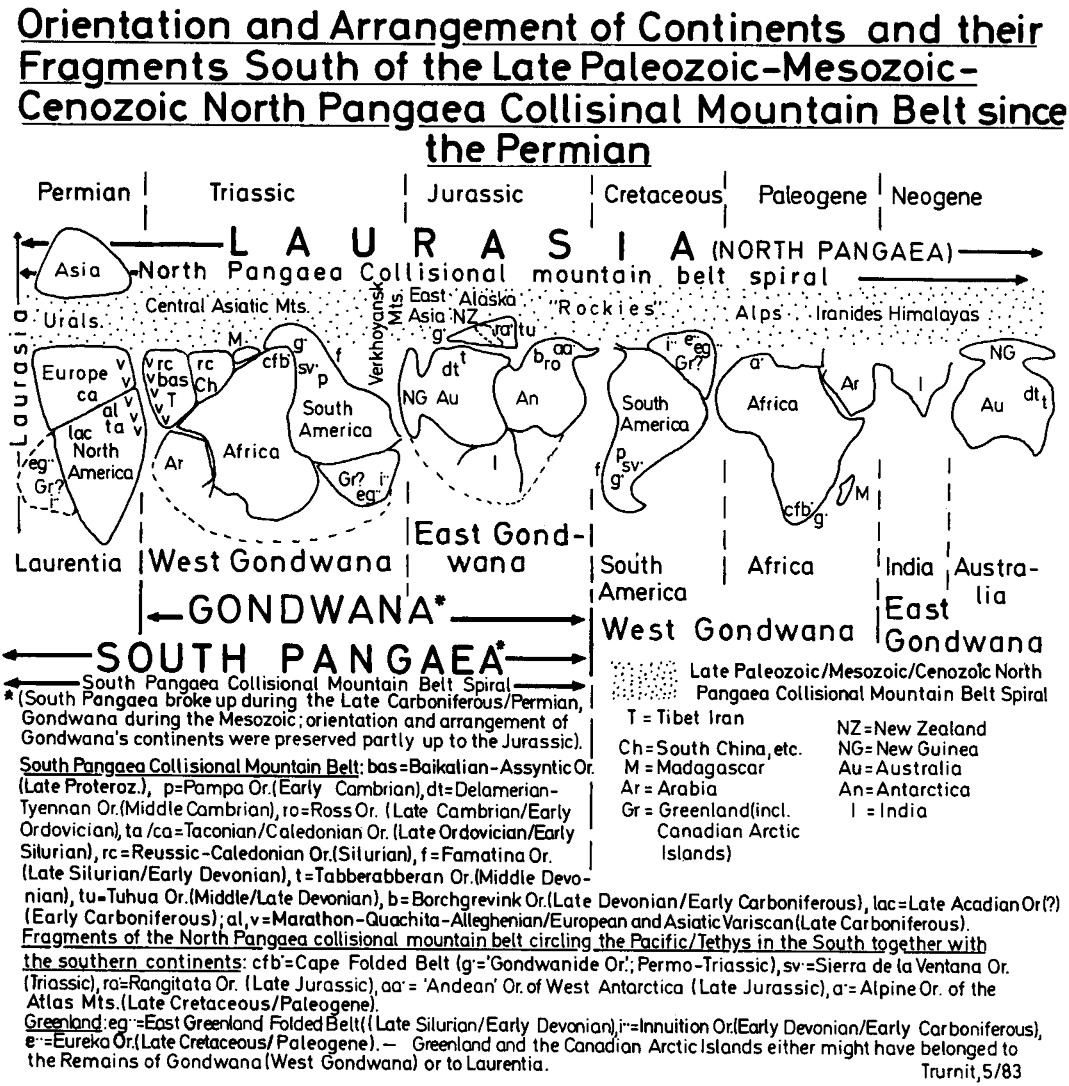



Fig. 10.—Orientation and succession of continents and continenal fragments south of the Late Palaeozoic-Mesozoic-Cenozoic collisional mountain belt after the collision of the northern and southern continents to the west of the eastward migrating shape of the Pacific/Tethys and before separating anew to the east of the Pacific in the Mediterranean/Caribbean settings (equatorial and Pangaea hemisphere views).

niferous and the Permian, South America and Antarctica during the Jurassic and Cretaceous only fitted loosely to- gether with the relics of the southern parts of the older lap of the North Pangaea collisional mountain belt spiral with West Antarctica (Antarctic Peninsula) and northwestern South America (Hilgenberg 1966) (Fig. 10).

The Appalachians-Caledonides orogenic belt (Phillips *et al.* 1976; Gee et al. 1983; Rickard *et al.* 1983; Gambles 1984; Watson 1984; Williams 1984; Barker and Gayer 1985; Gibbons and Gayer 1985; Keppie 1985; Roberts 1985; Trurnit 1985c; Figs. 10, 11) is that fragment of the two-lap South Pangaea collisional mountain belt spiral which migrated North together with North America and Europe (Laurentia) during the Late Carboniferous to collide during the Permian with Siberia/Kasakhstania to form the Urals, i.e. the beginning of the North Pangaea collisional mountain belt spiral and the nucleus of North Pangaea/Laurasia (Figs. 10. 11). The remaining West Gondwana and East Gondwana megacontinents collided till the Late Jurassic/Early Cretaceous with this Laurasia nucleus and transmitted a large part of the remaining South Pangaea collisional mountain belt spiral (mainly parts of the younger lap) to the older lap of the North Pangaea collisional mountain belt spiral from Central Asia (Indosinian collision) via NE Asia, Alaska, Canadian west coast and approximately down to the Columbia River Line of the Western United States (Kimmerian-Laramide collision to the west of the Pacific/Tethys; Churkin and Trexler 1980, 1981; Churkin 1983; Fujita and Newberry 1983; Saleeby 1983; Churkin *et al.* 1985; Howell 1985; Howell *et al.* 1985; Parfenov and Natalin 1985, 1986; Saito 1985; Xiong and Coney 1985). South America was the first continent which did not collide with a margin containing South Pangaea collisional mountain belt fragments (Laramide collision; Fig. 10). From the fragments of the South Pangaea collisional mountain belt spiral still remaining with the Gondwana continents in the southern hemisphere some will soon be incorporated via the SW-Pacific island arcs (Tuhua orogen/orogeny of New Zealand; parts of the Ross orogen of Antarctica) into the younger lap of the present-day North Pangaea collisional mountain belt spiral.

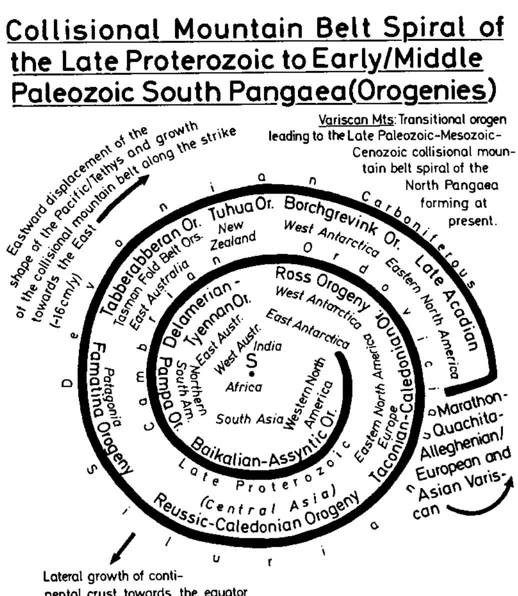



Fig. 11.–Collisional mountain belt spiral of the Late Proterozoic and Early to Middle Palaeozoic South Pangaea (South Polar view).

The Appalachians-Caledonides orogenic belt did not result from the closure of a proto-Atlantic Ocean (Argand 1924; Wilson 1966) but represents a fragment from the Late Proterozoic and Early to Middle Palaeozoic two-lap South Pangaea collisional mountain belt spiral marking the trail of the eastward migrating shape of the Palaeozoic Pacific or Iapetus Ocean (Figs. 10, 11). The Paleo-Iapetus was closed by the Taconian collision, the Neo-Iapetus by the Late Acadian collision. Palaeo—and Neo-Iapetus have their Mesozoic equivalents in the Palaeo- and Neo-Tethys.

Only the terranes Southeast of the Clinton-Norumbega-Fredericton Fault in Eastern North America (e.g. Meguma Terrane, Avalon Composite Terrane, Acadia Composite Terrane, etc.; Keppie 1985) were added to the North American continent after the Late Acadian collision between South Pangaea and Europe (the latter a fragment of the then disintegrating Pre-North Pangaea). The domain of terranes Northwest of the Clinton-Norumbega-Fredericton Fault and Southeast of the Brompton-Bay Verte Line (e.g. Gander Composite Terrane, Boundary Composite Terrane, etc.; Barker and Gayer 1985, Keppie 1985), an equivalent to the Central Domain of Stöcklin (1977) and the «Kimmerian Continent» of Sengör (1985a, b; 1986, 1987) between the Palaeo-Tethys and the Neo-Tethys sutures of the North Pangaea collisional mountain belt spiral, has been transferred to South Pangaea during the Taconian collision not from Europe but from a yet unknown continent of the pre-North Pangaea breaking up.

The succession of collisions (paroxysms of orogeny) of the individual segments of the reconstructed South Pangaea collisional mountain belt spiral (Figs. 10, 11) from the former east to the former west and from the younger towards the older is: Late Acadian (Appalachians-Caledonides of Eastern North America and Western Europe: Early Carboniferous), Borchgrevink (Antarctica: Late Devonian/

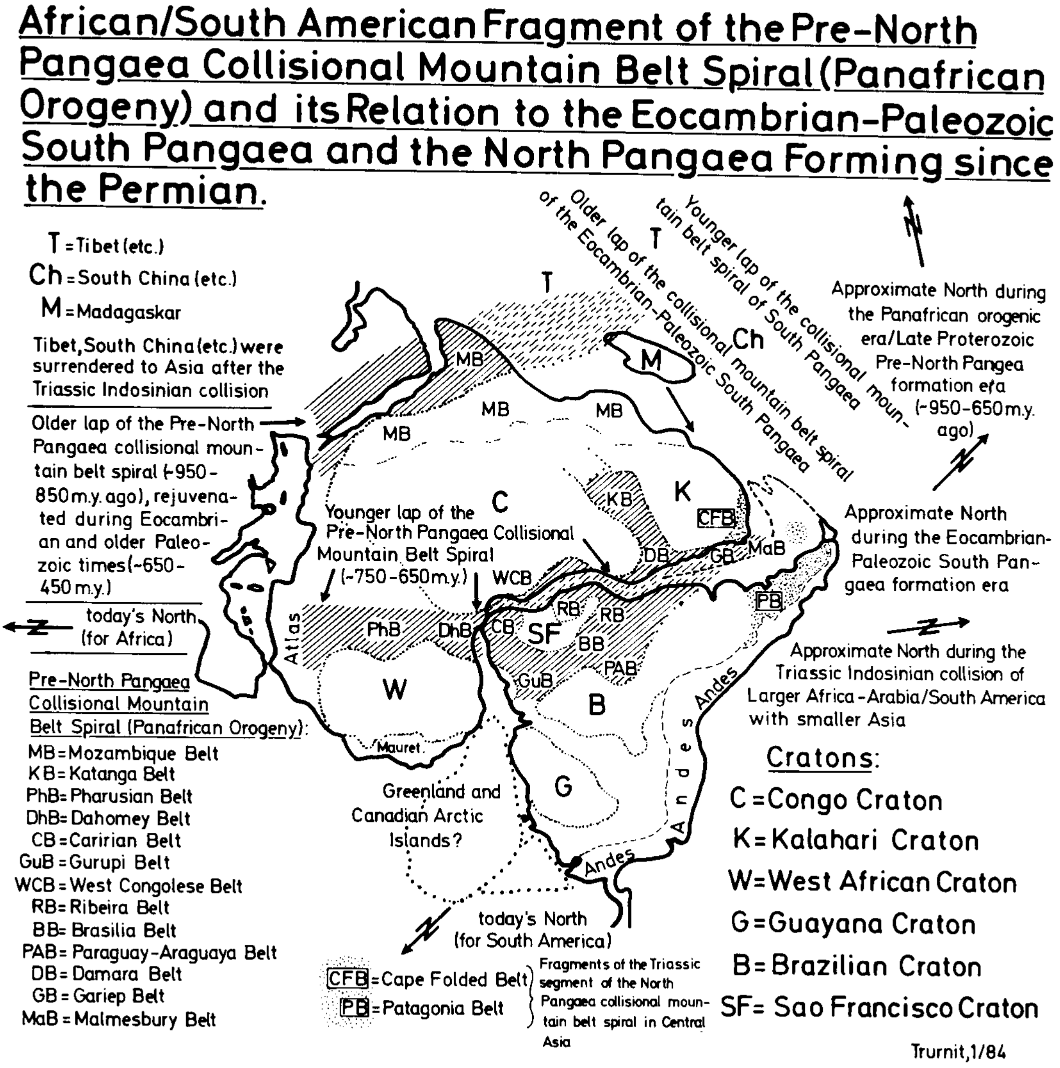



Fig. 12.—The South America/Greenland (?)/Africa/Arabia fragment from the pre-North Pangaea collisional mountain belt spiral; fragments off the east coast of today's Africa with segments from both laps of the South Pangaea collisional mountain belt spiral and a segment from the older lap of the pre-North Pangaea collisional mountain belt spiral were lost to smaller Asia after the Triassic Indosinian collision (closing of the Paleo-Tethys).

Early Carboniferous), Tuhua (New Zealand: Devonian), Tabberabberan (East Australia: Devonian), Famatina (Patagonia, South America: Silurian/Early Devonian), Reussic-Caledonian (South and Central Asia: Silurian), Taconian-Caledonian (Appalachians-Caledonides of Eastern North America and Western Europe: Ordovician/Silurian), Finnamarkian (Late Cambrian/Ordovician), Ross (Antarctica: Late Cambrian/Early Ordovician), Delamerian-Tyennan (East Australia: Cambrian), Pampa (Patagonia, South America: Early Cambrian), Baikalian - Assyntic - Cadomian (Central and South Asia, Europe, Eastern North America: Late Proterozoic) (Trurnit 1984c, 1985c) (Figs. 10, 11).

From the age of their orogenies, the East Greenland Folded Belt (Early Palaeozoic) and the Mauretanides-Rokelides Belt of West Africa (Late Proterozoic, Early and Middle Palaeozoic) (Grant 1973, Williams 1984, 1985, Barker and Gayer 1985, Deynoux *et al.* 1985, Dallmeyer 1986, Dallmeyer and Villeneuve 1986; Figs. 10, 12) should be segments of the South Pangaea collisional mountain belt. Greenland (the Arabia of South America; Arabia: The future Greenland of Africa?), however might be a part of West Gondwana and only moved into its present position during the Late Cretaceous/Tertiary (Figs. 9, 10, 12). The West African Mauretanides and Rokelides and the East Greenland Folded Belt might be a Verkhoyansk/South Anyuy-type of mountain belt in South Pangaea, a young segment of the pre-North Pangaea collisional mountain belt or part of a pre-Variscan-type of mountain range from the era of change from the pre-North Pangaea growth to the South Pangaea growth.

## THE LATE PROTEROZOIC PRE-NORTH PANGAEA

A fragment from the pre-North Pangaea collisional mountain belt spiral of Panafrican-Brasiliano age is shown on Figure 12 (Almeida *et al.* 1976, Shackleton 1976, Garson and Shalaby 1976, Kröner 1977, Bertrand and Davidson 1981). The Pharusian-Dahomey-West Congo - Brasiliano - Ribeira - Paraguay/Araguaya-West Damara-Gariep-Malmesbury segment of the pre-North Pangaea collisional mountain belt spiral during the pre-North Pangaea growth era (approximately from 950 m.y. to 650 m.y. ago) was most probably facing the equator and belongs to the younger lap, the Hijaz-Mozambiquian segment was facing the North Pole and belongs to the older lap. After the collision between the then smaller Asia (Kasakhstania/Siberia) and the formerly more extended SE/E-coast of greater Africa/Arabia (part of the West Gondwana megacontinent) during the Triassic Indosinian collision, parts of the Panafrican Mozambiquian segment from the pre-North Pangaea collisional mountain belt spiral (older lap) and of the former East African fragment from the South Pangaea collisional mountain belt spiral (both laps) (Figs. 10-12) remained attached to the Early Mesozoic Asia which at present displays a chaos of mountain ranges from five laps (only counting those of the last 950 m.y. and not taking into consideration Variscan-type of mountain belts) belonging to three different collisional mountain belt spirals (Fig. 8). Strike-slip movements along the trends of the belts and the agglomeration and mixture of tectonostratigraphic terranes during the growth of the individual spirals have additionally contributed to the chaos (Trurnit 1984a, c).

## CONCLUSIONS

The Earth's history appears to be subdivided into alternating North Pangaea growth/South Pangaea breakup eras and South Pangaea growth/North Pangaea breakup eras (Pangaea Cycles and Great Pangaea or Convection Cycles). In the hemisphere of the Pangaea growing, a collisional mountain belt continuously growing behind the eastward migrating shape of the Pacific, winds around a cratonic nucleus in the form of a two-lap spiral, thus affecting the lateral growth of continental crust, the cyclical repetition of orogenic events for a certain longitude and the Global Tectonic Megacycles.

The Appalachians-Caledonides orogenic belt has been found not to have resulted from the closure of an unitarian Palaeozoic Proto-Atlantic Ocean. Instead it represents a fragment of the double trail of the Palaeozoic Pacific (the closed Paleo-Iapetus Ocean and the closed Neo-Iapetus Ocean), i.e. a fragment of the two-lap South Pangaea collisional mountain belt spiral.

The strike-slip movements occurring along the trend of the collisional mountain belt spiral both in the Pangaea area and at the margins of the rotating Pacific plate, the formation of pre-collisional West Pacific island arcs and the agglomeration of these island arcs and of a large part of the separately rotated fragments from the Pangaea breaking up and from its old, dis-integrating collisional mountain belt spiral to the west of the Pacific into the new collisional mountain belt of the Pangaea growing, and the continental splinters scaled of post-collisionally in the Mediterranean/Caribbean settings to the east of the Pacific from the old disintegrating Pangaea and its old collisional mountain belt spiral and incorporated in the form of tectonostratigraphic terranes into the new collisional mountain belt of the Pangaea growing, demonstrate that the majority of continental crust (except for platform sediments yet unaffected by orogenic deformation) represents a gigantic puzzle. The difficulty of finding the pieces which once passed for some time as neighbours through the same sequence of plate tectonic settings, increases with age.

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