

BRAZILIAN MEGAFaultS

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ABSTRACT

The main known Brazilian continental faults with a length of more than 100 km were summarized in the text.

An attempt to describe their characteristics in the frame of the regional tectonic organization and evolution instead of just classifying them according to their geometric or genetic features, was done with the intention to bind these structures to the regional geological history. Brittle and ductile megashears, sutures, rifts, extensive thrusts, etc., which cut the $8,511 \times 10^6 \text{ km}^2$ of the Brazilian Precambrian basement and its Phanerozoic and volcano-sedimentary cover portray a typical evolution of an old tectonic platform similar to the Siberian, African, and other large and old continental areas of the world.

The most striking ductile shears are generally of Upper Proterozoic age, showing transpression and transtensional features. Large thrusts, brittle and ductile, border the Middle Proterozoic terrains being also considered of Upper Proterozoic age. Inside the older cratons such as the Amazon Craton, old grabens are infilled with Middle Proterozoic volcano-sedimentary formations or apparently conjugated faults are observed.

The opening of the Atlantic Ocean produced extensive activation of older lines of weakness and generation of rifts and grabens inside the continent and along the newly formed passive margin. The Takutu and Jurua lineaments are probably such features where spreading was aborted.

More recently, tectonic activity concentrated on some faults with compression near the Andean border and possible extension along the Atlantic border expressed, respectively, by the Iquiri and Batã faults and the Paraíba Rift System.

The term "gigafault" is proposed for some more expressive faults such as welded and aborted plate margins, actual plate margins or faults with an extension of several hundreds or thousands of kilometers.

Key words: Faults, Tectonics, Rifts, Suture, Lineament, Fracture, Brazil.

RESUMEN

El conocimiento de las fallas continentales de Brasil, de más de 100 km de largo, se resume en el texto. Se intenta describir sus características en el marco de la organización tectónica y evolución regionales, en vez de sólo clasificarlas de acuerdo a su geometría y génesis, con la intención de relacionarlas con la historia geológica regional. Los megacizallamientos frágiles y dúctiles, suturas, rifts, sobrecorrimientos, etc., que cortan los $8,511 \times 10^6 \text{ km}^2$ del basamento precámbrico Brasileño y su cobertura volcano-sedimentaria fanerozoica, presentan una típica evolución de una plataforma antigua similar a la Siberiana, Africana y otras áreas continentales antiguas en el mundo.

Las zonas de cizalle dúctil más impresionantes son, generalmente, de edad proterozoica superior, y muestran rasgos transpresivos y transtensionales. Grandes corrimientos, frágiles y dúctiles, rodean a los terrenos del Proterozoico medio y son consideradas, también, de edad proterozoica superior. En el interior de los cratones más antiguos, como el cratón Amazónico, antiguos grabens están rellenos con formaciones volcano-sedimentarias del Proterozoico medio.

La abertura del Atlántico produjo la reactivación extensiva de antiguas líneas de debilidad y la generación de rifts y grabens dentro del continente y a lo largo del entonces recientemente formado margen pasivo. Los lineamientos Takutu y Jurua son, probablemente, rasgos donde hubo expansión abortada.

Más recientemente, la actividad tectónica se concentró en algunas fallas con compresión cerca de los Andes y con extensión cerca del margen continental Atlántico, expresada por las fallas Iquiri y Batã y por el Sistema de "rift" Paraíba, respectivamente.

El término "gigafalla" se propone para algunas fallas más significativas, tales como márgenes de placas, soldados y abortados, márgenes actuales de placas y fallas con extensión de varios centenares o miles de kilómetros.

Palabras claves: Fallas, Tectónica, Rift, Sutura, Lineamientos, Fractura, Brasil.

INTRODUCTION

During the work of the 202 IGCP Project Megafaults of South America, a definition of megafaults as being those faults which have a length of more than 100 km has been proposed. Its application shows, however, some problems specially when one deals with major lineaments, fault swarms, longitudinal faults in fold belts, and fundamental faults, in terms of the proposition of the Russian geologists (Peyve, 1945). Lineaments, for example, have been defined very broadly in geological literature. One of the frequently accepted definition is that they represent important lines of the landscape which reveal the hidden architecture of the bedrock (*in O'Leary et al.*, 1976). Lattmann (1958) considered lineaments as linear features which exceed 3 km in length. Here we considered those usually thought to be faults longer than 100 km.

In cratonic regions and also along the major known fault systems of the world (San Andreas, Alpine, Moine, etc.) there is not something like a fault but a fault swarm. Generally, this may be related to fault splaying or lateral propagation of secondary faults above a major basement rupture. In some cases, flexures on basin borders belong to the brittle-ductile transition, expression of a superficial splaying of deeper basement faults.

Longitudinal faults are common in fold belts, and they have an important role in the evolution of the orogenic belts.

Peyve's (1945) term "fundamental fault" implies planar discontinuity surfaces which cut the whole crust until the mantle, sometimes hidden or detectable by indirect ways like the alignment of alkaline or ultrabasic intrusives, ophiolites, discontinuity of formations and, in general, of very complex and frequently polycyclic nature.

In this paper we could not avoid such questions. However, an essay of summarizing the knowledge of the better known Brazilian megafaults has been done although it is unfortunately possible that some linears which in our personal opinion are poorly known and were omitted, might be really proven to exist in future research.

The main Brazilian megafaults were focused excluding those of the continental margin which are supposed to be analyzed by another IGCP Project.

Avoiding exhaustive lists of faults and their main characteristics, an attempt to frame the megafaults into the tectonic organization of the South American Platform is here exposed.

GENERAL TECTONIC FRAME

Brazil is an extensive country of $8,511 \times 10^6$ km², occupying practically the whole of the South American Platform. Here, the term platform means the stable area in relation to the Andean Orogen (*Almeida et al.*, 1978). Figure 1 gives an idea of the tectonic scheme of the country.

The Brazilian oceanic border shows the characteristics of a typical passive margin while its extreme west shows some reflexes of the Andean evolution on the stable continent.

Basement rocks are composed of Precambrian formations from Archean (Jequie Cycle) to Upper Proterozoic (Brasiliano Cycle or Pan African in Africa) age. They are generally deeply eroded and exposed in the Central Brazil, Atlantic, Guayana and La Plata Shield areas.

The Phanerozoic sedimentary covers are more concentrated in the Amazon, Parnaíba and Paraná basins, and have Eo-Paleozoic to Recent ages.

During the opening of the Atlantic, these basins were strongly activated and affected by basic and alkaline volcanism from which the most famous manifestation were the Paraná Basin traps.

Linear rifting took place along the Takutu and Parnaíba rift systems and along the Transbrasiliano Lineament during Mesozoic and Cenozoic times.

The Precambrian basement rocks are organized as Upper Proterozoic fold belts surrounding older cratons composed by Middle-Lower Proterozoic and Archean formations. The main Upper Proterozoic fold belts are the Ribeira, Araçuaí, Brasília, Paraguai-Araguaia and the Northeastern Fold Systems. The cratons are the Amazon, São Francisco, São Luís, Rio de La Plata and Luís Alves cratons. Actually, the Rio de La Plata and Luís Alves are smaller units and the São Francisco is divided by the Espinhaço Belt into two pieces. The major

craton is the Amazon craton exposed on the Central Brazil and Guayana shields.

The Amazon Craton shows rocks of Middle Proterozoic (belonging to the Transamazonic Cycle (1,800 Ma) to Lower Proterozoic and Archean

ages. Cratonic covers of 1,400 to 1,700 Ma are widespread. The São Francisco Craton shows the same variety of ages and an Upper Proterozoic cratonic cover (Bambuï Group).

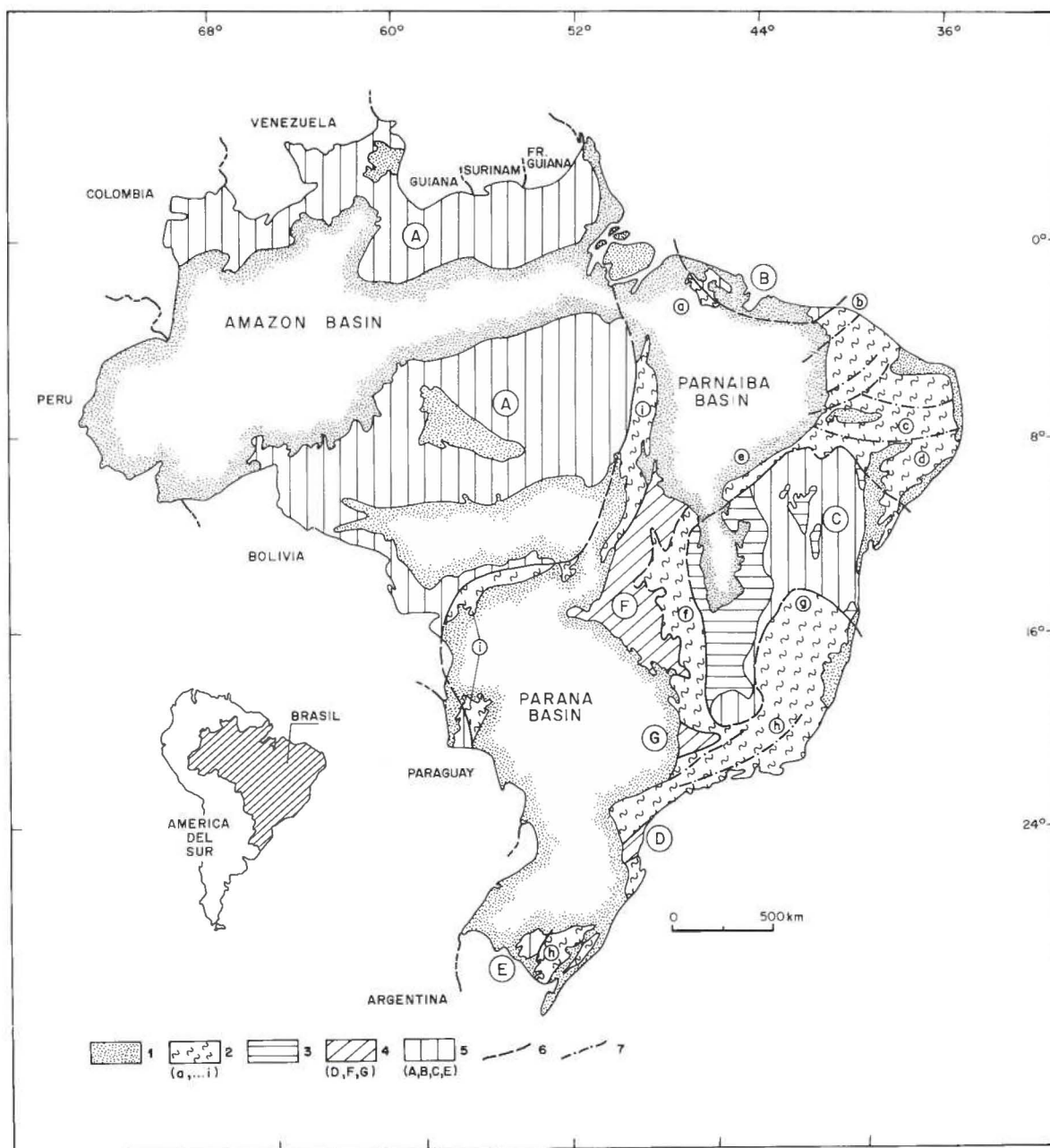
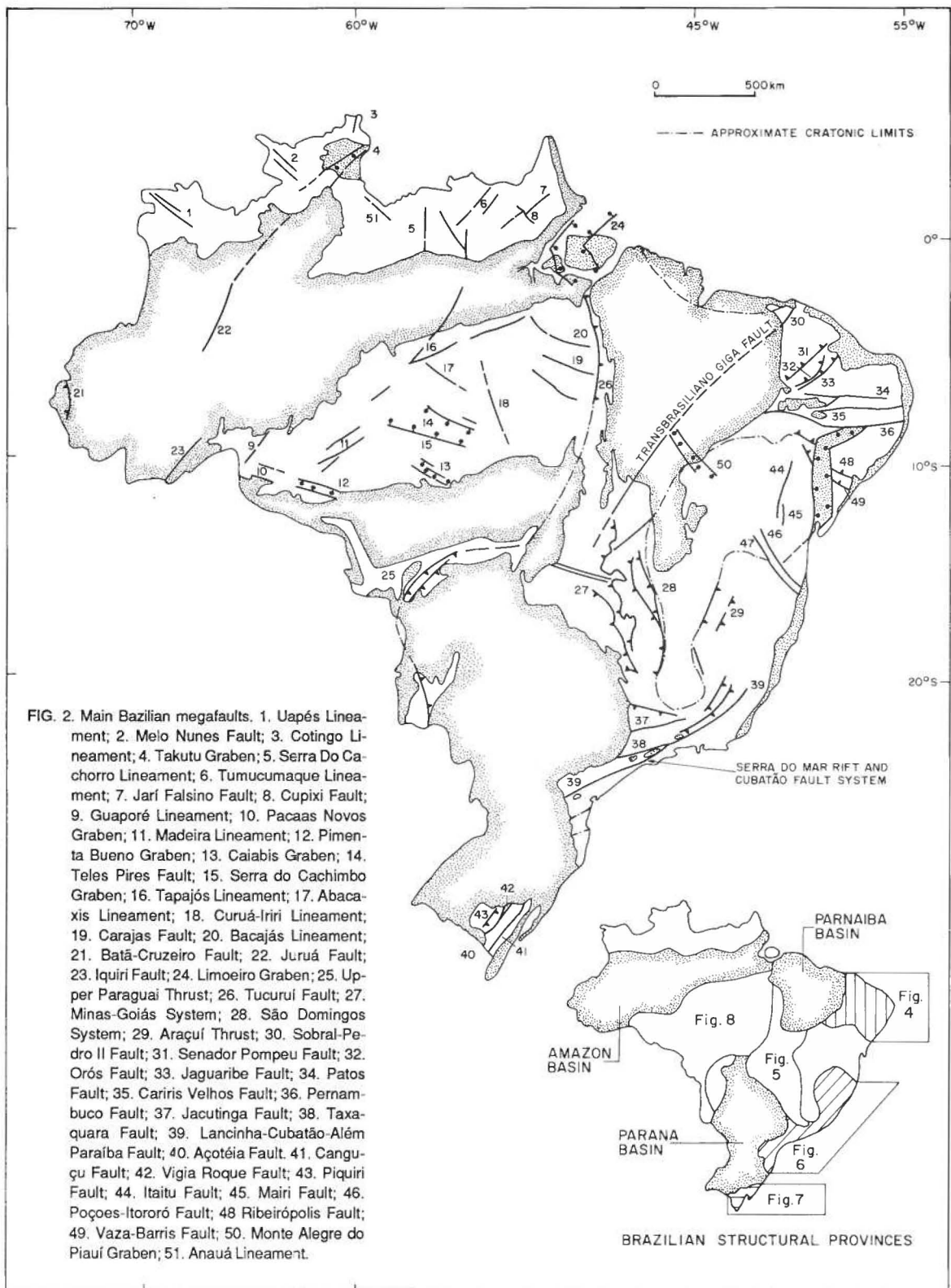


FIG. 1. Tectonic outline of Brazil. 1. Phanerozoic Cover; 2. Folded belts of Brasiliano age (470-700 Ma); a. Gurupi Belt; b. Médio Coreau Belt; c. Northeastern Fold Belt; d. Sergipano Belt; e. Rio Preto Belt; f. Brasília Belt; g. Araçuaí Belt; h. Southeastern (Ribeira) Belt; i. Paraguai-Araguaia Belt; 3. Bambuí Platformal Cover of Brasiliano age; 4. Archean Blocks and Median Massifs; D. Luis Alves; F. Goiás; G. Guaxupé; 5. Cratons; A. Amazon; B. São Luís; C. São Francisco; E. Rio de La Plata; 6. Cratonic limits; 7. Main internal tectonic block divisions.



ORGANIZATION OF THE FAULT SYSTEMS

As matter of better comprehension and fluency, the known megafaults were grouped according to criteria of regional tectonic evolution.

First, we describe those faults related to the Precambrian to Eo-Paleozoic evolution of the cratonic areas and the nearby belts and later, the old intra-plate faults. Then, the Meso-Cenozoic rifts are analyzed and the modern faults related to the Andean tectonics. Finally, other faults, which are still less known although very expressive are briefly cited.

FAULTS ORIGINALLY RELATED WITH PRECAMBRIAN TO EO-PALEOZOIC EVOLUTION OF CRATONIC AREAS AND MARGINAL FOLD BELTS

CRATONIC BORDER THRUSTS

Such faults are generally longitudinal and usually easier to define in modern fossiliferous and well exposed terrains than in old Precambrian and very erosion-flattened and also weathered terrains as are those of Brazil.

Next to the Amazon Craton. The eastern border of the Amazon Craton is delimited by a major suture zone with a linear sequence of ultrabasites first formally designated by Almeida (1974) as Tocantins-Araguaia Marginal Suture. As part of this structural feature, an about 400 km long north-south trending fault called Tucuruí fault by Trouw *et al.* (1976) was described. It placed mafic-ultramafics and phyllites of the Araguaia fold belt over sandstones and slates of the cratonic cover.

It was considered as post-metamorphic and the above mentioned authors, based on a 510 Ma K-Ar age found in an included basalt in the shear zone, considered this fault Upper Precambrian. The shear zone is about 200 m thick and a study of striae by Hasui and Matta (1984) allowed to define the thrusts' kinematics. Sadowski (1983) interpreted this suture zone as a result of the collision of the Amazonian Craton with a former cratonic mass which came from the east. The vergence is clearly to the west, and the tectonic polarity and the rising degree of metamorphism to the east allow to think of an east dipping Precambrian subduction zone (Fig. 3). After the collision, the eastern mass was probably fragmented and shear-

ed by extense transcurrent faulting described below.

Around the São Francisco Craton. Large thrust systems in the marginal belts around the São Francisco Craton are being gradually discovered. On its northern border, this craton is rimmed by the Sergipano Belt of presumably Upper Proterozoic age (Brasiliano). An extense overthrust or nappe system (Sadowski, 1983) may be seen throwing upper greenschist facies rocks on lower greenschists formations. It is the Ribeirópolis blastomylonitic schists belt with a length of more than 150 km. The age of the thrust is probably Upper Proterozoic, having in view that it is cut by a granite of Brasiliano age, and cuts metasediments of this cycle. Further to the south of this thrust system a high angle oblique slip fault zone called Itaparanga or Vaza Barris underlies the limit between the cratonic cover (Estancia Group) and the fold belt (Fig. 4).

On the western and eastern borders of the craton, extense thrusts affect the Bambuí Cover and miogeoclinal sequences. Although mapped, these structures are very poorly described with one exception in the Goiás State, studied by Drake (1980). This author suggested that some of the low angle faults around the São Francisco Craton, parts of which may be seen in the Caldas Novas tectonic window, might have overthrust older Araxá schists along a distance of about 200 km over the cratonic sediments of the Bambuí Group (Fig. 5).

The southern rim of the São Francisco Craton shows a very complex geology. Its marginal belts, generally of medium to high grade of metamorphism, are visibly cut by transcurrent faults of ductile and also brittle character. Gneisses in between these lineaments show frequent horizontally to subhorizontally folded cataclastic foliations. Some authors, after careful field studies, relate these features to a basement nappe tectonics (Campos Neto and Basei, 1983a). In such a context large thrusts were designated as Nappe de Socorro, Nappe de Igaratá, Guaxupé thrust wedge, etc. We believe, however, that the question of defining nappes in polymetamorphic and polyphasic gneissic terrains is rather controversial, specially in regions of Precambrian ages. Sadowski (1983, 1984) dis-

cussed that folded and stretched gneissic foliations with blastomylonitic structure could be related to different causes than thrust tectonics such as, for example: **a.** Basement reactivation in PT conditions slightly milder than those which originated the pre-existing rocks; **b.** Transpression effects between large transcurrent shear zones; and **c.** Syn or late kinematic deformation of gneisses.

In spite of this controversial situation, some structures are being accepted such as the Guaxupé Block or wedge. This unit (Figs. 2, 6) was first considered to be a median massif (Almeida *et al.*, 1976), and is represented by high grade metamorphics consisting of gneisses, granulites and charnockites apparently overlying rocks of lower degree of metamorphism rimmed by a belt of intensely deformed blastomylonitic rocks. Some of the cataclastic foliations were dated by Basei (1986, oral commun.) in about 660 Ma. No other really solid evidence of very large nappe structures has been shown although thrust faulting and smaller

nappes are being suspected in several places of the Ribeira Belt by different authors (Pio Fiore, oral commun.; Sadowski and Motidome, 1985; among others).

Next to the Río de la Plata Craton. An upthrust fault system called Piquiri, on the eastern border of the Río de La Plata Craton was described in a revision paper by Jost *et al.* (1984) (Fig. 7). It is composed by ramified cataclastic belts 200-1,000 m large dipping horizontally till 40° to the ESE and striking NNE. The thrusting was apparently towards the west and contracted wedges of sedimentary and epimetamorphic layers of Proterozoic age. The Piquiri faults are offset by a transcurrent fault system denominated Açoteia and were intruded by a syenite dated 570 ± 37 Ma (Cordani *et al.*, 1973). Jost *et al.* (1984) based on field data supposed that the Piquiri faulting took place after the folding of the Upper Proterozoic formations during the Brasiliano Cycle.

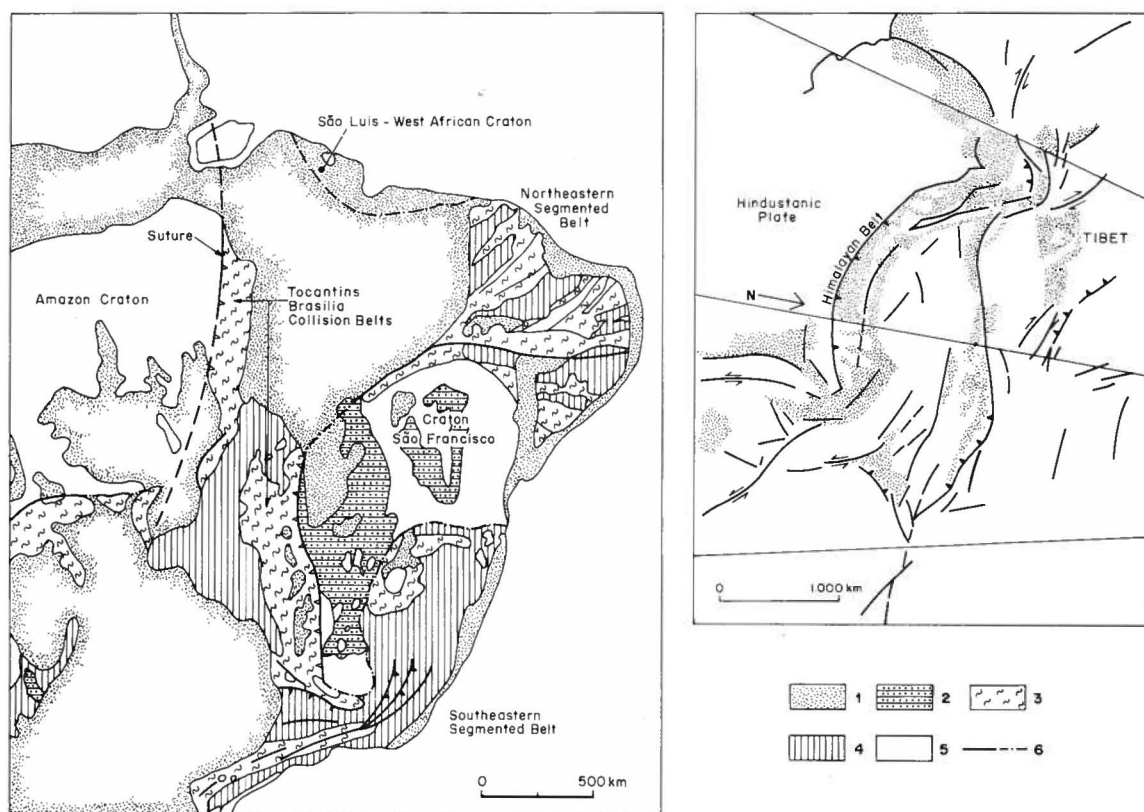


FIG. 3. Geometric analogy between the general structure of the Himalayan Collision Belt and adjacent areas with the Araguaia Suture zone and the Brazilian northeast (after Sadowski, 1983). 1. Phanerozoic Cover; 2. Brasiliano Cover; 3. Brasiliano Belts; 4. Reactivated basement by the Brasiliano cycle and older continental fragments; 5. Cratonic Basement; 6. Cratonic limits exposed, covered.



FIG. 4. Main faults of the north-northeast marginal belts of the São Francisco Craton (modified from Brito Neves, 1983).
1. Sedimentary cover; 2. Precambrian areas; 3. Structural trends; 4. Fault; 5. Thrust fault.

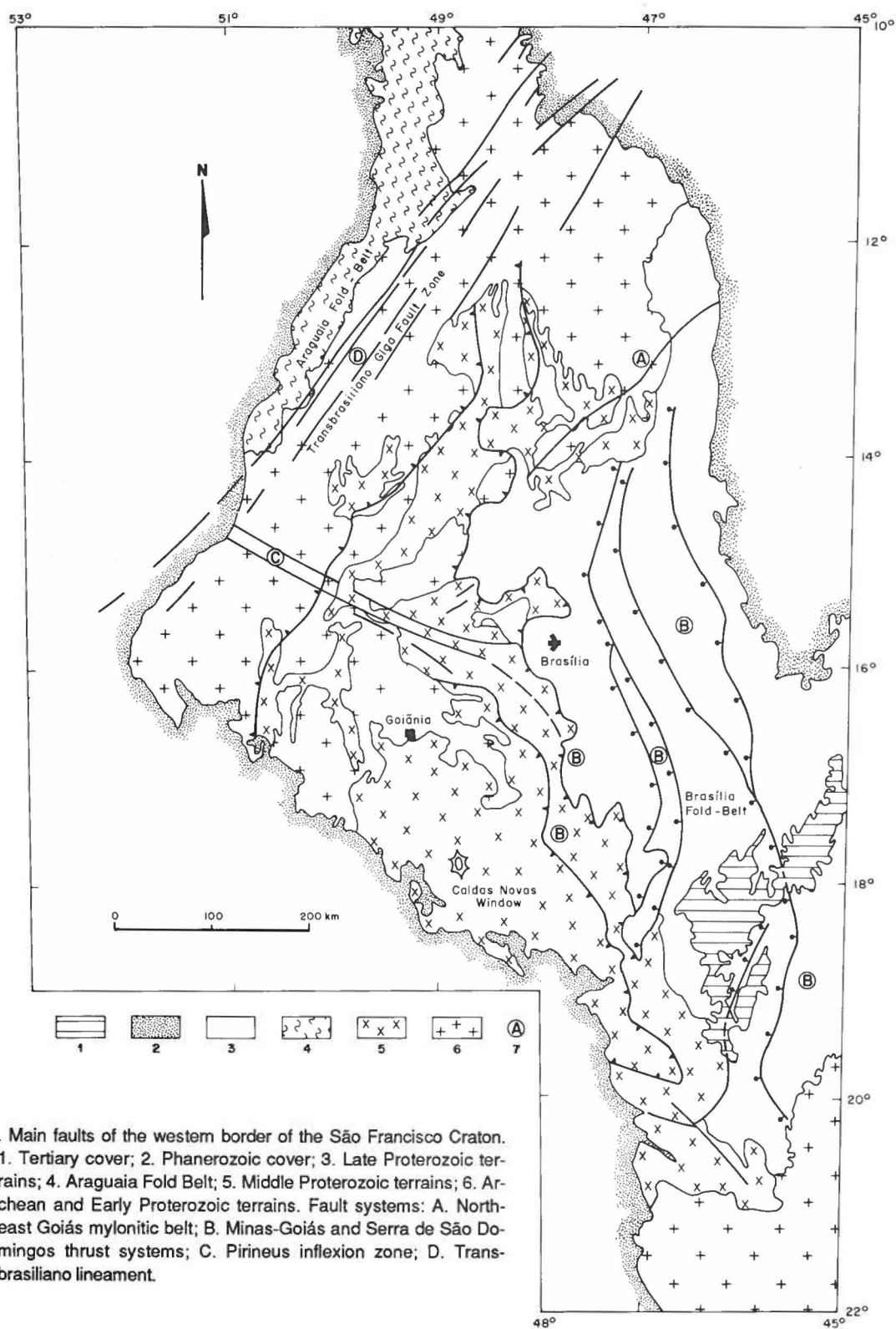
INSIDE THE CRATON

Amazon Craton. The Guayana and Central Brazil shields are mostly represented by the old terrains of the Amazon Craton. Both shields show, inside the craton, large shear zones striking around N60°E and N20-60°W (Fig. 8).

These shear zones are usually lineaments composed by fault swarms and show local names such

as Bacajas, Abacaxis, Juruena, Madeira, Guapore, Tumucumaque, Jari-Falsino and Oiapoc lineaments and, in a more direct way, Melo Nunes, Marauia, Uraricoa and Cupixi faults.

Possibly, some lineaments, especially those trending N60°E and N60°W, visible in the SLAR (Side Looking Radar Imagery) and LANDSAT images, are conjugates related to an east-west main tectonic compression. However, some published



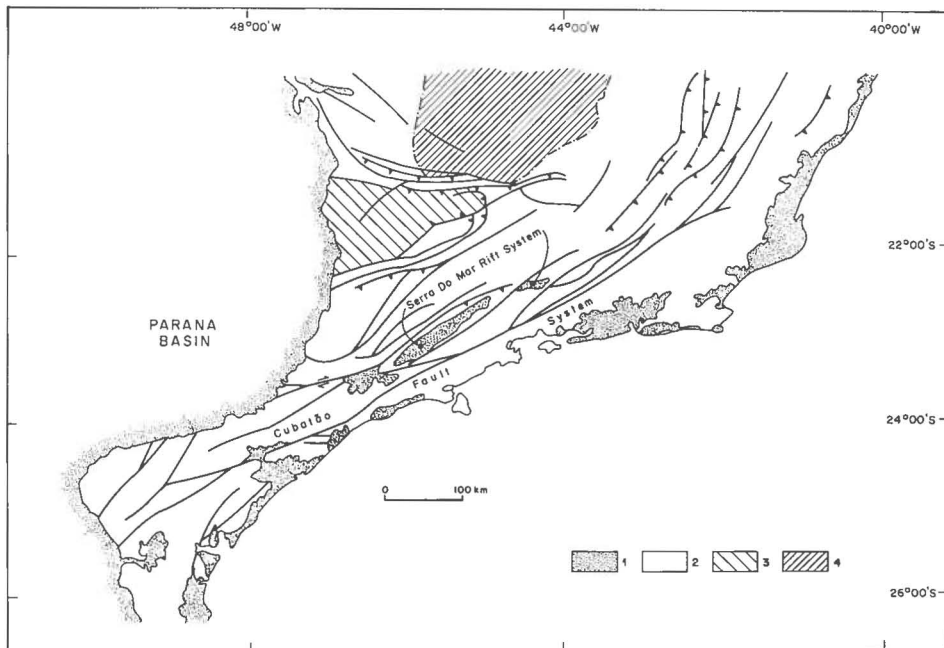


FIG. 6. Main faults of the marginal belts south and southeast of the São Francisco Craton. 1. Phanerozoic Cover; 2. Folded belts (Brasiliano age or rejuvenated); 3. Guaxupé Block; 4. São Francisco Craton.

maps of the RADAM (Radar da Amazonia) Project, show that many north-west trending structures are subparallel to old fold directions with dip components probably related to extension components bordering large grabens (Caiabís and Pacaás Novos grabens, for example) while NE and NNW lineaments are oblique to the old fold directions and some show evidences of lateral displacement.

It is possible that these structures are related to the inversion event which took place at the final stages of evolution of older north-west trending orogens inside the craton. One of the most important north-west trending faults was mapped near the western border of the Amazon Craton and cuts the Carajas Province. It was designated Carajas Fault by the local mining geologists and by Hasui and Almeida (1985). Its aeromagnetic and physiographic signature is clearly seen. This fault cuts Archean metabasites and iron formations of the Grã-Pará sequence as the Precambrian Gorotire sandstones. Its nature, however, is poorly known.

Another fault, the Teles Pires Fault, is approximately 800 km long. Its nature is also still unclear. It underlines the NW-SE border of the volcano-sedimentary Precambrian sequences of the Cachimbo-Beneficiente plateau. It cuts formations dated $1,550 \pm 50$ Ma.

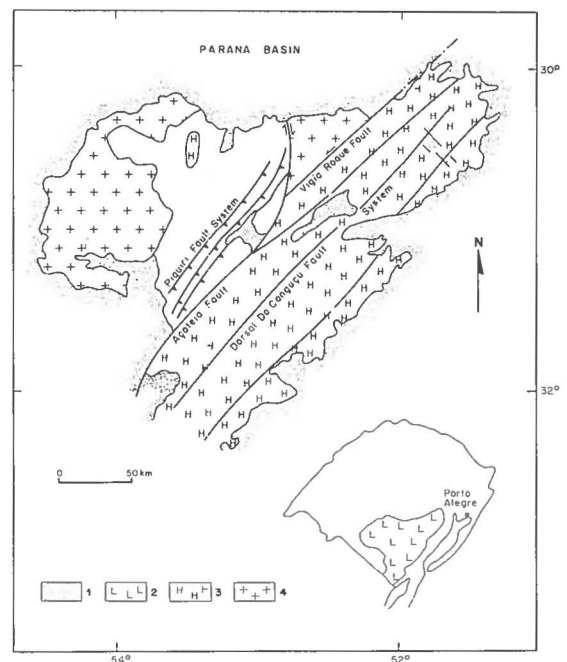


FIG. 7. Faults next to the Rio de La Plata Craton (after Jost *et al.*, 1984). 1. Phanerozoic Cover; 2. Brasiliano cycle (L: low-grade terrains; H: high-grade terrains); 4. Pre-Brasiliano terrains.

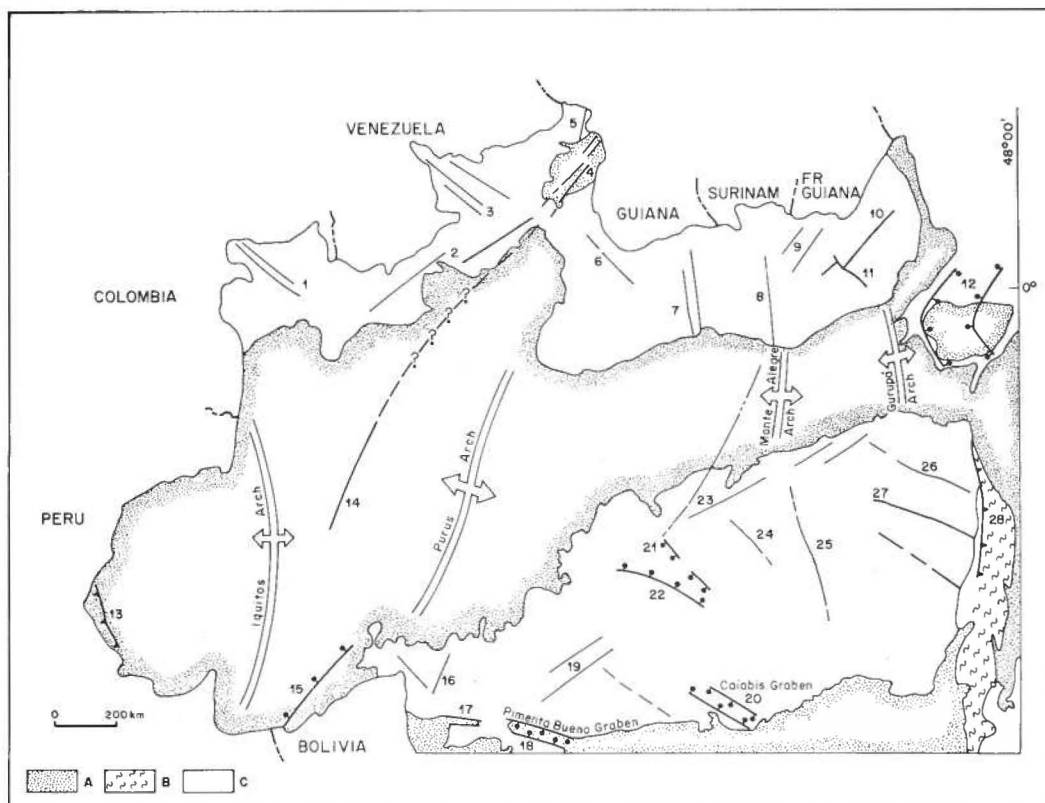


FIG. 8. Faults inside the Amazon Craton (based on geological maps of the Radambrasil Project (see References) and modified). 1. Uapés Lineament; 2. Takutu Lineament; 3. Parima Lineament; 4. Takuru Graben; 5. Cotingo Lineament; 6. Anauá Lineament; 7. Serra do Cachorro Lineament; 8. Monte Alegre Lineament; 9. Tumucumaque Lineament; 10. Jarí Falsino Fault; 11. Cupixi Fault; 12. Limoneiro Graben; 13. Batã-Cruzeiro Fault; 14. Juruá Fault; 15. Iquiri Fault; 16. Guaporé Lineament; 17. Pacaás Novos Graben; 18. Pimenta Bueno Graben; 19. Madeira Lineament; 20. Caiabís Graben; 21. Serra do Cachimbo Graben; 22. Teles Pires Fault; 23. Tapajós Lineament; 24. Abacaxis Lineament; 25. Curuá Iriri Lineament; 26. Bacajás Lineament; 27. Carajás Fault; 28. Tucuui Fault.

São Francisco Craton. The portion of the São Francisco Craton covered by the Bambuí Upper Proterozoic cratonic cover shows a series of near east-west trending lineaments which could be eventually related to the east-west trending compression associated to the final evolution of the north-south striking marginal fold belts. However, none of these lineaments has been individualized till the present.

Some important faults about which more specific knowledge has still to be obtained should be mentioned. They are the Itapebi and Itarantim lineaments and the faults in the cratonic area which covers part of the Bahia State (Fig. 2).

The Itapebi lineament is composed by two sub-parallel faults along a northwest striking line limiting a portion of the São Francisco Craton with the Araçuaí belt. They extend about 300 km between

Poções and Iitororó and offset the Itarantim-Itabuna alkaline lineament. These faults also run near the border of the Pardo Basin, and show very clear geophysical signature defining a gravimetric low. In the regional context of possible subdivisions of the São Francisco Craton, they would be placed on the rim of the Salvador Craton.

The Itarantim lineament is also a zone of two major subparallel faults along which Upper Precambrian alkalines were intruded and where small rests of a Jurassic basin are seen near the city of Ilheus. It strikes northeastward along at least 120 km from the coast into the continent affecting a highly metamorphosed basement of Archean age.

The Maracas-Planalto da Conquista, Monte Santo faults and the Jacobina fault swarm, in Bahia, are additional possible megafault zones which were shortly described by Mascarenhas *et al.*

(1984) and belong to the basement of the Salvador cratonic area of Cordani (1973).

The Maracas shear zone is a rejuvenated fault zone which divides greenstone terrains from Archean granulitic terrains of the Jejué block. The Jacobina shear zone on the limits of the Jacobina Formation and the basement is composed by two main faults, Itaitu and Mairi, which show thrust and directional components. They are supposed to be Precambrian structures. The Monte Santo mylonitic belt is a north-south trending shear zone of about 200 km, along a clear gravimetric trend limiting two large crustal blocks called Serrinha and Remanso.

TRANSCURRENT FAULTS AND MYLONITIC BELTS IN THE MARGINAL FOLD BELTS

North-northeast of the São Francisco Craton. The Brazilian northeast is cut by what Ebert (1962) called the transversal zone, composed by hundreds of kilometers long ductile shear zones represented by about five main mylonitic belts irradiating from under the sediments of the Parnaíba Synclisis and spreading radially on the shield area. These are structurally discordant megaductile shear belts whose former continuity in the African continent should be sought for, such as the Ngouranderé fault in southern Cameroon, continuing the Pernambuco Megafault and the southern border of the northwest African Craton extending into the Sobral-Pedro II and later Transbrasiliano Fault System.

They cut Upper Proterozoic structures and their basement transversally, offsetting the fold axes right laterally for tens to hundreds of kilometers. Ductile tear of about 40 km on each side of the main shear zones may be observed along the Pernambuco and Patos faults (Sadowski, 1984). An axial ratio stretch of at least 31 was estimated by the author for the Patos main shear zone. Shortening in the transversal zone far from the faults related to the simple shear rotation component was estimated as being $\sqrt{\lambda^2} = 0.53$ and stretching of $\sqrt{\lambda^1} = 1.9$. This means that flattening of pre-existing folds or even folding of former planar structures surely happened related strictly to the simple shear mechanism.

These faults were reactivated during and after the opening of the Atlantic. In some places the Pernambuco fault was reactivated as a normal fault

and its vertical slip reached 2,000 m in the northern border of the Cretaceous Jatobá Basin (where it takes the name of Ibimirim Fault).

In the Ceará State, the Sobral-Pedro II fault zone preserved Cambro-Ordovician molasses from erosion. The same fault zone continues into the Paleozoic Parnaíba Basin where it affected Devonian sandstones of the Serra Grande Formation, and perhaps continues along the Transbrasiliano lineament.

Magmatic activity apparently affected these faults, specially Patos and Pernambuco, through the injection of small stocks of alkaline granite called Moderna and Catingueira.

Thrust components very probably generated by transpressional effects next to the shear zones were detected in the region of Floresta near to the Pernambuco Shear and along the Aurora Virgation next to the Patos Shear (Sadowski, 1984).

Oblique thrust faults like the Senador Pompeu and Jaguaribe faults, subtransversal or diagonal to the Pernambuco-Patos east-west trending shear zones, are probably kinematically related but it is still not clear if they formed at the same time or if they were pre-existing faults which were involved in the transcurrent tectonism.

Several authors are presently studying this interesting fault system and works of Brito Neves (1975, 1983) should be consulted for a more general overview of the regional tectonic frame.

South-southeast of the São Francisco Craton. South-southeastern Brazil comprising the states of Rio de Janeiro, Minas Gerais, and Paraná, also shows important ductile shear belts, hundreds to eventually thousand kilometers in length. They are of complex nature. Part is related to very long ductile thrust zones and others to long transcurrent faults juxtaposing blocks of different age and structure with pull apart components. The first group is related to the already mentioned Guaxupé Thrust Block and the second to the Cubatão fault system. The Cubatão which also may be called Além Paraíba-Cubatão-Lancinha Fault System, has a length of more than 1,000 km and a strong ductile shear expression affecting rocks of practically all metamorphic grades and cutting granites 480 Ma (K-Ar) old (Sadowski, 1976). The deformation along the system seems to be progressive, affecting the rocks with dextral ductile and later with brittle shearing, generating in this way ex-

tense drags in granulites and gneisses and also Riedel jointing (Sadowski, 1983, 1984; Hasui and Oliveira, 1984; Silva *et al.*, 1982). So, the movement probably continued while the isograds were deepening.

Other expressive faults of the system are Taxaquara, Jundiuvira, Jacutinga, Caucaia, Rio Preto and Boquira faults. Their reactivation during the Tertiary gave origin to a continental border graben system locally called Serra do Mar Rift System (Almeida, 1976) (Fig. 6).

East of the Río de La Plata Craton. In southern Brazil, next to the Río de La Plata Shield, a similar mosaic of fault blocks as that of the southeastern mylonite belt region may be found. There, low dipping mylonite zones corresponding to the Piqueri upthrust already were cut by right lateral faults of the Açoteia system (Fig. 7). According to Jost *et al.* (1984), the Açoteia fault starts near Montevideo in Uruguay and strikes N30°E for about 700 km. Near to Pinheiro Machado it turns N60°E during 70 km and then splays or continues along the Paso de Marinho north-south striking fault. It shows a dominant right lateral component with secondary thrust movements showing to be a wrench fault with a compressional component. It continues until under the Paraná Basin sediments. Other faults parallel or subparallel to these are supposed to belong to the same system (Ibaré and Vigia Roque). However, maps seem to diverge about their continuity, nomenclature and nature. The Açoteia fault is supposed to be of Upper Precambrian age, while it was intruded by a 570 ± 37 Ma syenite and cuts granitoids of about 628 ± 30 Ma (Cordani *et al.*, 1973).

THE PIRINEUS LINEAMENT

In central Brazil, two linear Proterozoic mobile belts converge into this lineament which runs transversally to their strike. It has a strong gravimetric expression and is about 400 km long. Its nature is still not clearly understood. It runs along a N60°W strike from the south of the city of Brasília disappearing under an extense Quaternary cover (Fig. 5).

PALEOZOIC INTRA-PLATE FAULTS

Since the start of the consolidation of the South

American Platform until its reactivation through the breakup of Gondwana, a major crustal weakness zone showed a sporadic activity. It is a really spectacular lineament which cuts northern and central Brazil obliquely and seems to be more than 1,500 km long. It was called Transbrasiliano Lineament by Schobbenhaus *et al.* (1975) during the geological survey of central Brazil. Along its trend several grabens trapped Cambro-Ordovician molasses of the final orogenic stages of the northeastern fragmented fold belt system (Sobral-Pedro II faults). Devonian sediments were also preserved from erosion in the Agua Bendita Graben and remains of Juro-Cretaceous basaltic volcanism related to the reflexes of the birth of the Atlantic may be seen inside this lineament. Its gravimetric signature in central Brazil is relatively evident and some authors consider an eventual Cenozoic activity of this structure (Barbosa, 1970). Its former extension into Africa along the southern border of the west African Craton could be postulated. Transversal to the Transbrasiliano Lineament there is an extense graben called Monte Alegre do Piauí. It is limited by two northwest trending faults, Curimatá and Barreiro. The first is more than 300 km long. This structure juxtaposes Devonian and Permian sediments but apparently does not affect overlying Triassic beds. It seems to be offset by the Transbrasiliano Lineament (Figs. 5, 2).

MESO-CENOZOIC RIFTS

One of the present authors has pointed out in former papers (Sadowski, 1976, 1984) that the South American Platform suffered, during the Phanerozoic, several activations related to plate kinematics linked to periodical changes of the state of stress in the interior of the plate. One of the main events, the rifting of the Atlantic Ocean, was preceded by a strong linear tectonism and magmatism. This rifting, around 130-120 Ma ago, strongly affected the continent and so did in a minor scale later periods of activation mainly at about 107, 84 and 38 Ma. These generally extensional pulses generated intracontinental rifts (Takutu, Reconcavo-Tucano, and Serra do Mar rift systems) and activated old and new flexures (Goiano Flexure, Upper Parnaíba Uplift, Assuncion-Arch, Potiguar Flexure, and others) and volcanic lineaments (Iporá Alkalines, Cabo Frio-Poços de Caldas and Ceará lineaments). All these structures could be

probably related to deep or fundamental faults in Peyve's nomenclature.

THE TAKUTU GRABEN

This rift, in the Brazilian extreme north, in the northeastern tip of the Roraima territory, was installed along a high called Rio Branco Arch (Amaral, 1974) where deep basement represented by granulites, charnokites and kinzigites is exposed. Elevations up to 3,000 m above sea level are found in this region and basic and alkaline volcanism of Jurassic age affected the area. About 1,800-3,500 m of sediments together with basalt flows (Apoteri Formation) were found in the graben but seismic data suggest more than 6,000 m (Santos, 1984) (Fig. 8).

The graben, apparently, was installed along pre-existing reactivated transcurrent fault zones. Some of them show evidences of Cenozoic activity obstructing the drainage of the Branco river and allowing in this way the deposition of the Boa Vista fluvio-lacustrine formations. Szatmari (1983) proposed the extension of this rift until de Jurua valley in the Amazon plain and then extended it to Perú, on the Pacific coast. Other authors traced it along other paths. Further future investigations should clear these interpretations.

THE SALVADOR-TUCANO RIFT

This graben belongs more to the assemblage of structures related to the continental margin. It is intimately related to the opening of the Atlantic. It originated in Cretaceous times and is composed by three main basins. The northern one called Jatoba, is bordered by the reactivated Pernambuco Fault (Fig. 2).

SERRA DO MAR RIFT SYSTEM

It borders the coastal Santos Basin and is about 1,000 km long. It shows four included basins: the Taubate, Rezende, São Paulo and Curitiba Tertiary basins. This rift was installed along old originally transcurrent basement faults. A volcanic extrusive, overlying sediments of the Rezende

Basin, was dated about 40 Ma (K-Ar) (Riccomini *et al.*, 1983). The sediments are faulted in several places what implies even a more modern tectonism affecting this region (Fig. 6).

FAULTS EVENTUALLY RELATED TO THE ANDEAN TECTONICS

In the western extreme of Brazil, in the region of the Acre Territory, some signs of the Andean orogenies are visible. Two relatively modern faults affecting the Pliocene-Pleistocene Solimões Formation have been detected. One, a thrust fault with a vergence towards the east, was called Batã-Cruzeiro do Sul; the other, the Iquiri Fault, is transversal to the Andean strike and runs 170 km along the Iquiri river. It displaces the Solimões strata in about 190 m down dip being considered as a normal fault (Radambrasil, 1976).

Next to Bolivia, in the region of the Madera River Province as also more inside of the Brazilian territory on the northern end of the Parecis Plateau, several grabens striking east-west and north-west were defined. They are called Caiabis, Pacaas Novas, Uopione and Pimenta Bueno, and are being considered as mainly related to the activation of the craton during the Precambrian (between 1,600-1,100 Ma, approximately). The only exception would be the Pimenta Bueno graben which contains Mesozoic sediments and basalts. It shows a large megafault on its southern border which was called Presidente Hermes and cuts Juro-Cretaceous basalts (Fig. 2). More recently, crews of Petróbras defined an extense linear structure which was called Jurua by Szatmari, who published a quite polemic paper about it (Szatmari, 1983): it would be a part of a large aborted rift extending from the Takutu Graben to the Pisco Fault in Perú. The idea is very attractive and favoured the discovery of oil and gas in this region. However, the connection between these structures needs more investigations.

The Jurua Fault zone is more than 300 km long and shows evidences of transpression. A Juro-Cretaceous age is considered for this feature. In our opinion, it could be an aulacogenic structure.

CONCLUSION

From the whole assemblage of megafaults exposed in this paper we could extract some major structures which could be designated as gigafaults: megasutures or those fundamental faults with an extension of several hundreds to thousands of kilometers which, during the geological history, acted as real or aborted borders of extensive plates. Such structures could be the Transbrasiliano lineament and its subparallel Takutu-Jurua alignment and the Tocantins-Araguaia su-

ture zone. Eventually, the Cubatão and Pernambuco fault systems could be classified under this term. Examples in other continental areas are the San Andreas, the Agadir faults, the Talas-Ferganá Fault or the major suture zones (as the Hindu Suture, the Ivrea-Verbano and Insubric Lines, etc.). In South America, the Bocono, Liquiñe-Ofqui and Tocantins deep fault systems are some examples of structures which we suggest could be considered under this designation.

ACKNOWLEDGEMENT

The authors thank the International Union of Geological Sciences (IUGS) and the IGCP-202 Megafaults of South America Project Leader Pro-

fessor Francisco Hervé for the support to publish this paper.

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