Simexmin

V SIMPÓSIO BRASILEIRO DE EXPLORAÇÃO MINERAL

V BRAZILIAN SYMPOSIUM ON MINERAL EXPLORATION

Depósitos Minerais Magmáticos de Ni-Cu-EGP, Cr, Fe-Ti-V Neoarqueanos e Paleoproterozóicos da parte Norte do Cráton do São Francisco

Neoarchaen and Palaeoproterozoic Ni-Cu-EGP, Cr, Fe-Ti-V Magmatic Ore Systems of the Northern Sao Francisco Craton

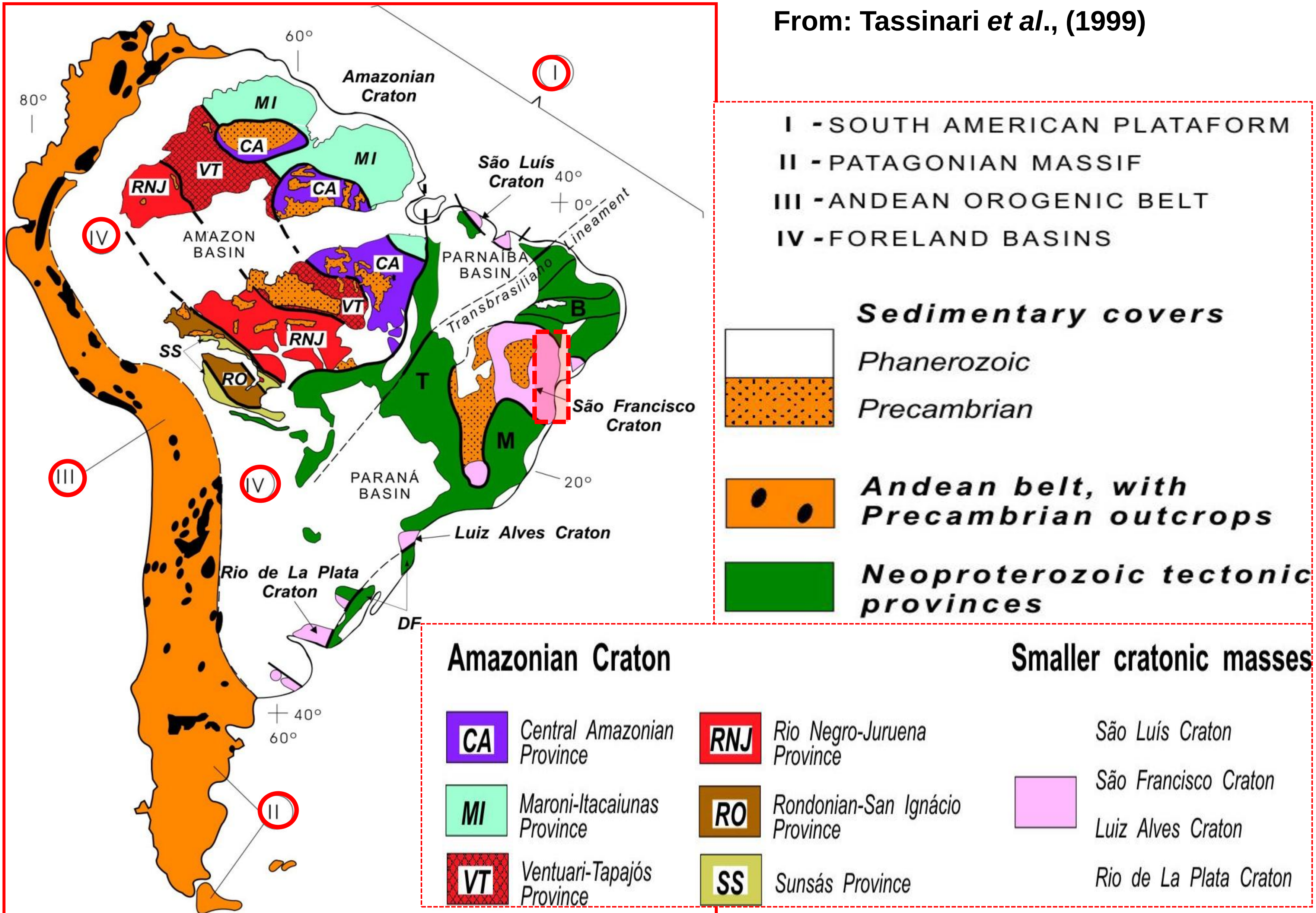
Reinaldo Brito

Case Studies:

- a) Santa Rita Ni-Cu,
- b1-Jacurici Valley Cr ,
- b2)Campo Formoso Cr
- c) Maracás Fe-Ti-V

Geochronological Provinces and the main lithological associations of the South American Platform

From: Tassinari *et al*., (1999)



Geochronological data
Serrote da Laje Complex

- Basement
- Layered Intrusion

Local	U–Pb zircon (Ma)	*T*DM (Ga)	Local	U–Pb zircon (Ma)	*T*DM (Ga)
Rio Coruripe Complex (Brito 2004)	2020	2.6-27	Leuconorite ((Brito 2004)	1970	
Campo Grande Complex (Brito 2008)	2900	3.1-3.3			
			Leuconorite (Brito 2004)		2.3-2.6

Geochronological data
Jacurici Complex

- Basement
- Layered Intrusion

Serrinha block

Local	Rb–Sr (Ma)	Pb–Pb single zircon (Ma)	U–Pb zircon (Ma)	T_{DM} (Ga)
Serrinha porphiritic orthogneiss (Rios, 2002)			3055.15 3078.98 2807.04 3095.94	3.12 3.17
Rio Capim tonalite (Oliveira et al., 1999)	3120	3000 2900 2650		

Local	**U–Pb zircon (Ma)**	***T*DM (Ga)**
Medrado Gabbro (oliveira 2004)	**2085**	
Medrado Gabbro (Oliveira 2000)		**3.2-3.4**

Geochronological data
Mirabela Complex

- Basement

Local	Pb–Pb single zircon (Ma)	U–Pb zircon (Ma)	T_{DM} (Ga)
Ipiaú tonalite (Ledru et al., 1994)	2634 ± 7		
Caraíba TTG (Silva et al., 1997)		2695 ± 12*	3.4
Caraíba chanockite (Silva et al., 1997)		2634 ± 19*	3.4
Ipiaú monzonite (Ledru et al., 1994)	2450 ± 1		2.4

- Layered Intrusion

Local	U–Pb zircon (Ma)	TDM (Ga)
Gabbro pegmatoidal (Brito et al in press)	2065	
(Abram 1993)		2.2

Geochronological data Rio Jacaré Sill

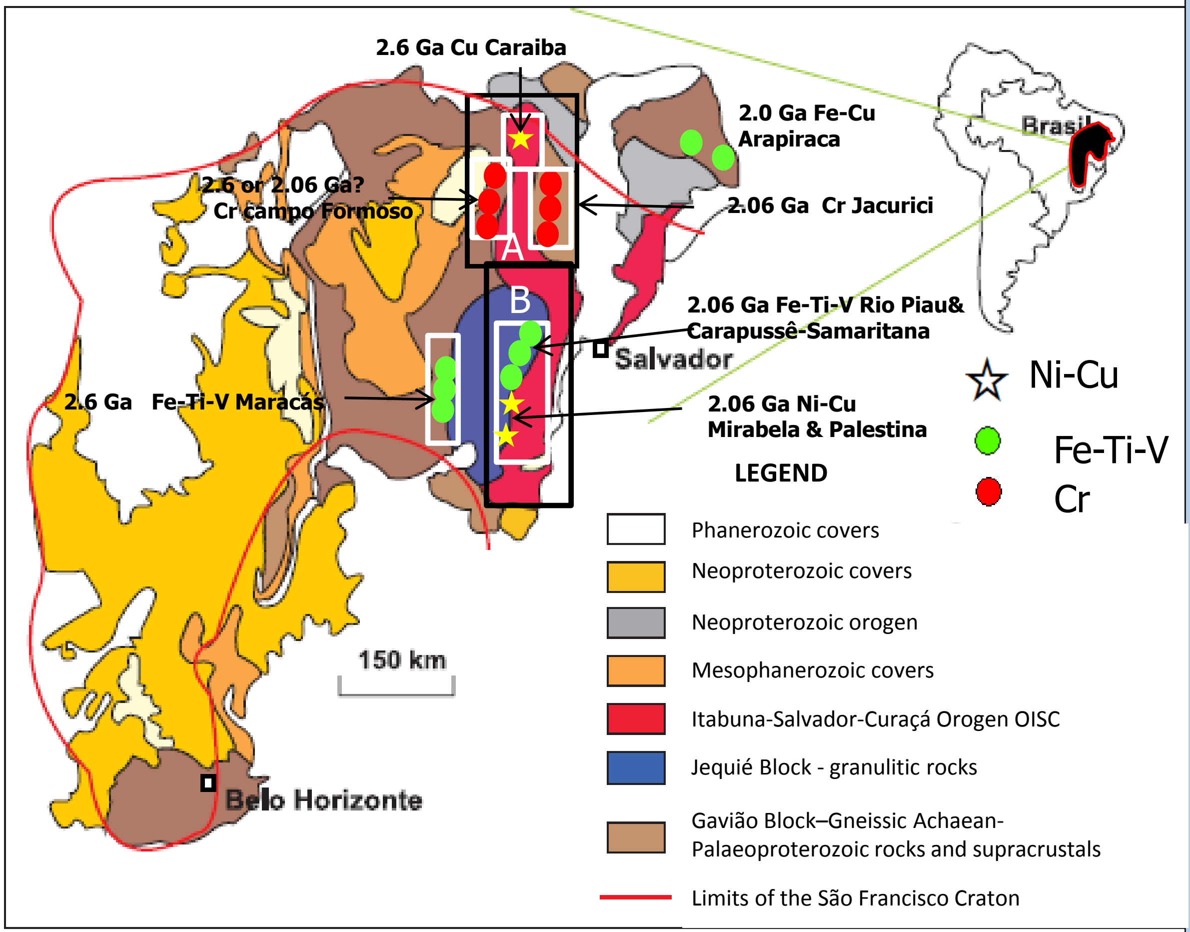
Jequié block

Local	Rb–Sr (Ma)	Pb–Pb WR (Ma)	U–Pb zircon (Ma)	T_{DM} (Ga)
Ubaíra basic Enclaves (Wilson, 1987; Marinho et al., 1994a,b)				3.3
Ubaíra migmatites (Wilson, 1987; Marinho et al., 1994a,b)	2900 ± 24			3.2
Jequié migmatite (Wilson, 1987; Marinho et al., 1994a,b)				2.9
Maracás granite (Alibert and Barbosa, 1992)	2800 ± 12	2660 ± 70		3.2
Mutuípe granodiorite (Alibert and Barbosa, 1992)			2810 ± 3	3.0
Laje granodiorite (Alibert and Barbosa, 1992)			2689 ± 1*	3.0
Mirante volcanics (Marinho, 1991)		**2519 ± 16**		**3.4**
Rio Jacaré Sill (Marinho 1991)		**2474 ± 72**		3.3
				3.2
Granito Pé de Serra (Marinho 1991)	**2560 ± 110**			

Layered Intrusions Nearchean/Proterozoic Eons

Erathem Era	System Period	Age Ma	
Paleo-proterozoic		1800	
	Orosirian	2050	Mirabela, Medrado, Arapiraca, Rio Piau, Samaritana
	Rhyacian	2300	
	Siderian	2500	Rio Jacaré Sill
Neoarchean		2800	

São Francisco Craton Neoarchaen and Rhyacian Magmatic Deposits



Along the border of the Meso-Neoarchaean blocks there are various metalogenetic corridors related to magamtic ore systems

Neoarchaen intraplate Magmatism

Caraiba Cu- deposit and the Fe-Ti-V Maracás deposit are related to a Neoarchean (2.6 Ga) intraplate mafic-ultramafic magmatism, and was latter affected by a 2.0Ga tectonometamorphic event.

Rhyacian intraplate magmatism

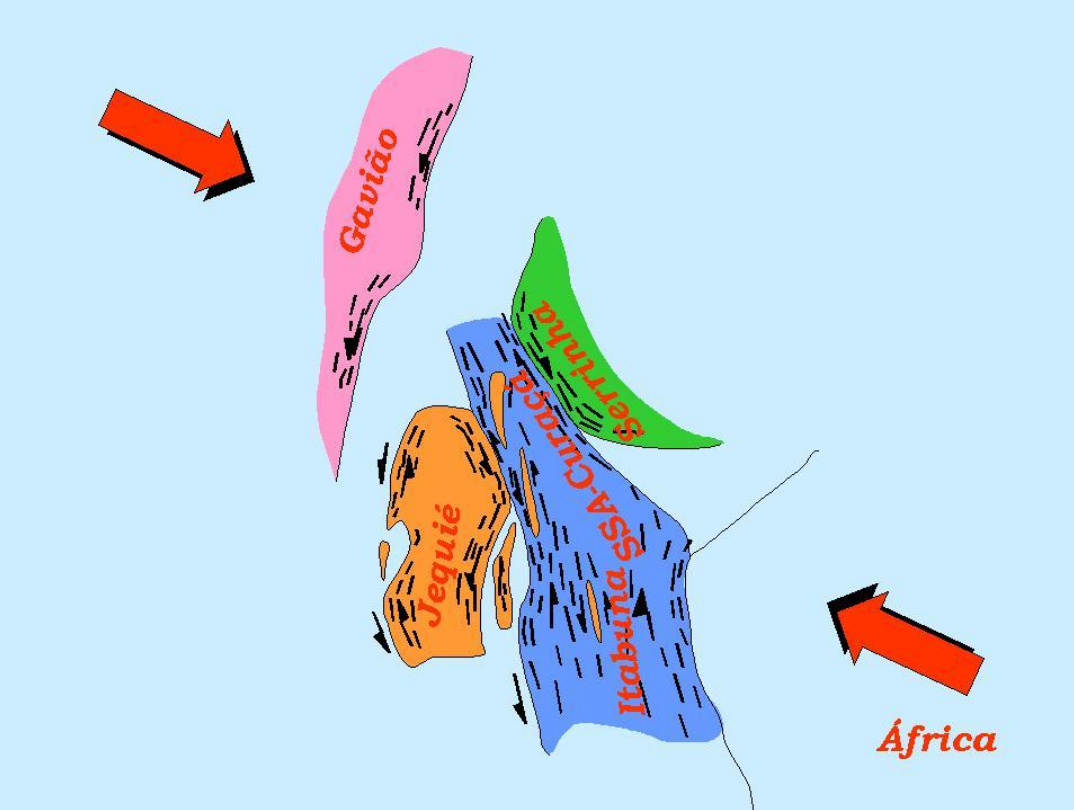
Mirabela-Palestina (Ni), Rio Piau-Samaritana-Carapussê (Fe-Ti-V) intrusions are related to a 2.06 Ga

Neoarchaean-Palaeoproterozoic Economic Magmatic metalic ore deposits

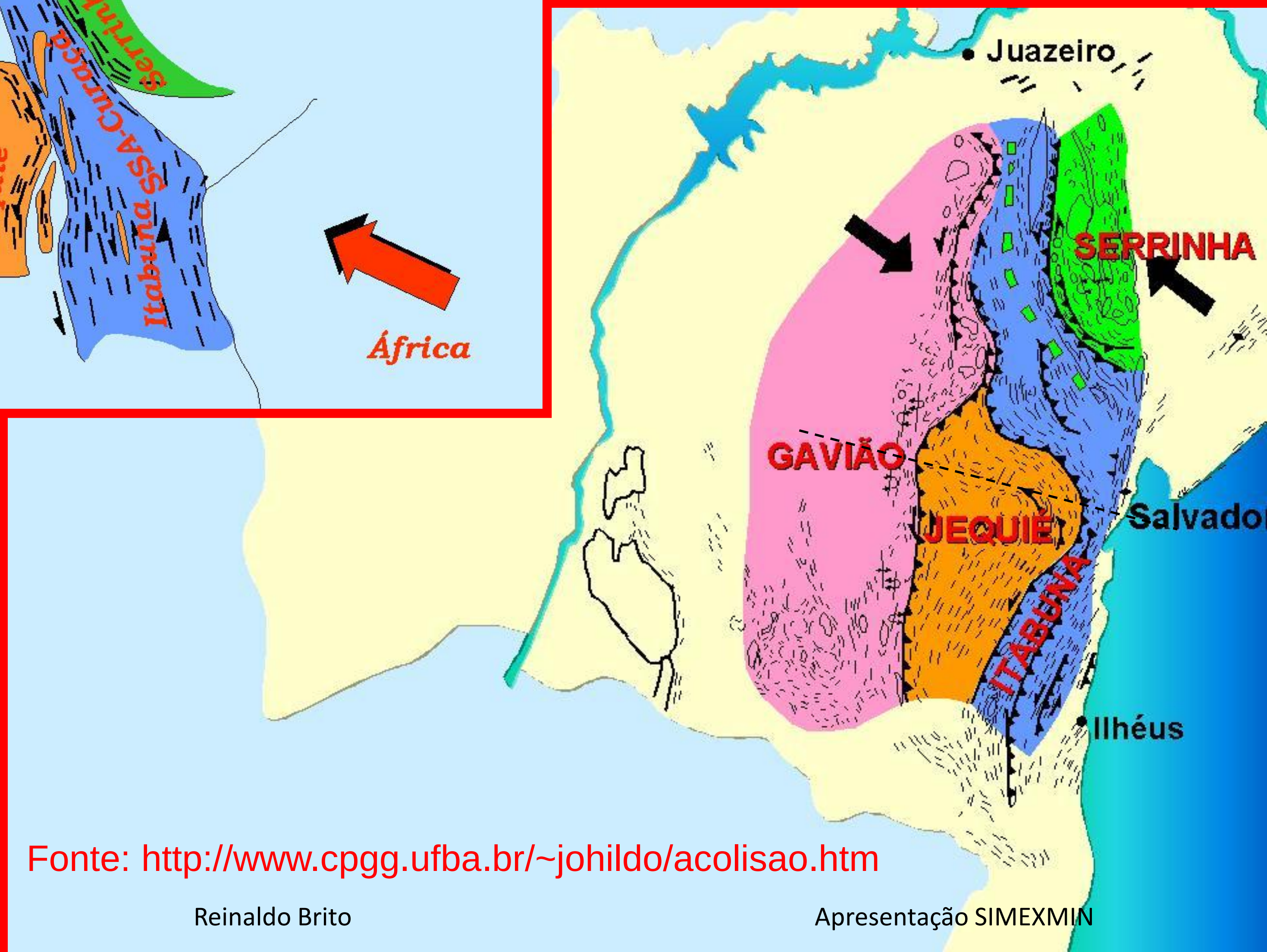
- Neoarchaen and Palaeoproterozoic Magmatic ore systems
- 1-Mafic-ultramafic layered intrusion-hosted magmatic Ni-Cu-PGE, Cr and Fe-Ti-V deposits
- a) Ni-Cu-PGE magmatic sulfide deposits-Mirabela
- b) Stratiform Bushveldt type and Komatitic/Picritic sills-related chromite deposits-Campo Formoso/Jacurici
- c) Bushveldt-type magnetic iron ores deposits –Rio Jacaré *Sill*
- Case Studies: a) Maracás Fe-Ti-V, b)Santa Rita Ni-Cu, c1) Jacurici Valley Cr , c2)Campo Formoso Cr

Discussion on the Mirabela and Palestina Intrusions in the context of the Rhyacian Amalgamation of the Sao Francisco Craton and the Orosirian Traphrogenesis

Rhyacian intraplate plume-related magmatism of the Sao Francisco Craton and its magmatic ore systems



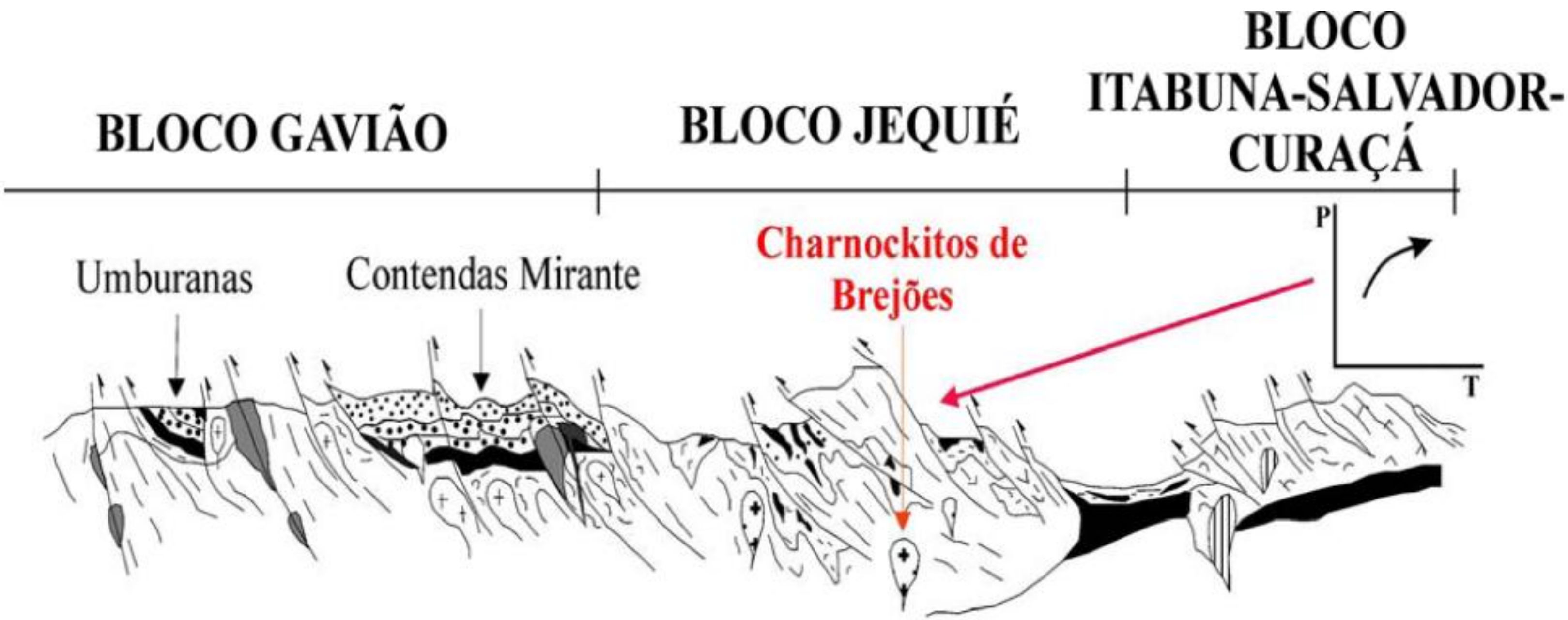
GEOTECTONIC HISTORY



This Portion of the São Francisco Craton was formed as a result of the 2.3 - 2.0 Ga. convergence of archaen continental blocks followed by the collison with the Congo Craton

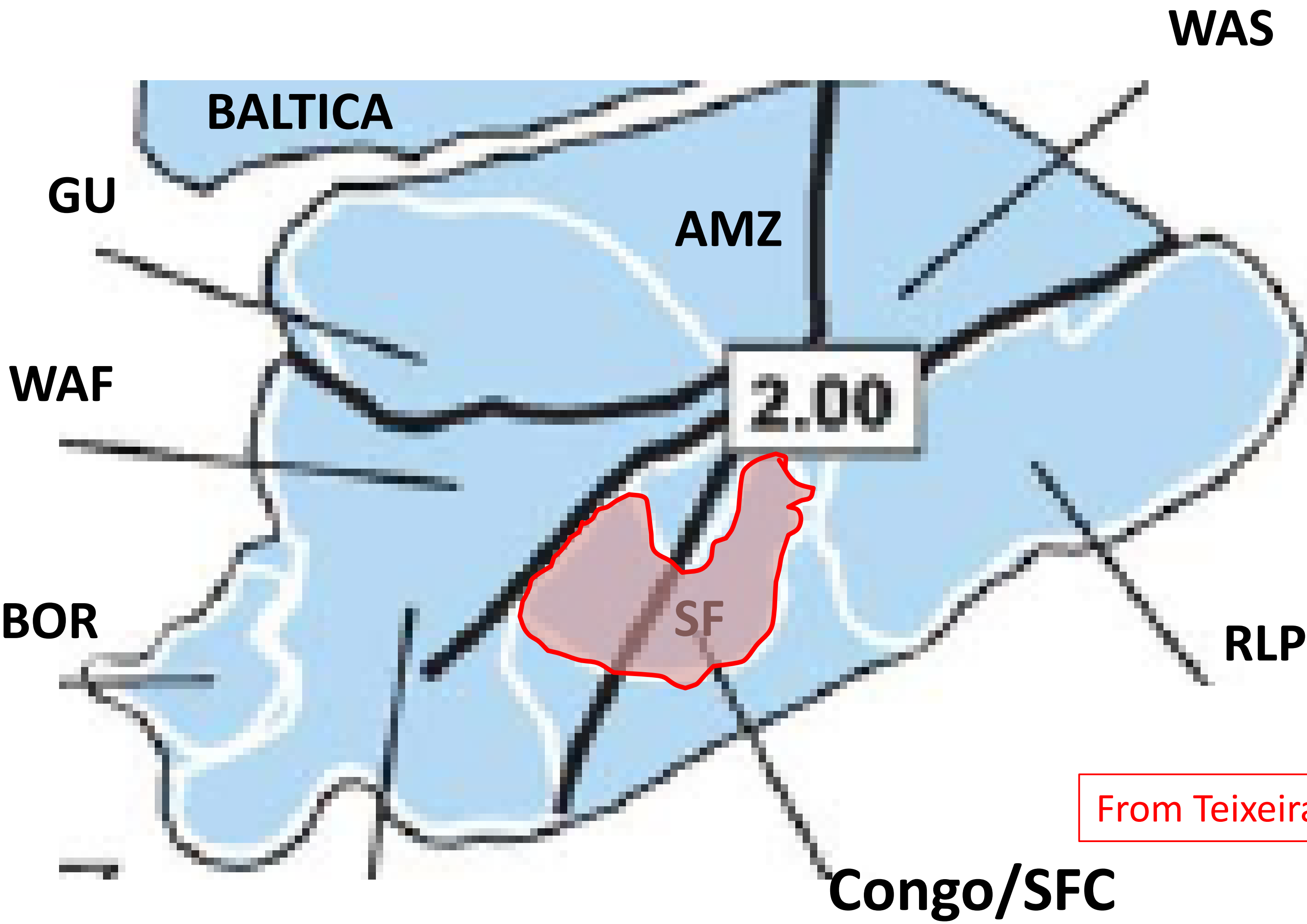
Fonte: http://www.cpgg.ufba.br/~johildo/acolisao.htm

Palaeoproterozoic Collision tectonics



- From Barbosa (2002)

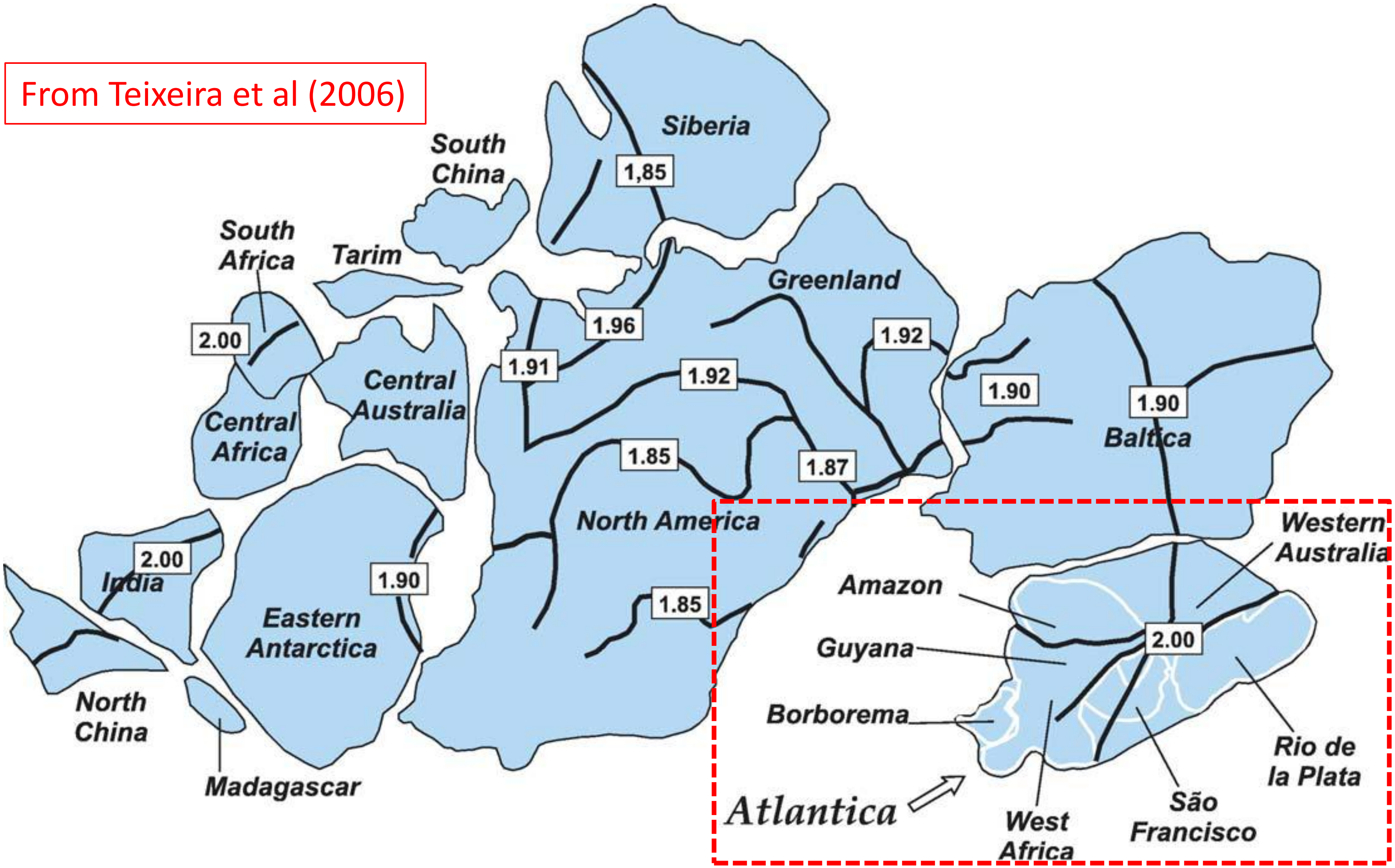
MAIN CONTINENTAL BLOCKS OF ATLANTICA



From Teixeira et al (2006)

Possible Configuration of the Atlantica Continent

From Teixeira et al (2006)

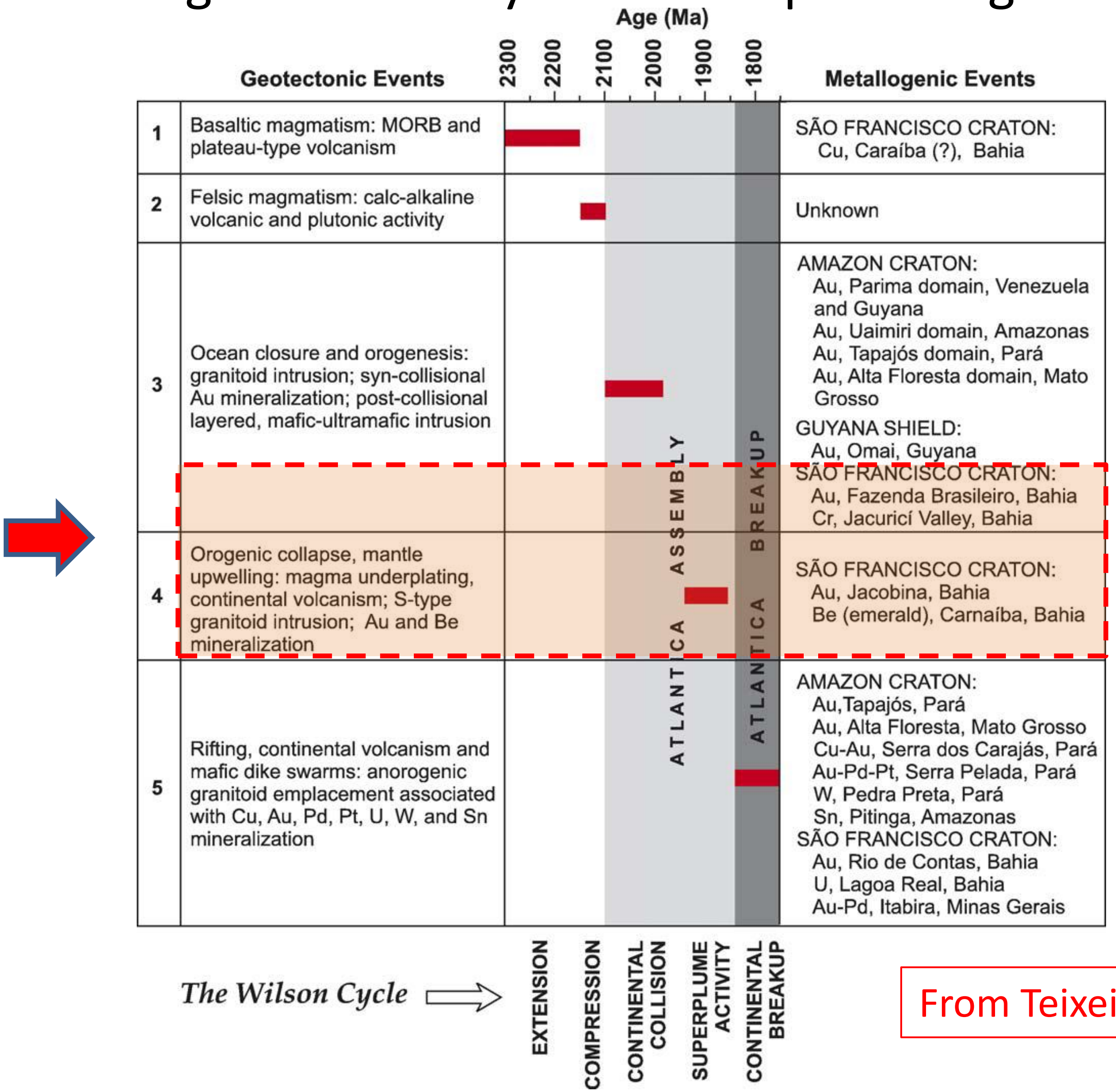


São Francisco Craton –Orosirian

SFC exhibits important mantle-derived intraplate magmatic episode, which is typical of anorogenic tectonic environment.

- This event have occurred immidiately after the Eburnian-Tranzamazonic collision between the Congo Craton and the Archaen Blocks that togheter formed the Congo-Sao Francisco Craton during the Orosirian-Rhyacian period 2,08 Ga.
- This magmatism corresponded to the mantle strong reaction to the formation of the Atlantica Continent (Brito Neves, 1999)

Orosirian convergence and Rhyacian intraplate magmatism in SFC



From Teixeira et al (2006)

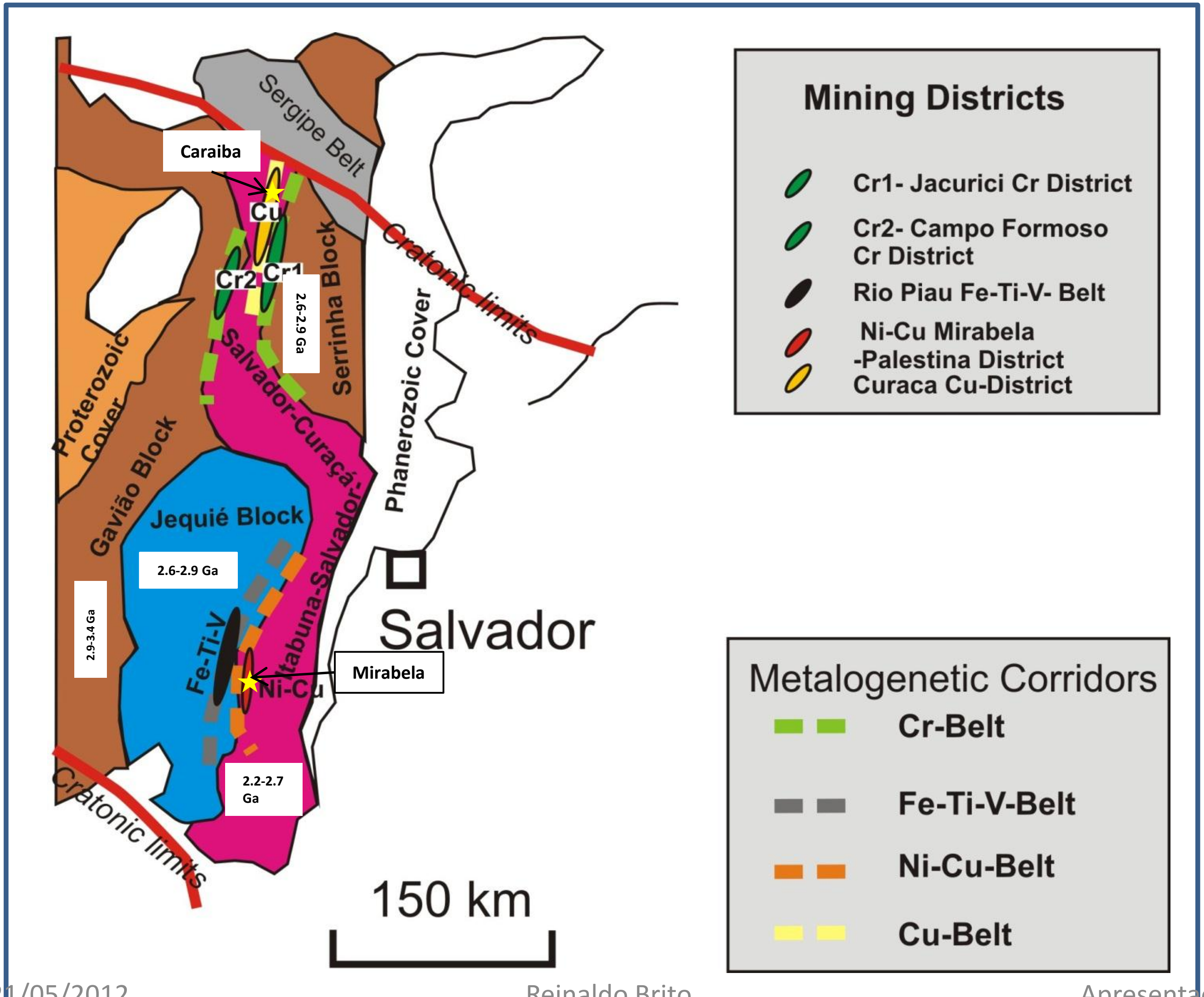
SFC-Orosirian intraplate magmatism

- (i) Layered mafico-ultramafic complexes of Bahia, which are important repositories of magmatic Cu-Ni-Cr and Fe-Ti-V deposits
- (ii) The Itiuba sienite batolith, the Guanambi Massif ;
- (iii) A-type granitic suites including augengneisses);
- (iv) The apatite-bearing Angico dos Dias Carbonatitic Complex ;
- (v) mafic dike swarms.

STRUCTURAL CONTROL

- The largest intrusive bodies, specially the large mafic-ultramafic complexes and the sienitic massifs are located along faults or shear zones of regional expression that represent older deep crustal structures reactivated during this extensional Orosirian event.
- Magma generated during this period might have channeled through these weak zones to ascend to crustal reservoirs, that brought about the present known areas of occurrence of mafic –ultramafic complexes that represent metalogenetic corridors where important magmatic ore systems are found.

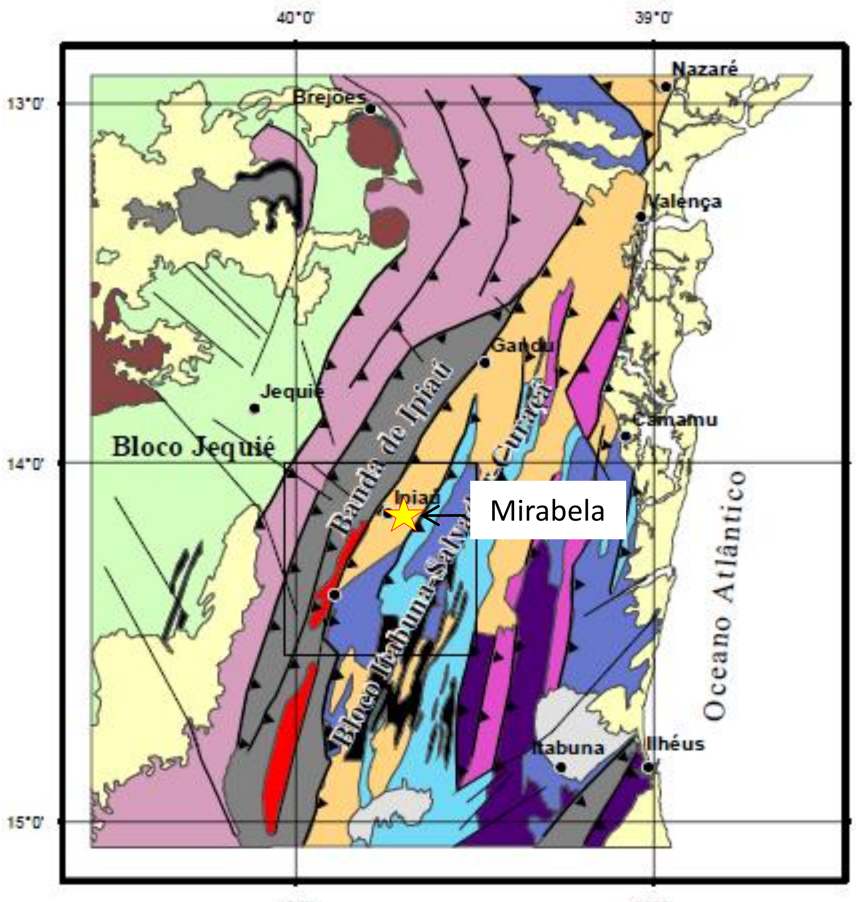
Mining Cr-Fe-Ti-V and Ni-Cu-PGE districts within the main metalogenetic corridors along the borders of the Itabuna-Salvador-Curaçá Block

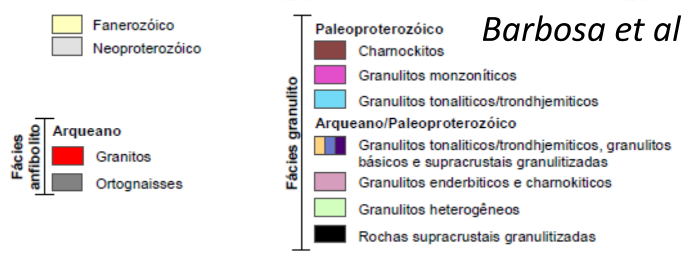


Geophysics and regional controls

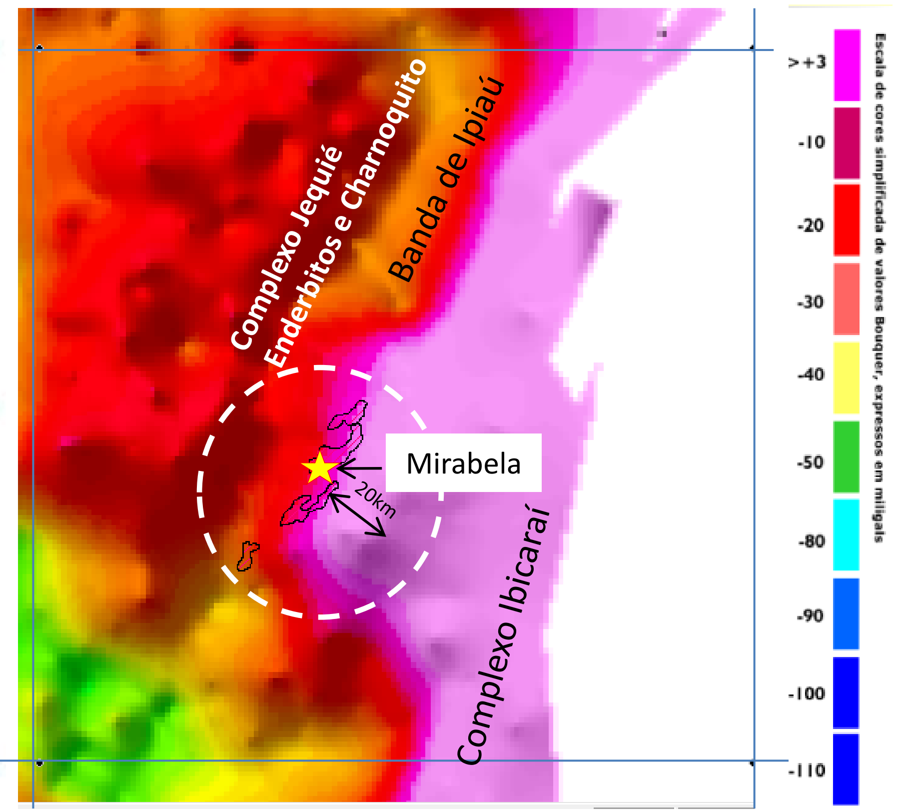
- Mirabela intrusion is located within megalineament, which separates two Archaean blocks : Jequié e Itabuna-Salvador-Curaçá.
- This linneament coincides with a linear zone of strong gravimetric gradient at the fault contact between the Ibicaraí Complex (east) and Ibicuí-Ipiau Complex (west)
- Mirabela intrusion sits 20 km to the west of group of gravimetric highs that ends up in a large gravimetric high (Bouguer >3 miligal.)

Tectonics and Gravimetry





Barbosa et al (2008)

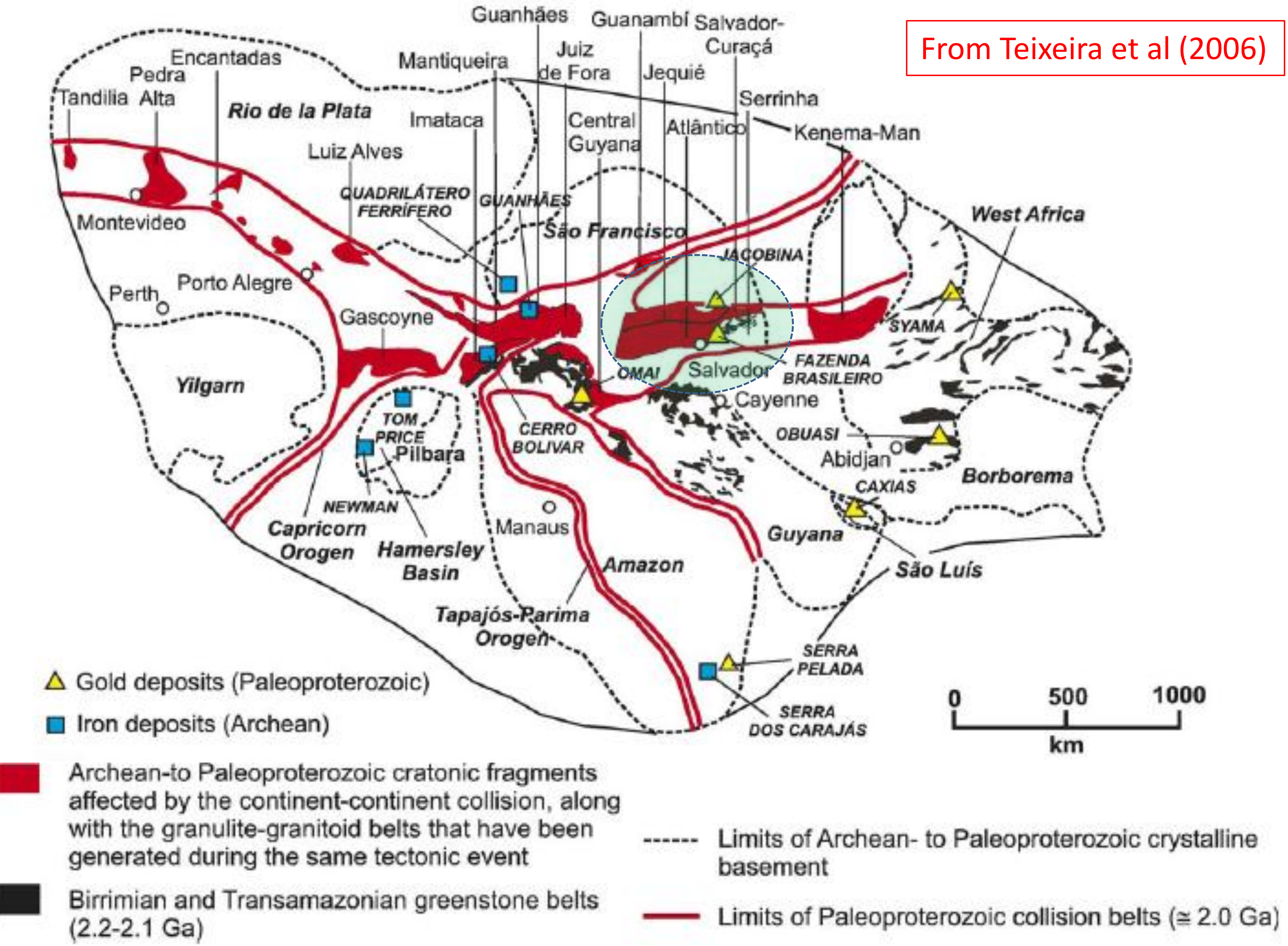


Mapa Bouguer do Estado da Bahia (Mota et al., (1979)

Possible Explanation for the gravimetric high and geographic distribution of the metalogenetic belts

- It is observed that the chromium belts are located far in the northern part of the (Salvador-Curaçá belt), whereas the Ni-Cu and Fe-Ti-V is in the southern part, (Itabuna-Salvador belt).
- This can be modeled by inferring a northward-drifting Sao Francisco Plate (Atlantica Continent) over a fixed hot spot or plume head.
- Magmas from this plume head could have been transported over hundreds of kilometers away from the plume center
- Mirabela sits over a gravimetric high because it is related to the end of the plate movement as it collided with the Amazon Craton, possible at the end of the Orosirian period.
- Thus the gravimetric high might represent the frozen underplated plume head that was just under Mirabela position in the Sao Francisco Plate when it start to stop the motion.

From Teixeira et al (2006)



Why the magmatism might be plume-related

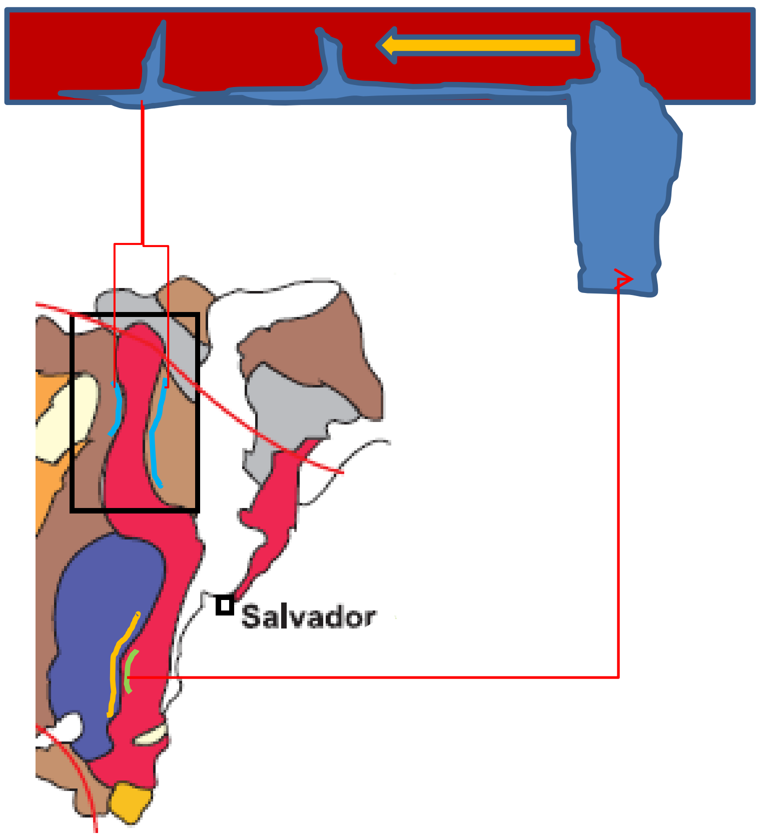
- plume-related magmatism are reckoned as responsible for the production of very large volume of magma in a short period of time (<4 millon years)
- They are usually credited for the formation of LIP – Large Igneous Province, such as Continental Flood Basalts, (eg. Paraná, Karoo, Cape Smith, Siberia and Large Layered Intrusions e.g. Bushveldt Complex
- The melting zone over the plume head may affect an area larger than thousands of square kilometers
- Magmas from the melting zone may travel thousand kilometers from the plume head
- Plate motion over a fix hot spot or plume head may leave a trail of contemporaneous mafic-ultramafic bodies along the track of this plate motion
- This trail are coincident with major crustal discontinuities, faults, rifts boundaries and axial zone of continental rift basins

São Francisco Plate&Orosirian Plume

T2

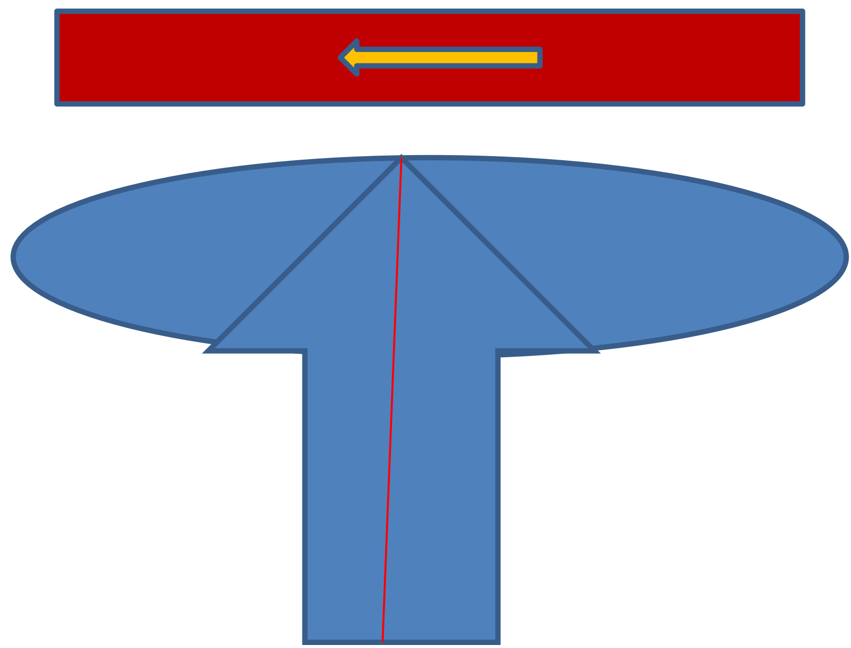
NW
Jacobina/Jacurici

SSE
Mirabela-Palestina



T1

NW
Jacobina/Jacurici



Mafic Magmatism at Jequié/ISCB border

- A group of small (<100 Km2), gabro-anortositic and mafic-ultramafic intrusive bodies,
- This group is located within the southern domain of the Itabuna–Salvador–Curaçá Block (Itabuna-Salvador belt) along the western border of the Jequié Block.
- Five massifs are distributed along an important NNE–SSW lineament, which is concordant along 300 km with the dominant regional structural *trend*.
- The mafic intrusive bodies from north to south :

1-Rio Piau; 2-Samaritana; 3-Carapussê; 4- Mirabela; 5-Palestina and 6-Potiraguá.

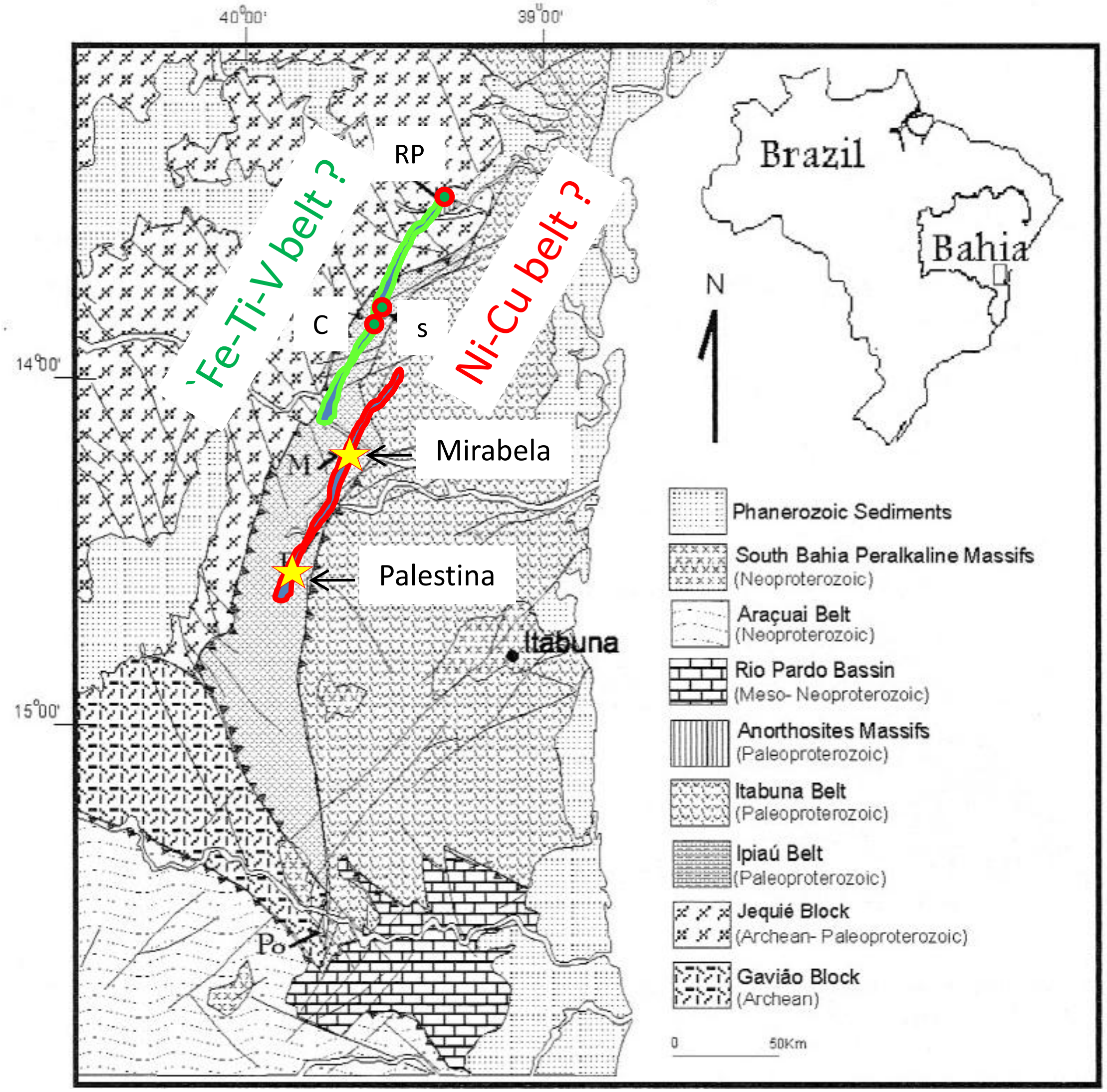
Mafic Magmatism at Jequié/BISC border and the Ni-Cu and Fe-Ti-V metalogenetic belts

- According to the type of mineralization, these five mafic-ultramafic massifs can be splited into two metalogenetic belts:

1- Eastern Ni-Cu Belt : Mirabela-Palestina corridor

2- Western Fe-Ti-V belt: Rio Piau-Samaritana-Carapussê corridor

Mafic-ultramafic complexes along Ipiau Belt and the Metalogenetic belts



According to the type of mineralization, these five mafic-ultramafic massifs can be splited into two metalogenetic belts:

1- Eastern Ni-Cu Belt : Mirabela-Palestina belt

2- Western Fe-Ti-V belt:

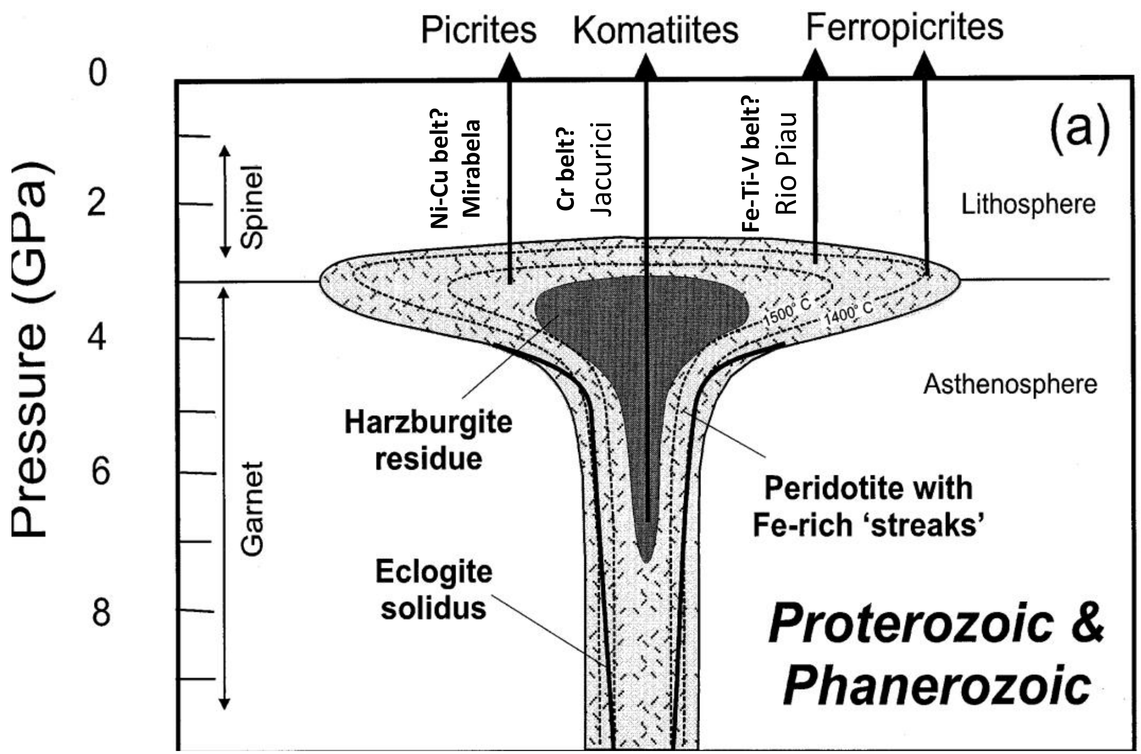
Rio Piau-Samaritana-Carapussê belt

Cruz et al 2000

Explanation for the different positions of the Metalogenetic corridors of the Itabuna-Salvador-Curaçá Block

- The preferential distribution of the mafic-ultramafic bodies along the borders of the ISCB indicates that they might represent the track of the Atlantica continent (plate) over a possible Orosirian plume head.
- The observed distribution of the different magmatic ore systems of the Itabuna-Salvador-Curaçá Block can be explained according to their former relative position within the the Sao Francisco Plate with respect to the possible Orosirian plume head.

Distribution of the different magmatic ore systems of the Itabuna-Salvador-Curaçá Block according to their relative position within the Sao Francisco Plate with respect to a possible Orosirian plume head



Schematic illustrations to show the simplified thermal and compositional structure of Proterozoic and Phanerozoic mantle plume starting-heads. Isotherms are labelled with potential temperature in degrees Celsius. The earliest melts to form are the high-Fe picrites/komatiites. These are derived from Fe-rich (`re-fertilised') peridotite `streaks' at the leading edge and margins of the starting-plume-head. Subsequent melts are generated by larger degrees of partial melting at higher mantle potential temperatures. From Condie (2008)

Final Conclusions

- The komatitic magmas from the plume center could have fed the chromium magmatic ore systems
- The picritic magmas adjacent to the plume center might have suplied the Ni-Cu magmatic ore systems; and
- The ferro-picritic magmas have possibly been responsible for the Fe-Ti-V magmatic ore systems.