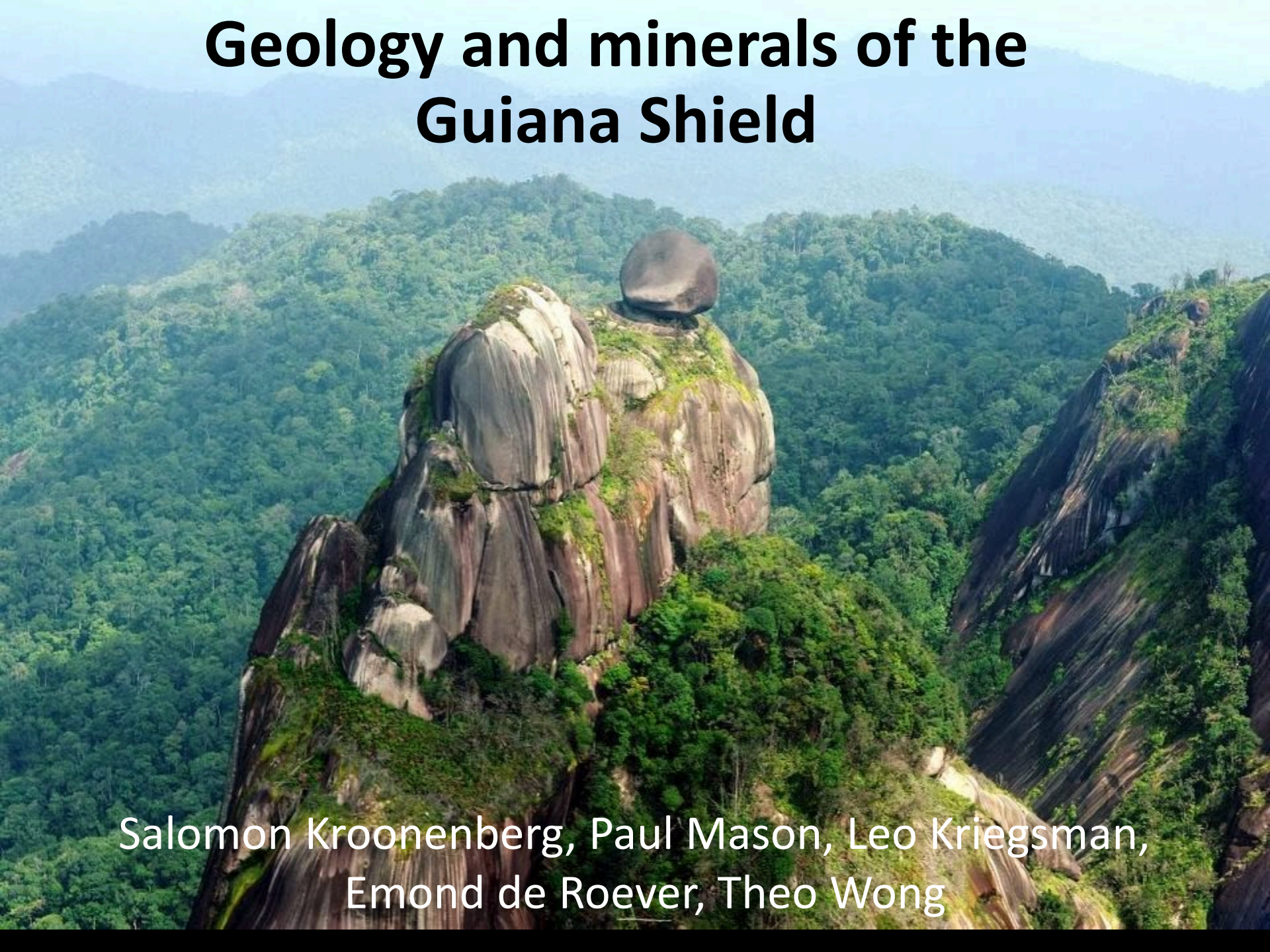
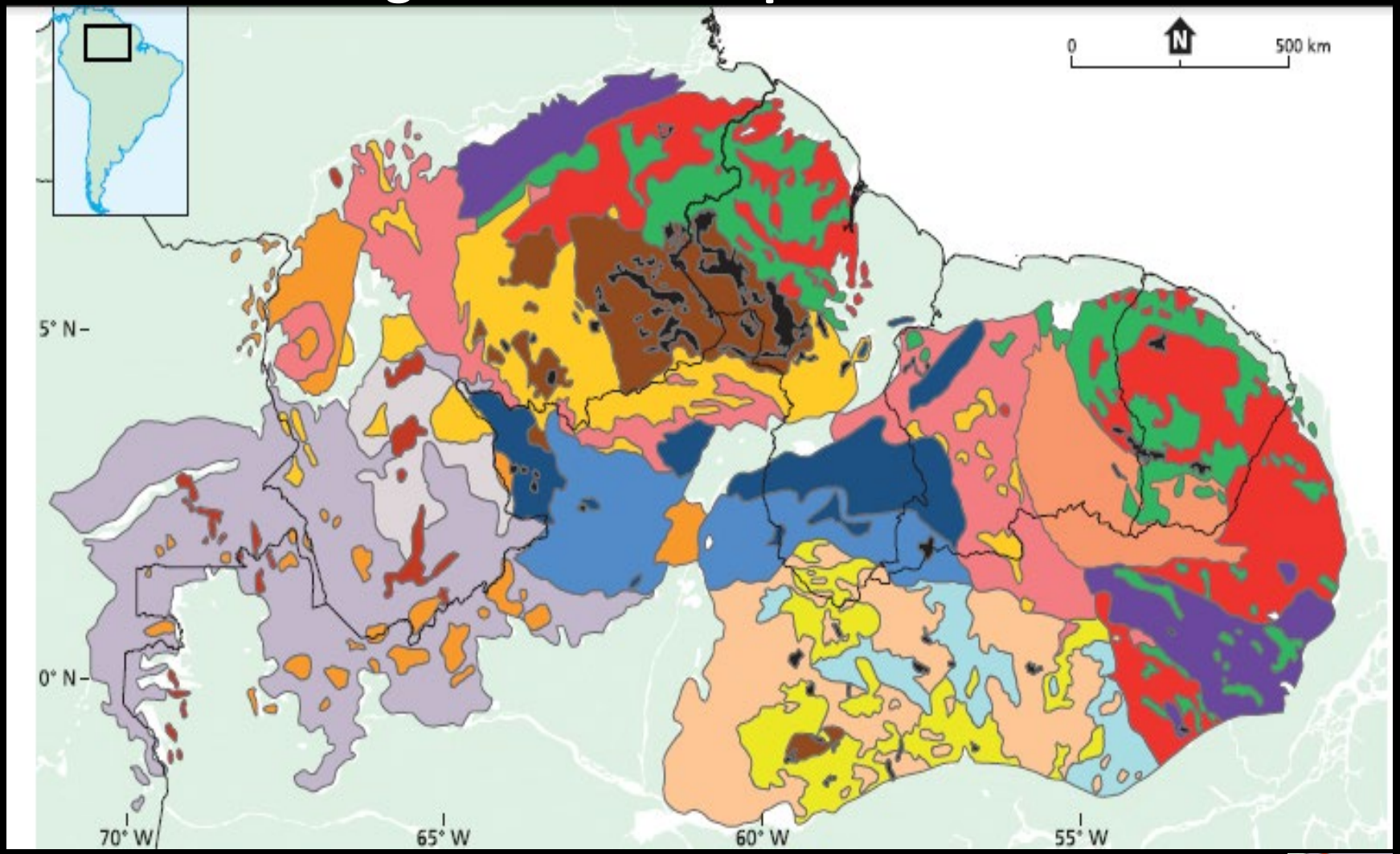
Geology and minerals of the Guiana Shield



Salomon Kroonenberg, Paul Mason, Leo Kriegsman,
Emond de Roever, Theo Wong

Geological sketch map Guiana Shield



Archean >3 Ga

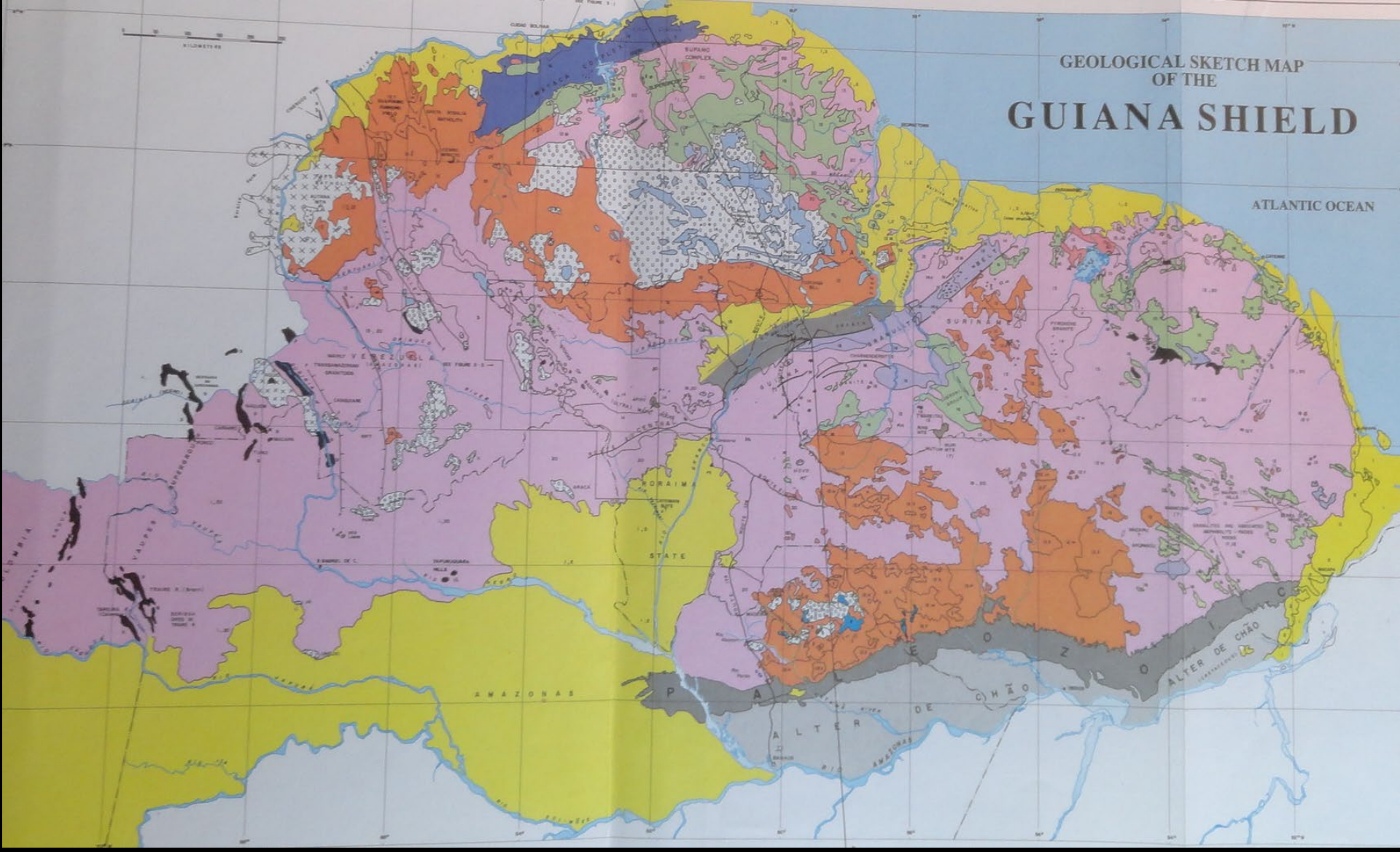
Greenstone belt 2.26-1.95 Ga

High-grade belt 2.08-2.05 Ga

Felsic volcanics + granitoids 1.98-1.95 Ga

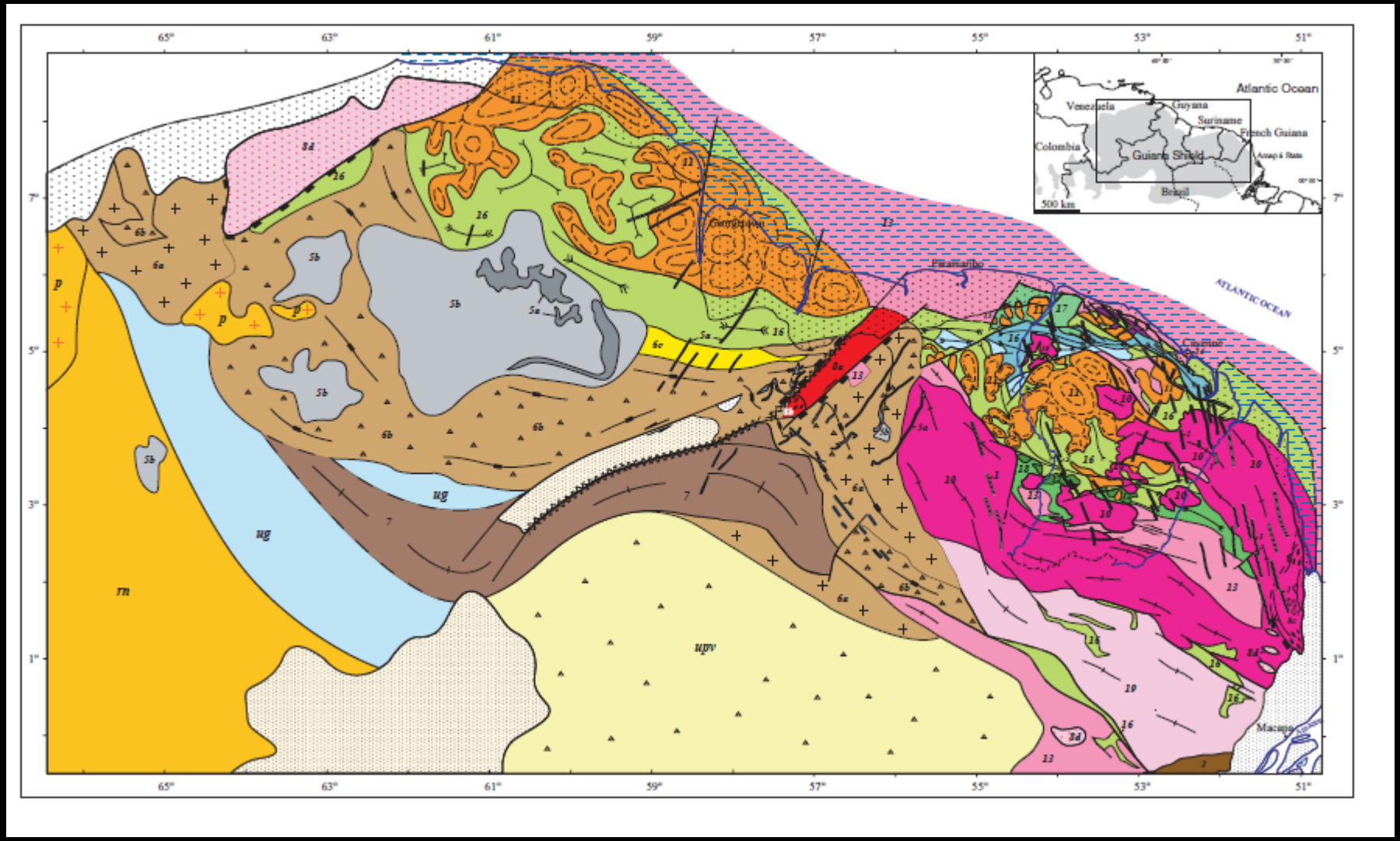
Roraima+dol. 1.87-1.73 Ga

Younger belts 1.83-1.72 Ga



Gibbs and Barron, 1993, book: *Geology of the Guiana Shield*

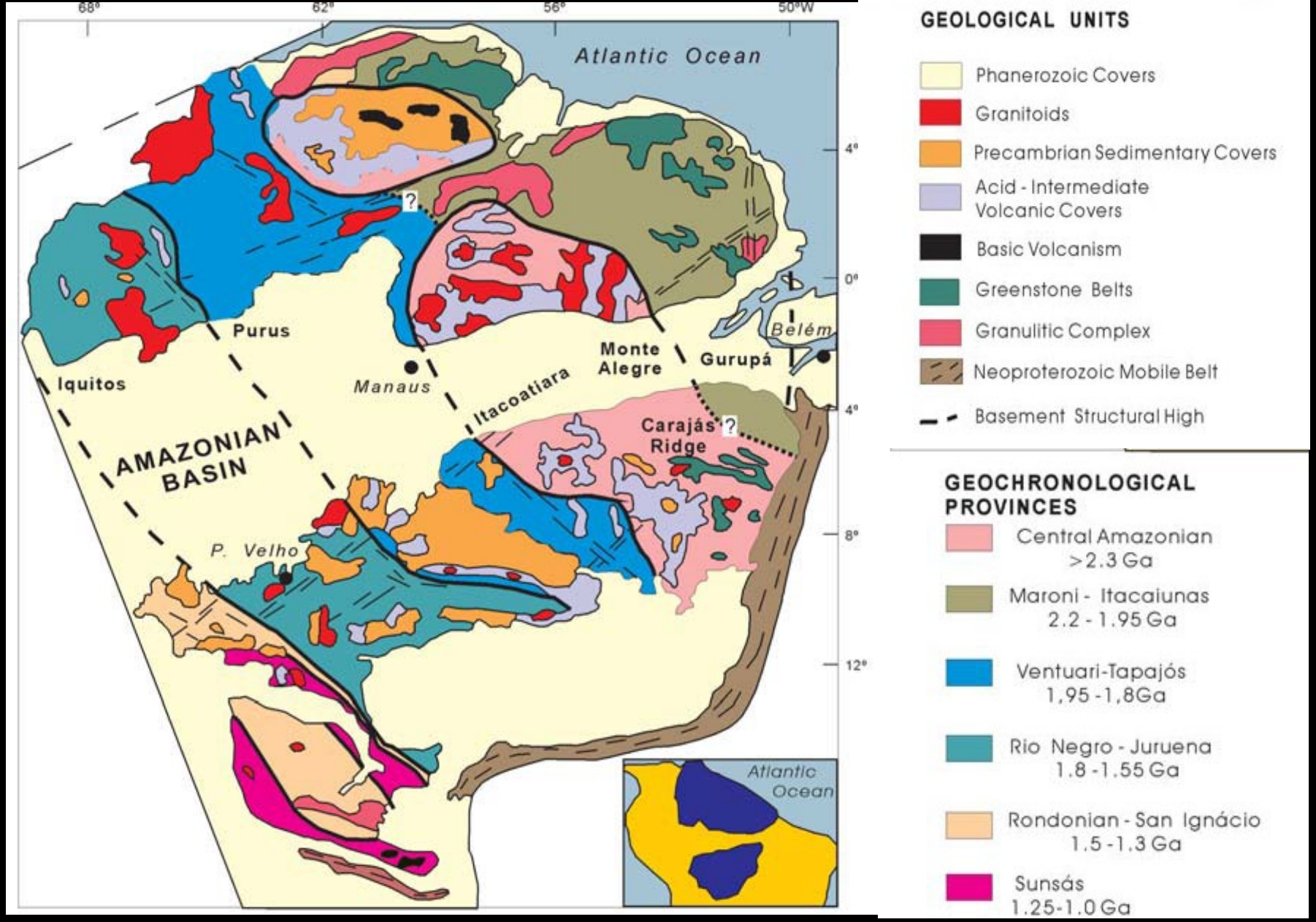
Still much unknown



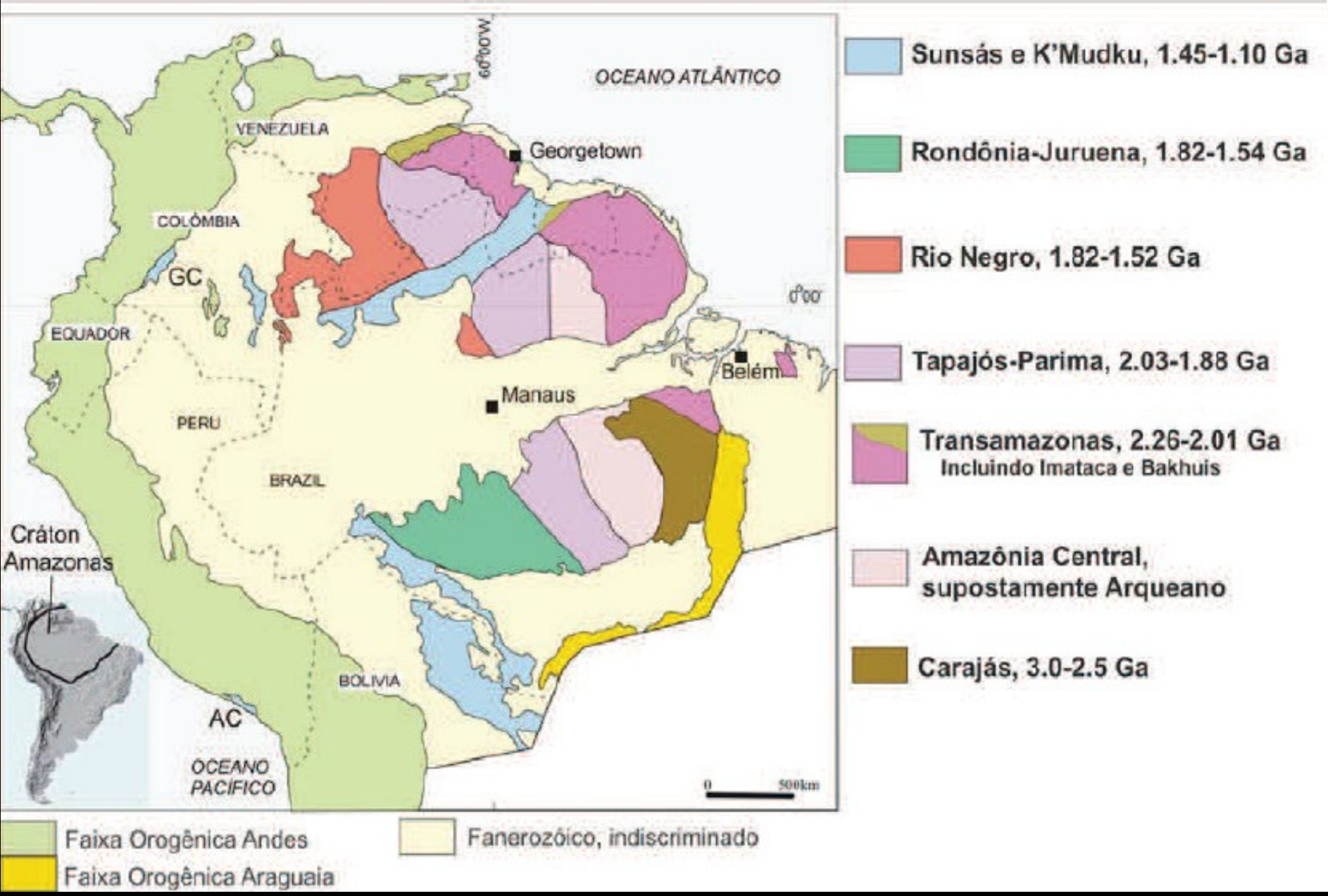
Delor et al., 2003: Trans-Amazonian Orogeny

Details in greenstone belt, good geodynamic analysis,

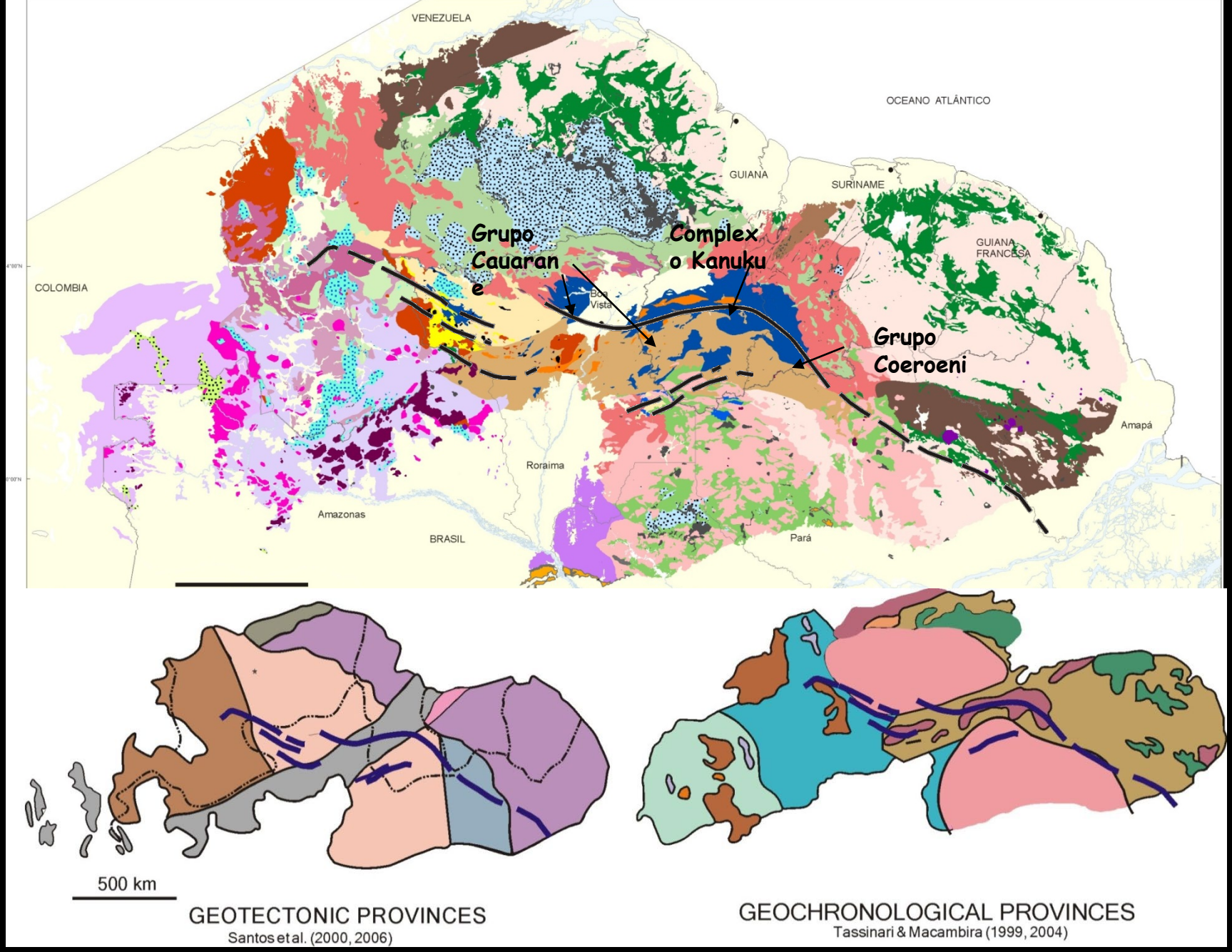
Little differentiation in Brazil



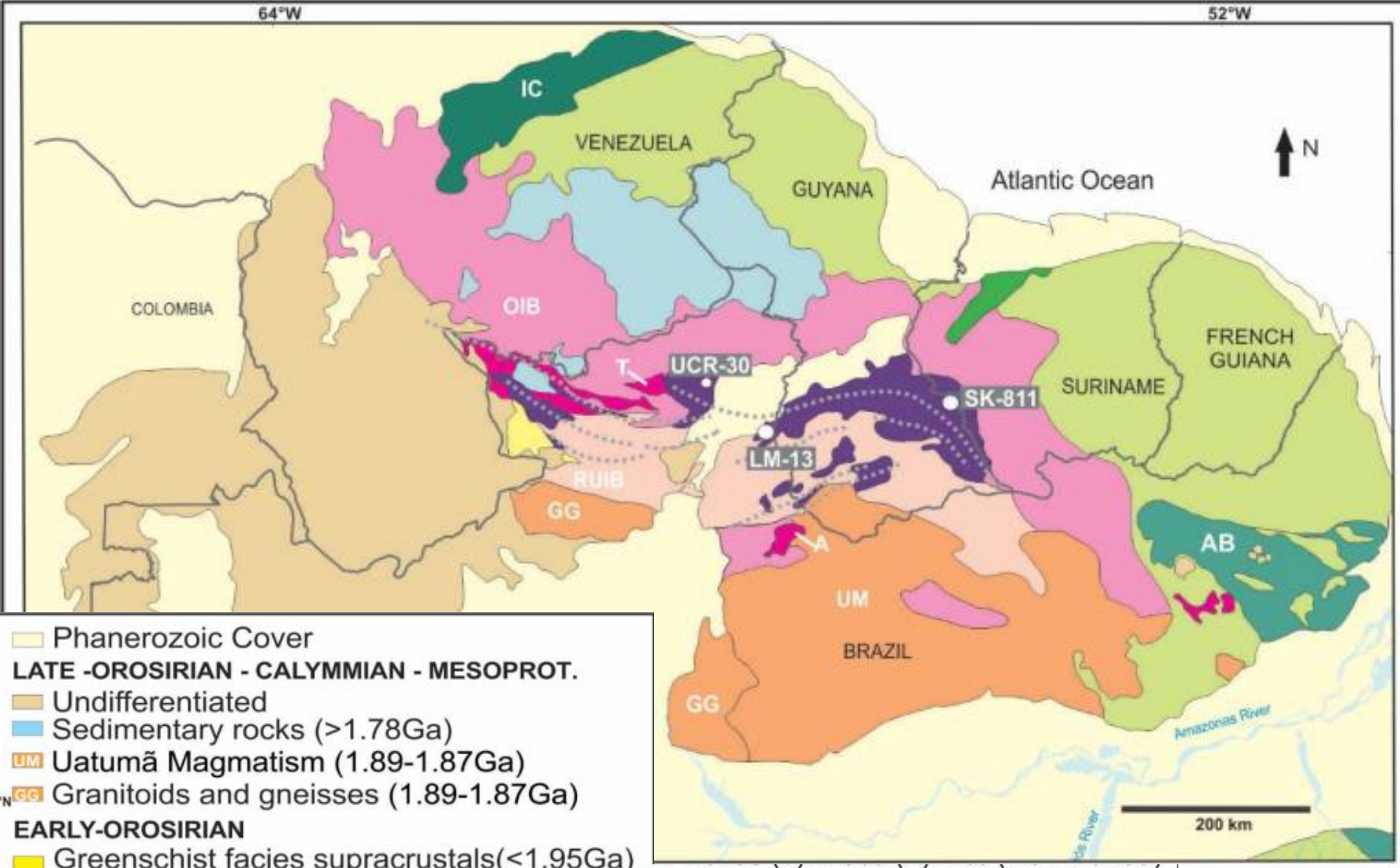
Tassinari&Macambira, 1999: westward continental accretion;
Influential map, but Guiana Shield mostly incorrect



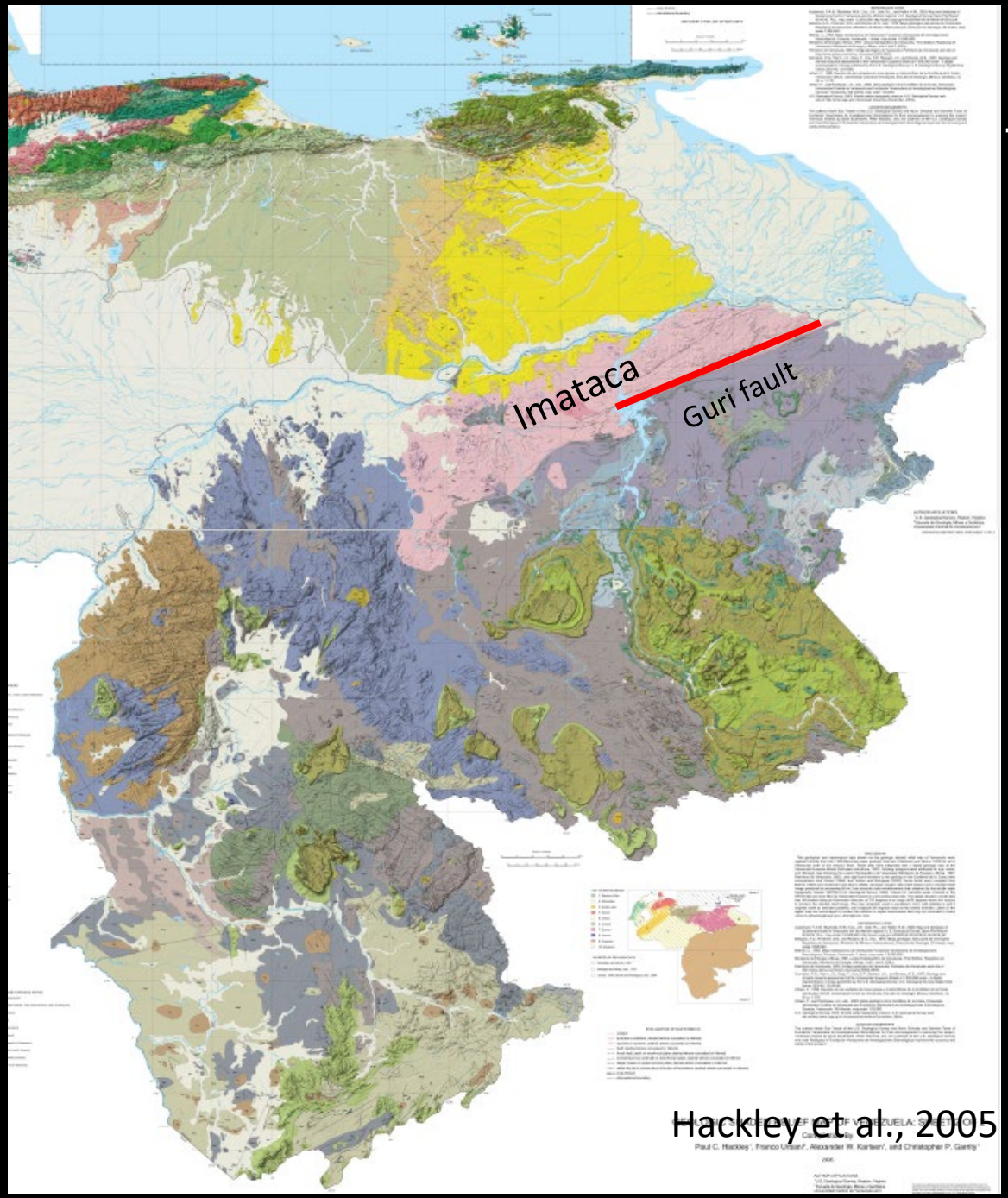
Last reconstruction by Santos, 2006; K'Mudku belt incorrect



Fraga et al., 2009: N>S younging, subduction and collision from south



Fraga et al., 2017



Hackley et al., 2005

Pre-Trans-Amazonian

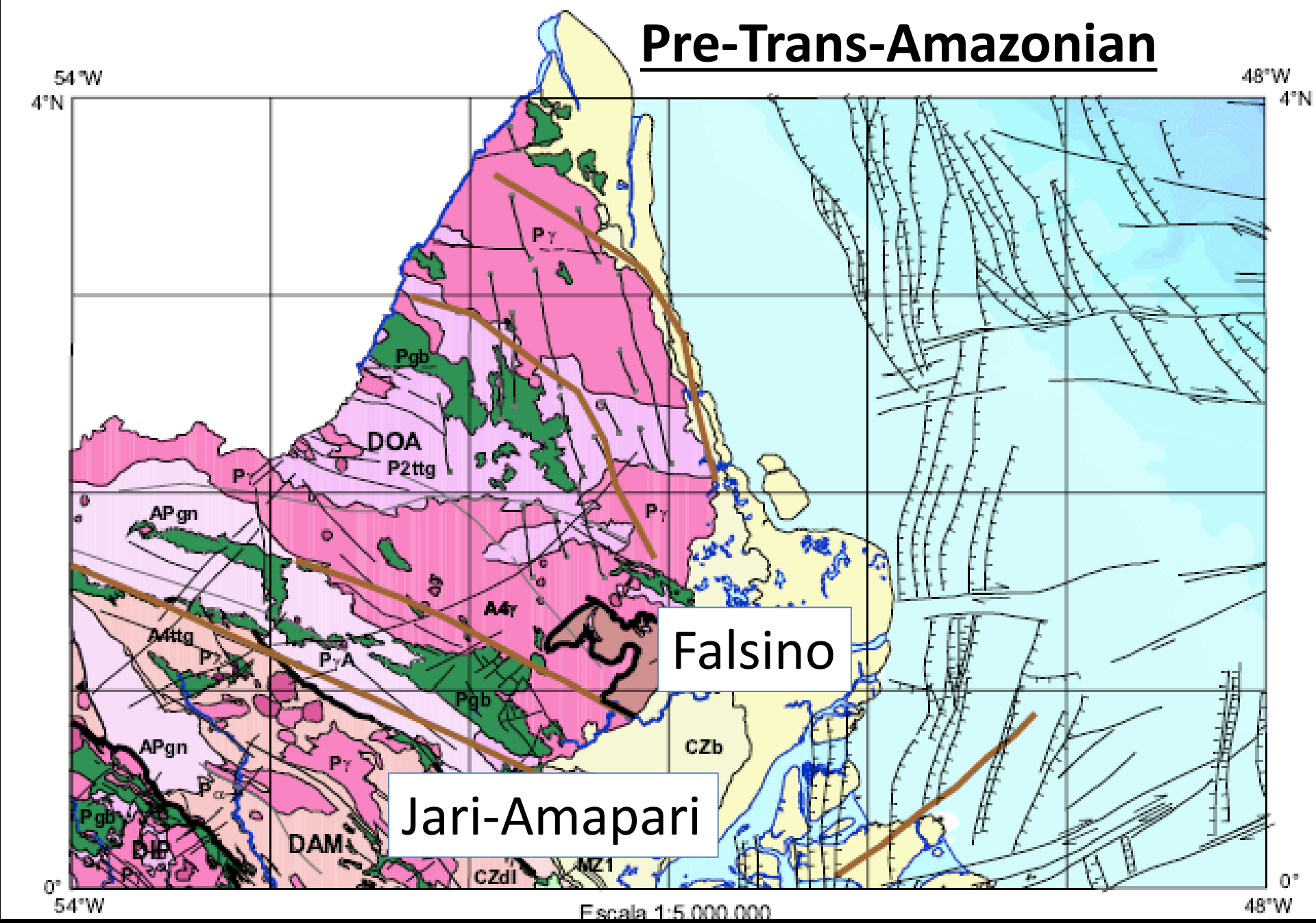
Imataca Archean belt, Venezuela
(allochthonous?)

Granulite-facies paragneisses, amphibolites orthogneisses, granulites, dolomitic marbles, BIF

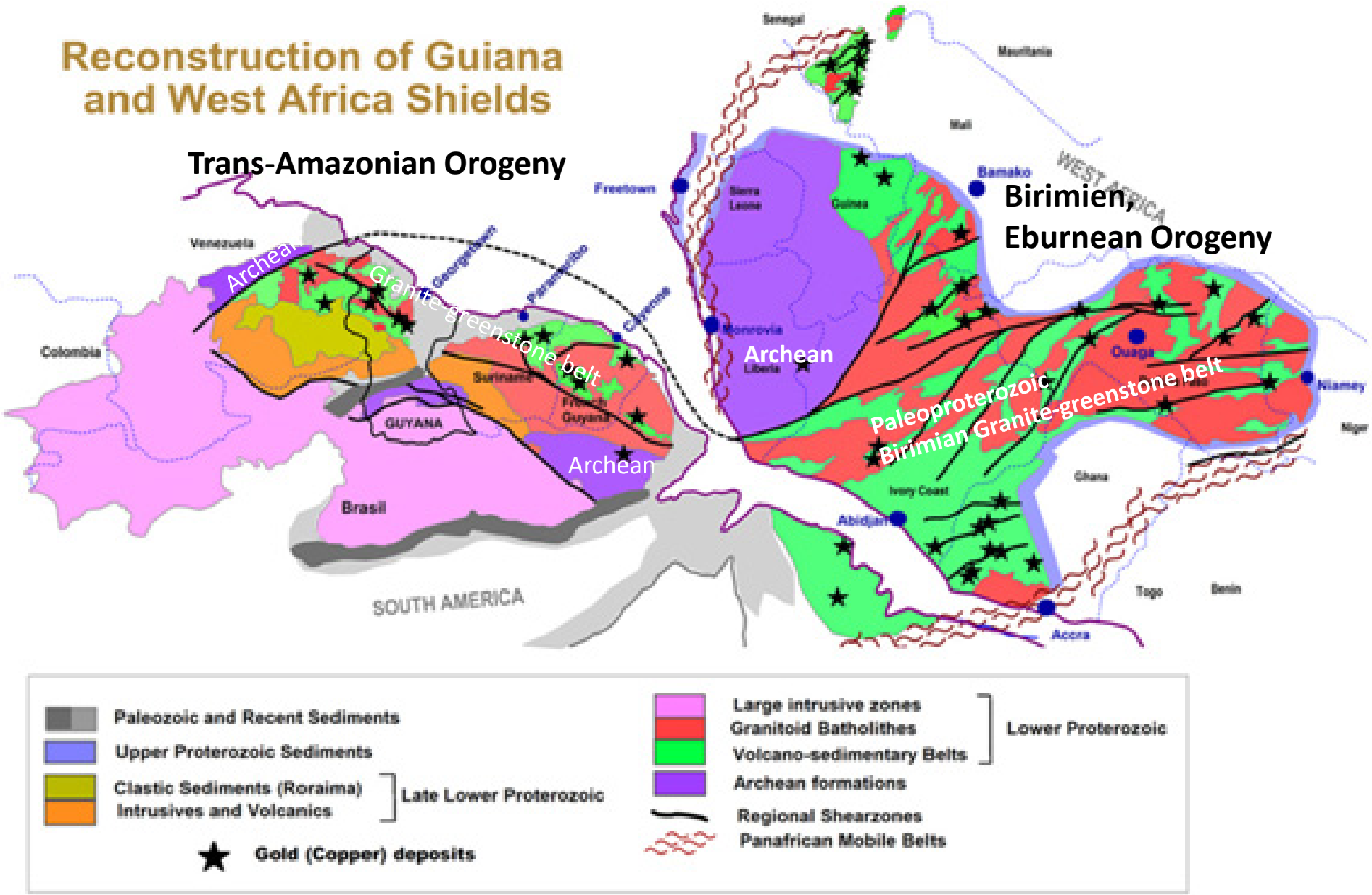
3.23 Ga (U-Pb SHRIMP) with metamorphic overprint down to 2.21-2.05 Ga (Trans-Amazonian)

Estratos de formaciones de hierro del Complejo de Imataca

Archean Banded Iron Formation, Superior/Algoma type, El Pao, Venezuela



Archean domains in Amapa, Brazil (CPRM)



Sandspringresources.com

Trans-Amazonian greenstone belts, 2.26-2.08 Ga (=Birimien, West-Africa)

Trans-Amazonian Orogeny Stage I: Greenstone belts, 2.26-2.08 Ga

			Supracrustals	Intrusives	Age (Ga)	Venez.	Guyana	Suriname	Fr Guiana	Amapa
Oro	Trans-Amazonian	3		Younger granites	1.99-1.95					
			Felsic volcanics		1.99-1.95					
Rhyacian		2	High-grade belts		2.08-2.05	Pastora-Carichapo	Barama-Mazaruni	Marowijne	Maroni N-S	Vila Nova
		Stage 1		Older granites	2.09					
			Migmatitic gneisses		2.17-2.08					
			Epicontinental fluvial deposits		<2.11					
				(Peraluminous) granitoids	2.10-2.06					
			Turbidites, greywackes, phyllites		<2.16					
				TTG diapirs	2.18-2.12					
			Island arc and., rhyol., chemical sed.		2.16-2.14					
			Ocean floor thol. (pillow)lavas, UM	(Ultra)mafic plutons	2.26-2.18					

STRATIGRAPHY TRANS-AMAZONIAN GREENSTONE BELTS IN THE GUIANA SHIELD

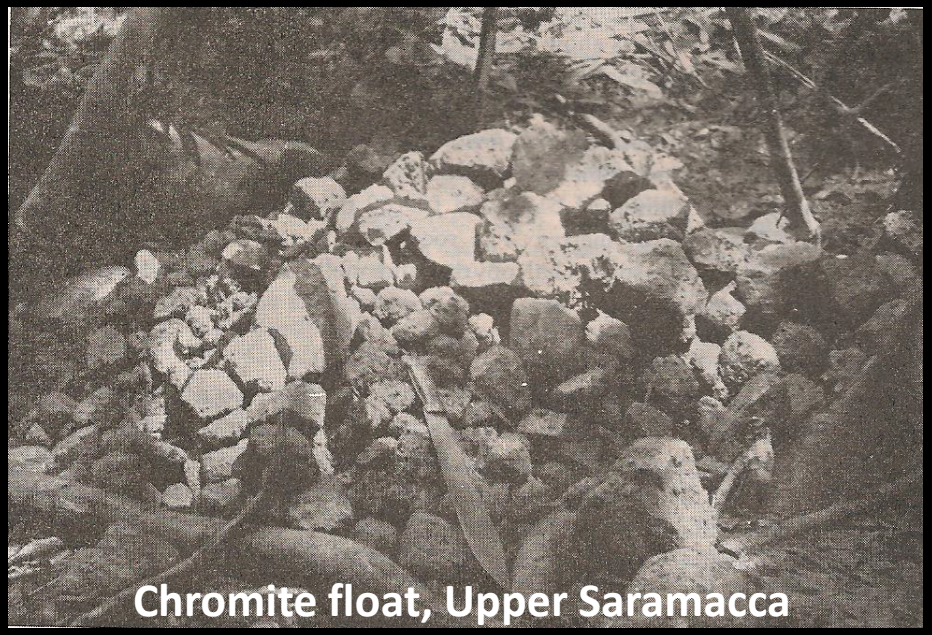
General consensus on major lithostratigraphic units but not on geodynamic interpretation

Tholeiitic pillow lavas, Poederberg, Suriname

Gold nugget, 245 gram

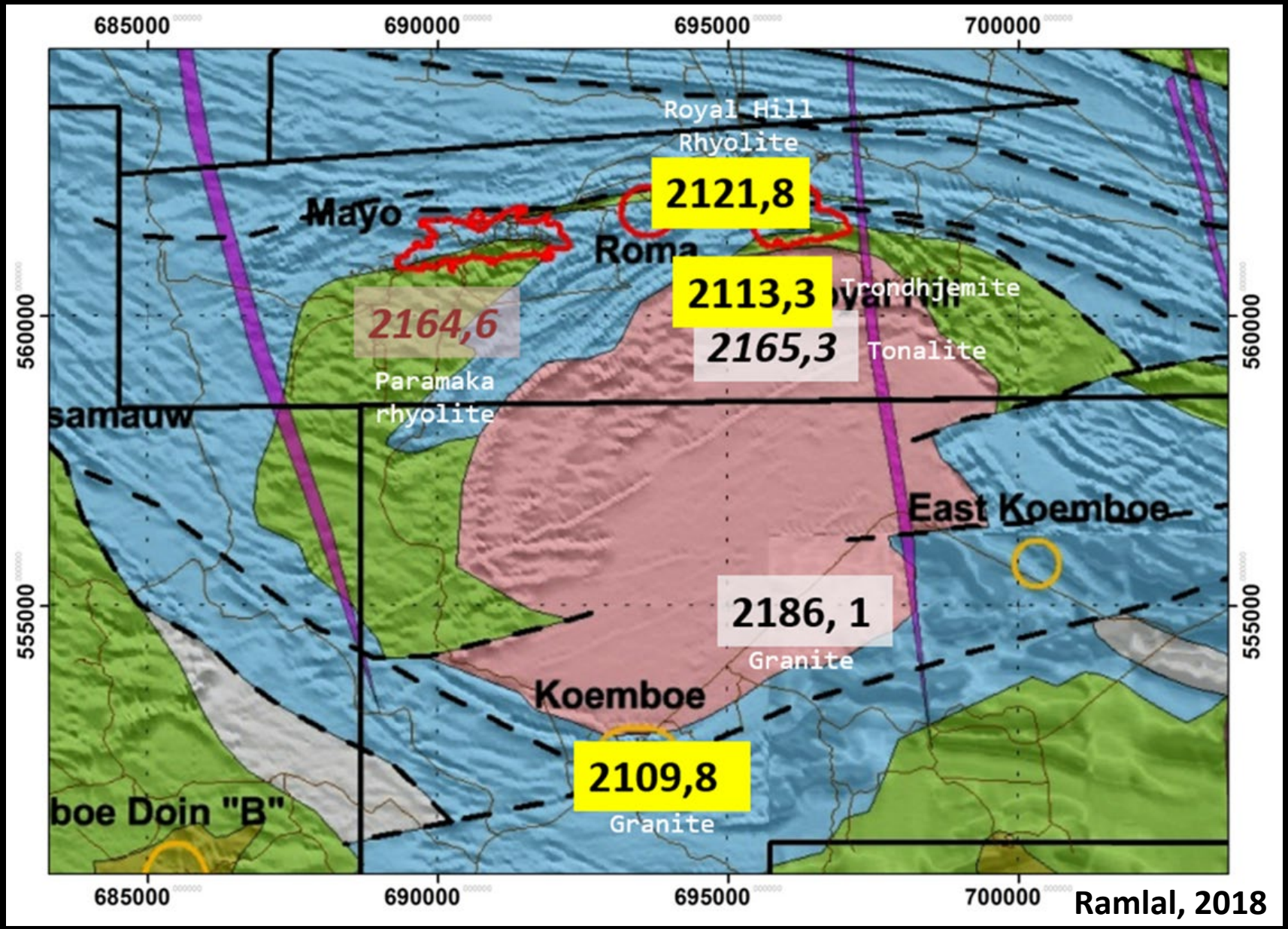
Diamonds in volcaniclastic komatiite from French Guiana

Nickel-rich talcschist Saramacca



Chromite float, Upper Saramacca

Serra do Navio manganese mine, Mn-laterite on Mn-carbonates
Vila Nova greenstone belt, Amapá, Brazil, 1975

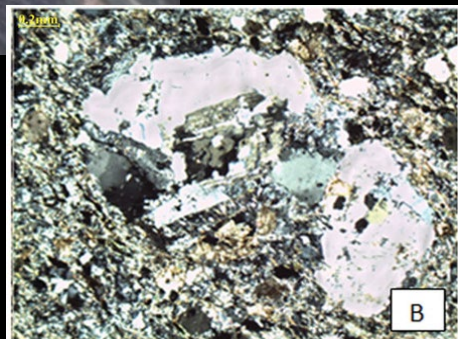


A typical multiphase TTG intrusion, IAMGOLD Rosebel Gold Mine

Meta-turbidites (Armina, Haimaraka Fmns)

Meta-greywackes, shales/ phyllites

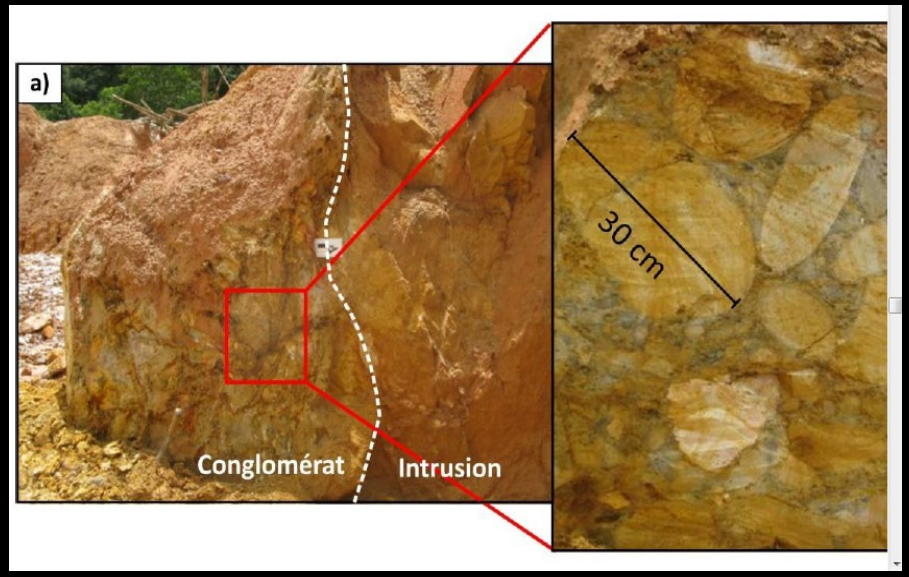
Detrital zircons ~2.16 Ga



Tonalite clast Armina Formation

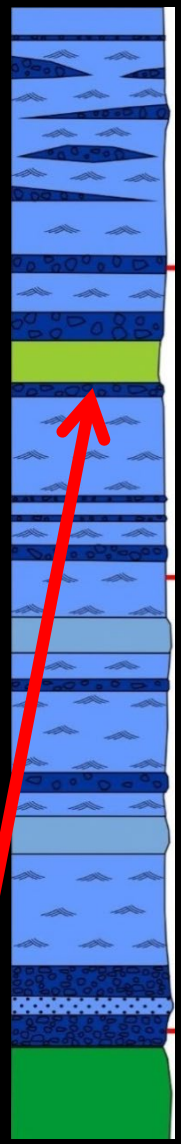
Naipal & Kroonenberg, 2016

Gold-bearing pyrite in metagreywackes and quartz vein
IAMGOLD Rosebel Gold Mines

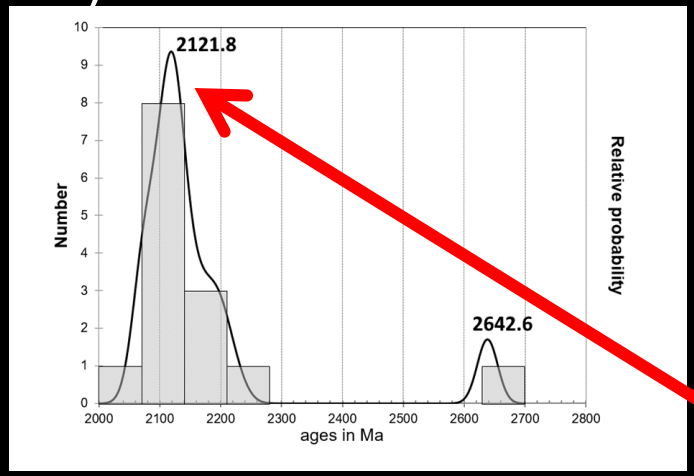


Rosebel basal conglomerate with granitoid pebbles (Daoust, 2016)

Rosebel fluvial sandstone



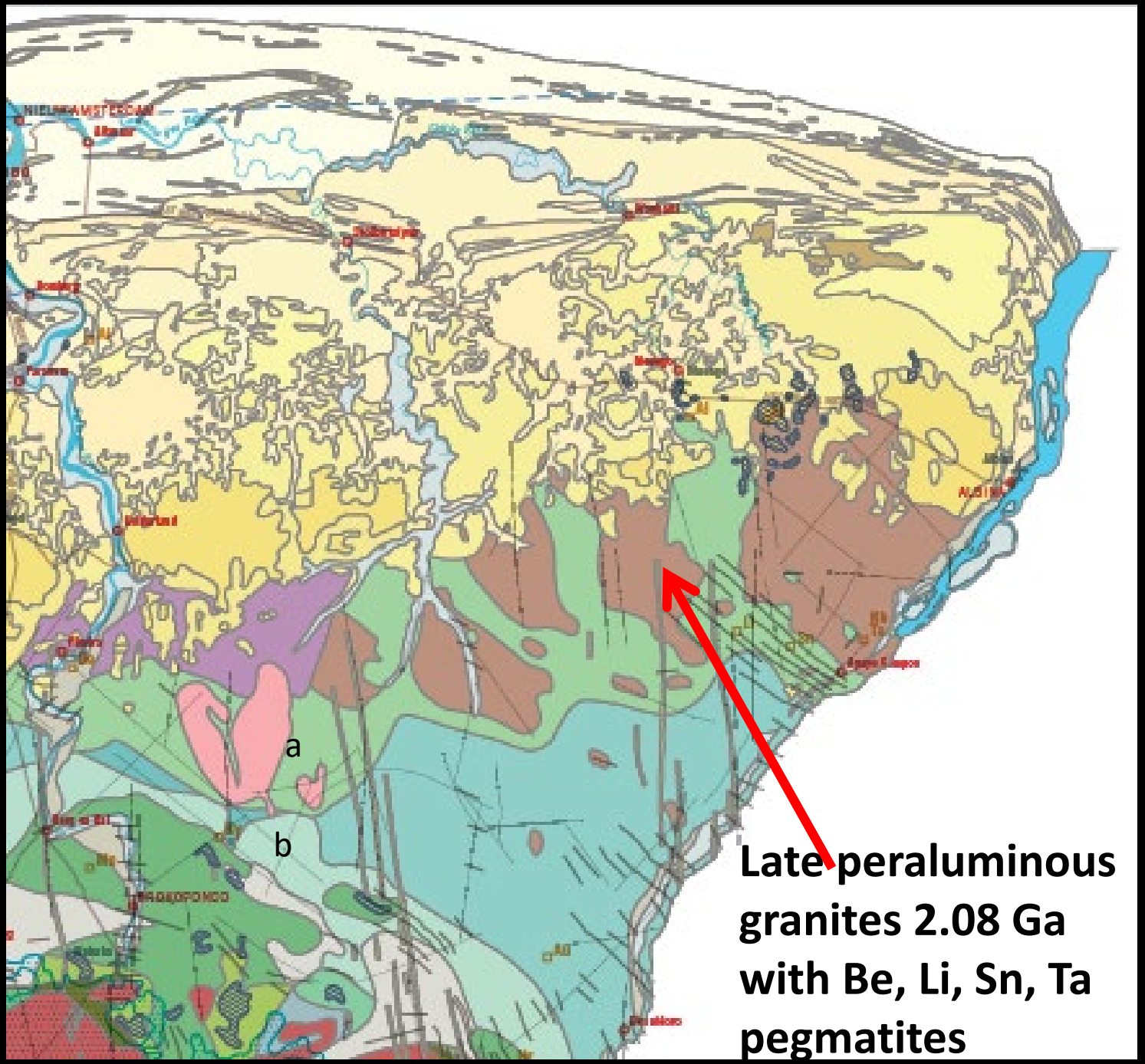
Daoust, 2016

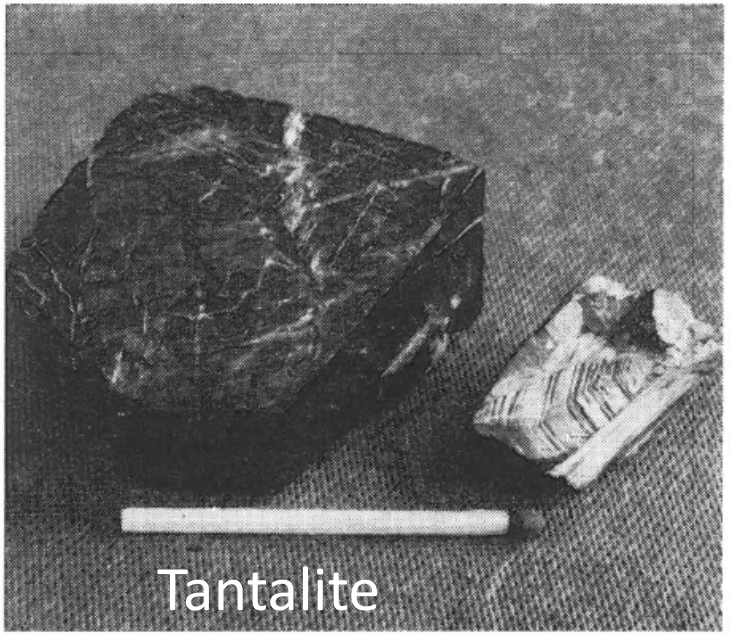


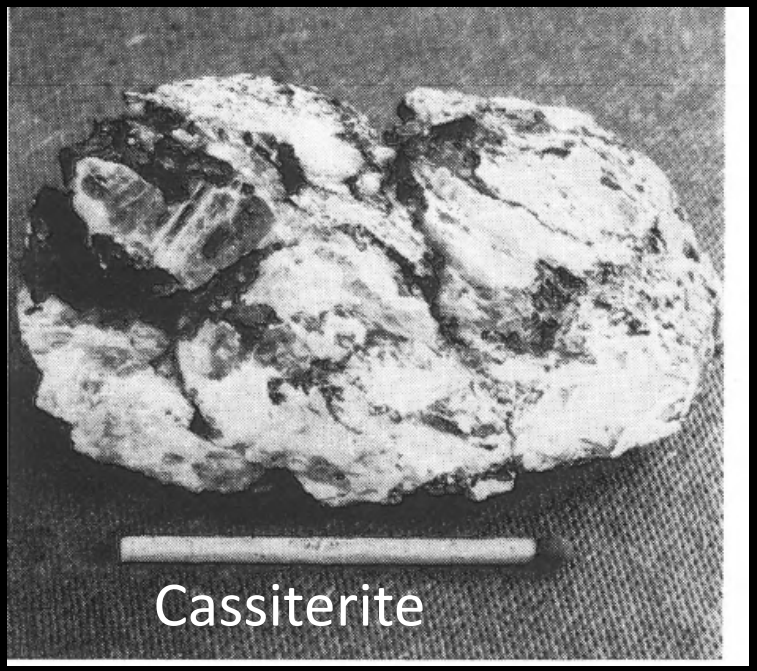
Intercalated rhyolitic ash bed: **2.12 Ga**

Only Suriname and French Guiana

Dissected by late Au-qz veins


a
b
Late peraluminous granites 2.08 Ga with Be, Li, Sn, Ta pegmatites

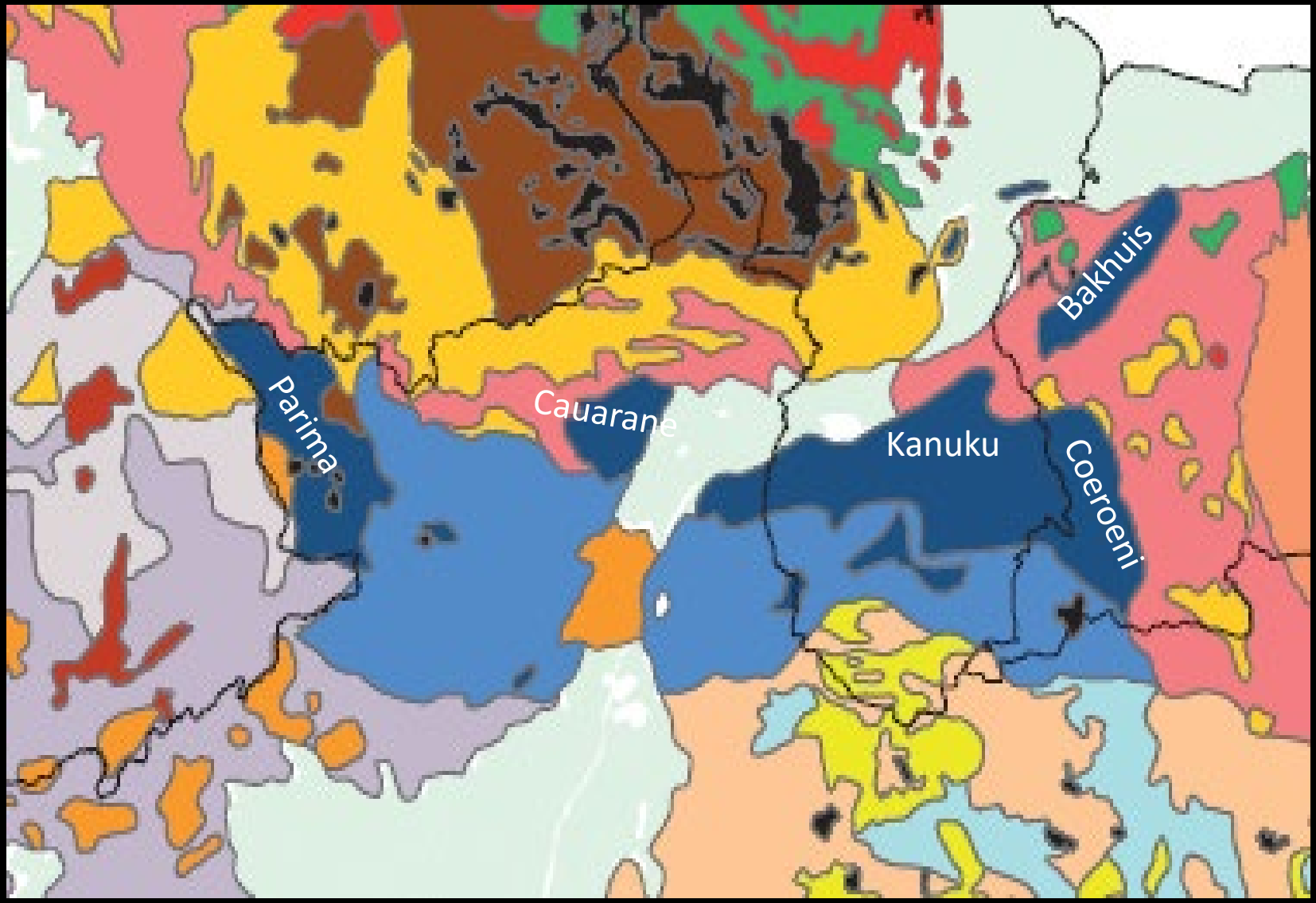

Tantalite


Cassiterite

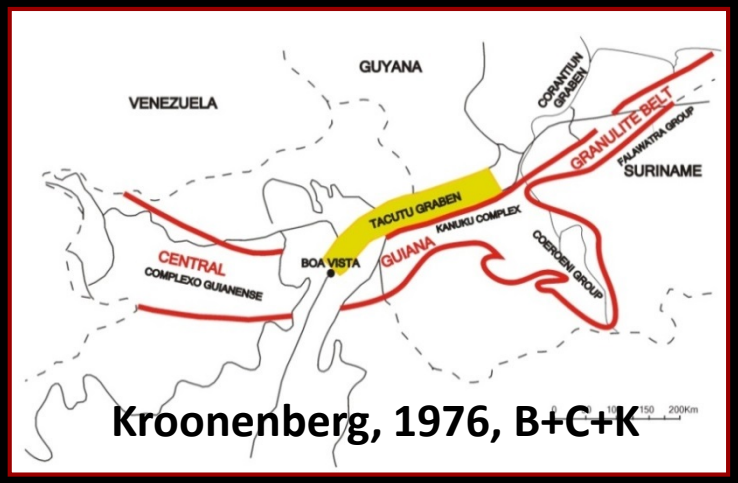

Amblygonite (Li-Al phosphate) quarry

Late pegmatite minerals: Sn, Ta, Be, Li

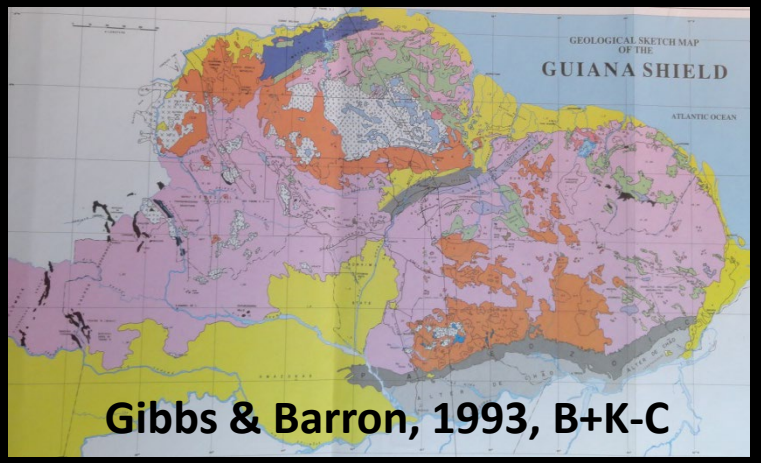
Trans-Amazonian Orogeny Stage II: High-grade belts: 2.08-2.03, 1.98 Ga



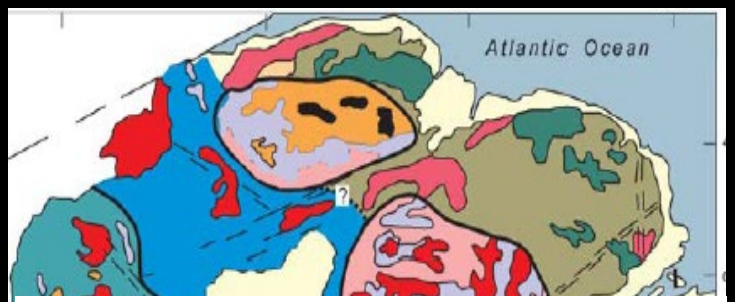
Rifting, sedimentation, high-grade metamorphism?
Or orogenic belt due to northward subduction from S?



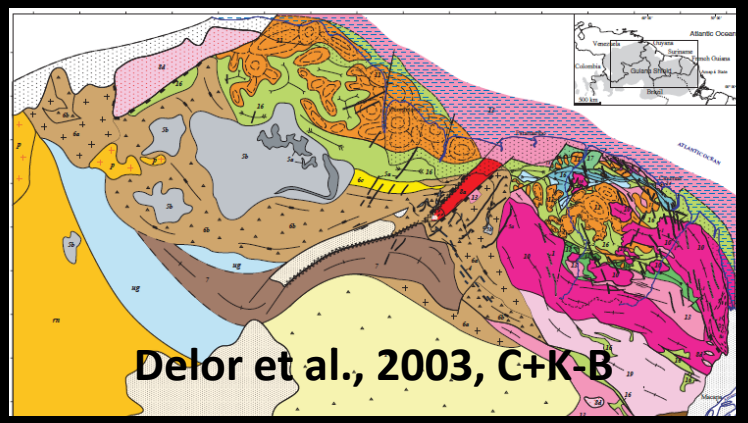
Kroonenberg, 1976, B+C+K



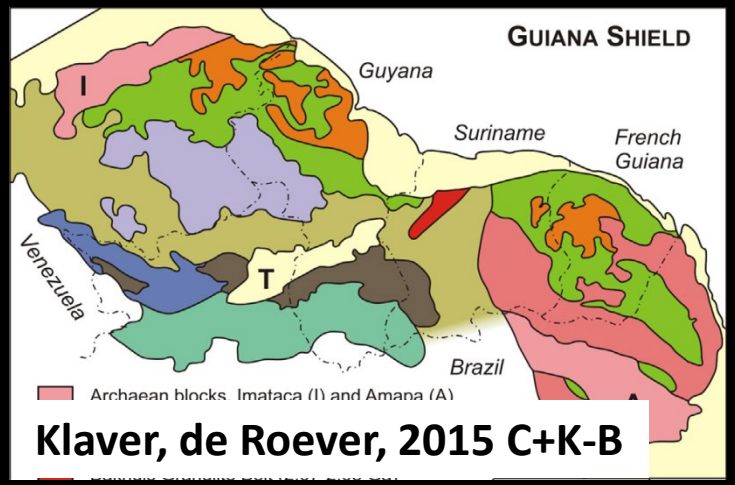
Gibbs & Barron, 1993, B+K-C



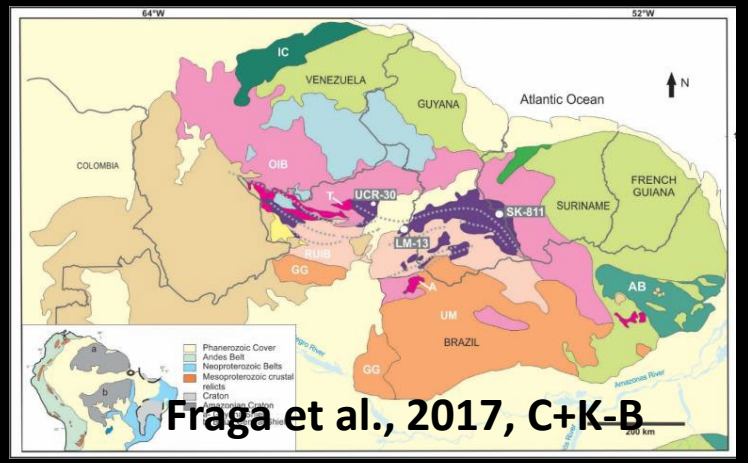
Tassinari,Macambira, 1999 B+C+K



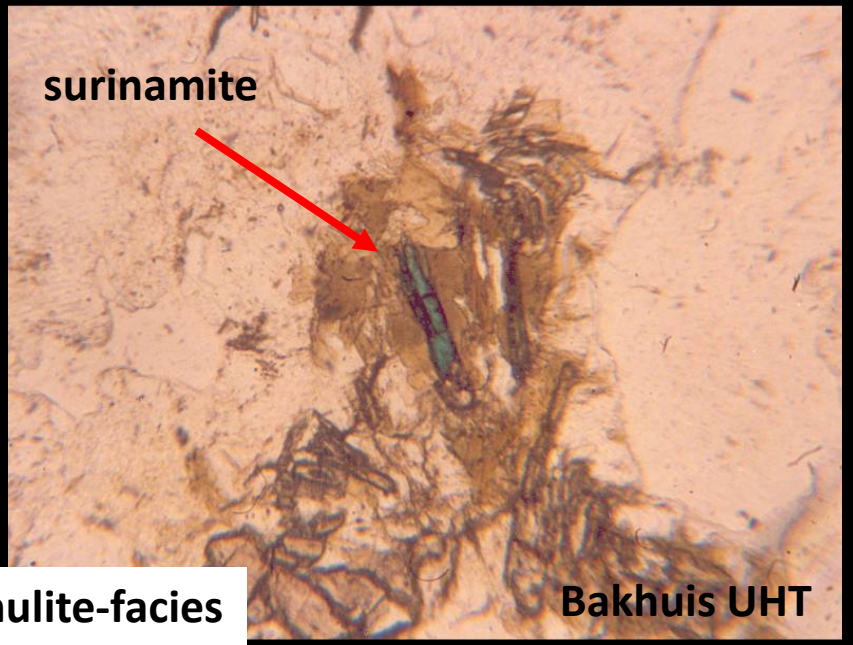
Delor et al., 2003, C+K-B



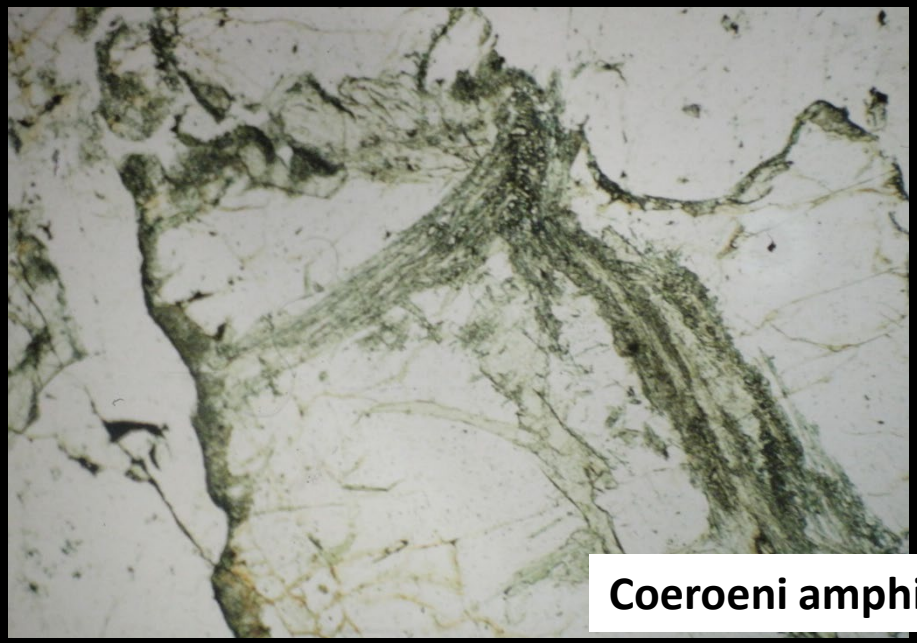
Klaver, de Roever, 2015 C+K-B

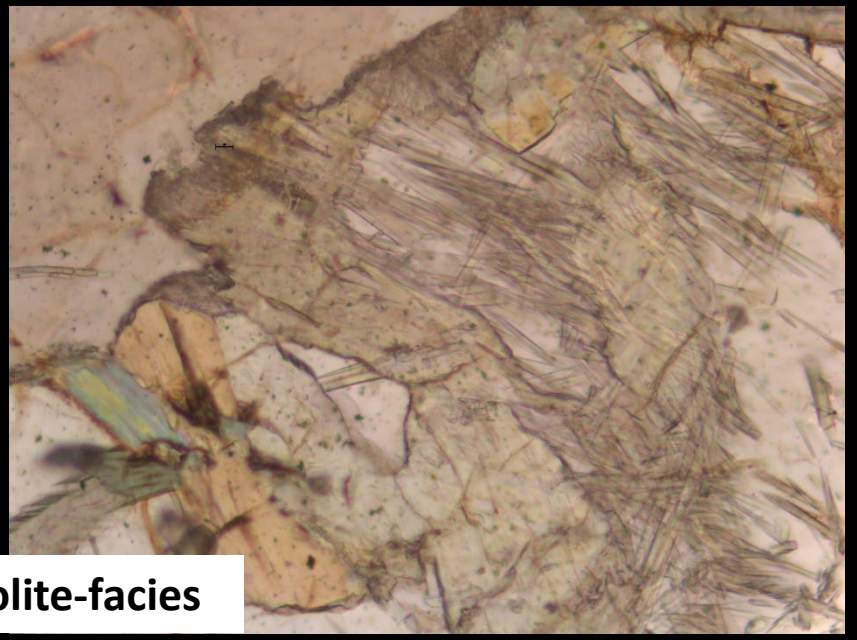


Fraga et al., 2017, C+K-B



Bakhuis UHT granulite-facies

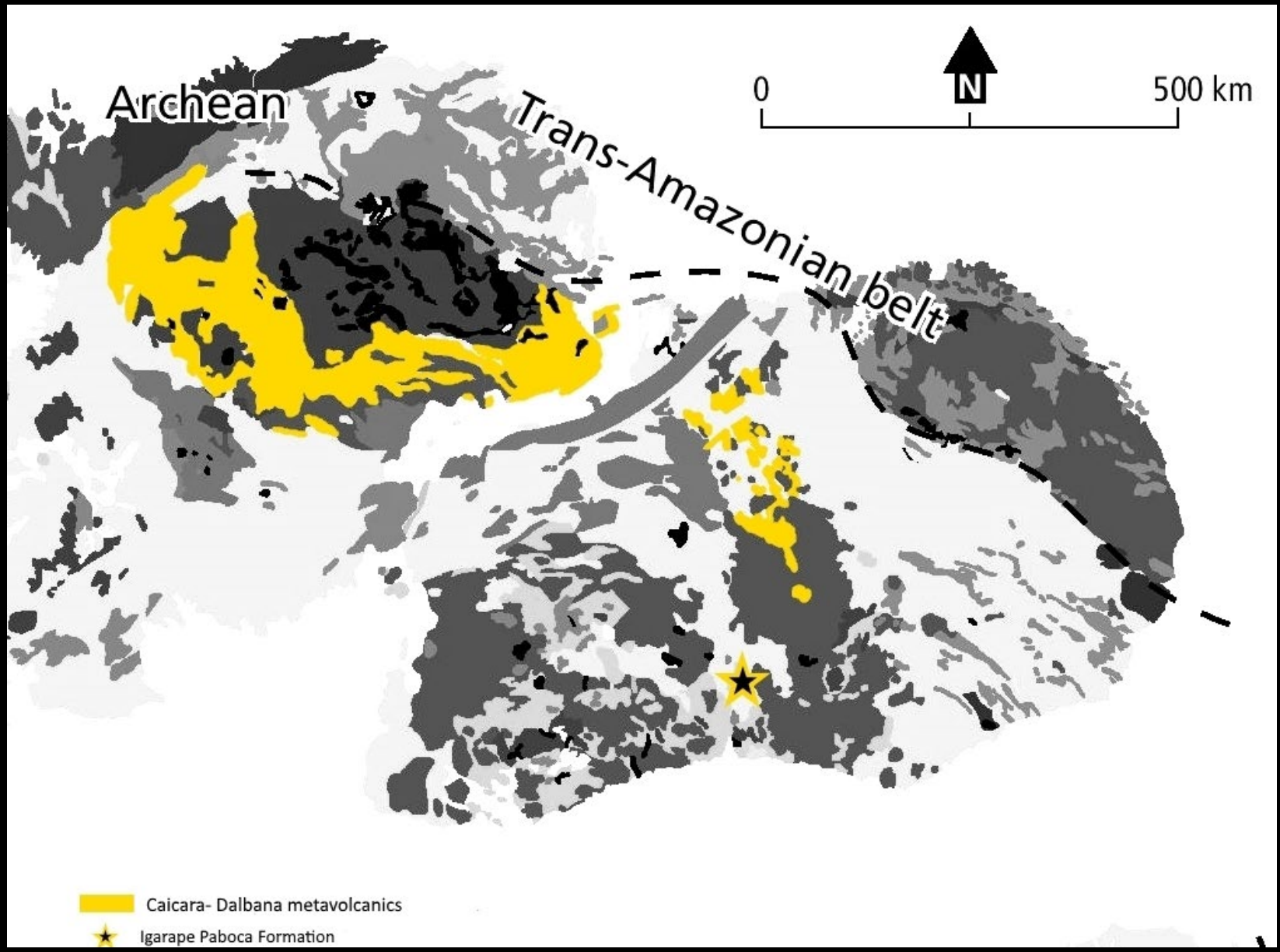




Coeroeni amphibolite-facies

Both belts have same age and anticlockwise metamorphic history, cordierite > HP assemblages

Trans-Amazonian Orogeny Stage III: felsic magmatism



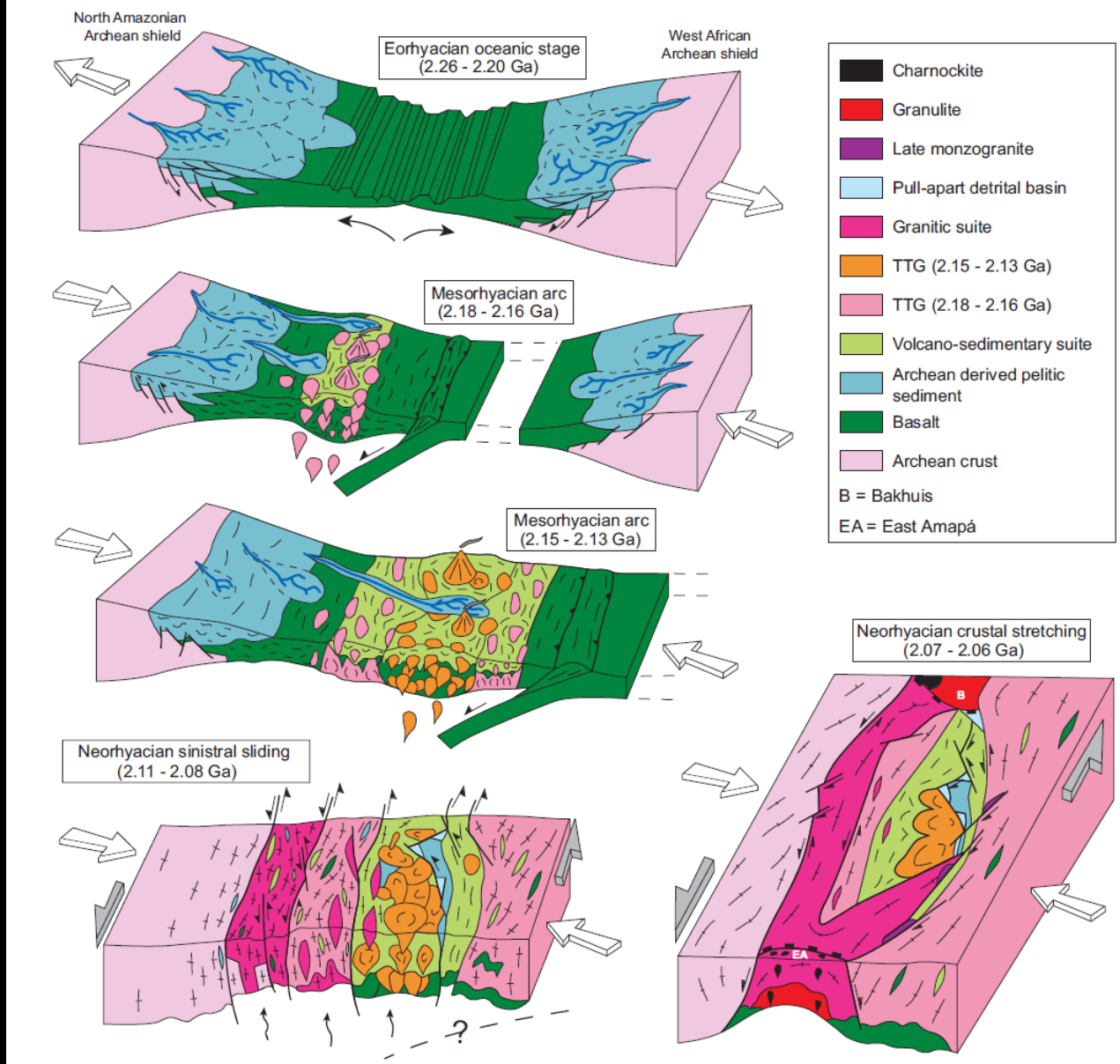
1.98 Ga Caicara-Dalbana felsic volcanic belt (Mahabier, 2017)

Ignimbritic felsic (meta)volcanics: 1987±4 Ma

Suriname: Dalbana,
Guyana: Iwokrama
Brazil: Surumu
Venezuela: Caicara

Biotite granite, subvolc. leucogranite gabbro, charnockite , 1.99-1.98 Ga

Suriname: Wonotobo
Guyana: Iwokrama
Brazil: Pedra Pintada
Venezuela: Cuchivero

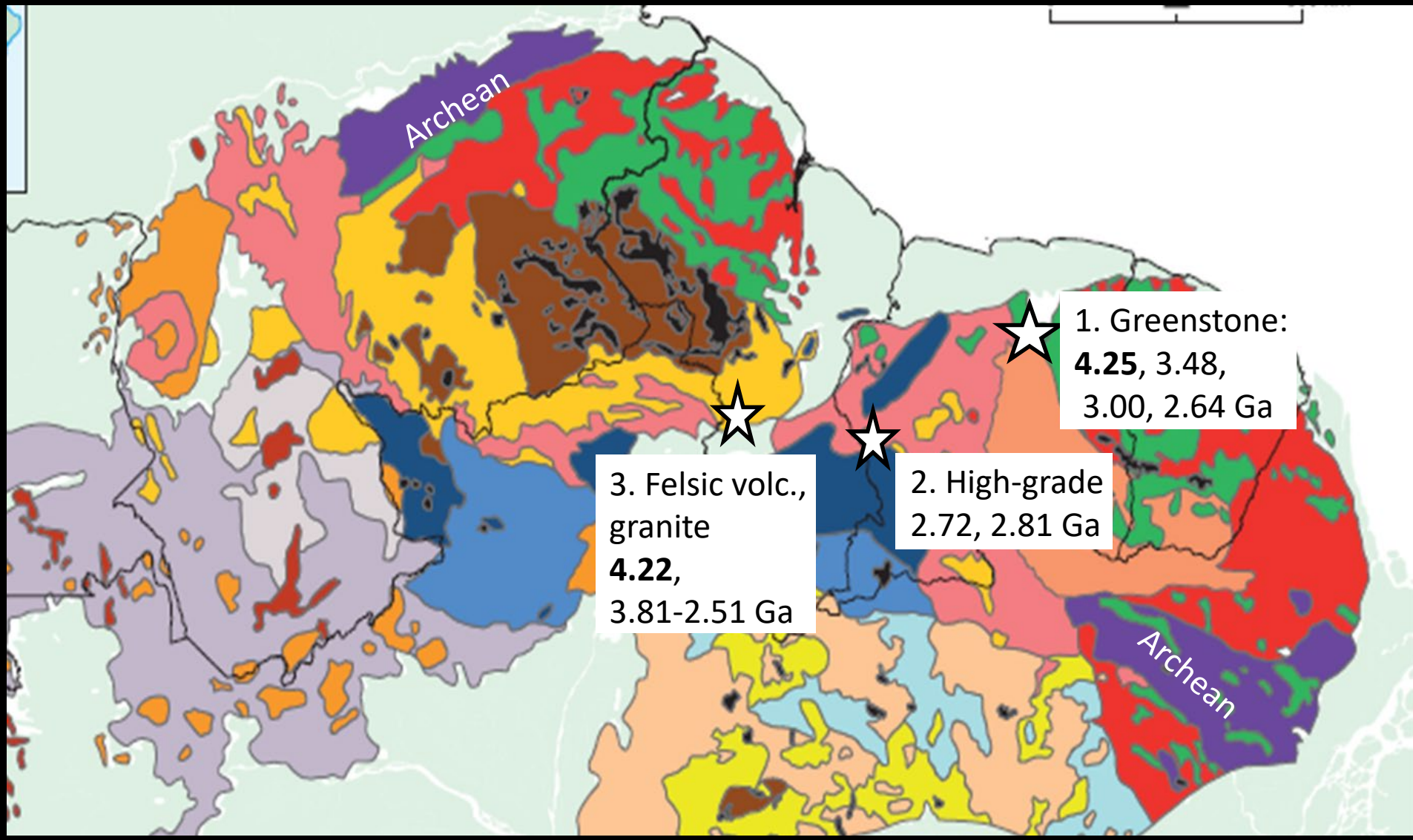


ig. 13.- A geodynamic evolution model for French Guiana Paleoproterozoic terrains.

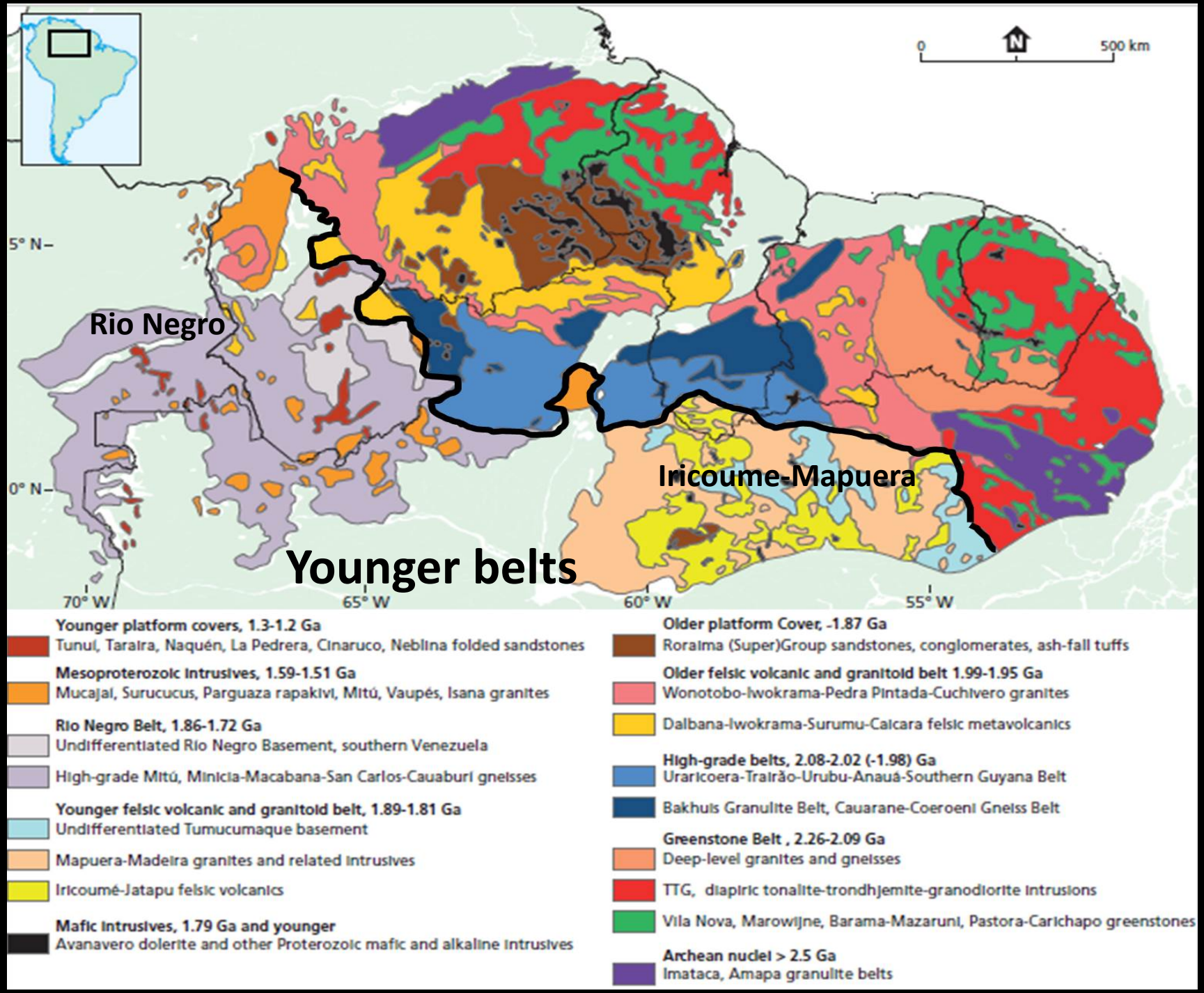
ig. 13.- Evolution géodynamique des terrains paléoprotérozoïques de Guyane.

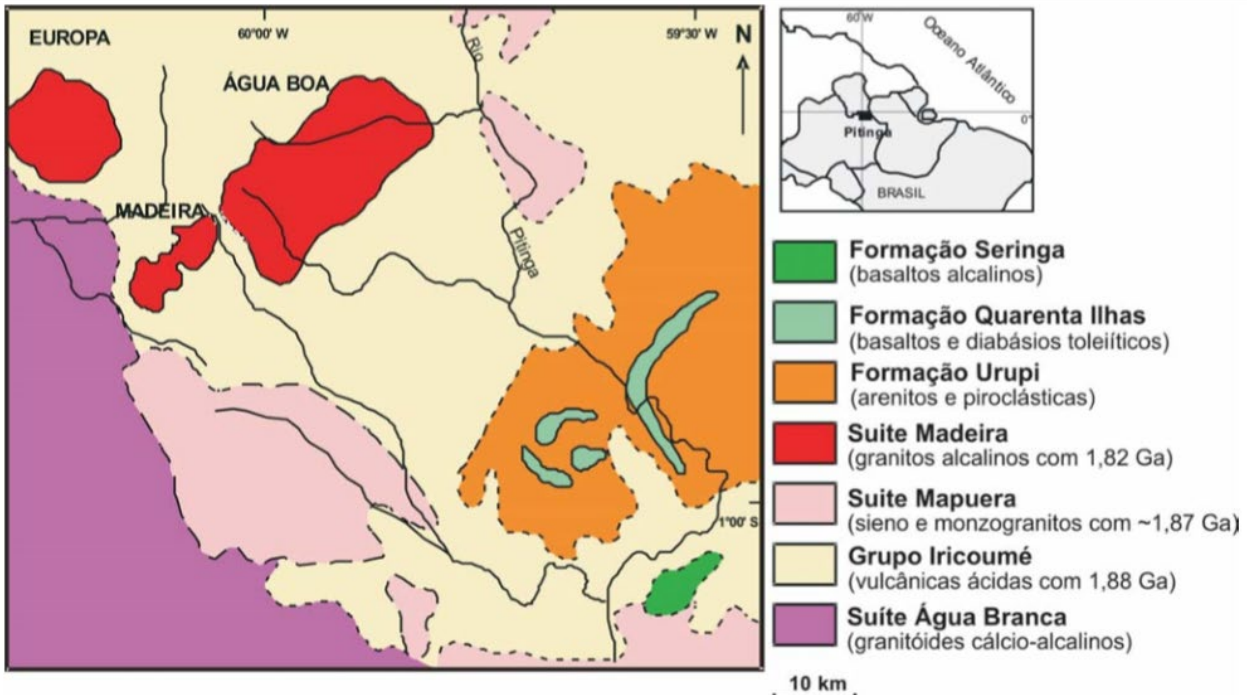
Delor et al., 2003

So far the only geodynamic model of the Trans-Amazonian Orogeny



Scarce Sm-Nd data suggest largely juvenile origin. **BUT**:
Hadean, Archean inherited zircon xenocrysts: older basement?


0
N
500 km
5° N
0° N
70° W
65° W
60° W
55° W
Rio Negro
Iricoume-Mapuera
Younger belts
Younger platform covers, 1.3-1.2 Ga
Tunuí, Taraira, Naquén, La Pedrera, Cinaruco, Neblina folded sandstones
Mesoproterozoic intrusives, 1.59-1.51 Ga
Mucajaí, Surucucus, Parguaza rapakivi, Mitú, Vaupés, Isana granites
Rio Negro Belt, 1.86-1.72 Ga
Undifferentiated Rio Negro Basement, southern Venezuela
High-grade Mitú, Minicia-Macabana-San Carlos-Cauaburi gneisses
Younger felsic volcanic and granitoid belt, 1.89-1.81 Ga
Undifferentiated Tumucumaque basement
Mapuera-Madeira granites and related intrusives
Iricoumé-Jatapu felsic volcanics
Mafic intrusives, 1.79 Ga and younger
Avanavero dolerite and other Proterozoic mafic and alkaline intrusives
Older platform Cover, ~1.87 Ga
Roraima (Super)Group sandstones, conglomerates, ash-fall tuffs
Older felsic volcanic and granitoid belt 1.99-1.95 Ga
Wonotobo-Iwokrama-Pedra Pintada-Cuchivero granites
Dalbana-Iwokrama-Surumu-Caicara felsic metavolcanics
High-grade belts, 2.08-2.02 (-1.98) Ga
Uraricoera-Trairão-Urubu-Anauá-Southern Guyana Belt
Bakhuis Granulite Belt, Cauarane-Coeroeni Gneiss Belt
Greenstone Belt , 2.26-2.09 Ga
Deep-level granites and gneisses
TTG, diapiric tonalite-trondhjemite-granodiorite intrusions
Vila Nova, Marowijne, Barama-Mazaruni, Pastora-Carichapo greenstones
Archean nuclei > 2.5 Ga
Imataca, Amapa granulite belts



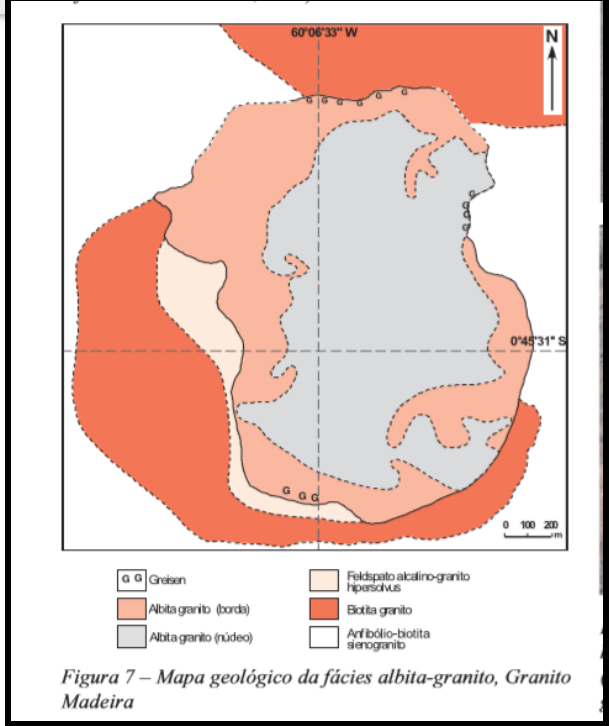


Figura 7 – Mapa geológico da fácies albita-granito, Granito Madeira

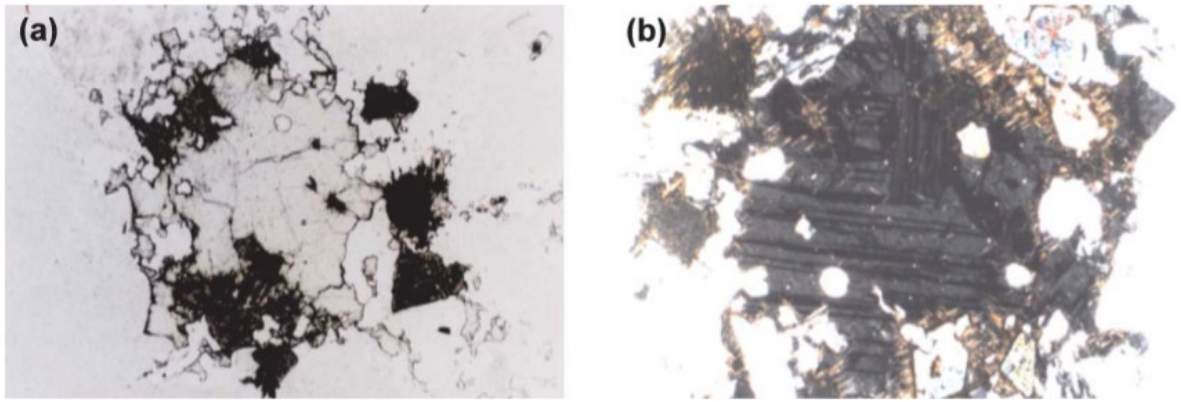
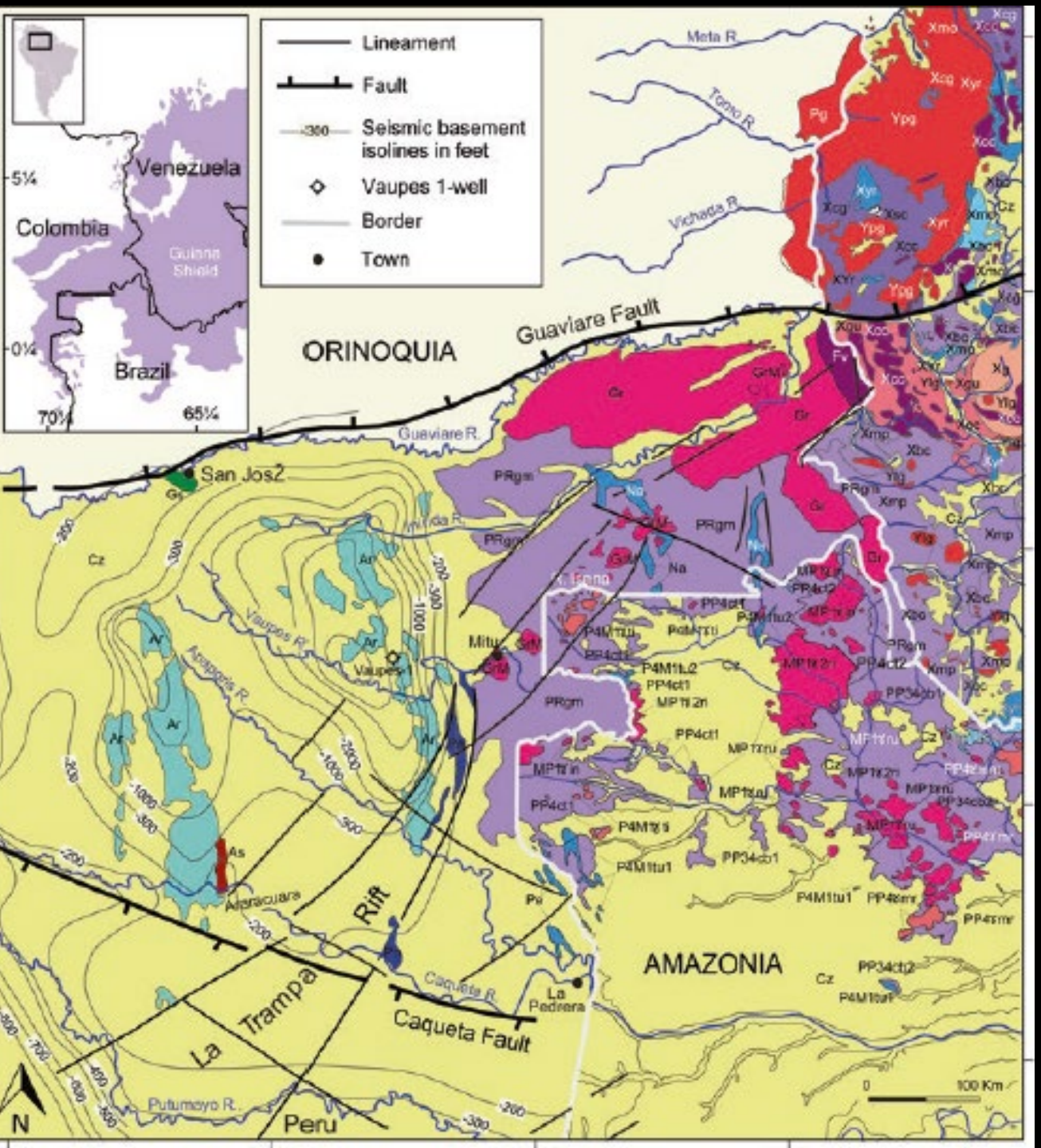


Figura 12 – Aspecto microscópico de cristais de criolita em albita-granito de núcleo. (a) Nicóis paralelos. (b) Nicóis cruzados); largura da imagem - 4 mm

Costi et al, 2005

Cryolite in albite granite, Pitinga tin mine, 1.88-1.82 Iricoume-Mapuera Belt, Brazil



Western Guiana Shield:

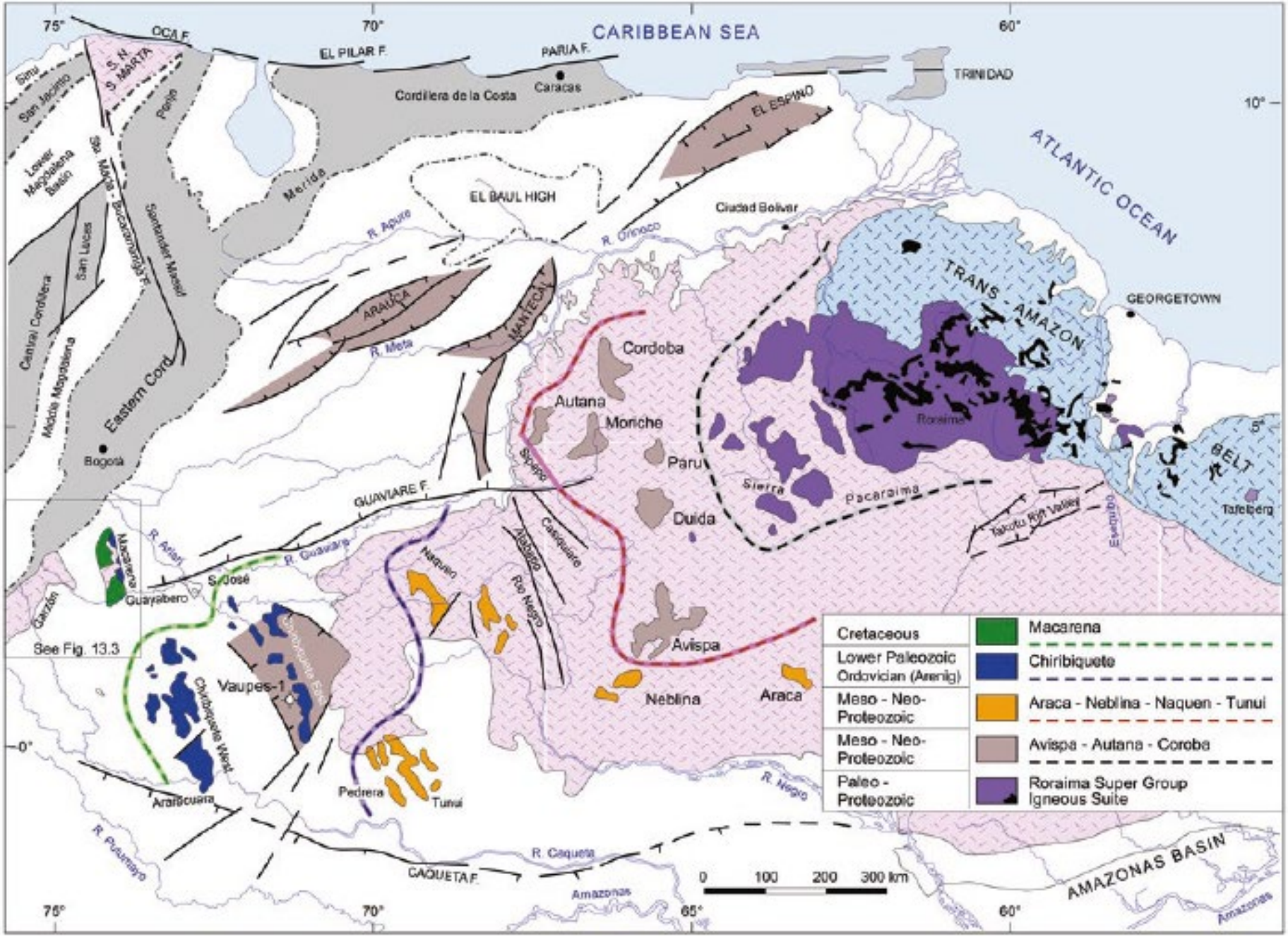
Querari orogeny, 1.86-1.72 Ga,

1.55-1.40 Ga anorogenic (rapakivi) magmatism

Tunui sandstones

Kroonenberg, 2018

Parguaza Rapakivi granite, Caño Cupaven, Venezuela; Sn, Ta; Al



Sandstone covers of the Guiana Shield

Kroonenberg, 2018

Roraima tepui, diamondiferous, Venezuela, Guyana

Tafelberg, Suriname

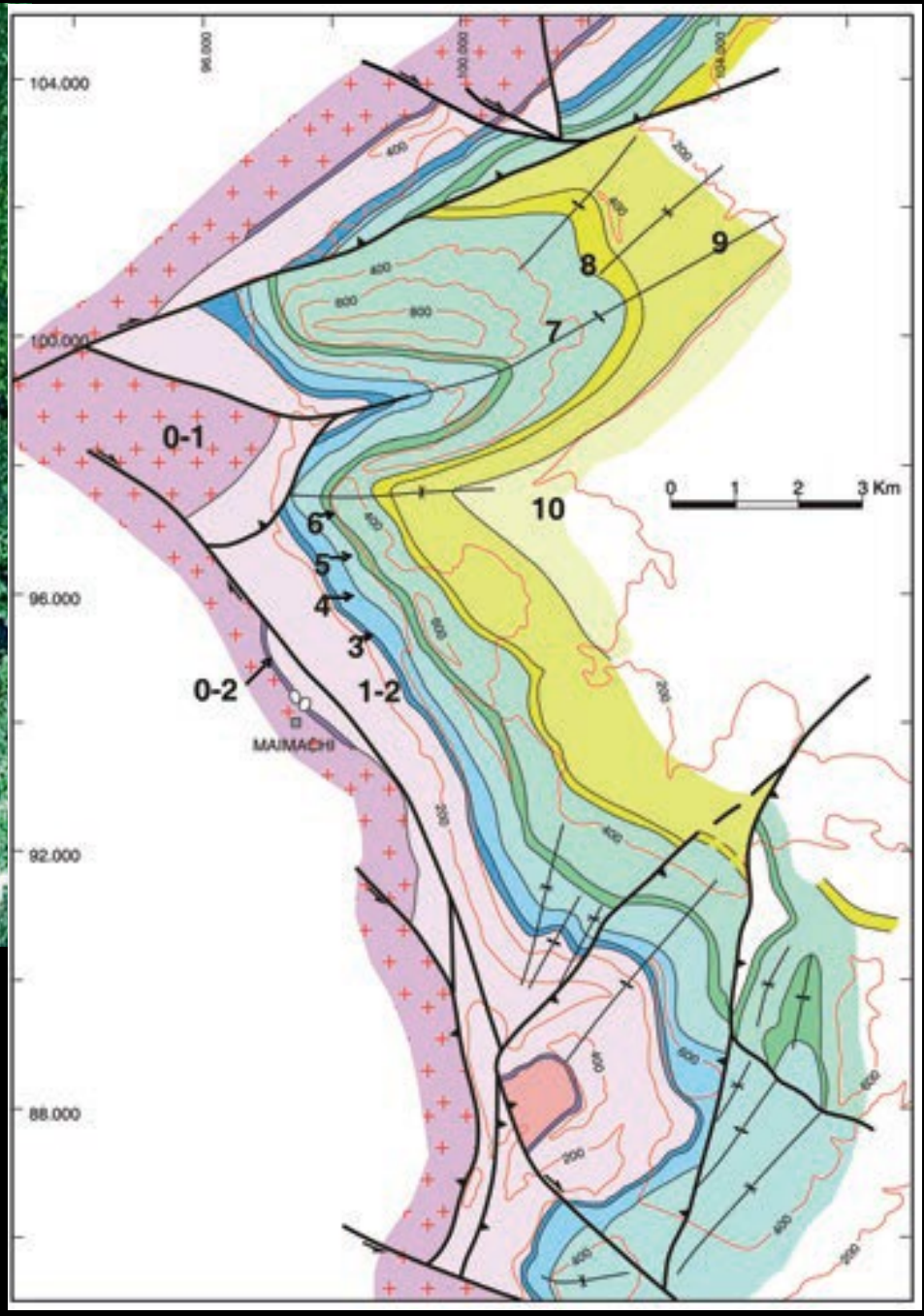
Tafelberg, Suriname

Basal paleosol

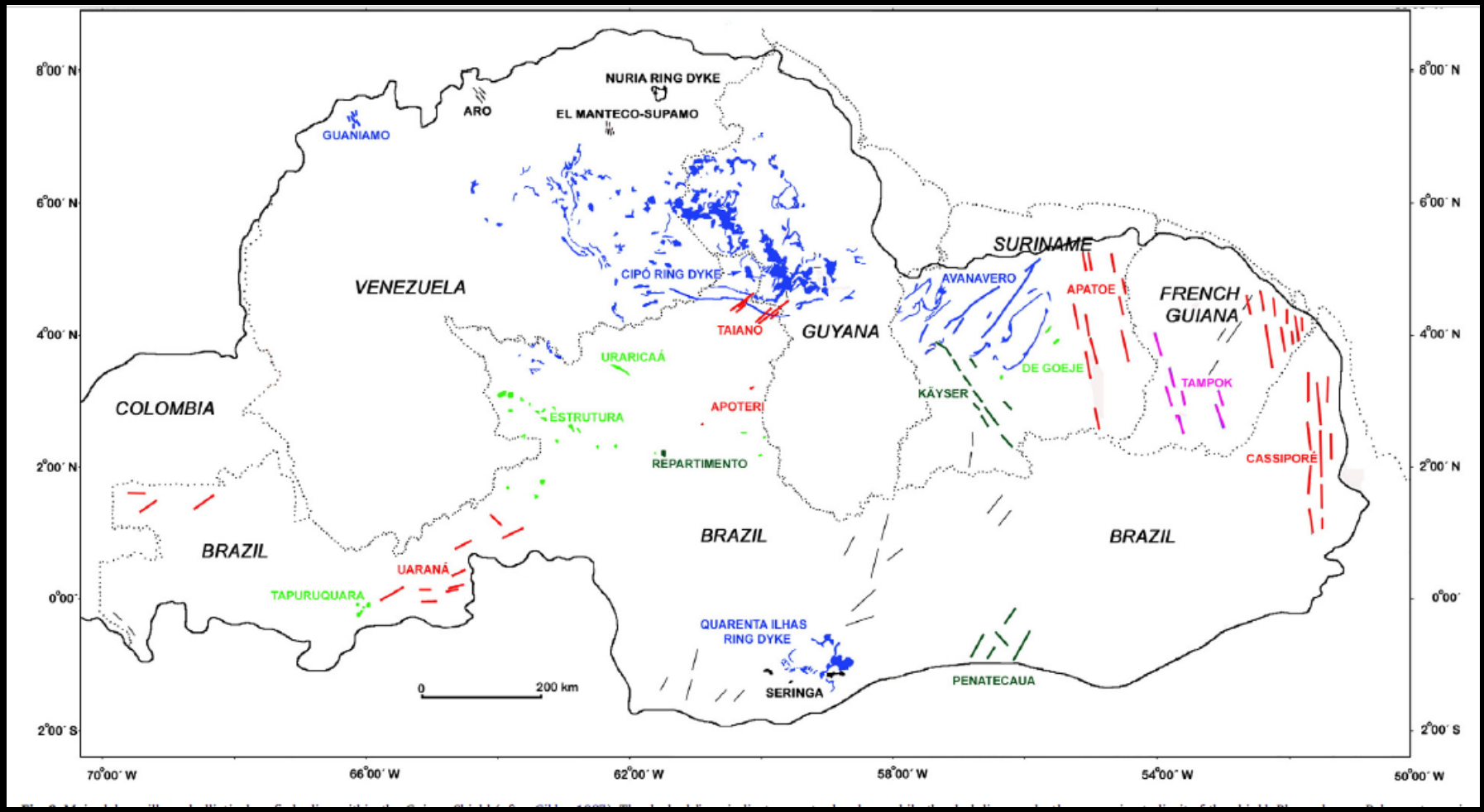
Dated ash bed

Roraima Supergroup,
1873 Ma,
Santos et al, 2003

Moriche Conglomerate on Cuchivero granite, Ventuari river, Venezuela:
Exploration for radioactive minerals, 1981



Gold-bearing Mesoproterozoic
Serranía de Naquén
sandstone ridge (800 m)
Colombia



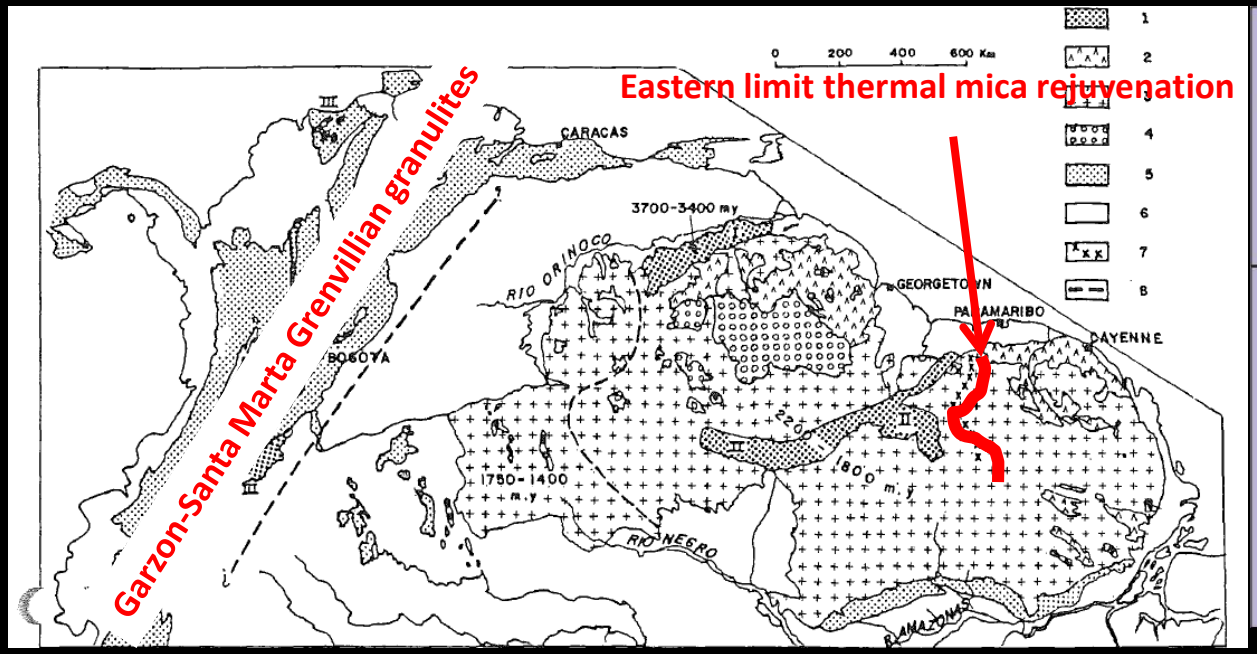
Dyke swarms in the Guiana Shield (Reis et al., 2013)

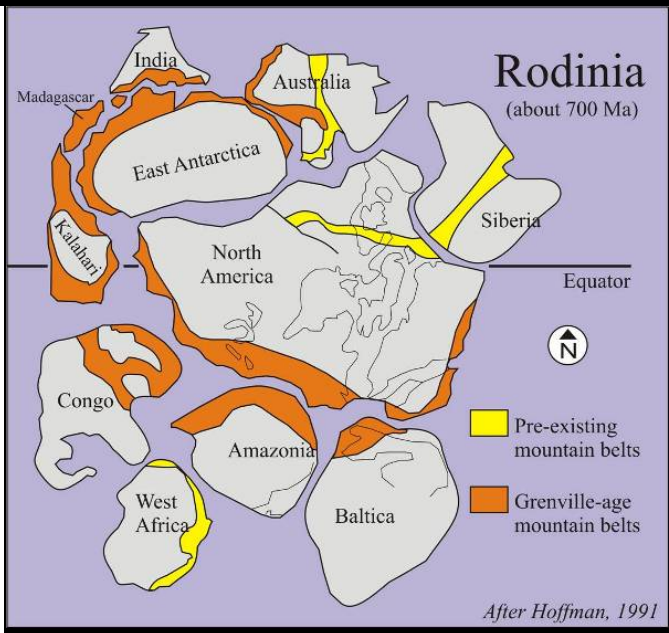
Avanavero 1783 Ma

Käyser, 1501 Ma

Tampok 809 Ma

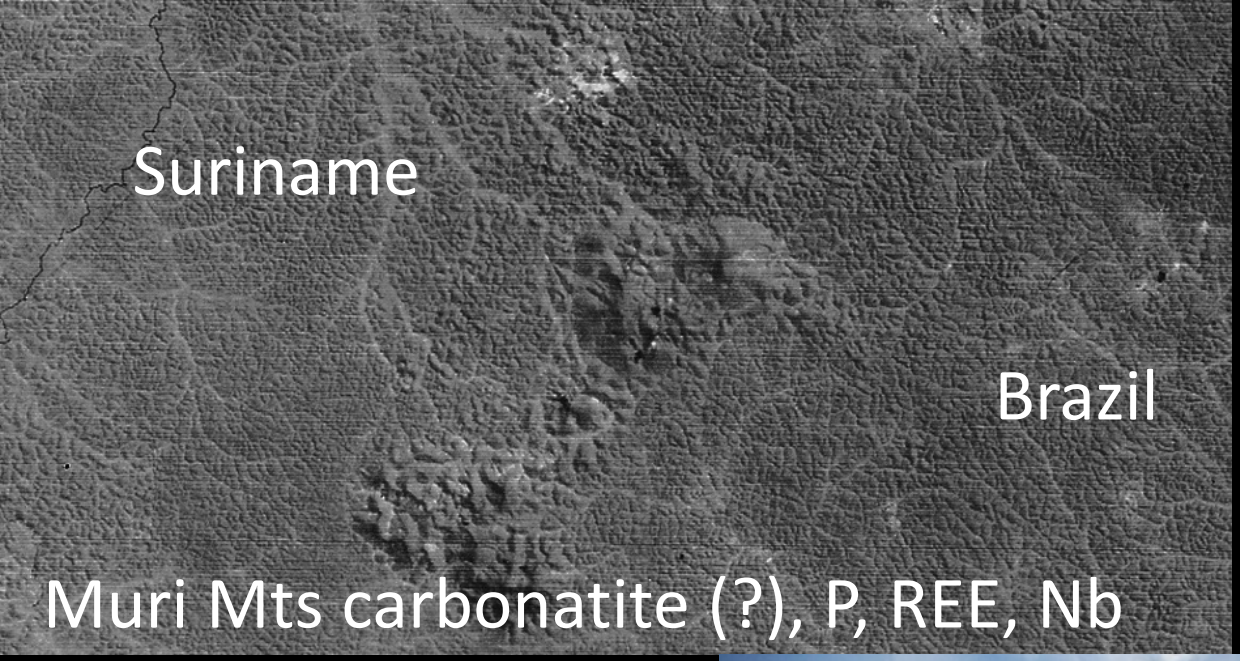
Apatoe-Penatecaua, 198 Ma





Grenvillian :~1200-1100 Ma:
Nickerie/K'Mudku/Orinoquense Metamorphic Episode
Widespread shearing, mylonitization, thermal resetting, alkaline magmatism

Amazonia-Laurentia collision (1 Ga): supercontinent Rodinia



Muri Mts carbonatite (?), P, REE, Nb

Alkaline magmatism
~1100-1000 Ma

Carbonatito Seis Lagos, Brazil (Nb)

Guaniamo diamond kimberlite, Venezuela, 840-710 Ma

Bauxite on mafic metavolcanics, granulite/anorthosite, rapakivi granites


Let’s get to work!