

The Bakhuis Granulite Belt in W Surinam, its development and exhumation

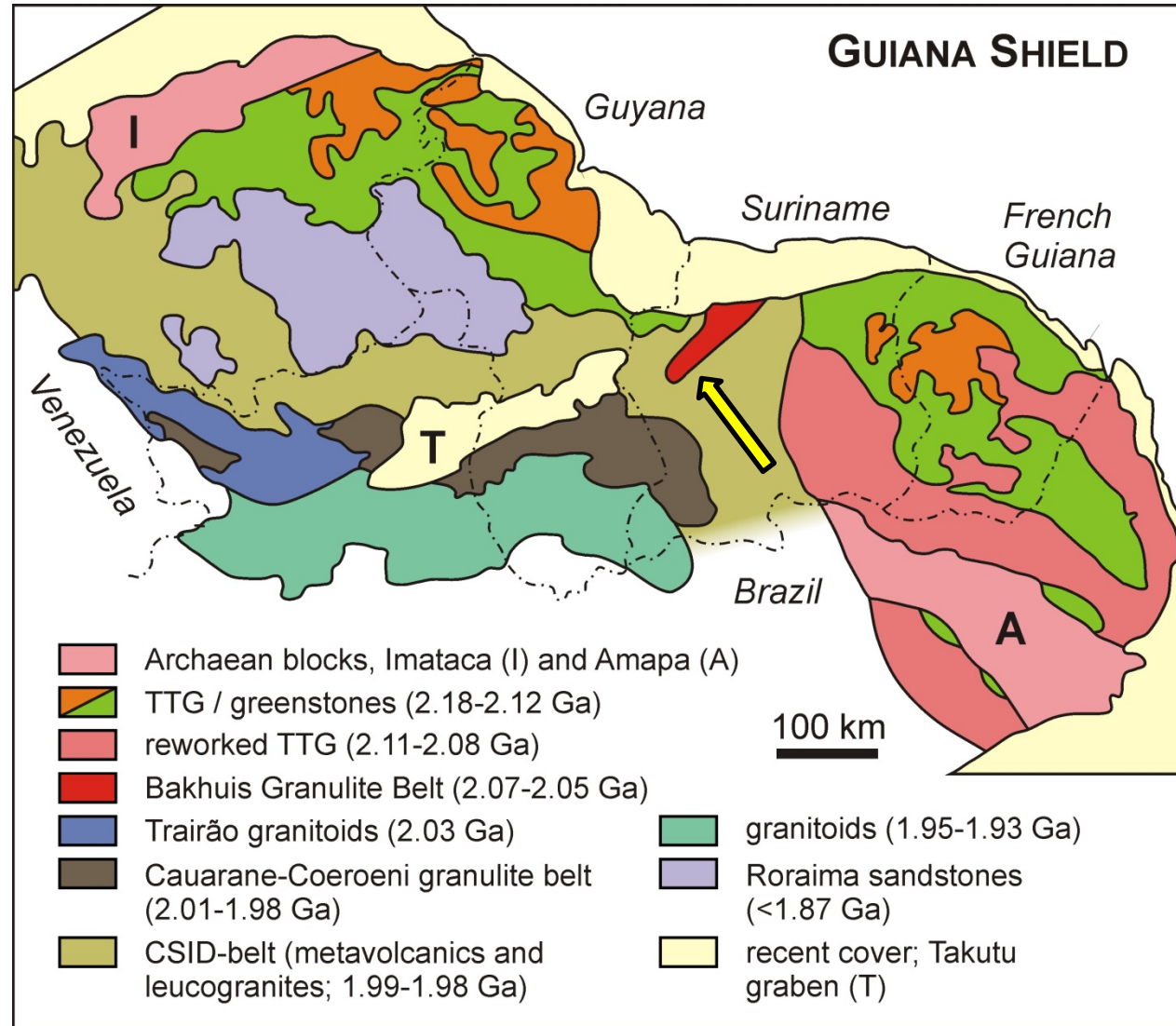
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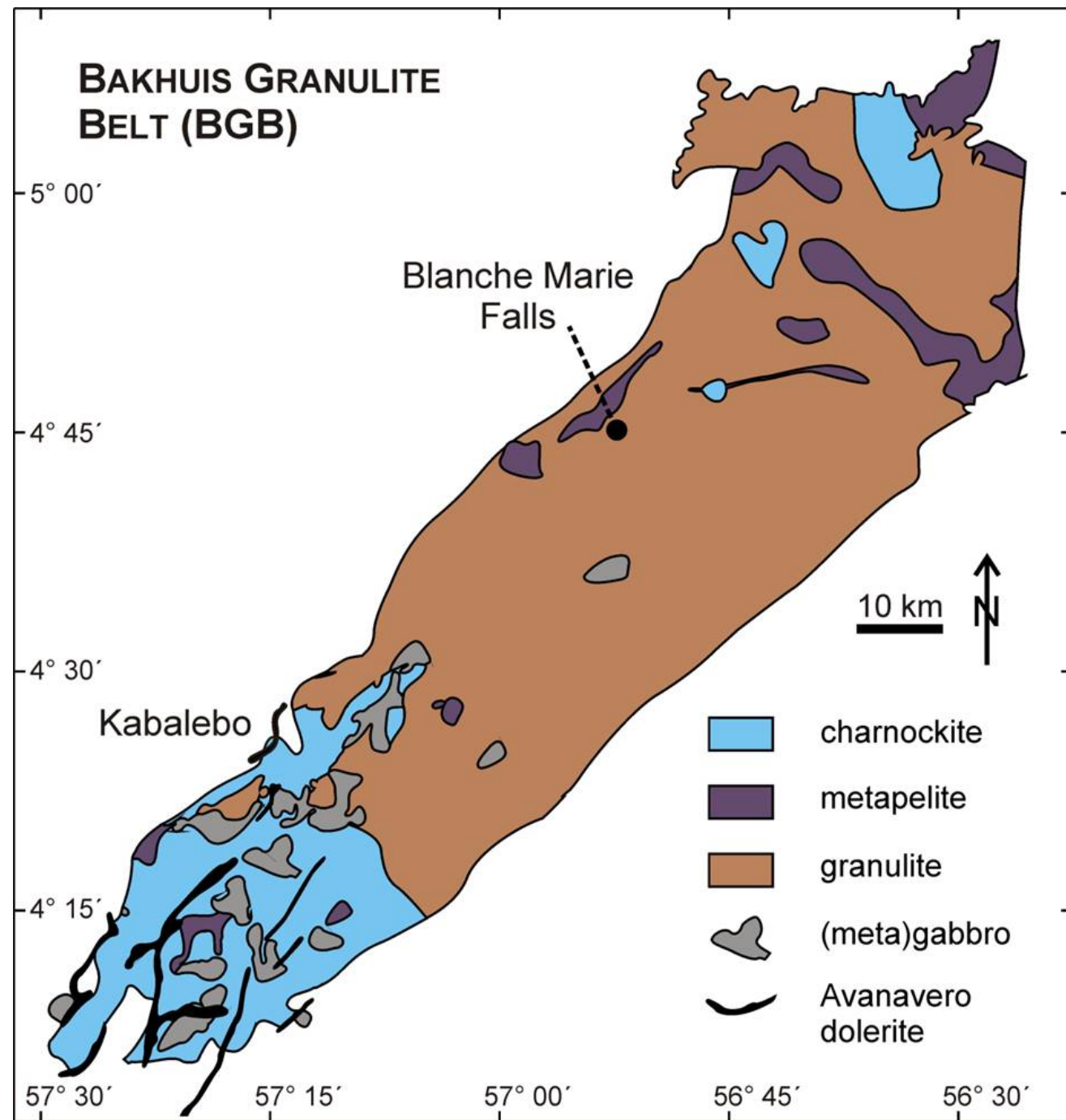
Bakhuis Granulite Belt

- BGB 30-40 x 100 km
- Between two arms of 1500 km long greenstone belt in the Guiana Shield, along NE coast of S. America
- Greenstone belt age 2.26 - 2.08 Ga



Bakhuis Granulite Belt

- intermediate and mafic granulites
- with metapelite intercalations
- younger felsic and mafic intrusions
- NW and SE faults separate belt from younger granites and metavolcanics and some greenstones and schists
- in the north sands of the coastal plain



Granulites : Supracrustals

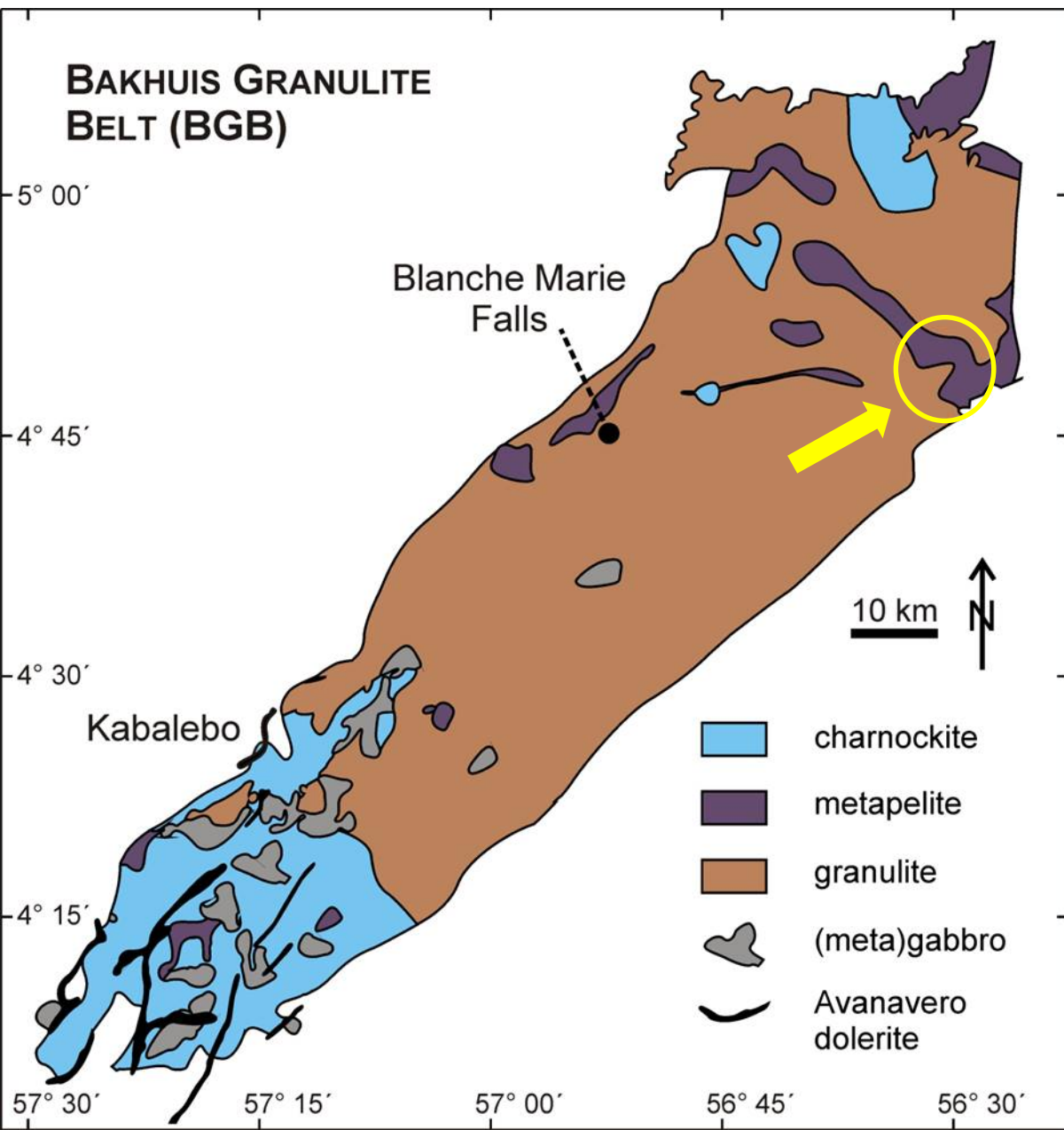


- Granulites show conspicuous banding at dm (cm-m) scale (coin for scale)
- Intercalations of clear metasediments such as metapelites, quartzites and calcsilicate rocks

Granulites : Supracrustals

- Mafic granulites have major and trace element chemistry of mafic volcanics
- Intermediate granulites in part derived from intermediate volcanics, with euhedral zircons of one age.
Zircon age 2156 ± 6 Ma, similar to age of volcanism in the greenstone belt in French Guiana, 2135 – 2160 Ma
- Intermediate granulites in part derived from metasediments with varying zircon habit and age, and wacke-like chemistry
- Granulites represent volcanic-sedimentary supracrustals, not much different from greenstone belt lithology

UHT Metamorphism in NE part of belt



Ultrahigh-temperature metamorphism defined as $> 900^{\circ}\text{C}$ (and regional)

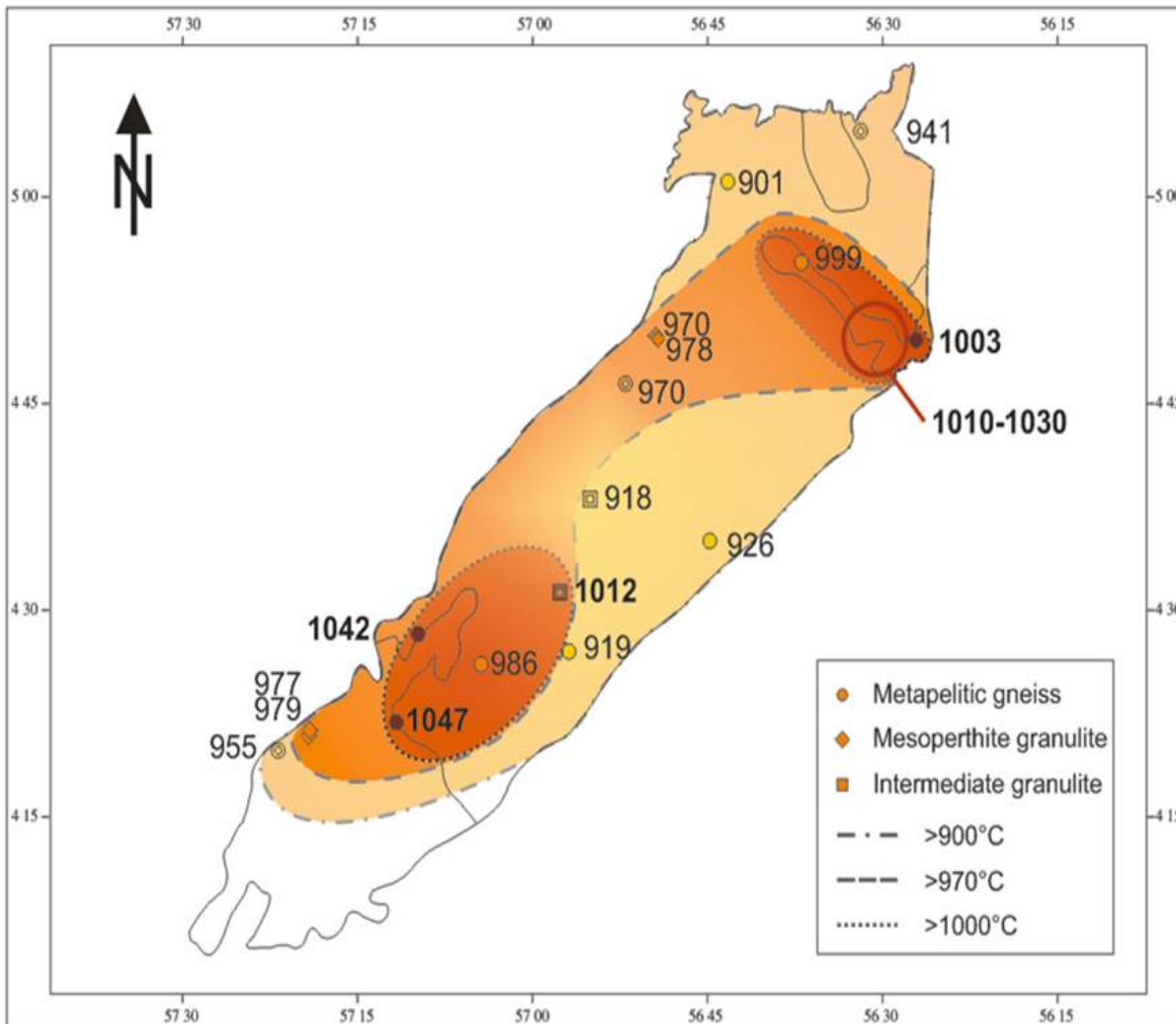
Characteristic assemblage
Al-rich Orthopyroxene +
Sillimanite \pm Sapphirine
in metapelite

Opx 8 – 10½ Al₂O₃

Feldspar thermometry
 T_{peak} 1000-1030 °C

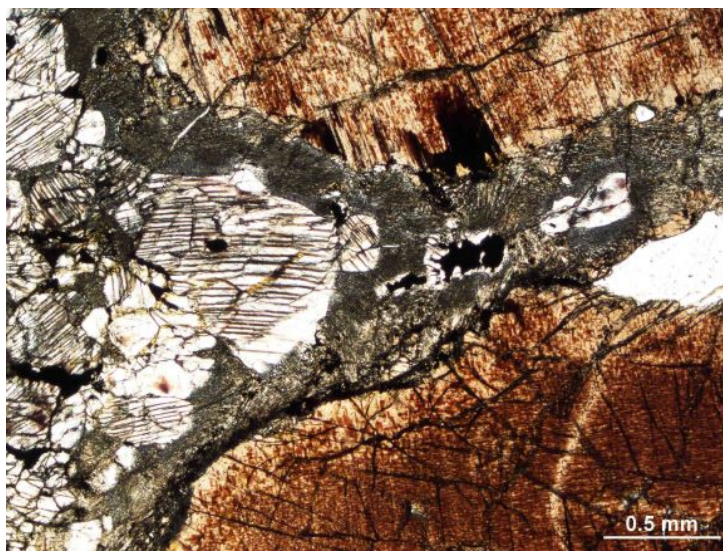
Opx - garnet P 9-10 kbar
(depth 30+ km)

UHTM peak temperature from feldspar thermometry



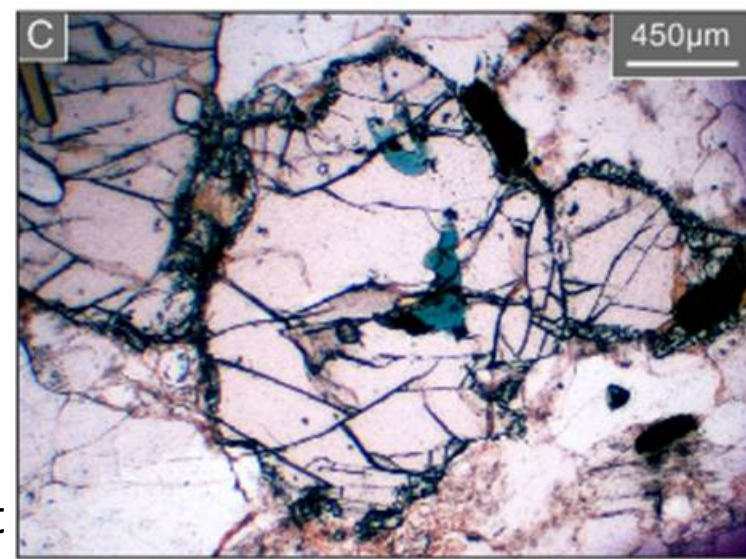
- T 900 - 1050°C :
UHT metamorphism (>900°) in entire BGB
- Other metapelites show cordierite + sillimanite ± Al-rich orthopx. :
not characteristic, but also formed by UHT metamorphism

NE part
of belt



Opx + sill

Sapph
in
Garnet

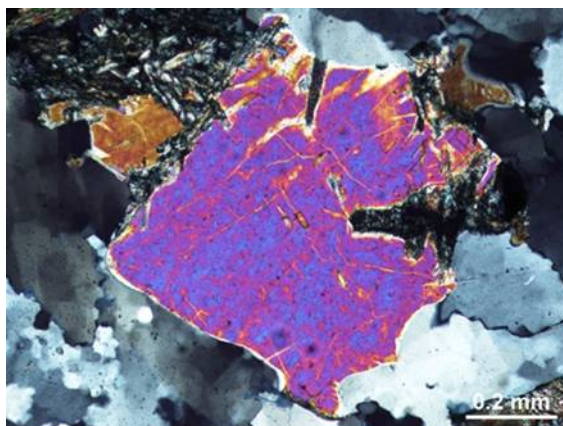


SW part
of belt



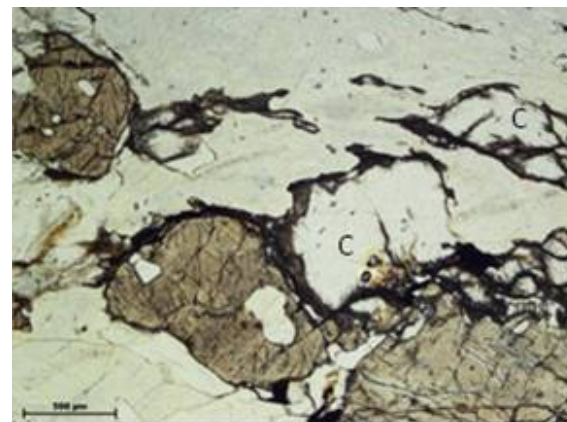
PPL

CO₂-
bearing
cordierite,
~ 2% CO₂



XPL

Opx +
Crd (C)

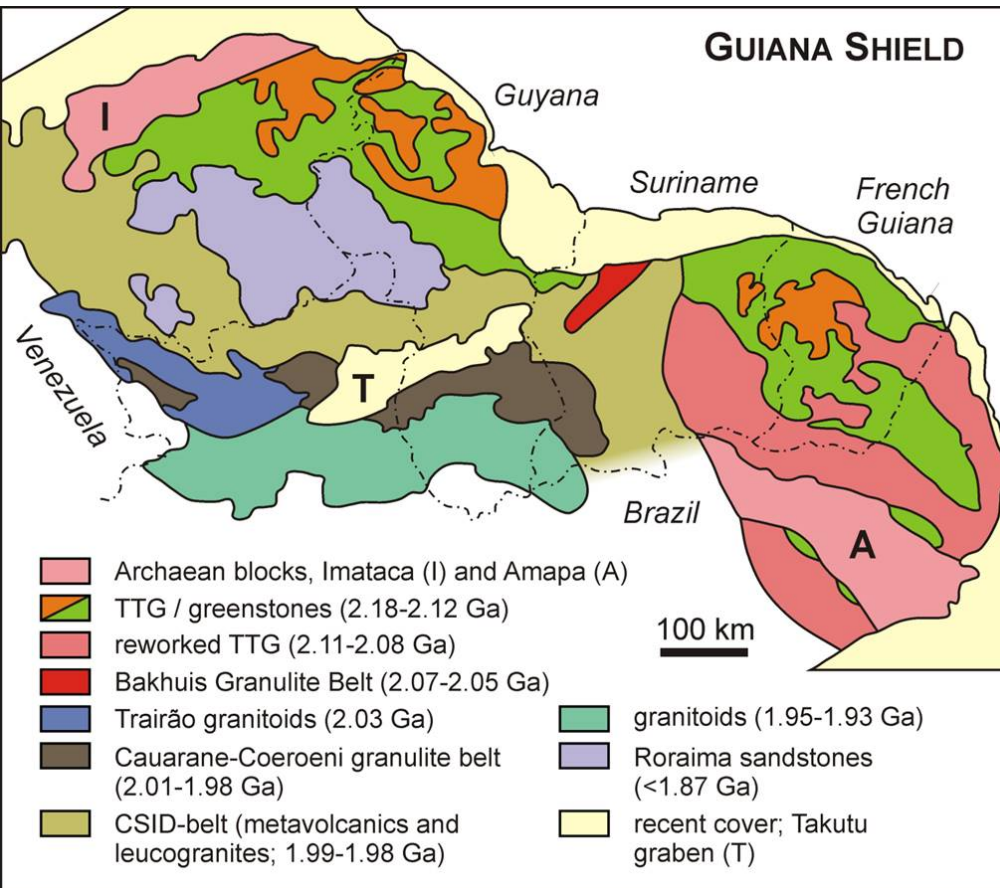


AGE of UHT Metamorphism

- Earlier work (2003): Pb-Pb evaporation dating of zircon, confirmed by SHRIMP, gave 2072 – 2055 Ma age
- Oldest age found for quartz-feldspar vein, 2088 ± 4 Ma for zircon (SHRIMP). Monazite from vein younger, 2056 ± 15 Ma. Therefore, probably peak of UHT metamorphism.
- Younger ages at 2075-2070 Ma and 2060-2050 Ma, with simultaneous zircon and monazite crystallization
- Youngest age for narrow rims 2031 ± 4 Ma (zircon, SHRIMP)
- Age range 2088 ± 4 to 2031 ± 4 Ma gives duration of 50 – 65 Ma, rather long for UHTM, slow cooling

Bakhuis Belt transects one greenstone belt or lies between two greenstone belts ??

- Picture obscured by younger granites and volcanics, 1.99 – 1.98 Ga



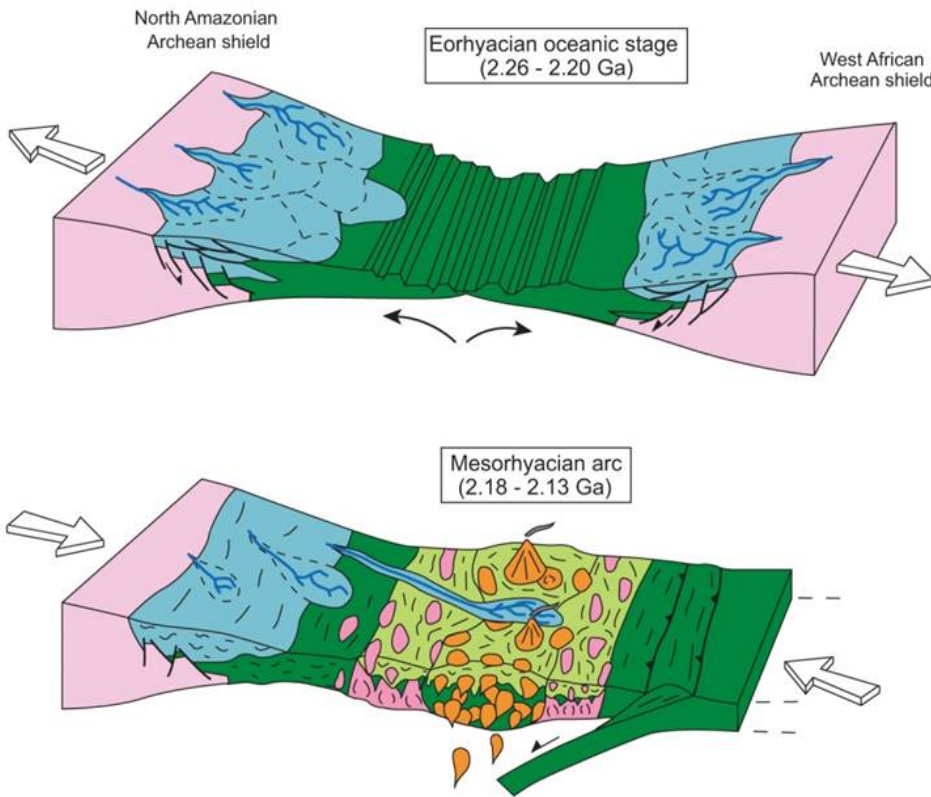
- W and E belt differ :
 - upper detrital unit only East
 - younger ages in West for metavolcanics, 2120-2145 Ma and undeformed TTG, 2090 - 2120 Ma
 - E : Archean to the south
- Map shows present time, after exhumation of BGB
- Bakhuis supracrustals metamorphosed at 30+ km depth, BELOW greenstone belt

- Probably one continuous greenstone belt above granulite protolith

Bakhuis Supracrustals

- How did they arrive at 30+ km??
- Intermediate granulite with 4 out of 10 zircon cores 2200 Ma or older, up to 2263 ± 72 Ma
- Coarser, non- pelitic greenstone belt metasediments mainly juvenile material, younger than 2.18 Ga (in French Guiana)
- Bakhuis metasediments may have origin outside the greenstone belt, near a craton with older material, West-African margin, where such material was available

Bakhuis Supracrustals



Delor et al., 2003

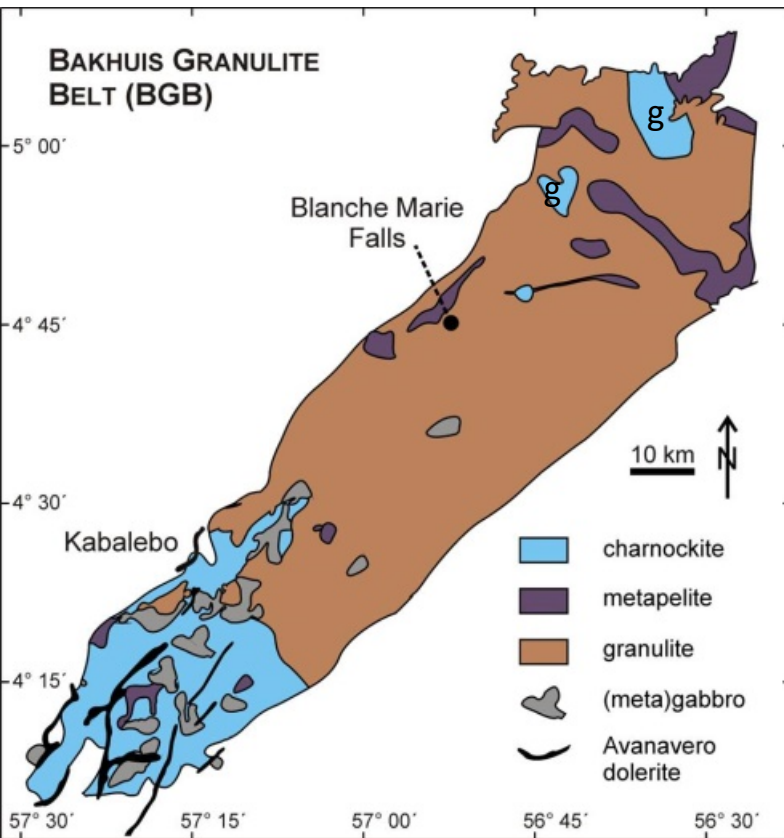
- If the Bakhuis metasediments indeed originated from the margin of the West African Shield (blue on profile), they may have been subducted in a late stage below the greenstone belt
- At 30+ km depth, they may have been subjected to UHT metamorphism. Cold instead of very hot : what is heat source ??
- Delor et al (2003) : mantle-derived thermal perturbation, situated probably in a zone of maximum crustal stretching, between the two greenstone arms (“slab tear??”)

Heat source for UHT metamorphism?



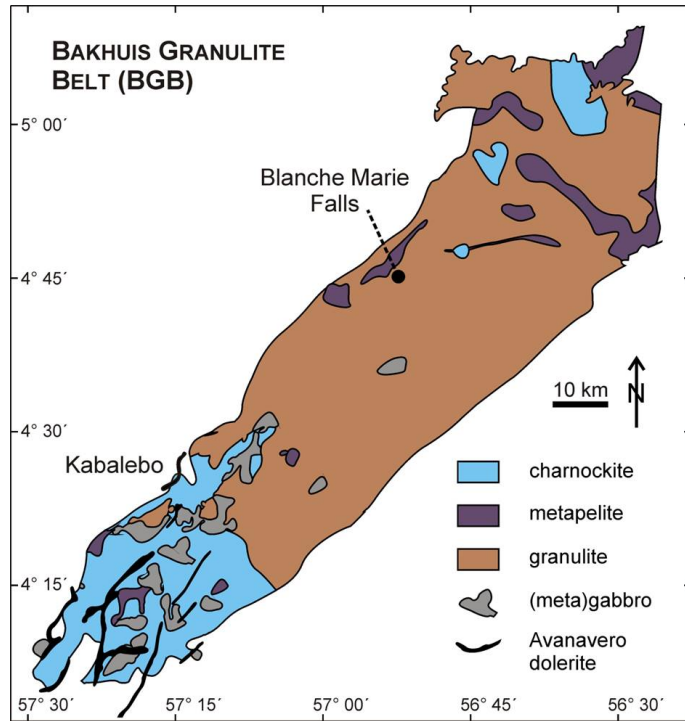
- Metadolerite dykes occur in BGB and not outside
 - High-grade
 - Contain zircons from granulites > false age
 - Too narrow for dating
 - In part folded, but much less than granulites
 - Slight folding implies age at late stage of folding and (probably) of UHTM
-
- Metadolerites are insignificant as heat source in terms of volume, but are a clear indication of contemporaneous mantle magmatism. More voluminous at deeper level (mafic underplating, upwelling) ?

Younger charnockites dominate SW of BGB



- Charnockite (opx granite) age 1993 – 1984 Ma, 70-80 Ma younger than UHT metamorphism, at 2090-2030 Ma
- Crystallization at 960-990°C, a new (U)HT event > 900°C
- 70-80 Ma younger than UHTM, so probably not related
- Charnockites associated with abundant mafic intrusions

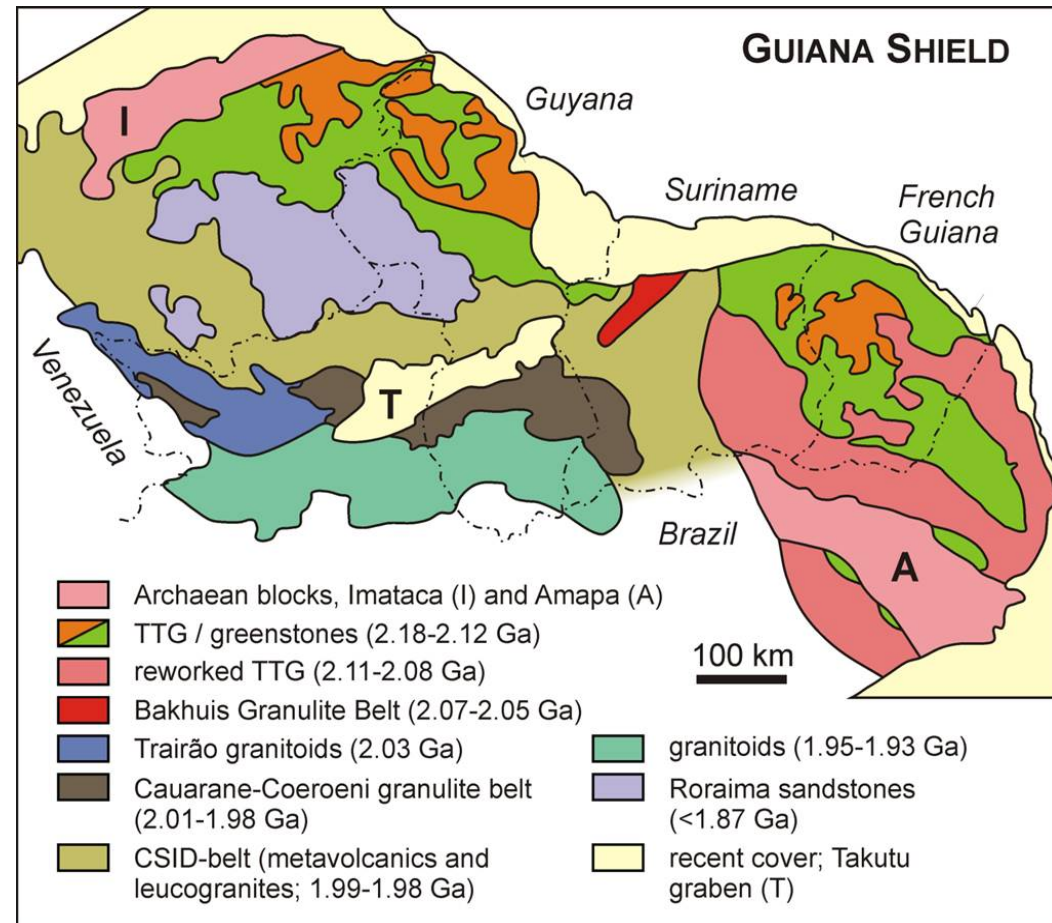
Charnockites and mafic bodies in SW of BGB



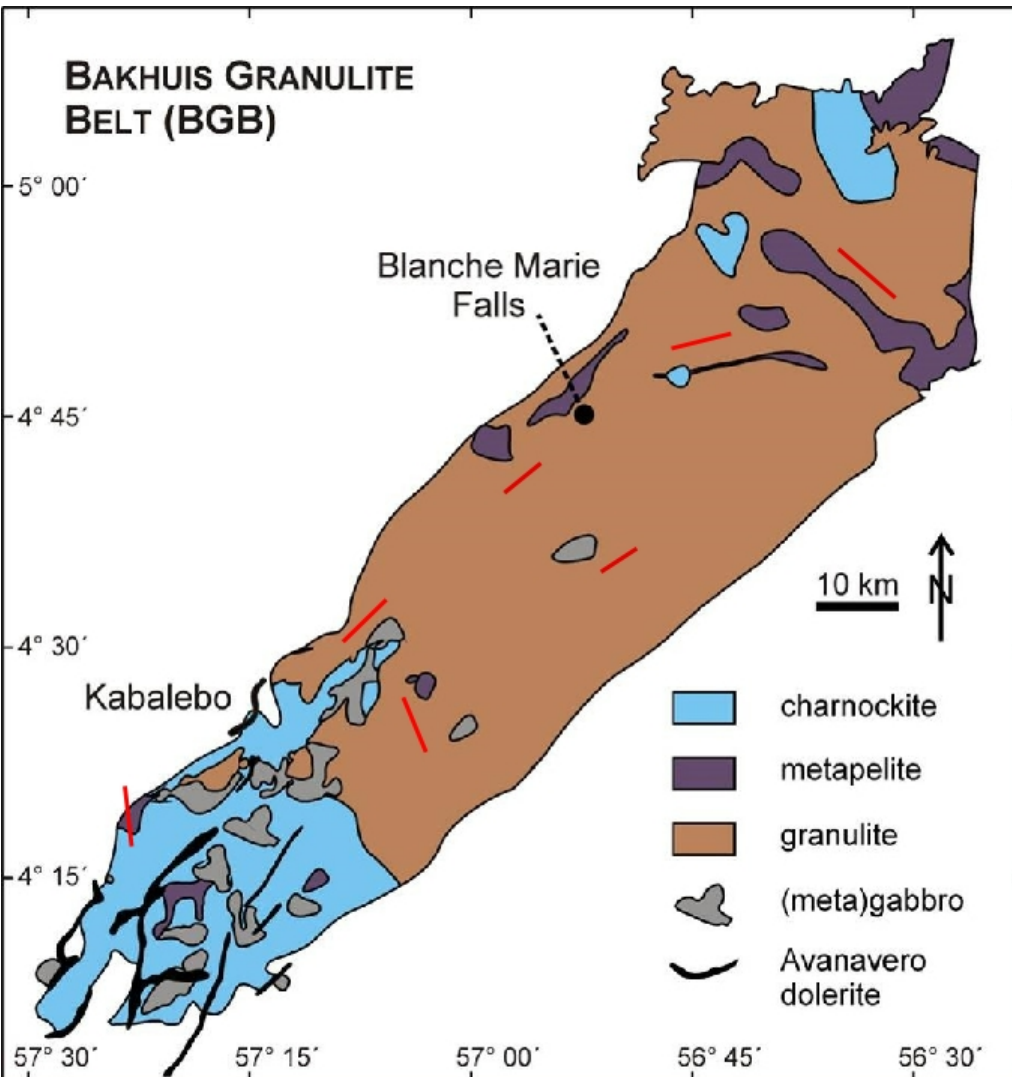
- Mafic bodies dated at ~1984 Ma, similar to charnockite age
- Charnockites formed by melting of intermediate granulites during intrusion of mafic magma
- Mafic bodies strongly resemble Alaskan-type mafic-ultramafic complexes, generally interpreted as the root zones of volcanic arcs

Charnockites and mafic bodies in SW of BGB

- Volcanic arc-like belt around BGB : felsic metavolcanics and leucogranites of 1400 km long Caicara-Dalbana belt, of 1990 – 1980 Ma age
- Caicara - Dalbana magmatism influenced SW of BGB
- The mafic bodies are not restricted to BGB, but also rather common in C - D belt in W Surinam

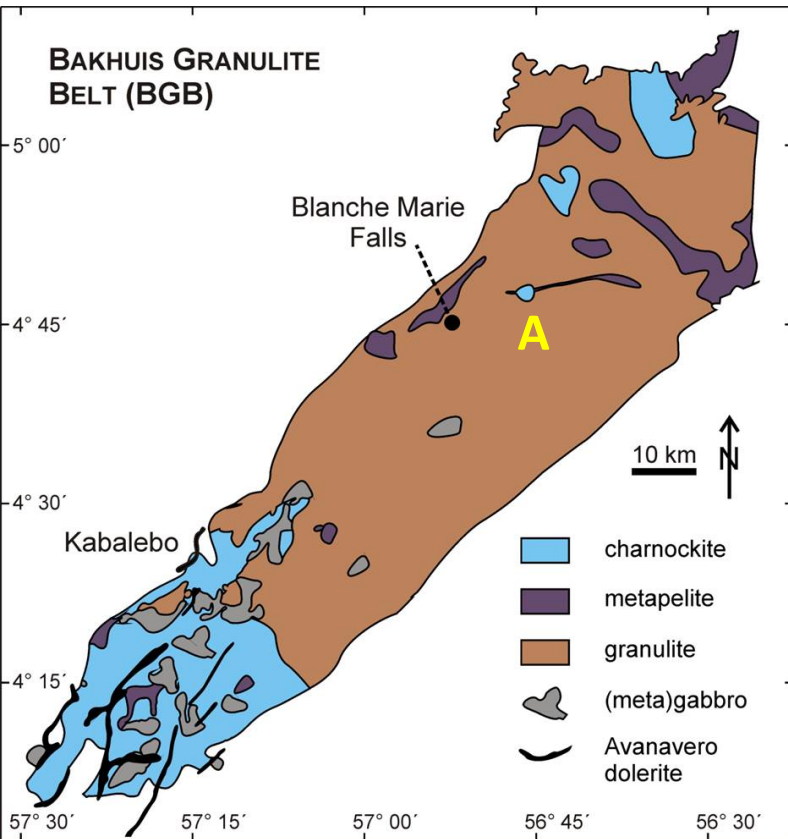


Structure and exhumation of BGB



- Banding largely subvertical
- Banding strike bends round from NE to SE in NE corner
- Bending of strike indicates dome-like structure
- Dahlberg (1971) : also bending at SW side
- SE side : younger fault zone cuts off dome-like structure

Anorthosite body with igneous layering

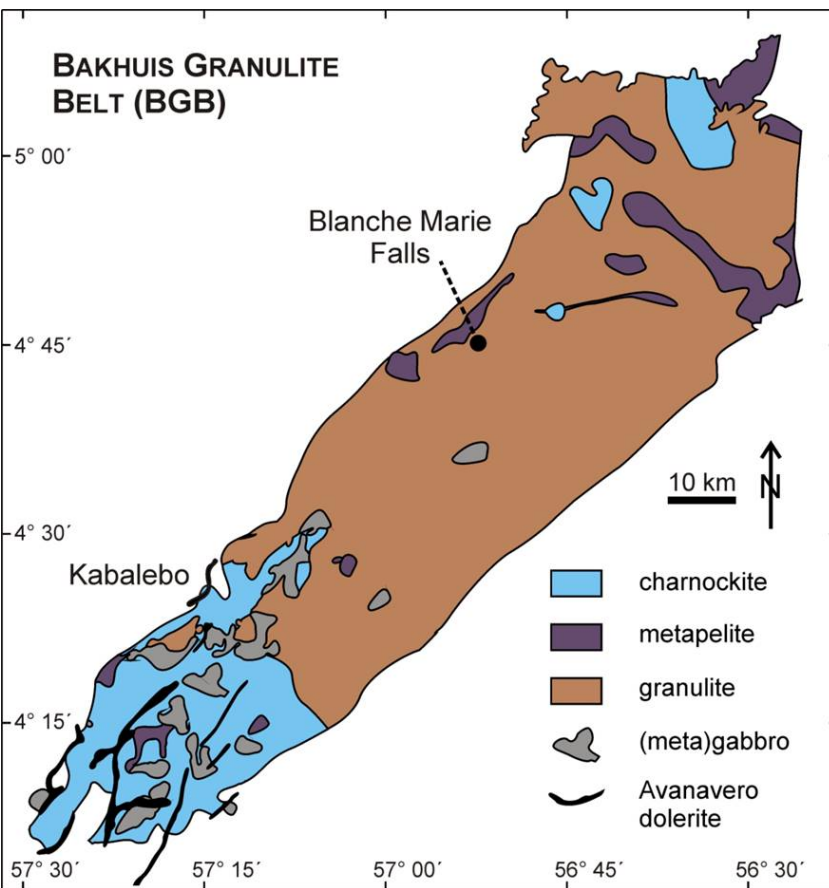


- Anorthosite body of 3 x 4 km covered by high quality bauxite
- Anorthosite age 1980 ± 5 Ma
- Body shows igneous layering, but layering is now subvertical
- Steepening of layering and banding, and probably doming : after 1.98 Ga, but before end of Trans-Amazonian orogeny (probably around 1.95 Ga)



- Considerable exhumation before end of T-A orogeny, in part during steepening/doming and in part before : hornblende in SW charnockite suggests 4-5 kbar (15 km)

Bakhuis Host and Nickerie Mylonite zones



- BGB bordered by 1+ km wide mylonite zones, Bakhuis Horst
- Nickerie Tectonothermal Event (or Kmud'ku) around 1200 Ma, from K-Ar and Rb-Sr ages of biotite
- Ar-Ar age of mylonites: 1214 ± 5 Ma
- Low-grade metamorphism, with muscovite, biotite, garnet
- SE zone cuts off dome structure, NW zone parallel to TA direction??

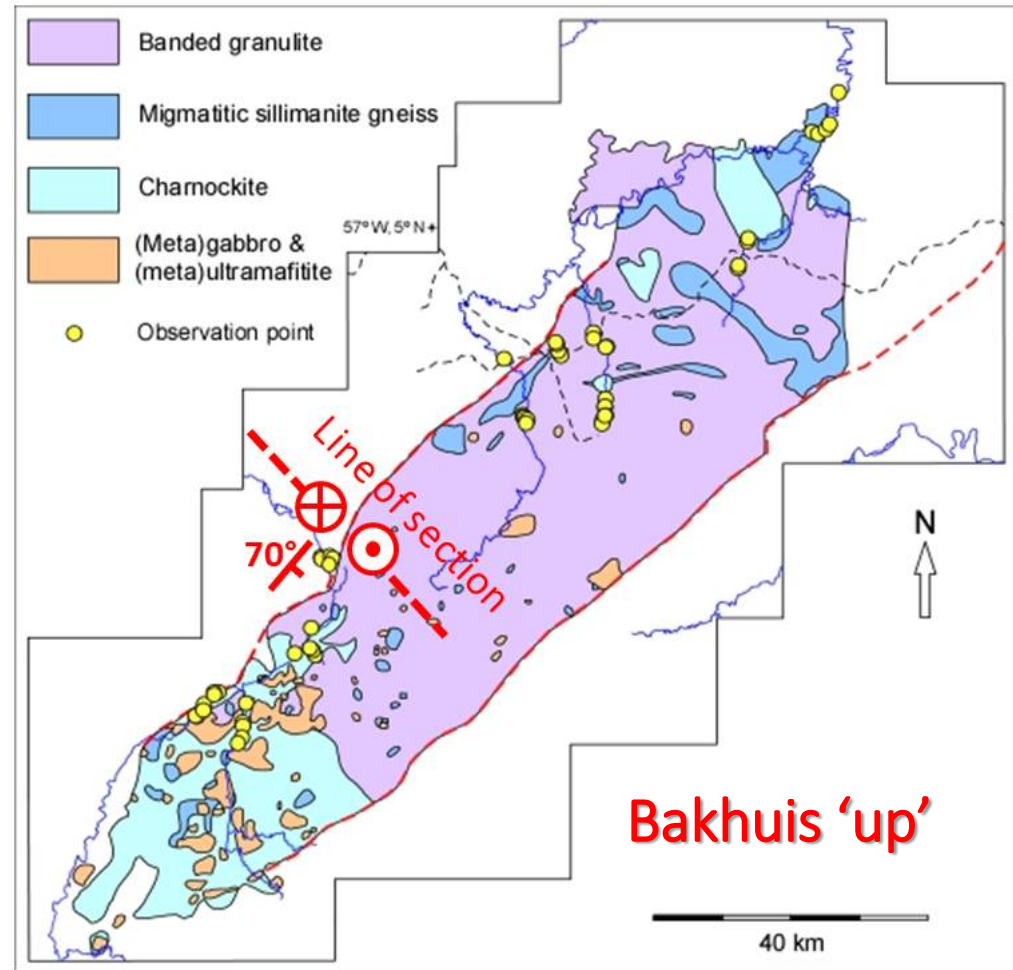
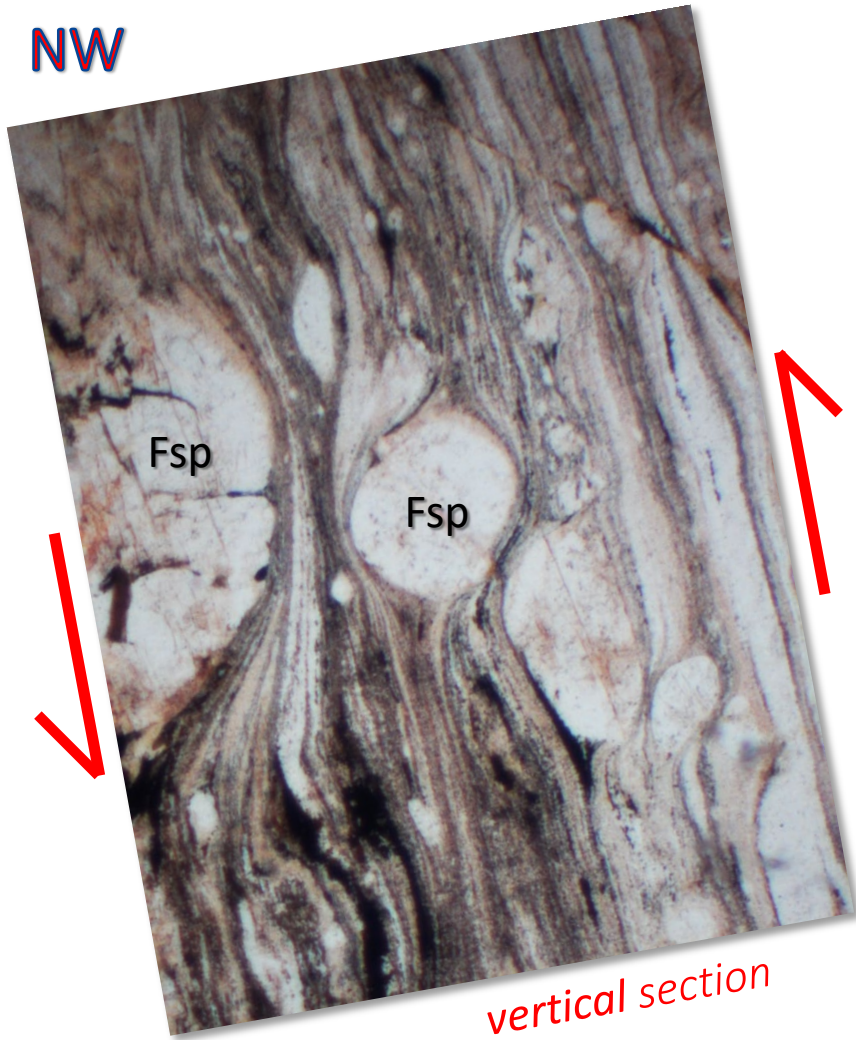
- Nickerie : Continued BGB exhumation

Bakhuis Horst or Bakhuis Pop-up ??

- Not an extensional Bakhuis Horst, with normal faults, but compressional Bakhuis Pop-up, with reverse dip. Also some strike-slip.

SE

NW



Continued, limited exhumation after Nickerie Event



- Along pseudotachylyte zones in/ near main Nickerie mylonite zones
- Ar-Ar dating of ps. (one location) : ~ 950 Ma, younger than Nickerie
- Tertiary : at least two bauxite levels in BGB, slight exhumation
- Horst-like topography, exhumation probably going on (extension or compression?)

THANK YOU !!

QUESTIONS ??

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