Stratigraphy of Guyana & the Greenstone Belts

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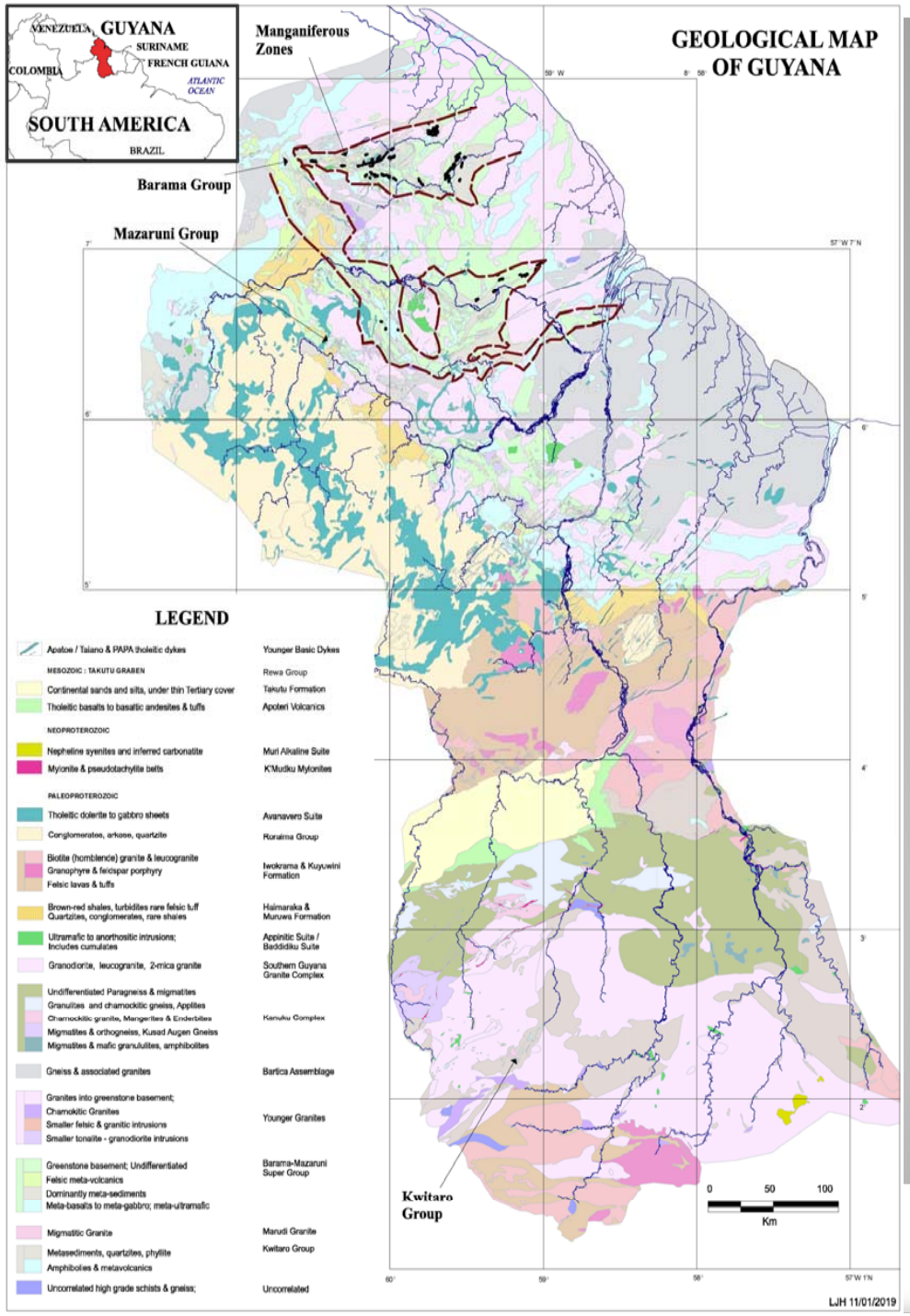
DATA SOURCES

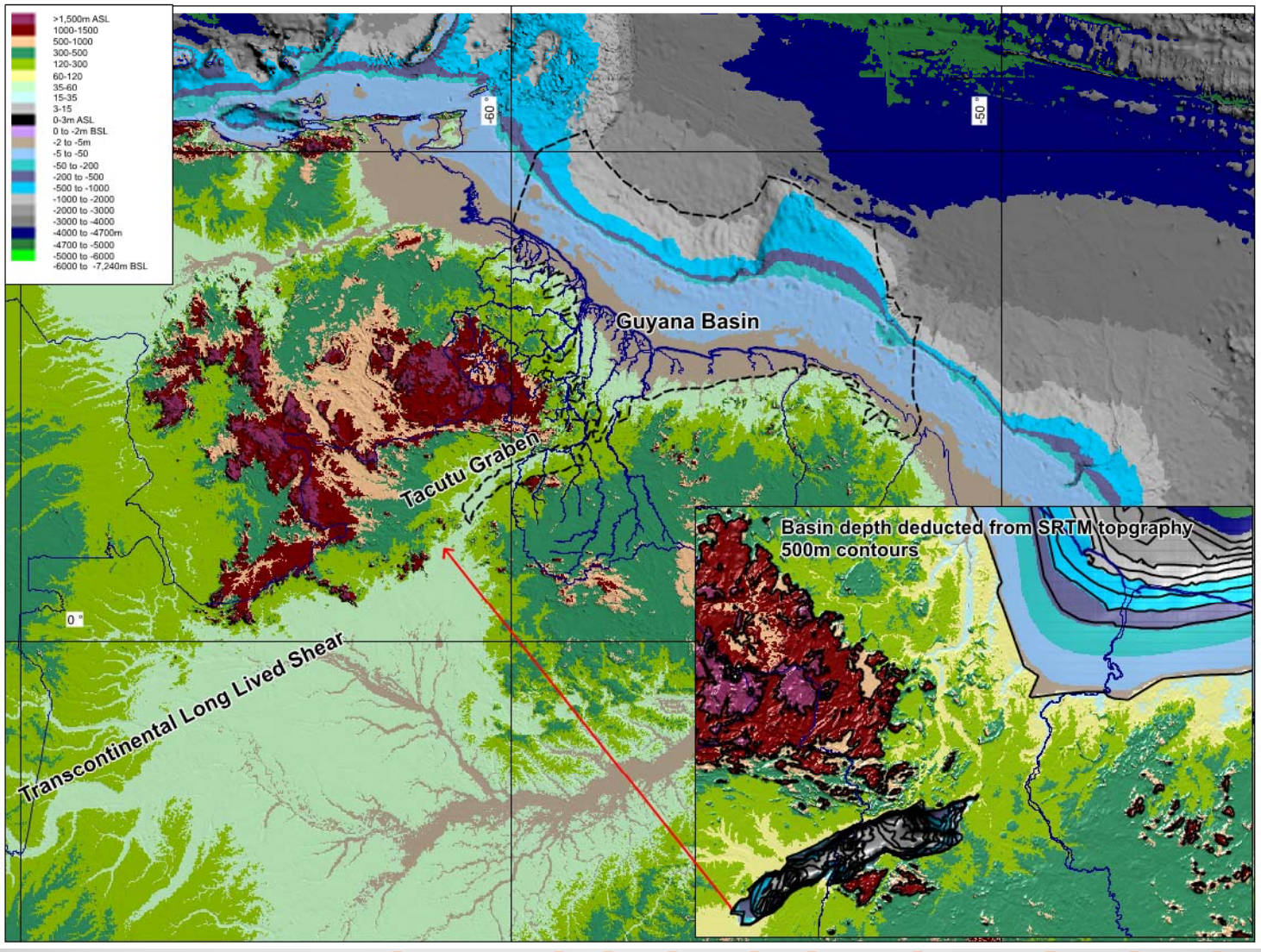
- 3 bibliographies on older literature; Dixon & George (1964), MacDonald (1968) and Sidder (1989).
- Gibbs & Barron 1993.
- Post 1992 MSc & PhD theses (9).
- Publications based on thesis and / or company mineral exploration.
- Company websites & reports – eg 43-101
- Guyana Geology & Mines Commission (GGMC)
  - Drainage & rock geochem, outcrop data, petrology, scanned historical maps all part of digital project reports. Historical company reports; digital & GGMC library – available for purchase

Guyana Geological Map - updated from GGMC



North & South Guyana: divided!

- Two halves of Guyana separated by the Jurassic-Cretaceous Takutu Graben.
- Pull-apart basin on a continent scale shear
- Basement depth under the sediment is over 5km deep – same as the ocean depths.
- Adjacent Kanuku Mountains only 500m high
- Two halves have different older geology, yet must have been adjacent since ~ 2Ga since the Muruwa Formation and Roraima Group also occur in Suriname



SRTM Topography with baisin depth deducted – Takutu Basin > 5km; as deep as the ocean!

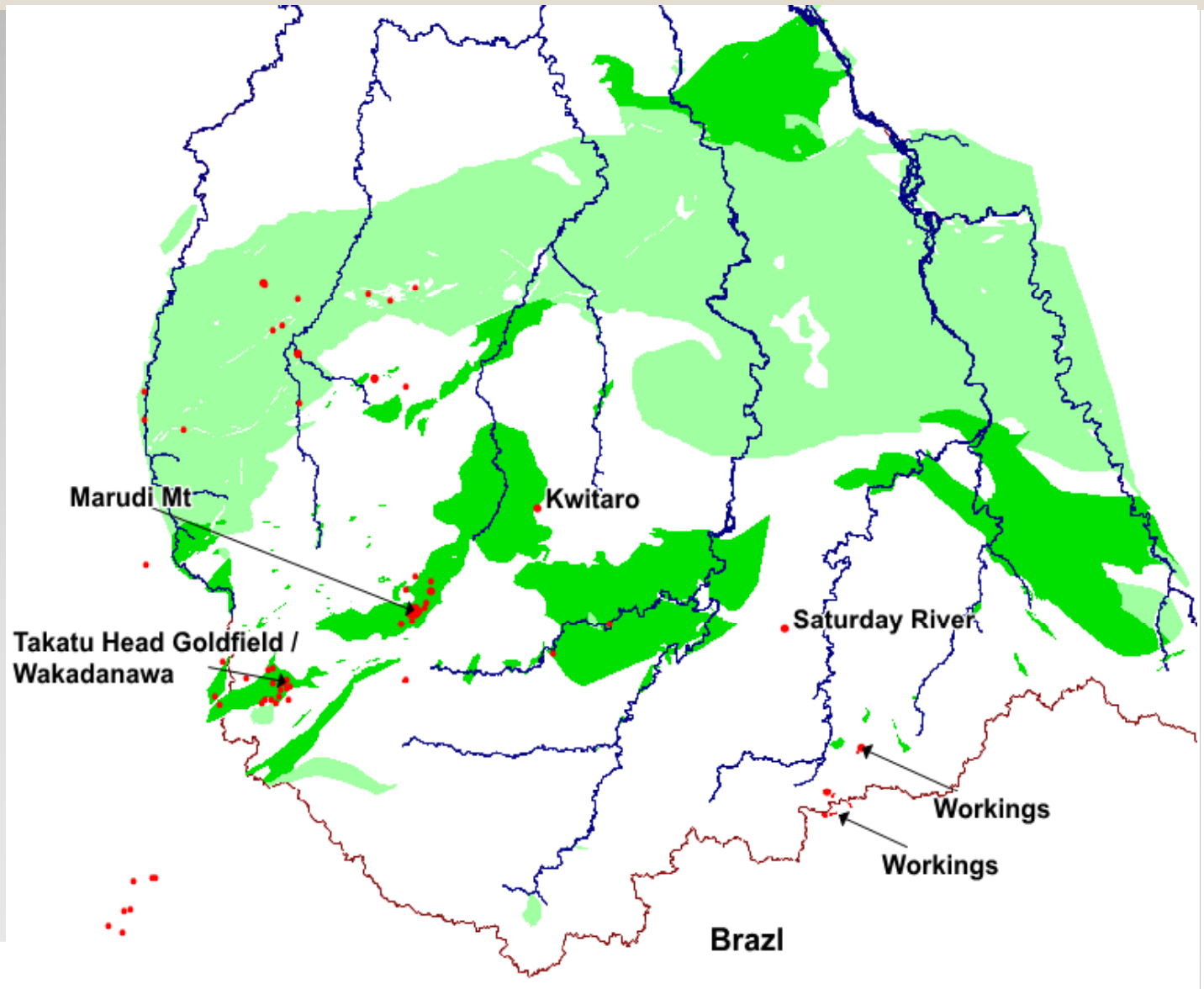
Geology southward of the Takutu Graben

- Kanuku Complex gneiss & assoc. granites incl. charnockites (1.96 Ga). Rare alluvial Au.
- Southern Guyana Granite Complex; >100km wide zone (1.93-1.98 Ga).
- Enclaves of Kwitaro Group in the granite complex– some with gold.
- Marudi Granite intrudes Kwitaro – 2.22Ga
- Uncorrelated gneiss & charnockites
- Kuyuwini Group; mod met felsic volcanics & assoc intrusions. 1.89-1.81 Ga – younger than the Iwokrama rocks 1.99-1,96 Ga

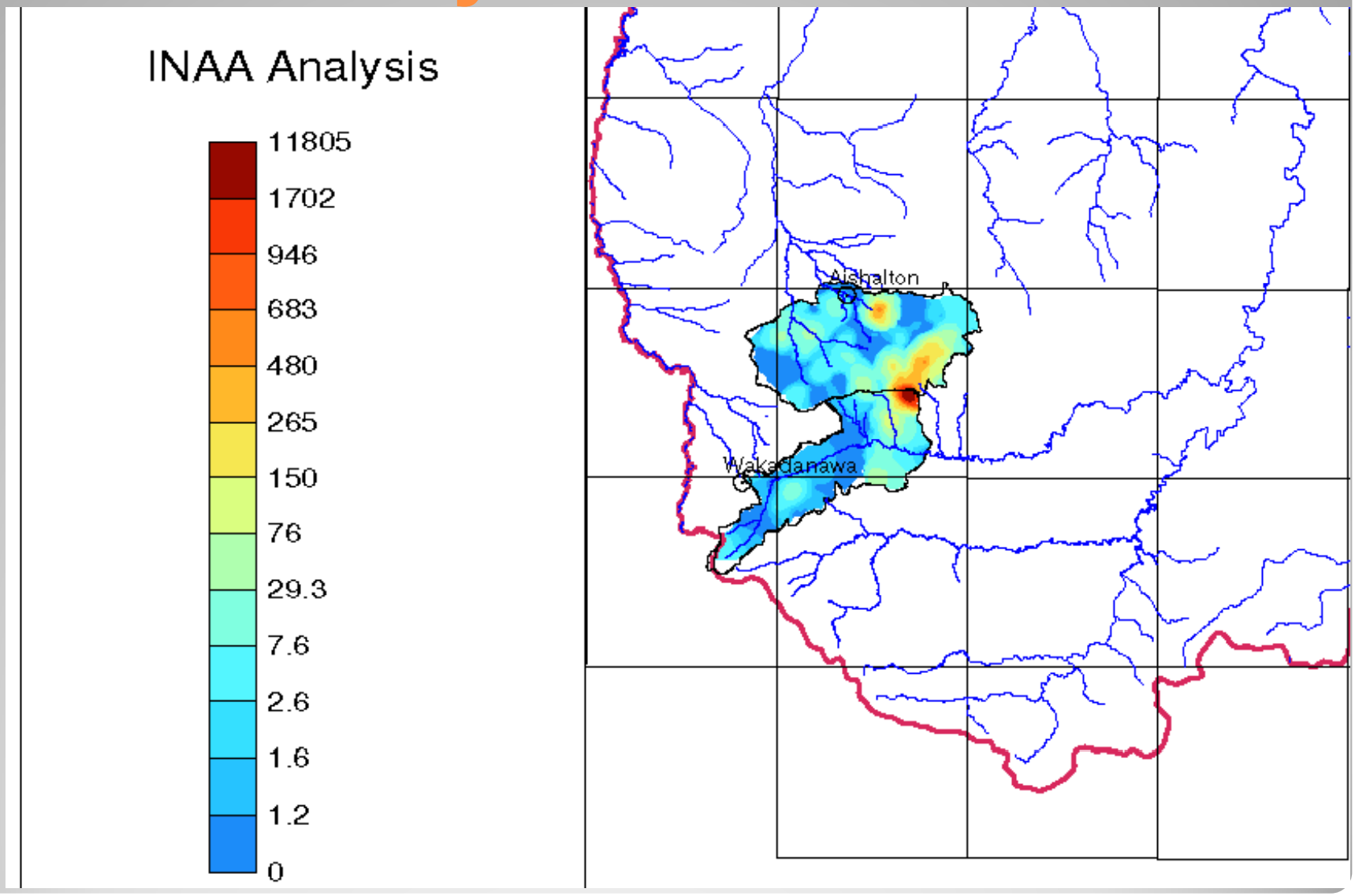
SOUTHERN GUYANA: the KWITARO GROUP

Mostly meta-sediments, some andesite, locally gneissose. More of a supracrustal formation than a greenstone, but locally gold-bearing.

Is minor gold in the Kanuku gneiss areas because it includes Kwitaro protolith?



Southern Guyana: SS Au



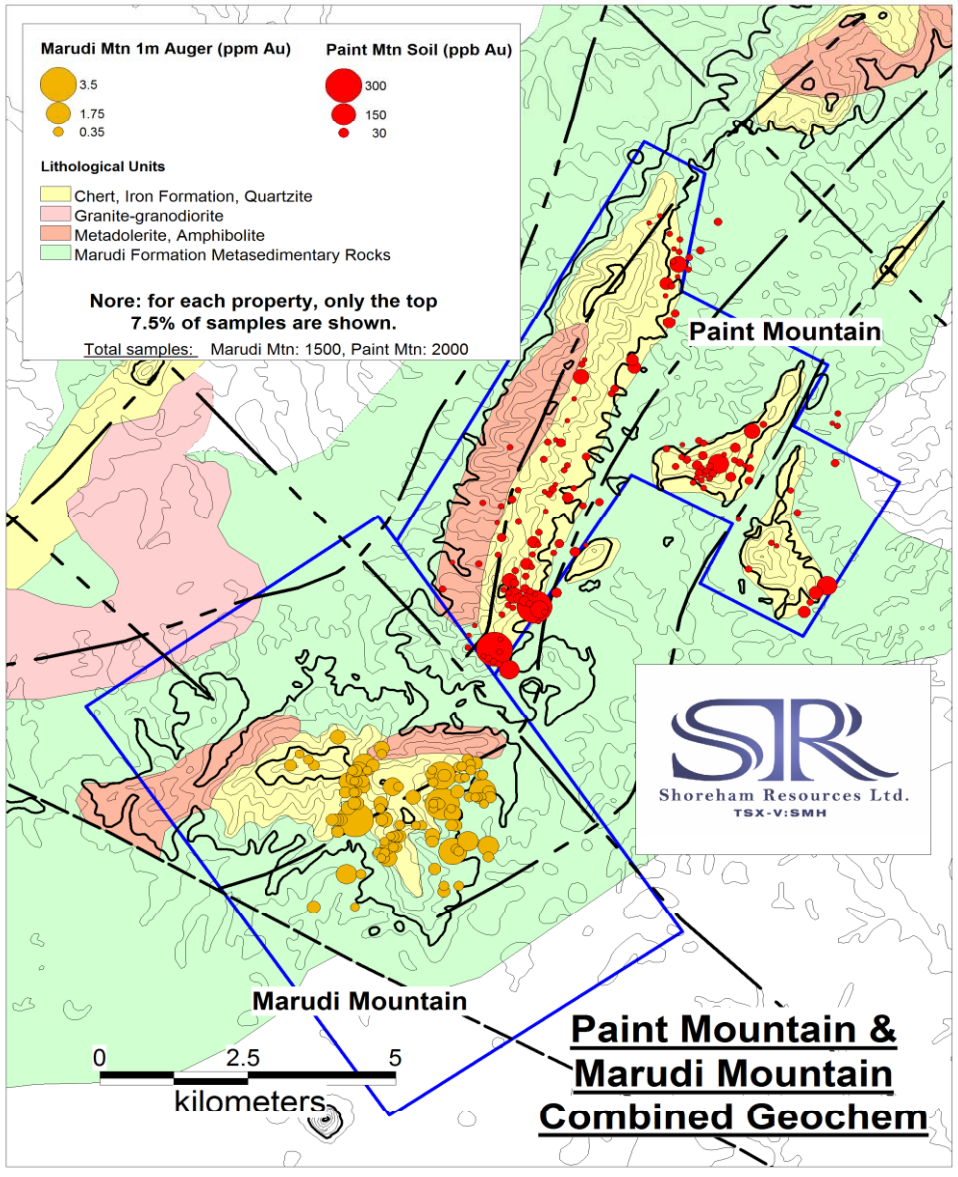
From GGMC website 2015

Kwitaro Group Lithologies

- Marudi Mountain: phyllite, metachert ("quartzite"), then meta-andesite with subordinate tuff and ironstone are overlain by amphibolite / meta-basalt
- Some layers of BIF-like rocks at both Marudi and Wakadanawa
- Post metamorphism feldspar porphyry dykes

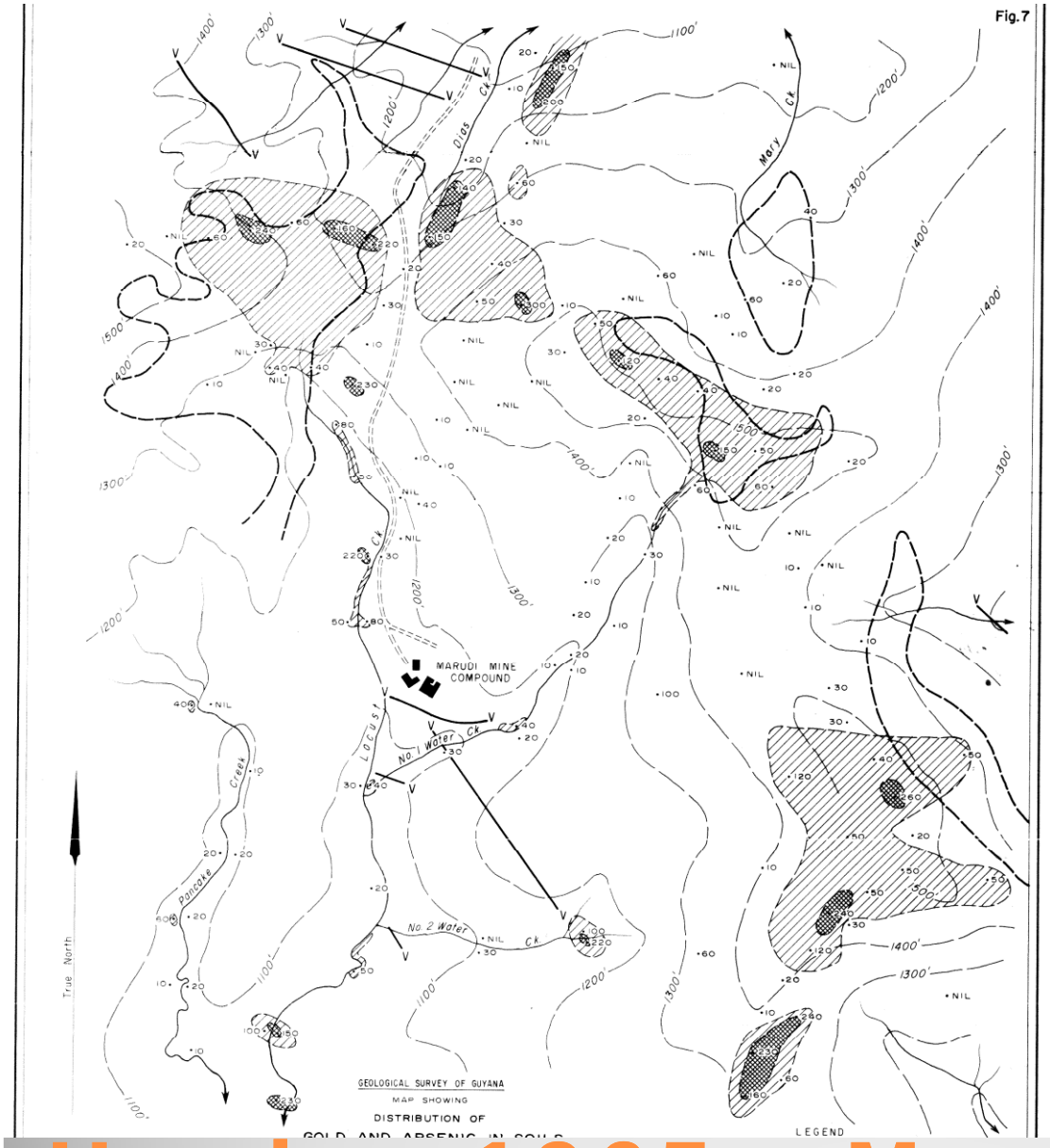
Kwitaro quartzite & BIF

Kwitaro at Marudi Mountain



Phyllite, amphibolite, chert & BIF intruded by Marudi Granite.
2 phases of folding

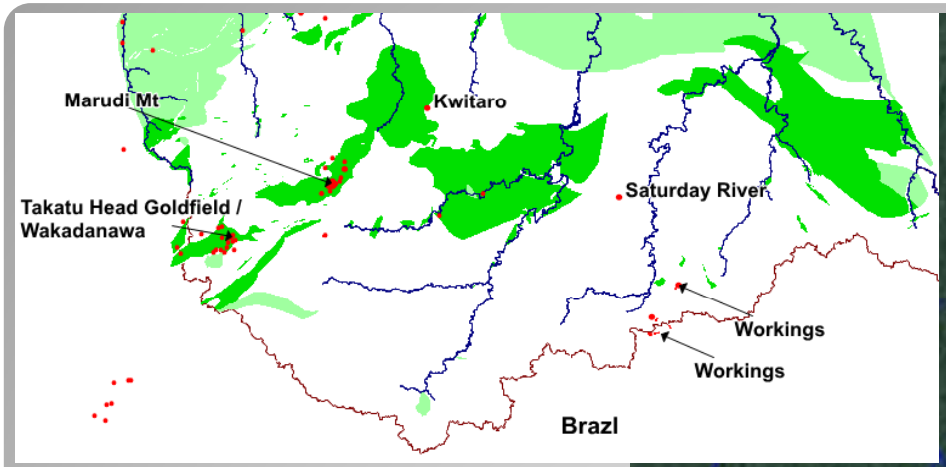
Kwitaro & Marudi granite as enclave in Southern Guyana Granite Complex.



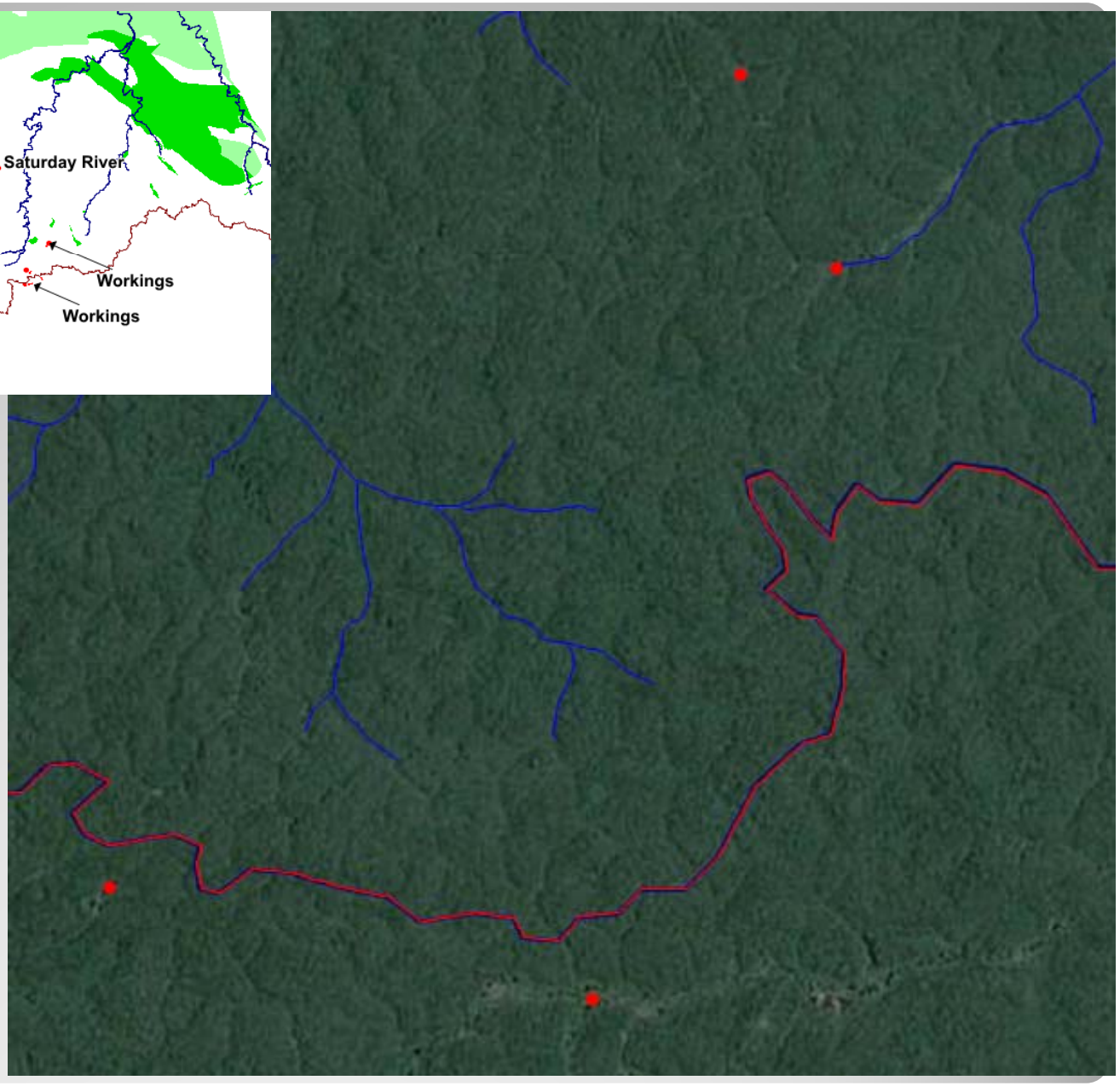
At Marudi good correlation Au & As.

Along strike (~25km) GGMC drainage geochemistry shows a consistent gold anomaly, but only spotty SS As – highest at Marudi – 21ppm. Amphibolitic geology can be traced by anomalous SS Ni, Co, Cu etc

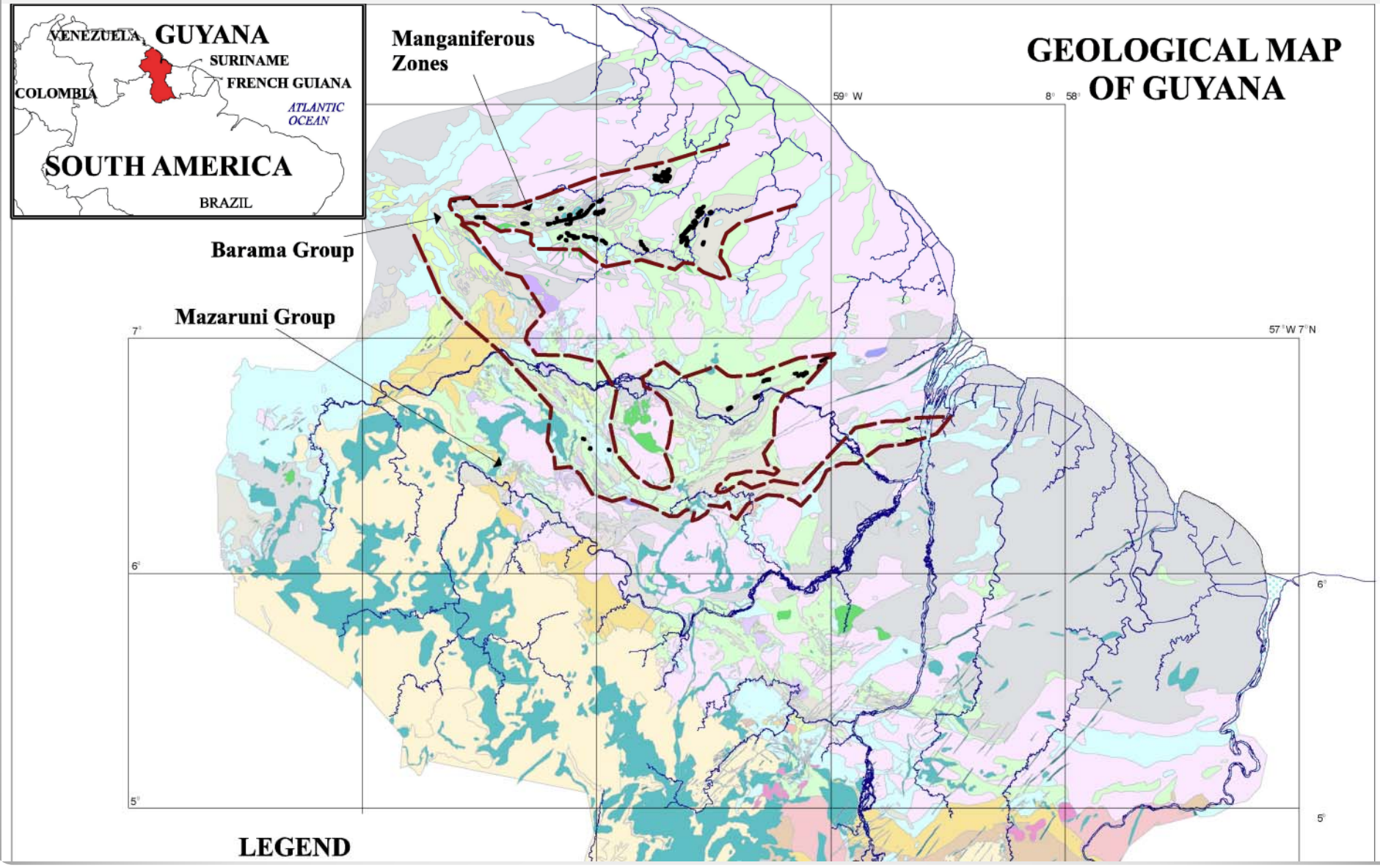
Hawkes 1965 – Marudi Au & As

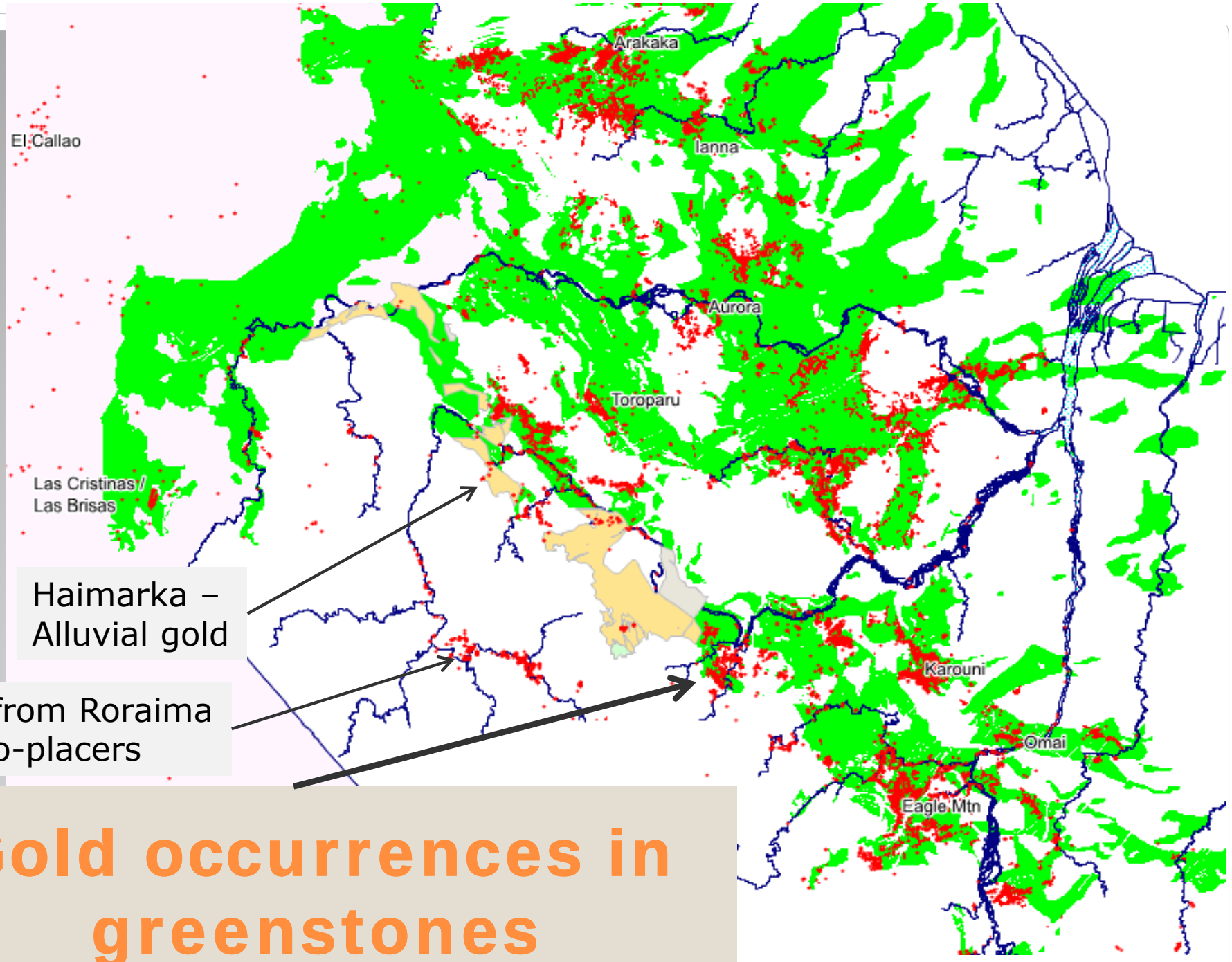


Google Earth: Granite geology, but gold workings suggests unmapped Kwitaro



North Guyana; Barama-Mazaruni Super Group





Haimarka –
Alluvial gold

Gold from Roraima
Palaeo-placers

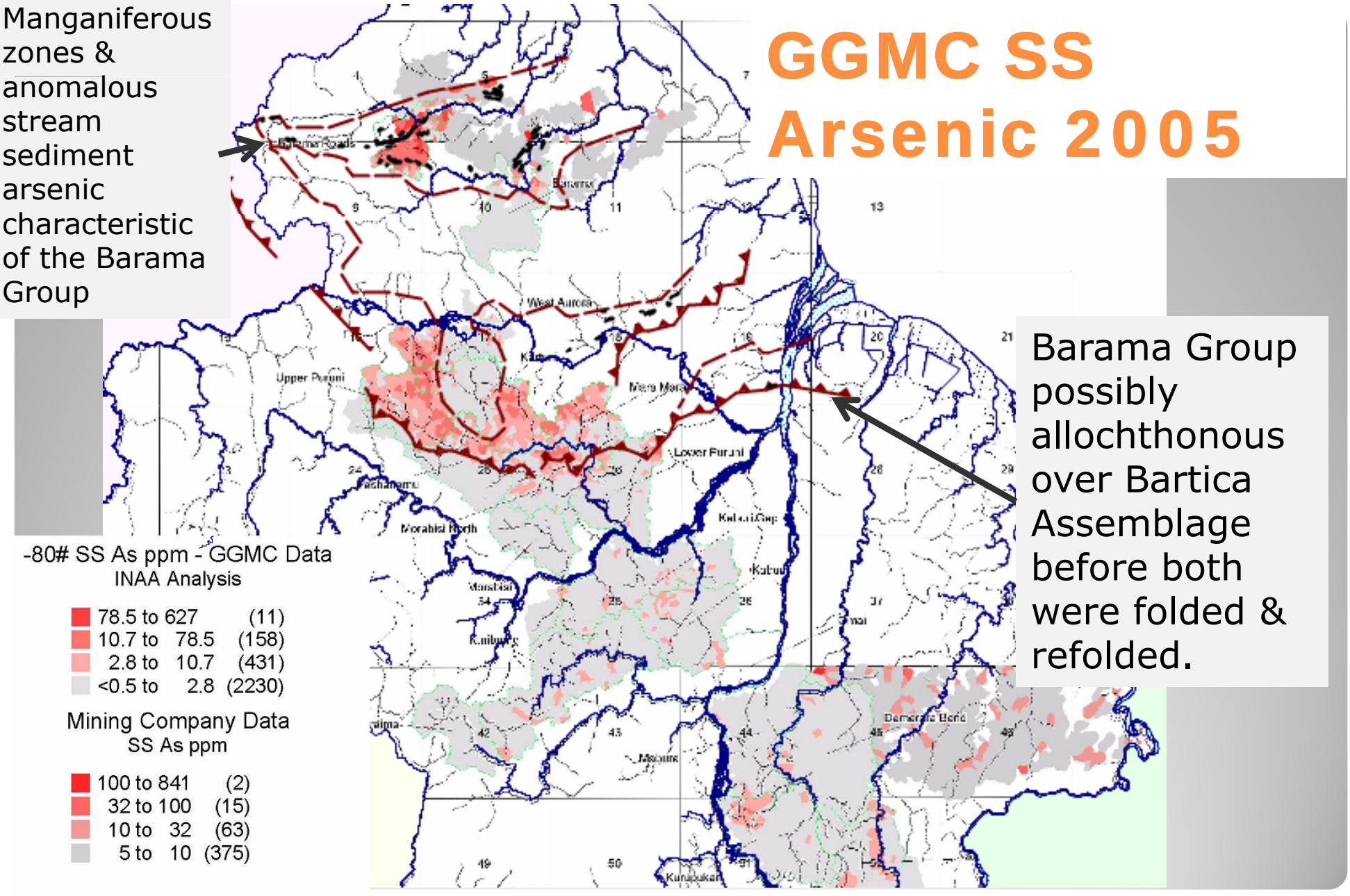
Gold occurrences in greenstones

Barama Group

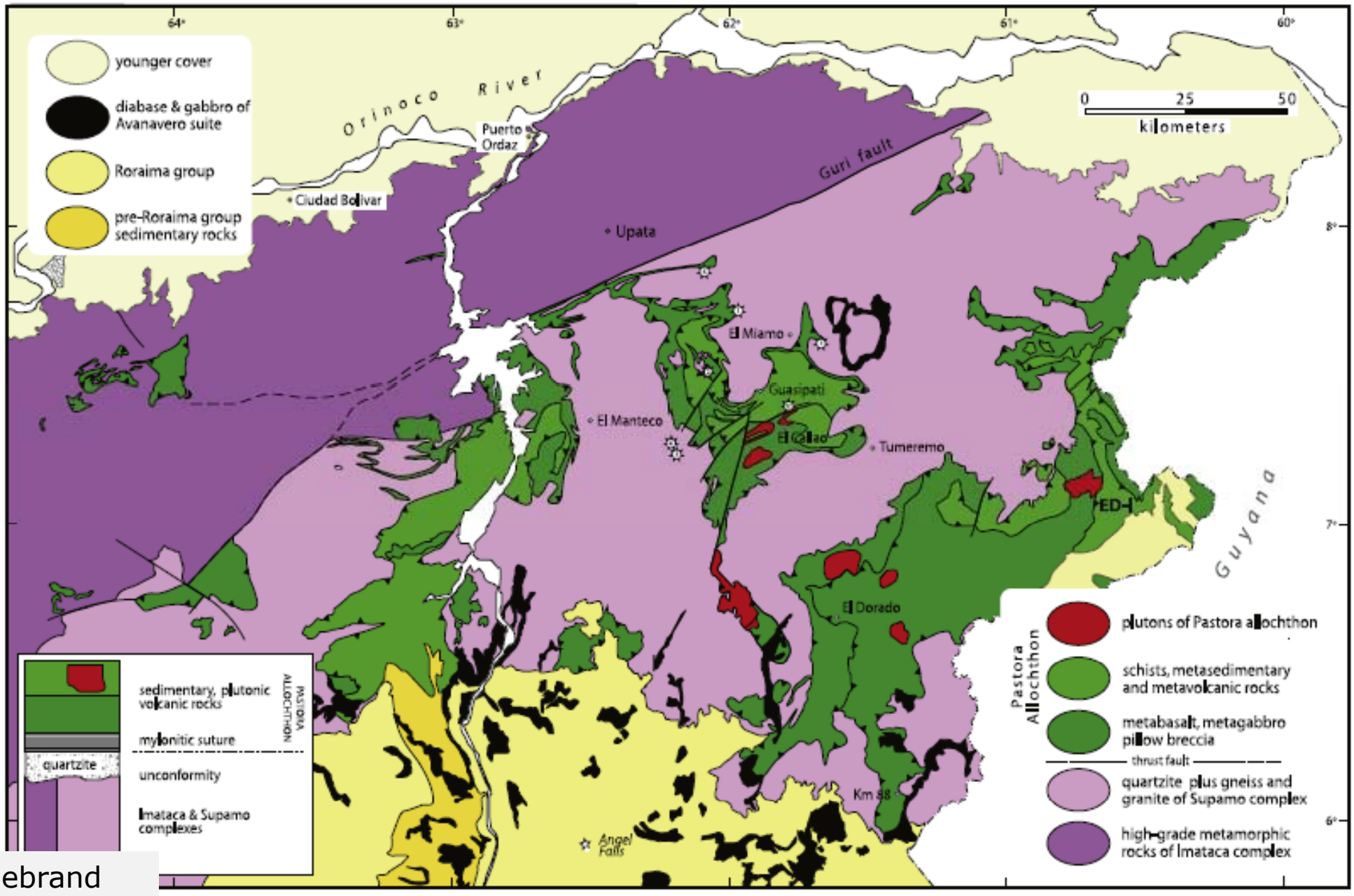
- Named after the Barama River.
- Meta-basic rocks overlain by increasingly felsic meta-volcanics and then the dominant meta-sedments.
- Can be traced westwards to Venezuela – El Callao Formation / Pastora Super Group
- Manganiferous sediments / gondites act as marker horizons
- Refolded folds / locally dome / basin structure
- Distinctive regional drainage geochemistry – almost always detectable arsenic, locally very high – 1000 ppm As near Arakaka.
- Low level, but common 1-2ppm Sb

GGMC SS Arsenic 2005

Manganiferous zones & anomalous stream sediment arsenic characteristic of the Barama Group

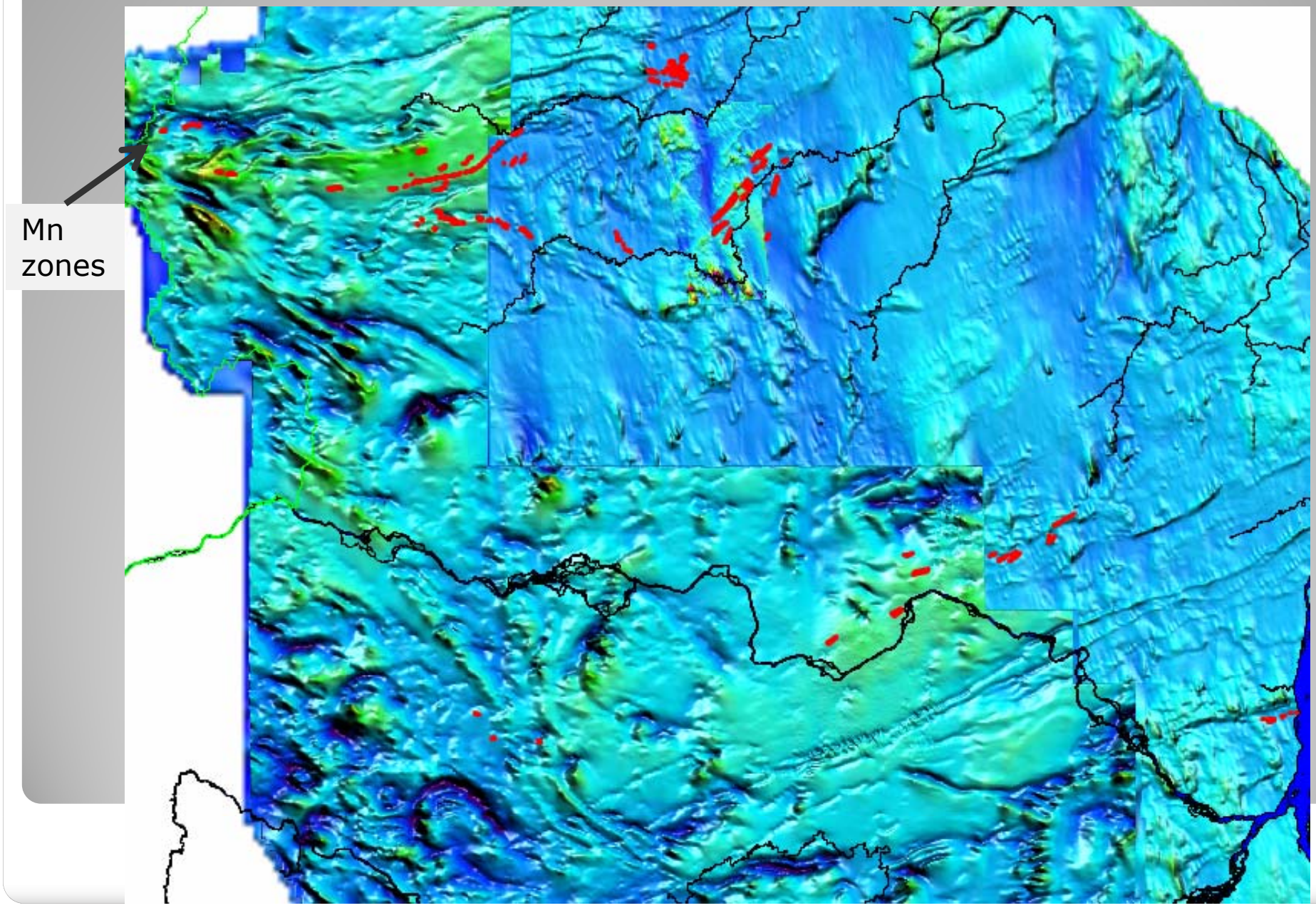


In Venezuela Greenstones are thrust over Granite & Gneiss then folded and refolded



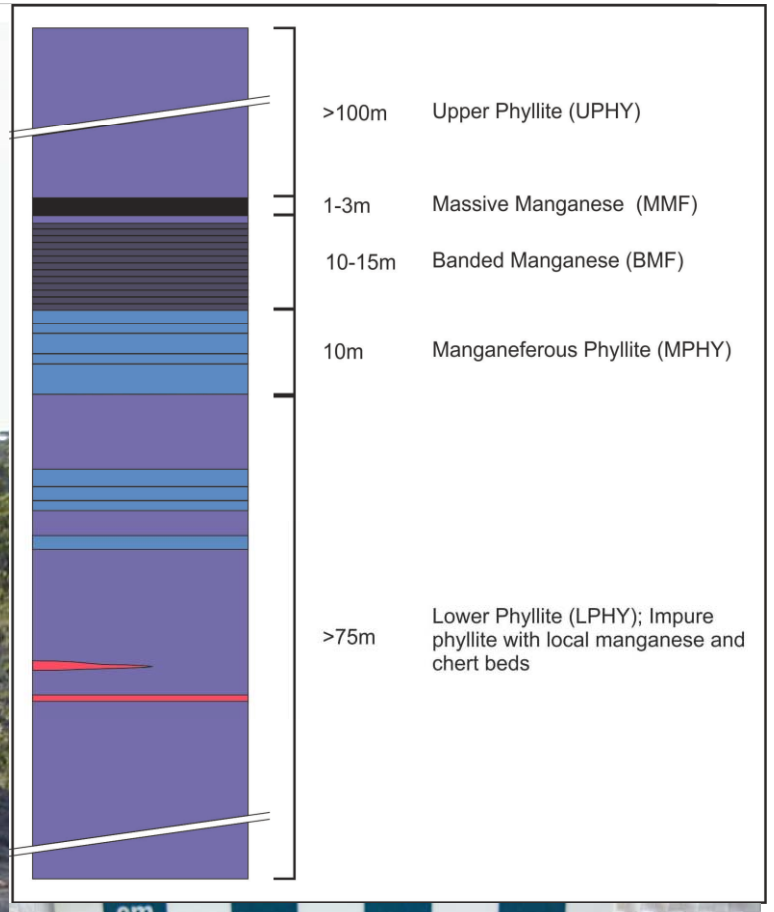
Hildebrand 2018

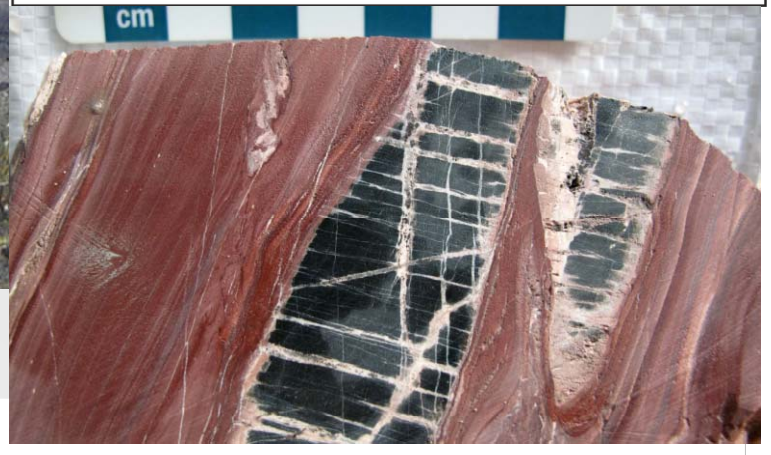
Aeromag shows mega-folds



Barama Group Stratigraphy

- amphibolites, chlorite schists and pillow basalts – Tenapu Formation
  - serpentinites and talcose rocks – Komatiites?
- calc-alkaline flows, tuffs and sub-volcanic porphyry stocks – Arawanta Formation
  - Shoshonitic hornblende-porphyries in the west
- Meta-sediments – quartzites (after chert?), red-brown phyllites, Mn zones - Matthews Ridge / Arawanta Formation
  - Eastern end some tuffaceous rocks (Tassawini)
- Lots of small diorite sills / stocks
- Unconformable greywackes / volcaniclastic conglomerates & fine igneous rocks in the east– Kokrit Formation.

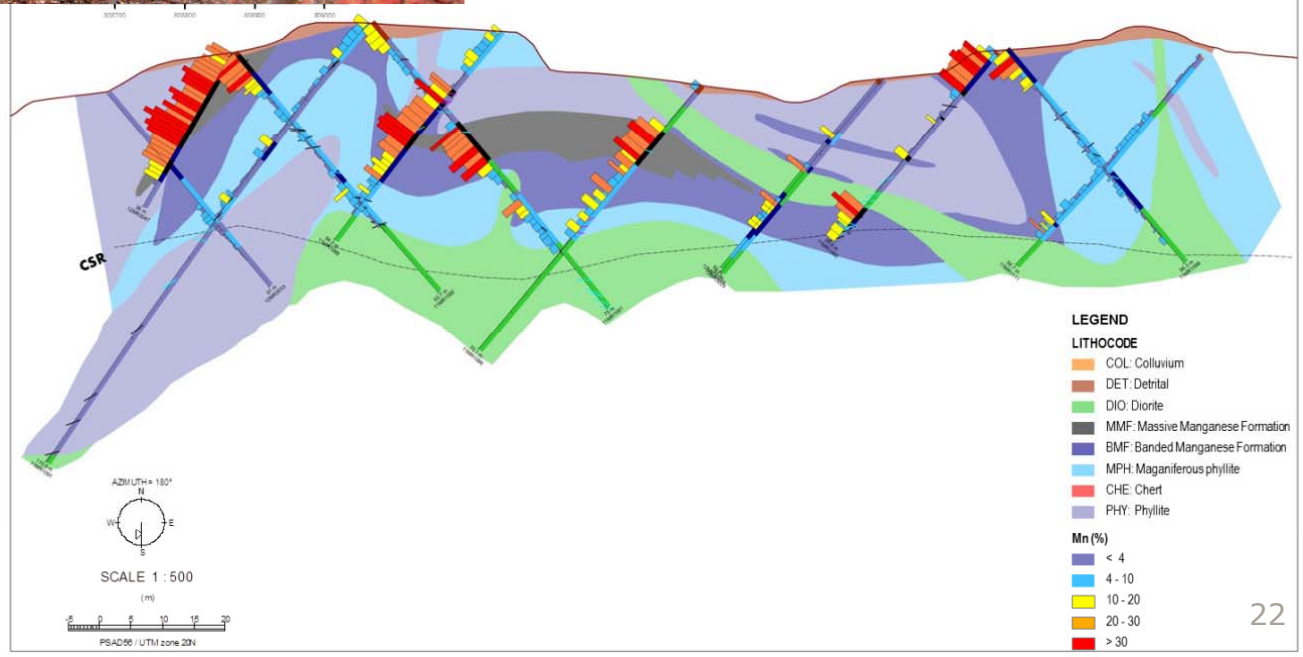




Matthews Ridge Mn

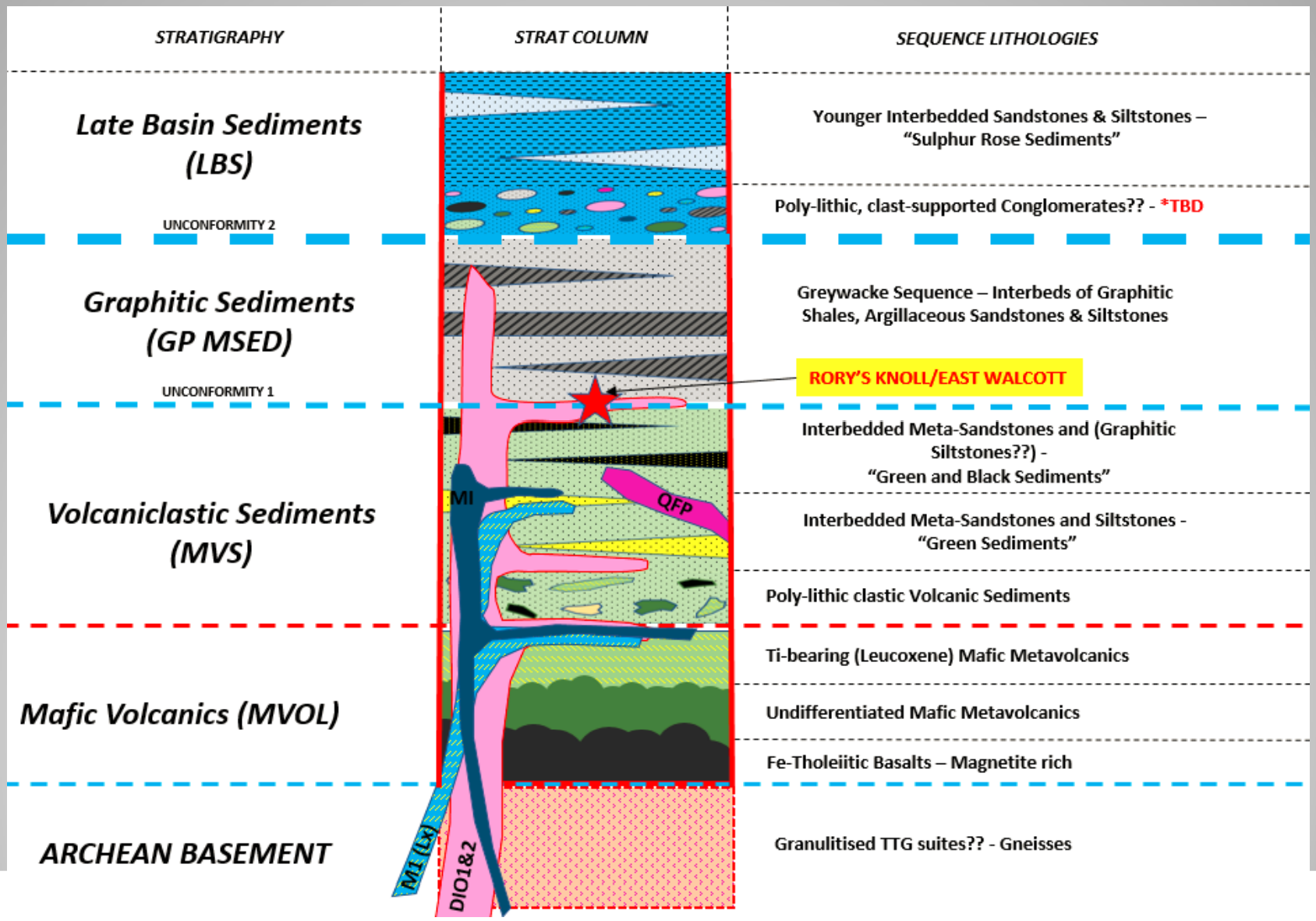
From Reunion Gold 2013

Folding – before intrusion of diorite?

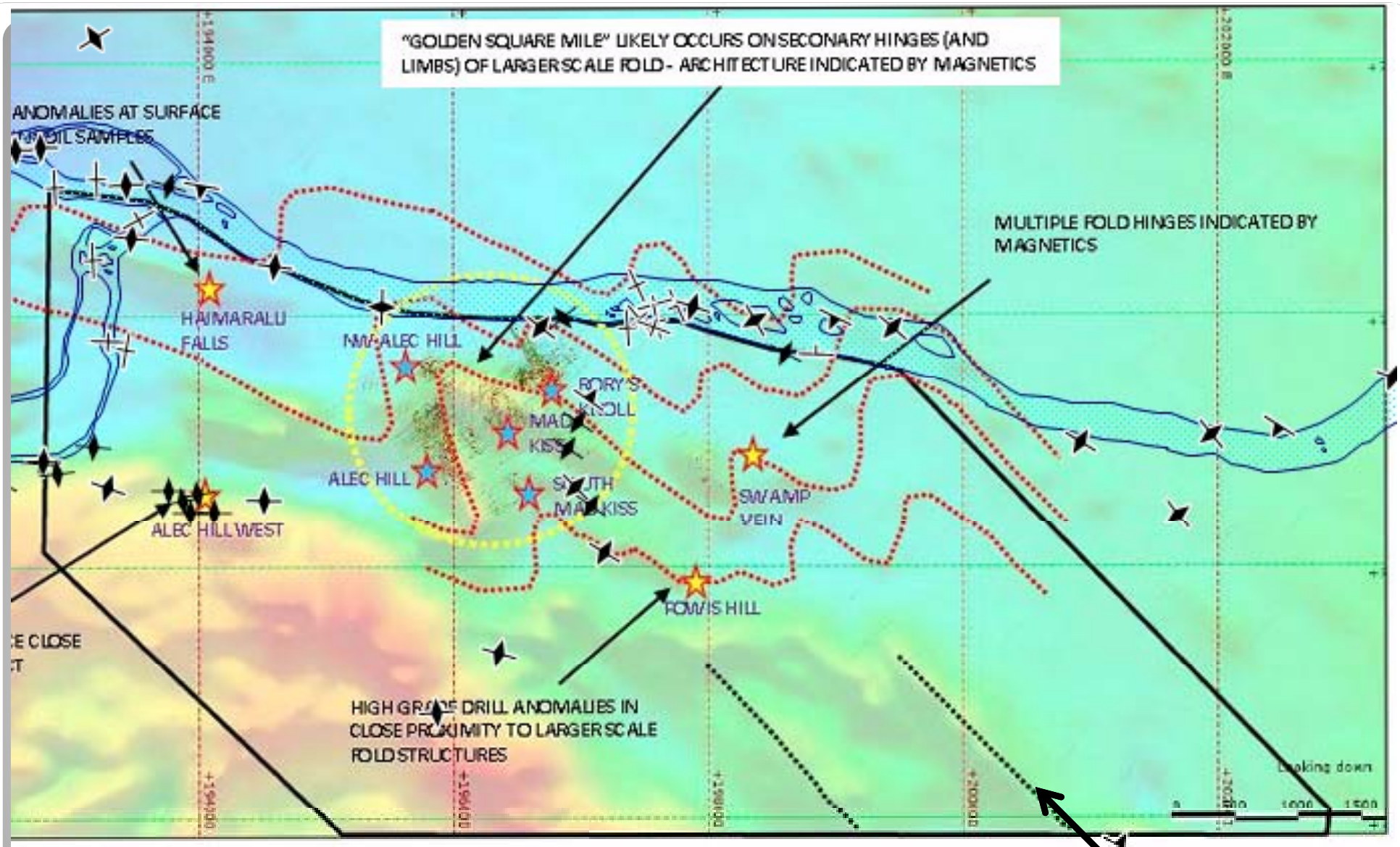


From Reunion Gold 2013

Aurora: Cuyuni Group = Barama Group



From Guyana Goldfields 2018



Aurora folding

Serictic shear;
Mapped as meta-sediment
by Bracewell 1948

From Guyana Goldfields presentation 2018
with GGMC 2003 & historical structural data

- Low angle structures:
  - Arakaka
  - Sona Hill (Toroparu)
  - Quartzstone
  - Eagle Mountain
  - Million Mountain

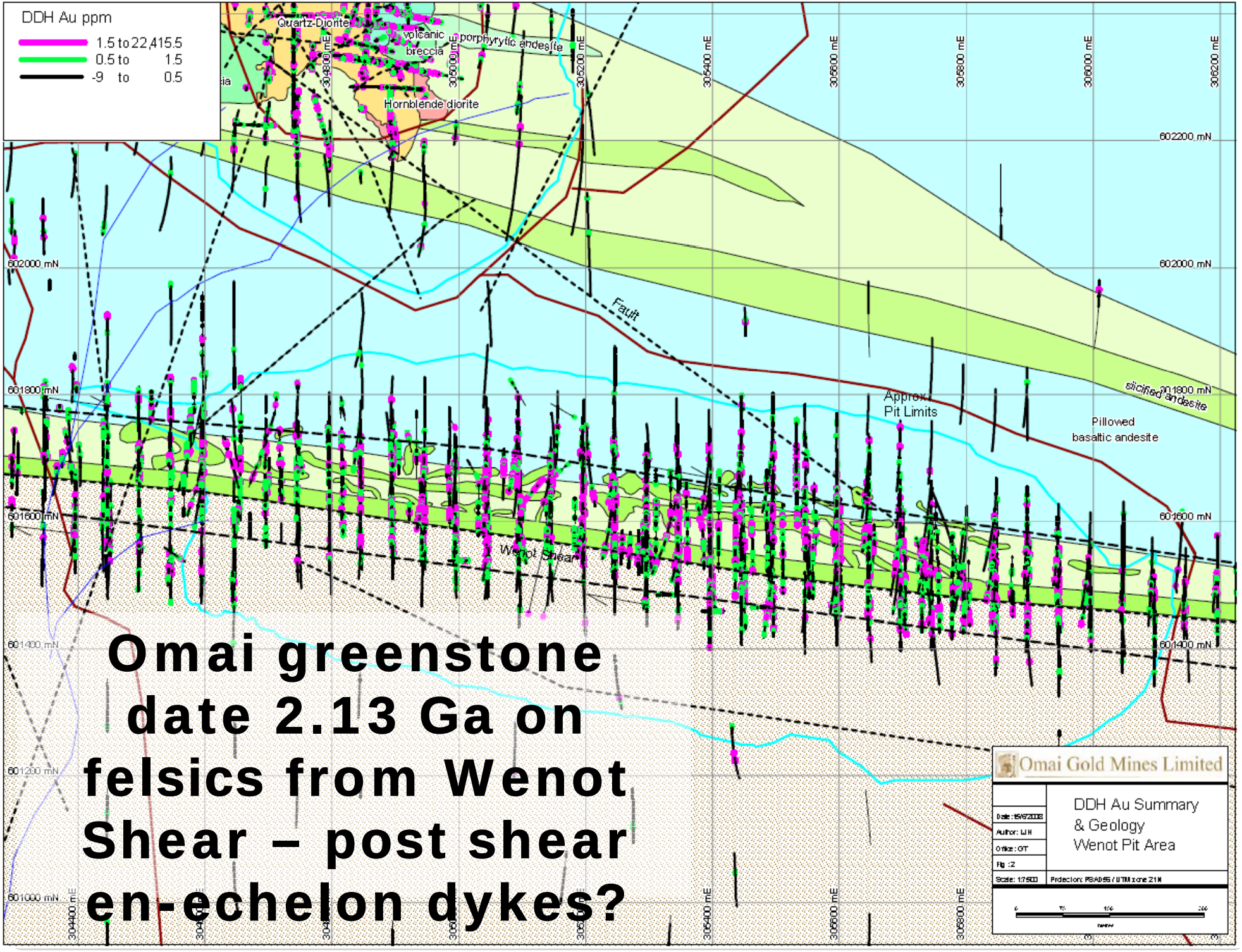
Evidence of thrusts in Guyana: maybe
Low angle structures - yes

Mazaruni Group

- Issineru-Haimaraka area considered as the "Type Area" by Gibbs & Barron 1993 & Renner & Gibbs 1987
  - Because it is less deformed & faulted.
- Issineru Formation
  - Basalt & gabbro, some tuffs & cherts
  - Upwards predominantly intermediate and felsic volcanics
  - Gradually more sediment zones
  - Greenschist facies
- Haimaraka Formation
  - Graywackes derived from Issineru
  - Some only zeolite facies

Mazaruni group - Omai

- Very similar geology to Barama Group
- Larger volumes of mafic metavolcanics / greenschists
- Intermediate and felsic volcanics
- Greywackes / meta-volcaniclastics, locally phyllitic
- Diorite intrusion into basaltic & andesitic rocks 2.09 Ga
- Some felsics post shearing – 2.13 Ga en-echelon intrusions in Wenot Shear, Omai
- Greywackes, locally conglomeratic
- No significant arsenic in GGMC Stream Sediments
- Minor SS As in the immediate Omai Mine area


DDH Au ppm
1.5 to 22,415.5
0.5 to 1.5
-9 to 0.5
Quartz-Diorite
volcanic breccia
porphyrytic andesite
Hornblende diorite
Fault
Wenot Shear
Approx. Pit Limits
silicified andesite
Pillowed basaltic andesite
Omai greenstone date 2.13 Ga on felsics from Wenot Shear – post shear en-echelon dykes?
Omai Gold Mines Limited
DDH Au Summary & Geology Wenot Pit Area

Omai Pillow Basalts and mafic meta-volcaniclastics

Haimaraka Formation = pre-Roraima, Not Mazarui Group

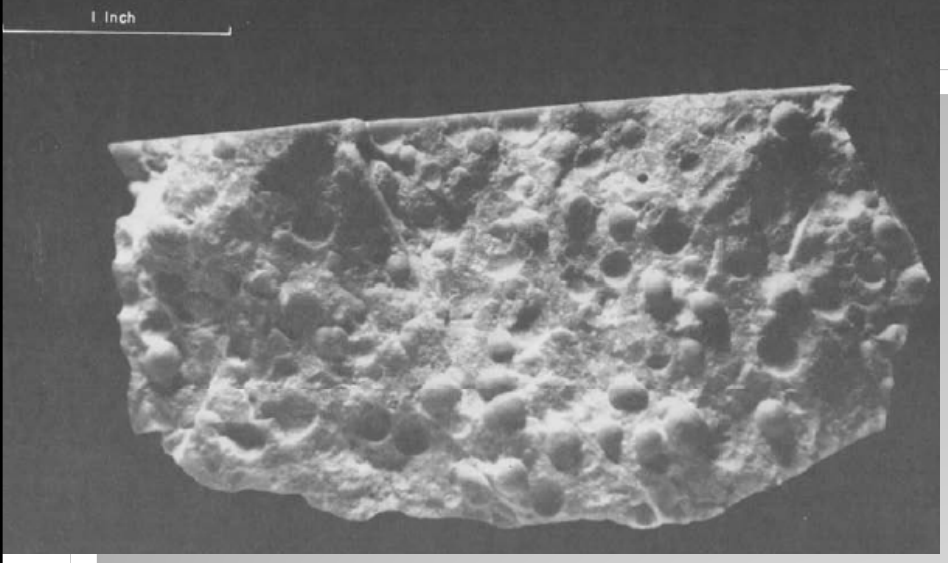
- Cuyuni River (Venezuela border) – unconformity between folded greenstones and the quartzitic / conglomeratic Los Caribes / Muruwa Formation. Originally called the "Western Cuyuni Formation"
- Conglomerate at the top with porphyry clasts
- Overlain by Haimaraka Formation – red/brn graywackes & shales – locally only zeolite facies
- Both show 2 phases open folding
- Covered by semi-flat Roraima Group

- No known primary gold occurrences in the Haimaraka, only alluvial gold & diamonds
- Primary gold in the Issineru Formation - Tamakay

Basement & "pre-Roraima rocks"

- In the Muruwa River west of the Essequibo a conglomeratic contact was drilled by Cogema between Muruwa and greenstone basement
- In the Essequibo & Corentyne Rivers Muruwa xenoliths occur in granite – so these Iwokrama associated granites are younger than the "Younger Granites"
- The Muruwa Formation also shows 2 phases of gentle folding
- East of the Essequibo there is a ~conformable contact of Muruwa with Iwokrama felsic and then ~flat Roraima Group
- West of the Berbice ~ conformable Iwokrama overlies Muruwa
- Lots of Iwokrama Formation south of the Pakaraima Mts
- North side only Muruwa & Haimaraka
- **Haimaraka is lateral equivalent of the Iwokrama**

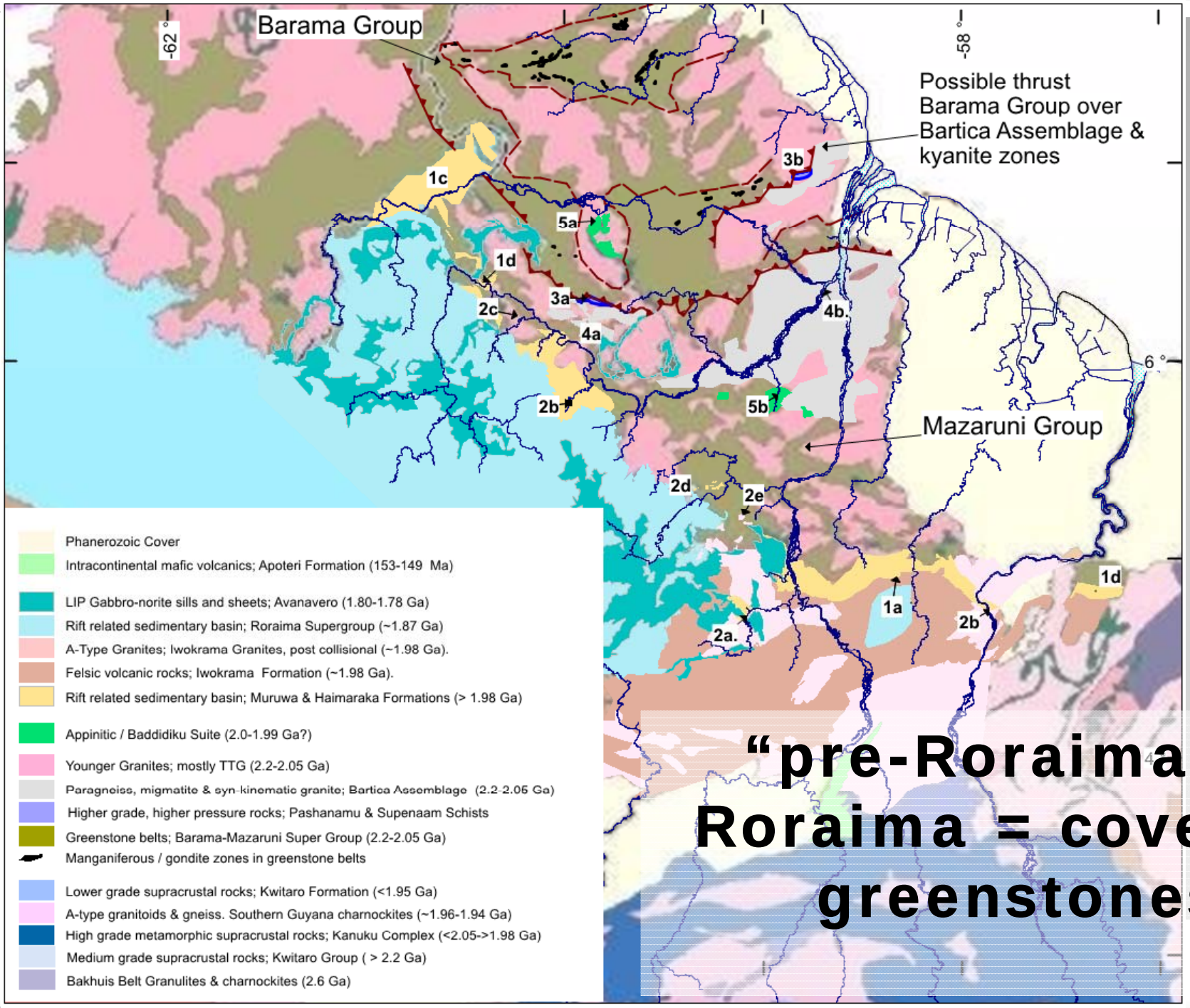
Haimaraka & Iwokrama "Balls"



Felsic tuff – accretionary lapilli in Haimaraka Formation
Merume River

Rhyolite "balls"
Iwokrama Formation
Berbice River

Bedded "balls"
Each bed has "balls" of approx same size.
Iwokrama Formation
Berbice River



“pre-Roraima” & Roraima = cover on greenstones

Geology & gold hidden under even younger / Phanerozoic cover 100km inland; Edge of the Guiana Basin

Conclusions?

- Kwitaro Group – completely different
- Mazaruni group probably the same as the Barama group / Pastora Super Group but distal to the manganiferous / arsenic rich areas
- Brought into proximity by thrusting?
- Roraima Group & "pre-Roraima" rocks unconformable on greenstones – post mineralisation
- What about the other graywackes / conglomerates – not sure
- Dating on post sediment felsic intrusions needed! – the Haimaraka is metamorphosed by granite near Enachu

Hopefully a few cogs turning!

This one from small scale workings 4m deep from the base of the Phanerozoic cover / White Sand – Mahdia area

Questions?