

Geological Survey of Brazil – CPRM

***THE EBSD IN THE SEM LABORATORY OF THE
GEOLOGICAL SURVEY OF BRAZIL
FROM THE EASTERN AMAZONIAN REGION***

Marcelo Vasquez

SEM LABORATORIES CPRM



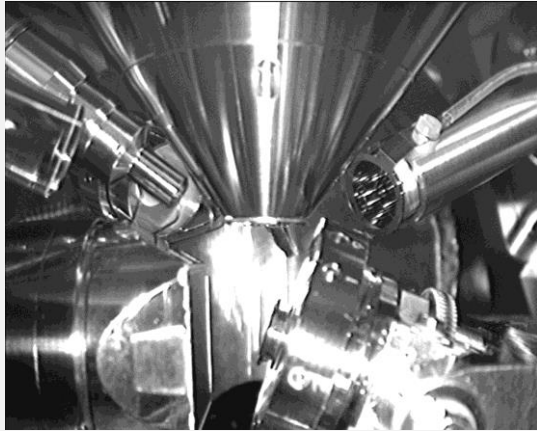
□ LAMIN-BE

*Laboratory of Mineral Analysis
Belém Office Branch*

□ UNB/CPRM

*Geoscience Institute - University of Brasilia
CPRM Headquarter*

SEM LABORATORIES CPRM



LAMIN-BE

- ❑ **Zeiss (W-gun)**
- ❑ **Oxford system**



UNB/CPRM

- ❑ **FEI (W-gun)**
- ❑ **EDAX system**

SEM LAMIN-BE

Laboratory of Mineral Analysis of Belém Office Branch



Images

- SE**
- EP-VP Mode**
- BSE**

Microanalysis

- EDS (X-Act, AZTec)**
- EBSD (HKL , Channel 5)**

LAMIN-BE FACILITIES

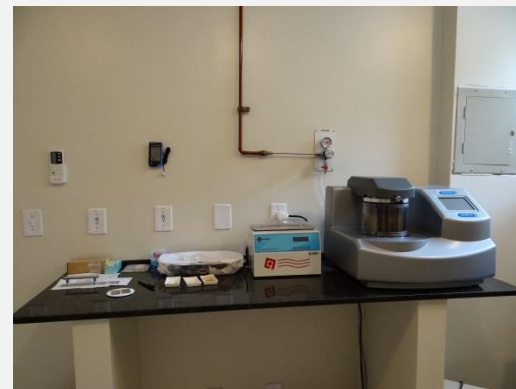
❑ Cutting/Grinding/Polishing



❑ Hot mounting press



❑ Coating (C, Au, Cr)



LAMIN-BE FACILITIES

□ Thin sections



□ Hot mounts
(epoxy, fenolic resins)

□ Cold mounts
(epoxy resins)



POLISHING

- ❑ **Mechanical-chemical Polishing**

- ❑ **Consumibles**

 - SiC paper**

 - Gridding discs**

 - Diamond suspensions**

 - Colloidal silica suspension
(0.2 μ m , alkaline)**

 - Polishing cloths**

 - Alumina powder**



EBSD SAMPLES

Metamorphic Rock Fabrics

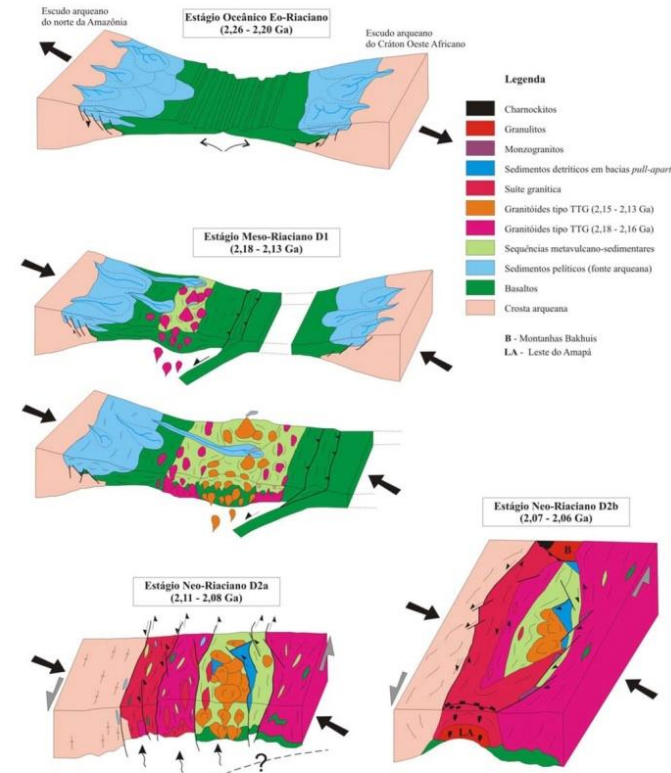
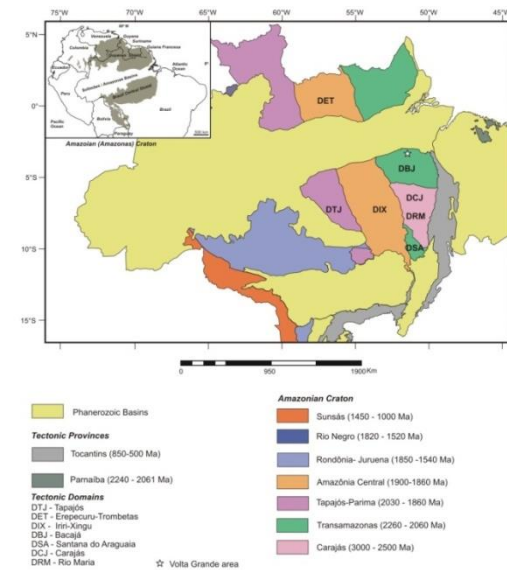
- ❑ **Nematoblastic Amphibolite**
- ❑ **Granoblastic Metapyroxenite**

Ore Fabrics

- ❑ **Fe / Cu-Au Deposits (BIF / IOCG Carajás)**
- ❑ **Cr / PGE Deposits (Cr-layered Tróia)**

Bacajá Domain

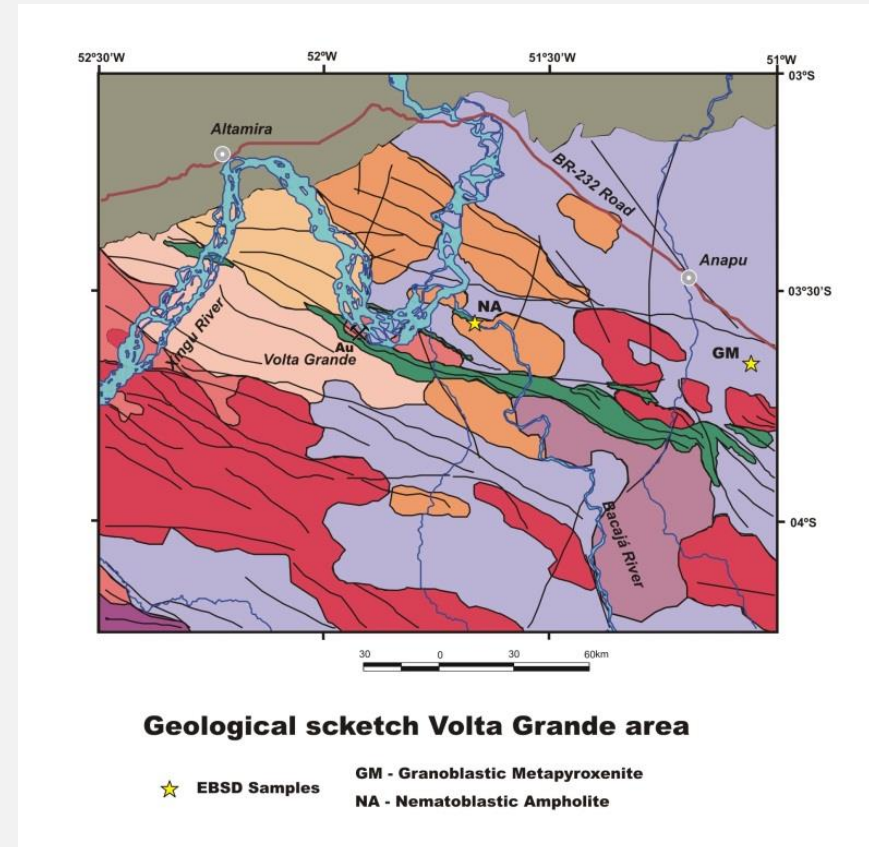
- 3.02-2.34 Ga embasement
- 2.36 Ga greenstone belt
- High grade metamorphism
 - 2.20 – 2.06 Ga events
 - Partial melting ($> 600^{\circ}\text{C}$)
 - UHT metamorphism ($900\text{-}1050^{\circ}\text{C}$)
- 2.1 Ga collision of SAM/WAf plate (continental collision)



(Delor et al. 2003 – GF 2-3-4)

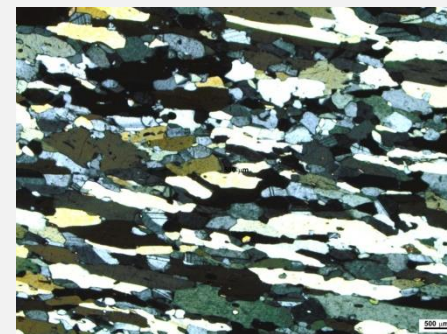
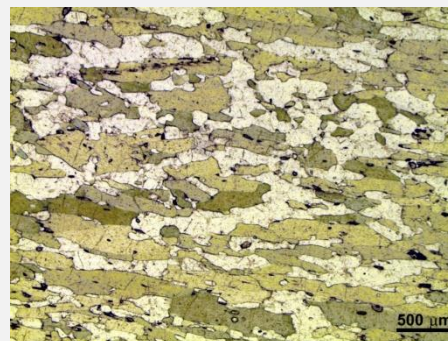
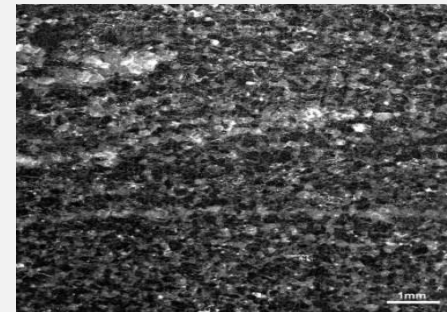
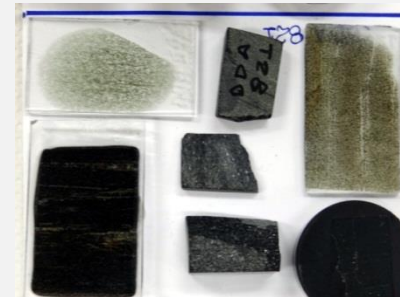
Bacajá Domain

- ❑ **Volta Grande Area**
(Belo Monte hydroelectric plant, VG mine)
- ❑ **Nematoblastic Amphibolite**
(metamorphosed basalt – Pl+Px)
- ❑ **Granoblastic Metapyroxenite**
(metamorphosed pyroxenite - CPx)
- ❑ **Few minerals phases**
(igneous / metamorphic)
- ❑ **Metamorphic rock fabrics**
(oriented / not oriented)
- ❑ **Crystalized new P-T conditions**
(recrystalized)



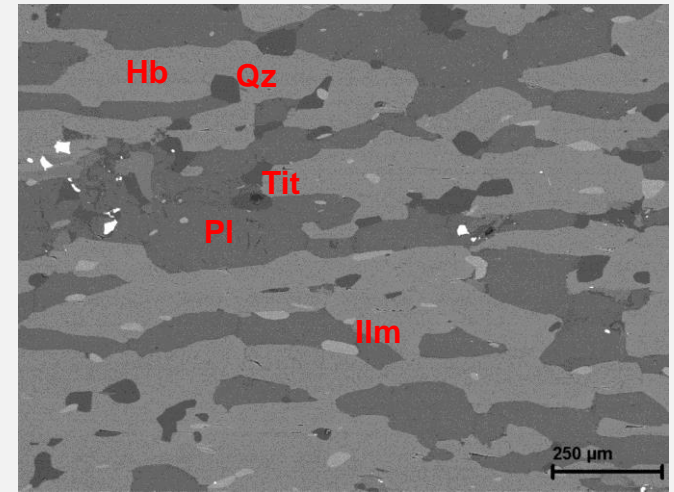
Nematoblastic Amphibolite

- ❑ *Macroscopic banding*
- ❑ Oriented amphibole crystals
- ❑ Monoclinic prismatic crystals (2/m)
- ❑ Nematoblastic texture
- ❑ Oriented plagioclase crystals
- ❑ Triclinic tabular crystals



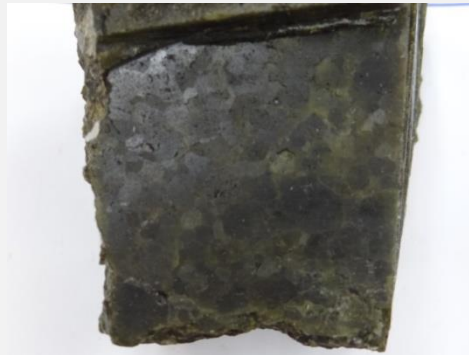
Nematoblastic Amphibolite

- ❑ Amphibole (Ca,Mg,Fe / Hornblende)
- ❑ Plagioclase (An50-55 / Labradorite)
- ❑ Accessory (Qz /Tit/Ilm/CPy/Py)
- ❑ Oriented crystals (Hb / Lab/Tit/Ilm)
- ❑ P-T crystallization (~ 550-600°C/ 8-10kbar)
- ❑ *Regional metamorphism (2.10Ga?)*
- ❑ *Main collisional phase (?)*



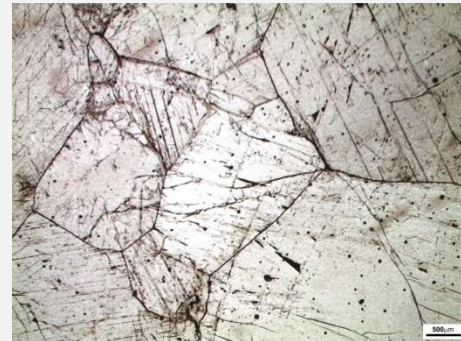
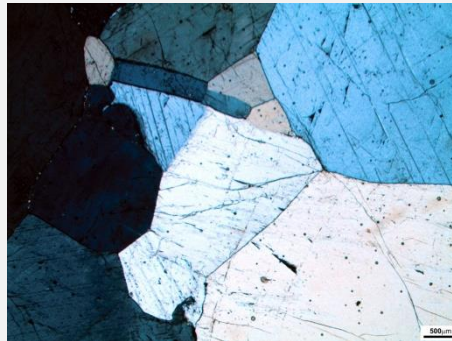
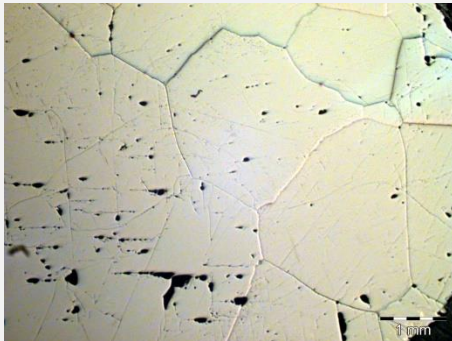
Granoblastic Metapyroxenite

- ❑ **Cumulate of pyroxene**
(crystal settling / sink by gravity)
- ❑ **Massive / coarse grains**
- ❑ **98% Clinopyroxene (Diopside)**
- ❑ **Monoclinic crystals**



Granoblastic Metapyroxenite

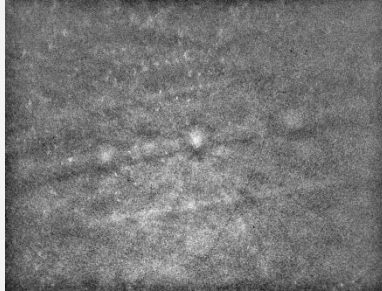
- ❑ Polygonal granoblastic texture (static growing / annealing)
- ❑ P-T recrystallization (~ 750-800°C / 5-8kbar)
- ❑ Thermal metamorphism (up welling asthenosphere mantle)
- ❑ LP granulite metamorphism / Post-collisional event



EBSD TESTS

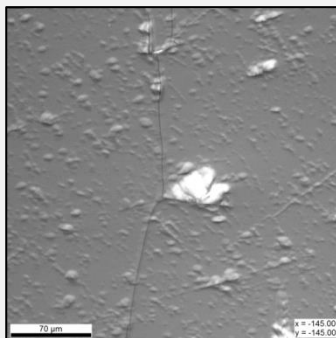
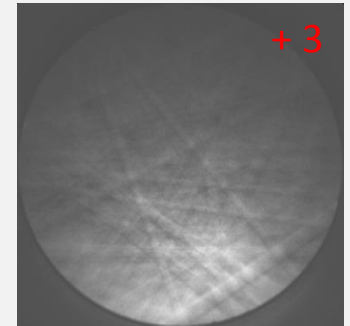
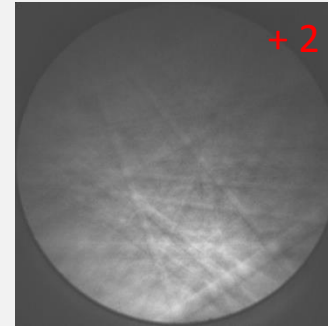
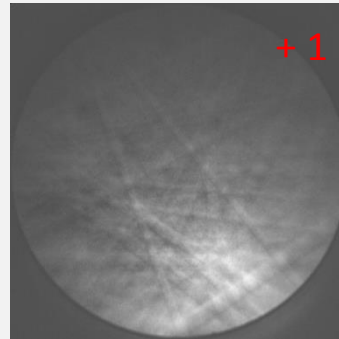
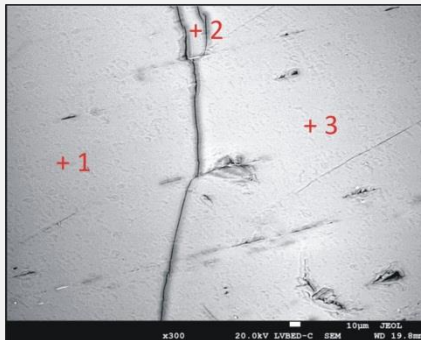
Granoblastic Metapyroxenite

August 2013



- ❑ Thin section
- ❑ Alumina powder (1 and 0,5 μm) polishing
- ❑ Carbon coating
- ❑ High vacuum

June 2015

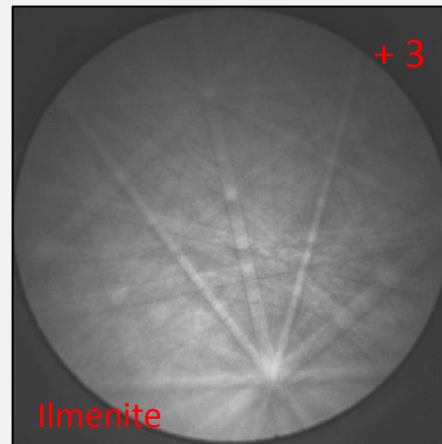
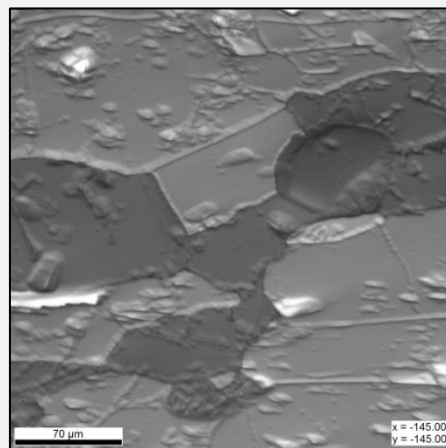
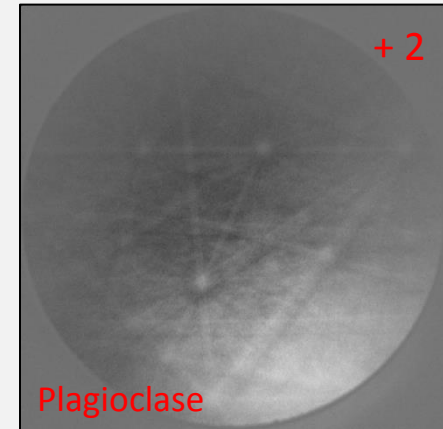
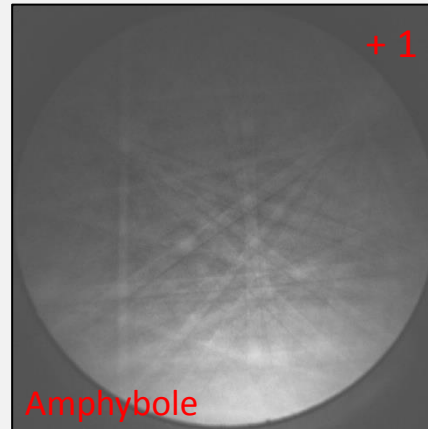
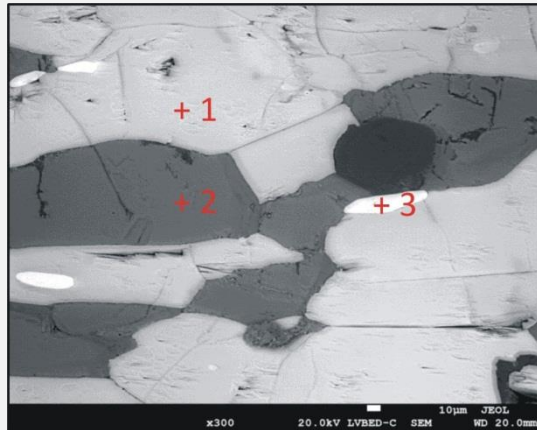


- ❑ Clinopyroxene
- ❑ Ion beam polishing (1000 μm)
- ❑ Low vacuum mode (40Pa) / 20Kv

EBSD TESTS

Nematoblastic Amphibolite

June 2015



- Thin section
- Ion beam polishing
- Low vacuum mode (40Pa) / 20Kv

Carajás Domain

2,78-2.76 Ga volcanism (Carajás basin)

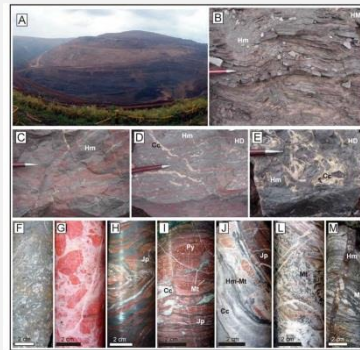
Iron deposits (BIF / IOCG)

BIF (N4E mine)

Fe oxides

Quartz

Carbonates



IOCG (Sossego mine)

(Igarape Bahia deposit)

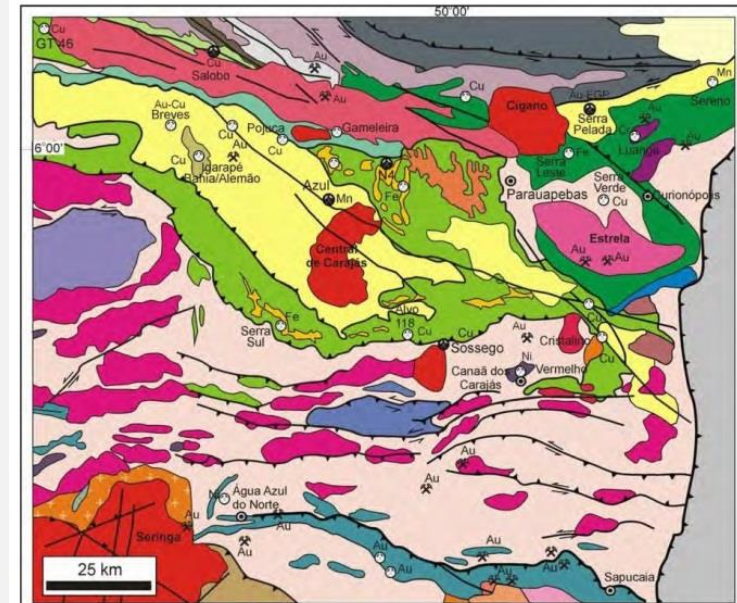
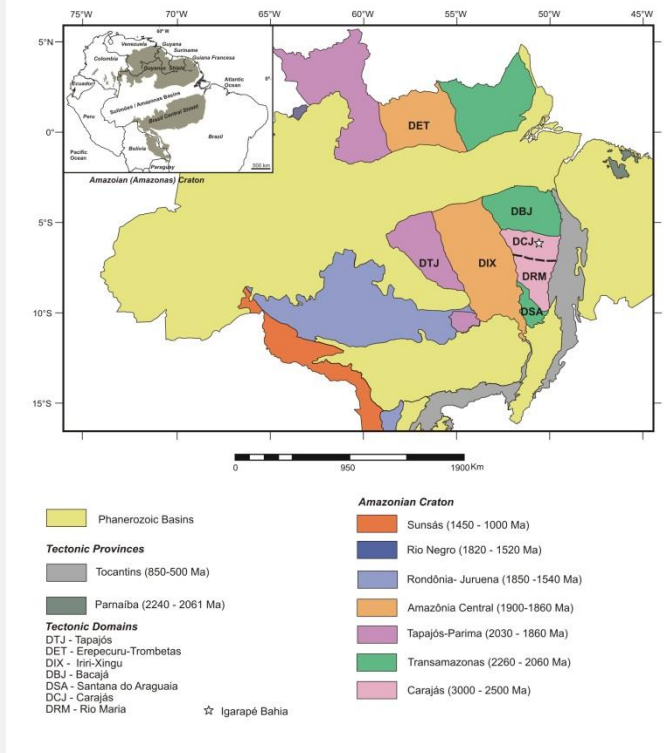
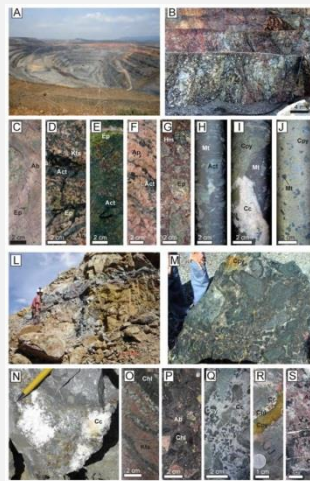
Fe oxides

Cu sulphides

Cu carbonates-OH

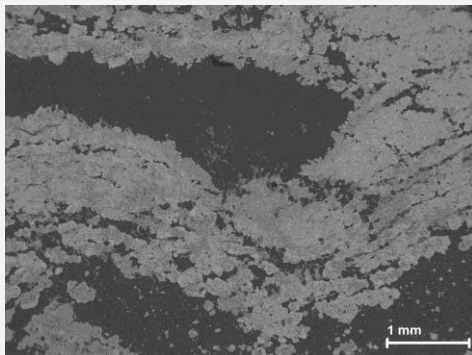
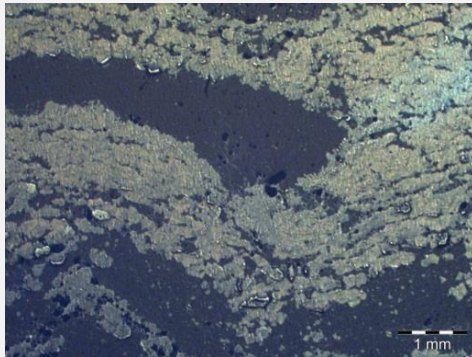
Cu native

Au



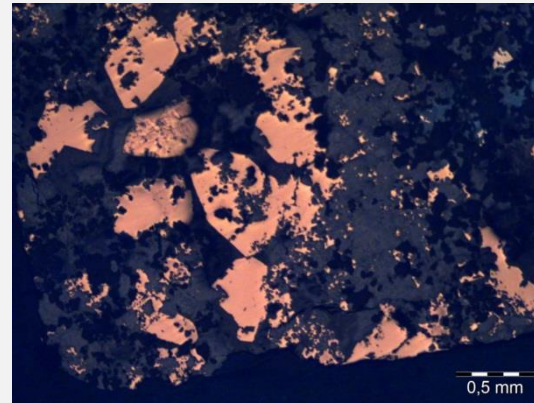
(Monteiro et al. 2014 – PMB)

BIF samples

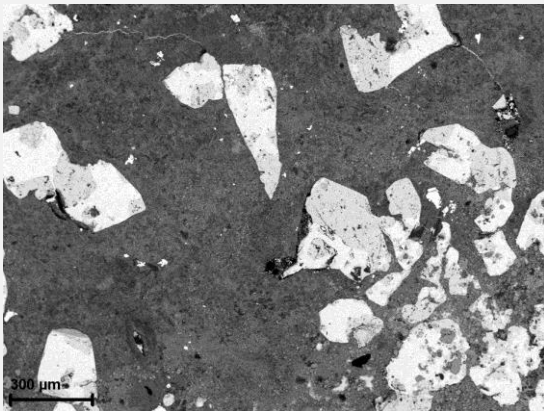


- ❑ PO hematite/magnetite
- ❑ BIF structural control
- ❑ Fe enrichment process

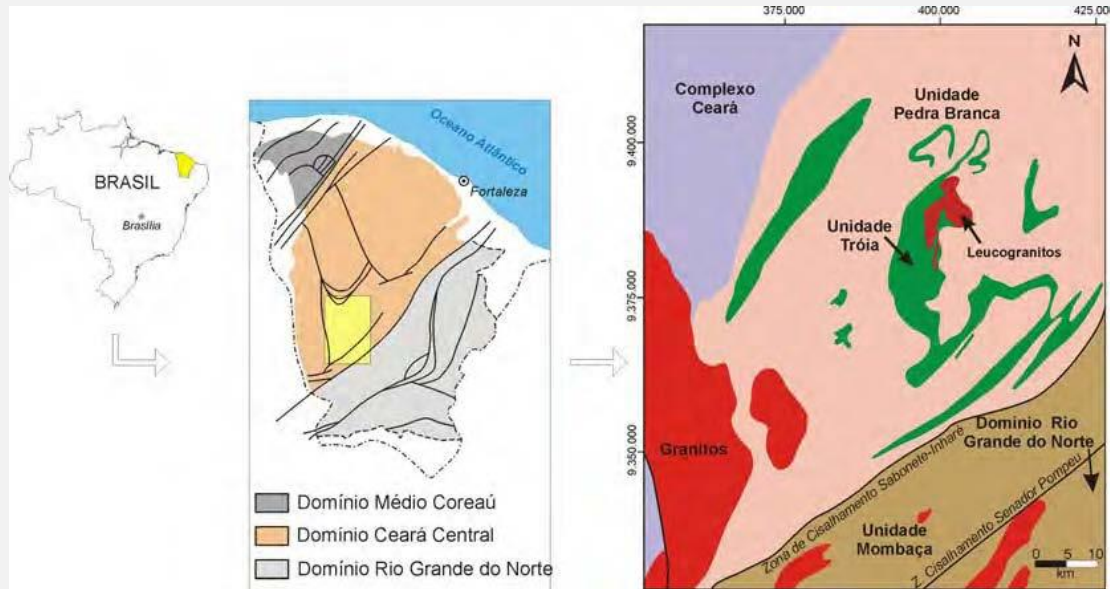
IOCG sample



- Cu enrichment
- Volcanogenic (?)
- Hydrothermal (?)



Troia Cr-PGE Deposit



- 2.2-2.1 Ga host rocks
- Layered UM Complex
- 2.08 Ga
- Ductile deformation

(Santos et al. 2014 – PMB)

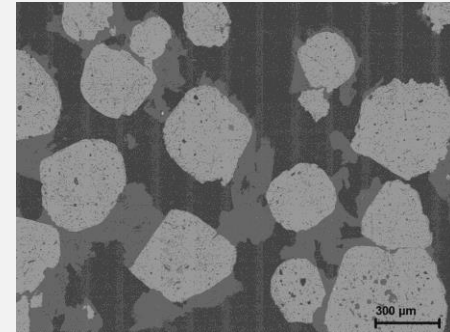
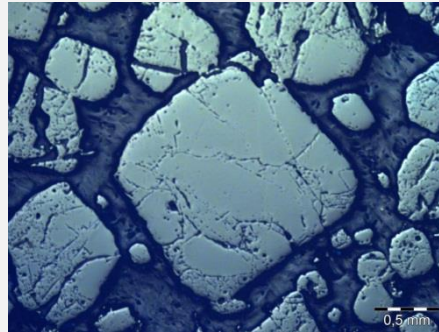
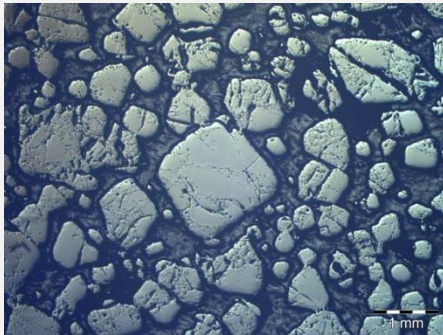
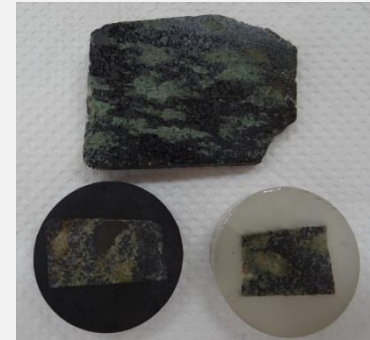
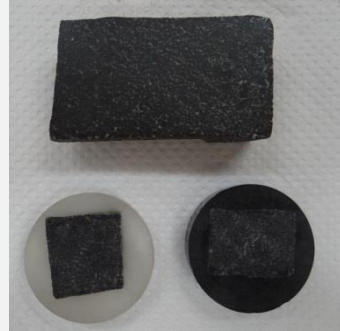


□ Metagabbro



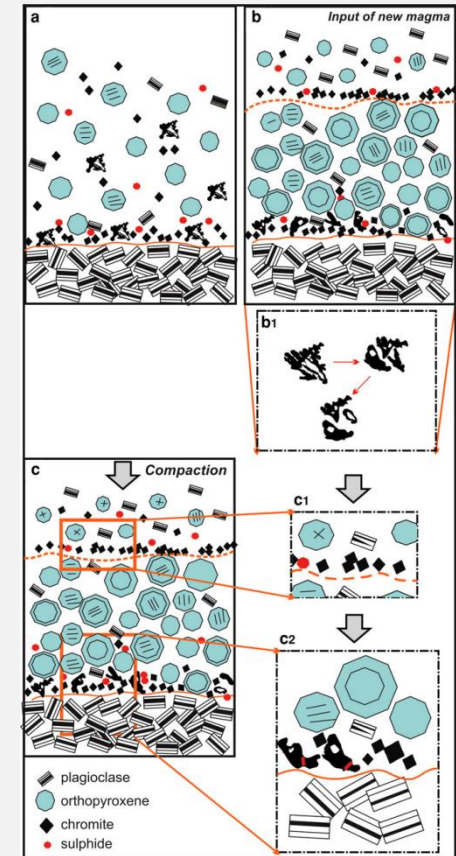
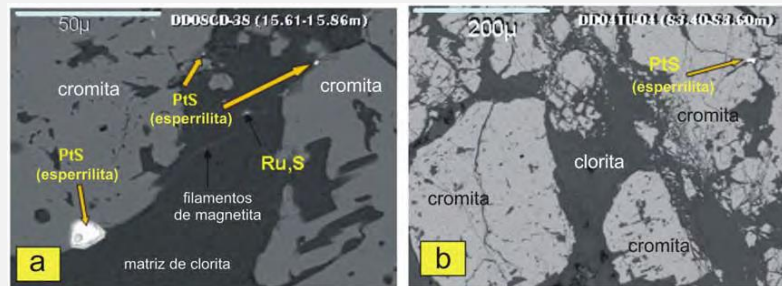
□ Chromitite layer

Cr-PGE Sample



EBSD Chromitites

- ❑ Magmatic control (crystal settling)
- ❑ Metamorphic control (recrystallization)
- ❑ PGE enrichment (Angeli, 2005 – PMR 49)

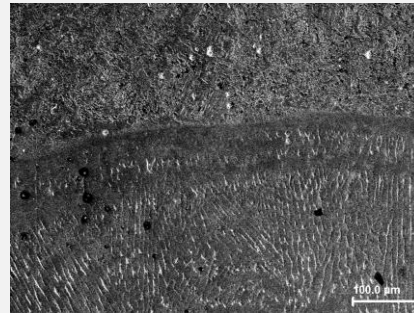
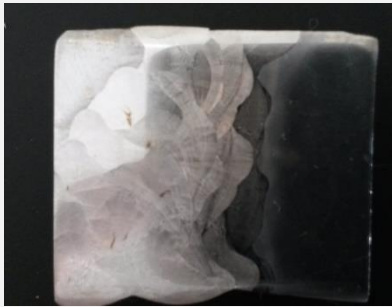


(Vukmanovic et al. 2013 - CMP 165)

PATERNSHIPS

UFPA

❑ Mechanical Engineering (stainless steel welding)



(Aguiar et al. 2015 - RM 20)



PCT GUAMÁ (<http://www.pctguama.org.br/>)
Science and Technology Park Guamá

❑ Laboratory Sensors And Onboard Systems - LASSE



REMARKS

CPRM CAN APPLY EBSD

- ❑ **Geology (PO metmorphism, structural,....)**
- ❑ **Mineral deposits (enrichment process, controls,..)**

SEM TEAM OF LAMIN-BE

- ❑ **Have facilities to prepare EBSD samples**
- ❑ **Have good SEM - EBSD**
- ❑ **Have rock /ore samples for EBSD**
- ❑ **Need an EBSD trainind (UFOP / UFMG / UNB)**
- ❑ **Need to pratice more EBSD**

REMARKS

EBSD PATERNSHIPS

- ❑ **RMIC (events, courses, trainne)**
- ❑ **Geology of UFPA (BIF/IOCG Carajás)**
- ❑ **Mechanical Engenering of UFPA (stainless steel welding)**
- ❑ **PTC Guamá (stainless steel welding)**
- ❑ **Chemitry of UFPA (gold jewelry alloys)**
- ❑ **IGAMA (gold jewelry alloys)**

Geological Survey of Brazil – CPRM

ACKNOWLEDGMENT

RMIC by invite to participate of this EBSD workshop



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