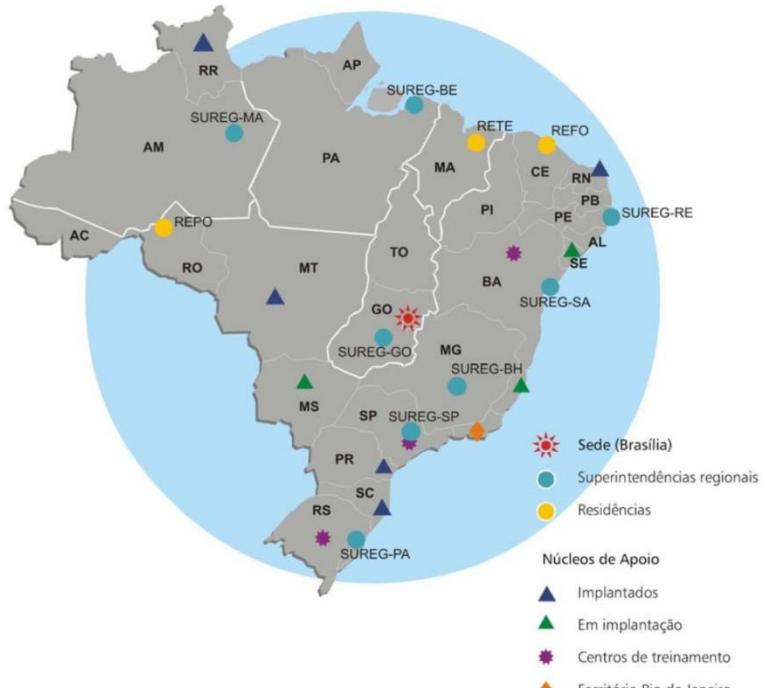


Geological Survey of Brazil – CPRM

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

Marcelo Vasquez

SEM LABORATORIES CPRM



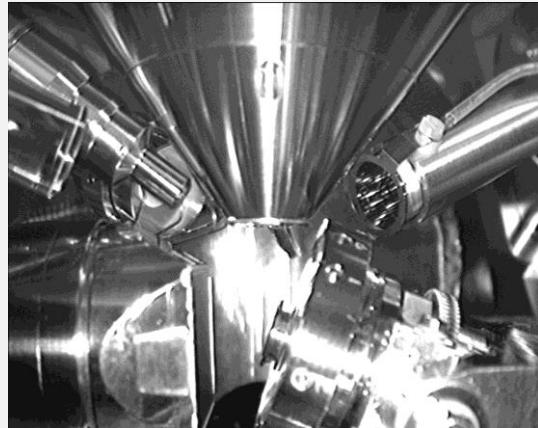
LAMIN-BE

**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/Griding/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**

- Consumables**

SiC paper

Gridding discs

Diamond suspesions

**Colloidal silica suspension
($0.2\mu\text{m}$, alkaline)**

Polishing cloths

Alumina podwer



EBSampleS

Metamorphic Rock Fabrics

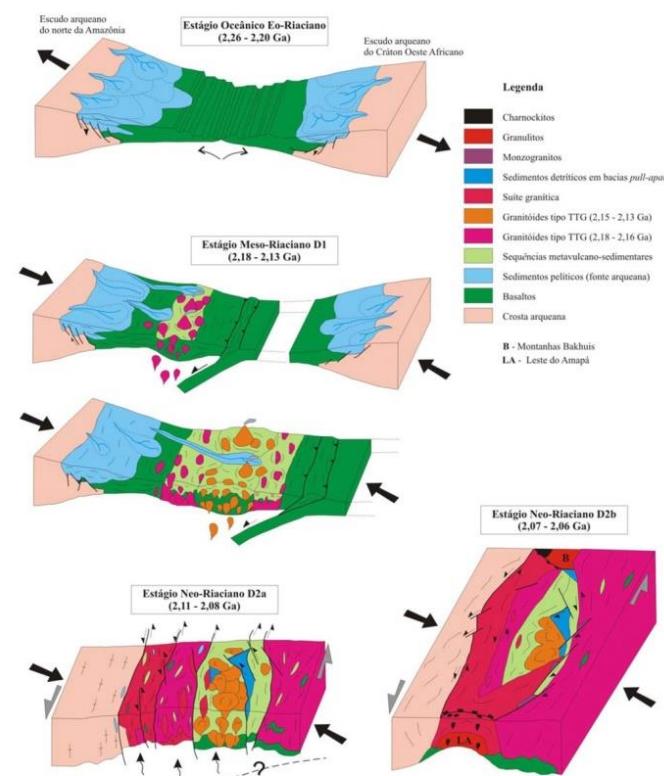
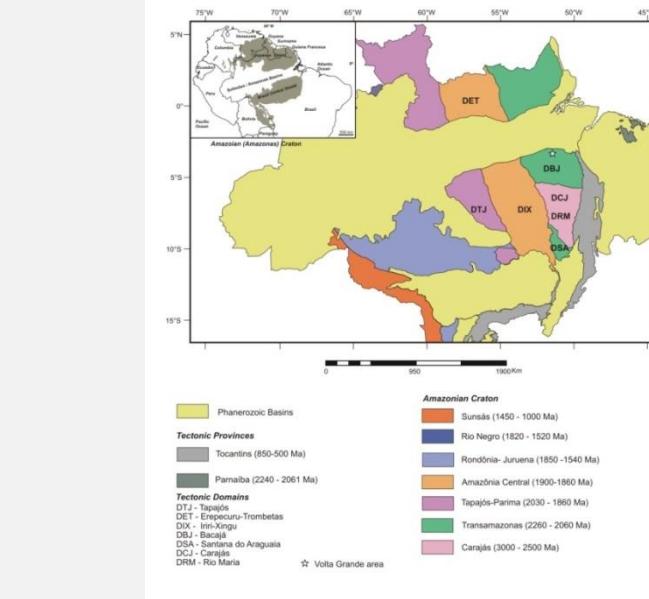
- Nematoblastic Amphibolite
- Granoblastic Metapyroxenite

Ore Fabrics

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

Bacajá Domain

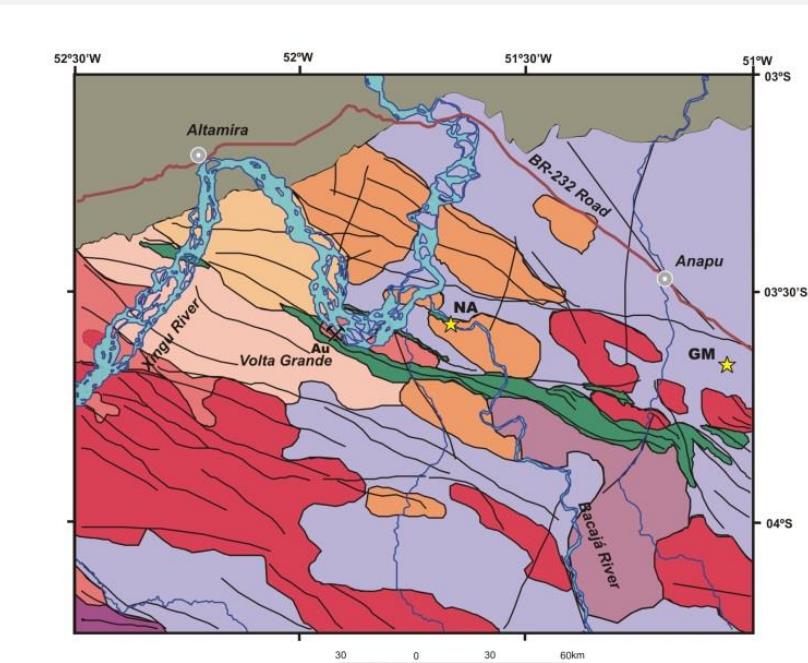
- 3.02-2.34 Ga embasement
- 2.36 Ga greenstone belt
- High grade metamorphism
 - 2.20 – 2.06 Ga events
 - Partial melting ($> 600^{\circ}\text{C}$)
 - UHT metamorphism (900-1050°C)
- 2.1 Ga collision of SAm/WAf plate
(continental collision)



(Delor et al. 2003 – GF 2-3-4)

Bacajá Domain

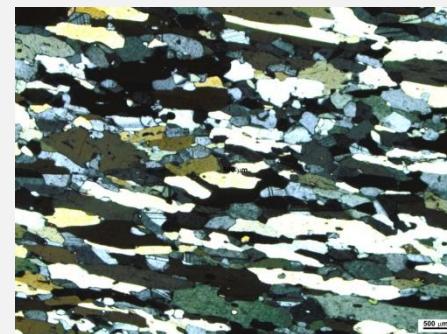
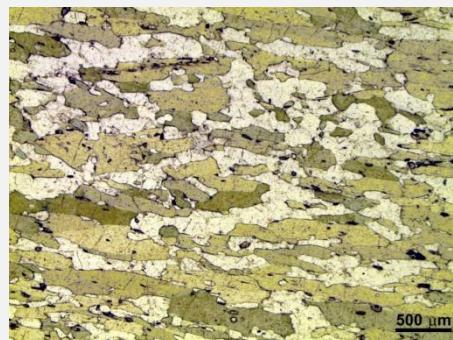
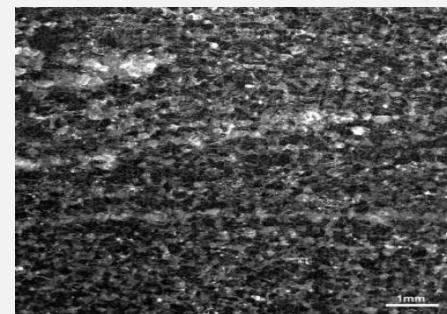
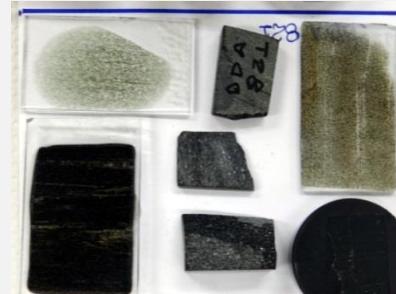
- **Volta Grande Area**
(Belo Monte hydroelectric plant, VG mine)
- **Nematoblastic Amphibolite**
(metamorphosed basalt – Pl+Px)
- **Granoblastic Metapyroxenite**
(metamorphosed pyroxenite - CPx)
- **Few minerals phases**
(igneous / metamorphic)
- **Metamorphic rock fabrics**
(oriented / not oriented)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



Geological sketch Volta Grande area

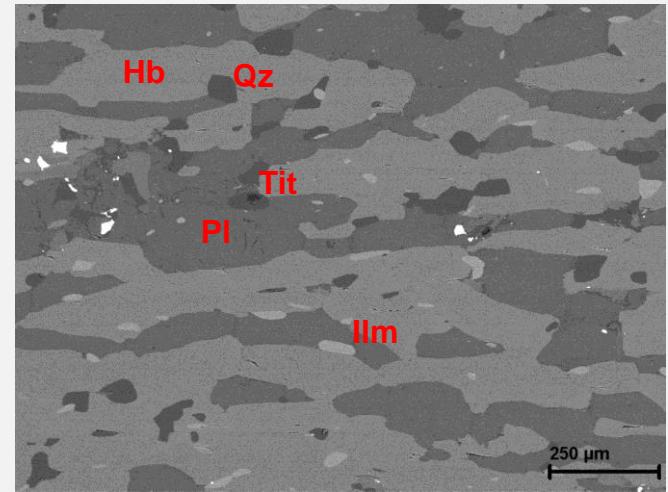
Nematoblastic Amphibolite

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



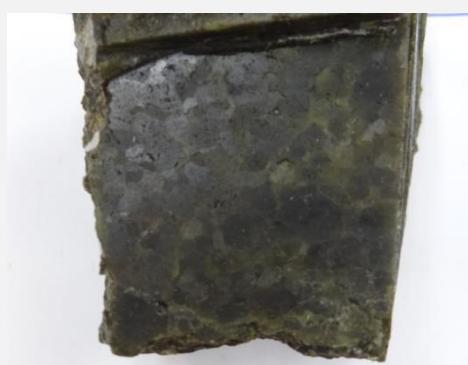
Nematoblastic Amphibolite

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



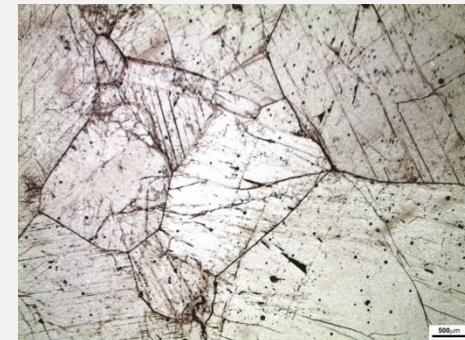
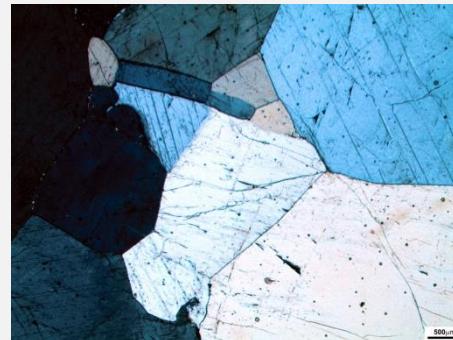
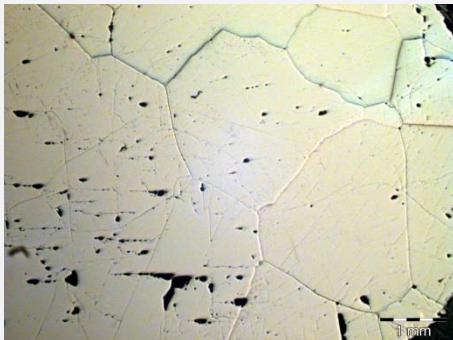
Granoblastic Metapyroxenite

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



***EBS**D TESTS*

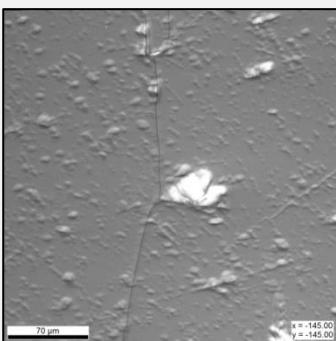
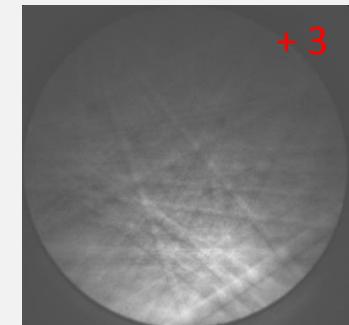
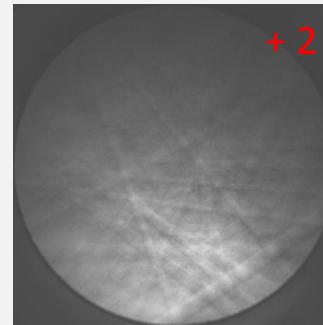
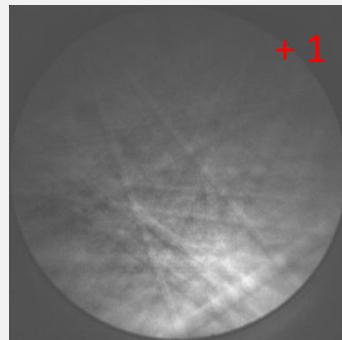
Granoblastic Metapyroxenite

August 2013



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

June 2015

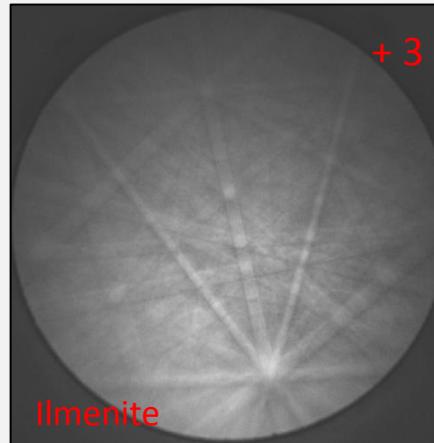
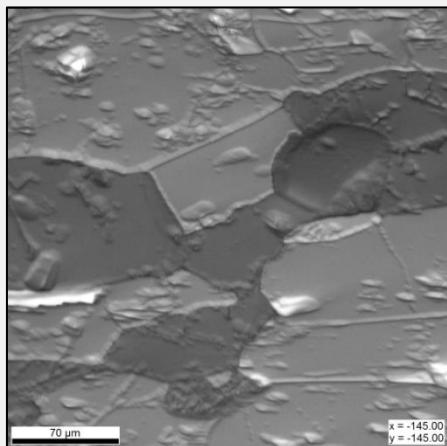
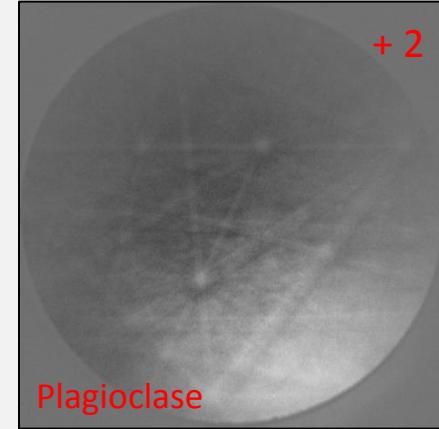
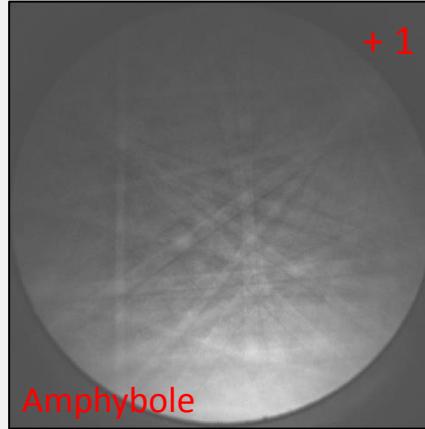
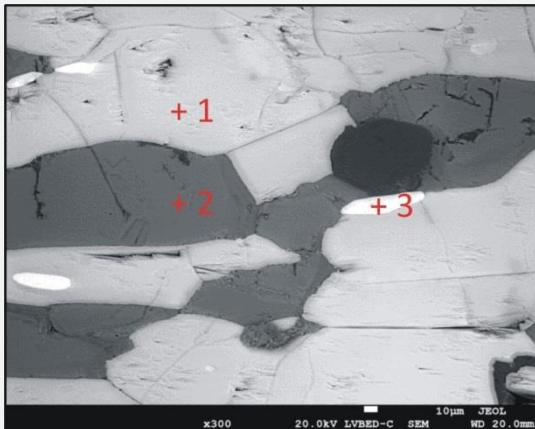


- Clinopyroxene**
- Ion beam polishing (1000µm)**
- Low vacuum mode (40Pa) / 20Kv**

EBSD TESTS

Nematoblastic Amphibolite

June 2015



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

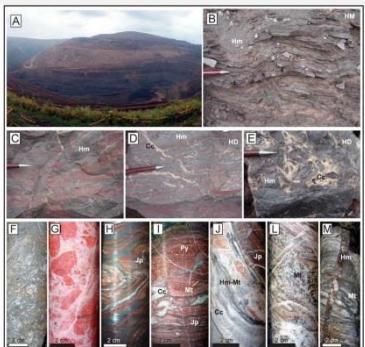
Carajás Domain

- 2,78-2.76 Ga volcanism (Carajás basin)

- Iron deposits (BIF / IOCG)

- BIF (N4E mine)

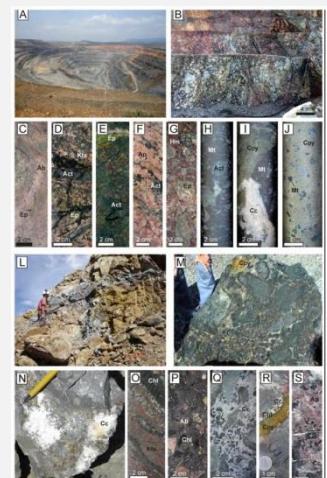
- Fe oxides
- Quartz
- Carbonates



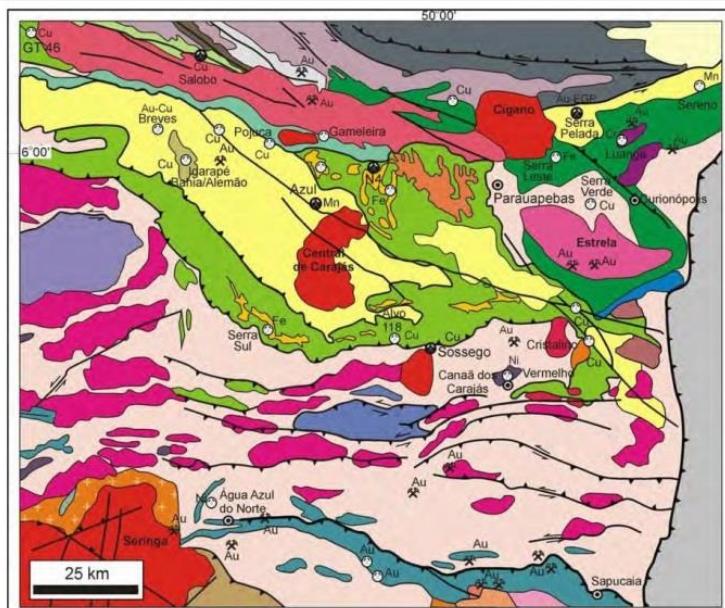
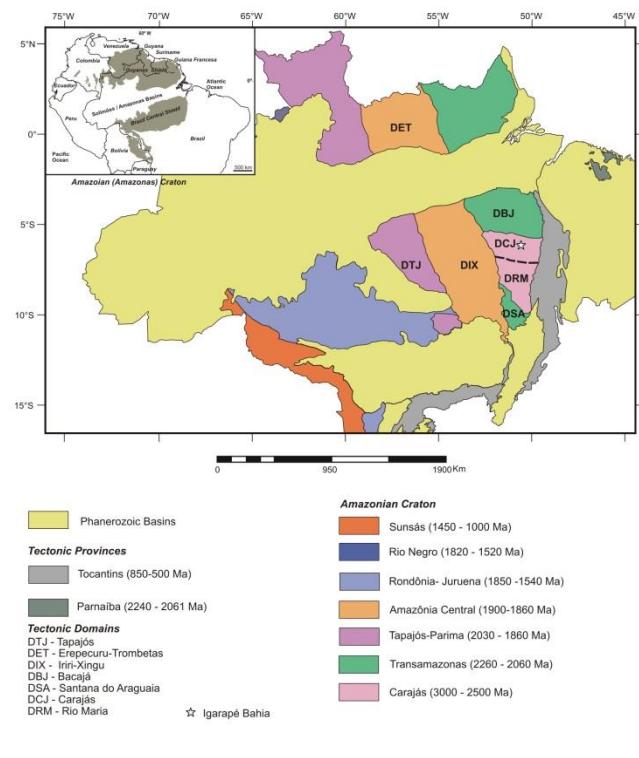
- IOCG (Sossego mine)

(Igarape Bahia deposit)

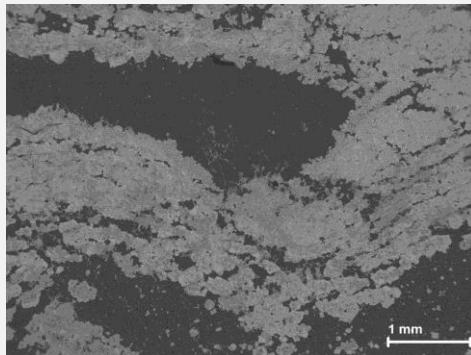
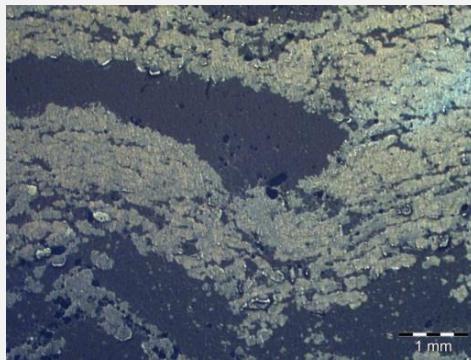
- Fe oxides
- Cu sulphides
- Cu carbonates-OH
- Cu native
- Au



(Monteiro et al. 2014 – PMB)



BIF samples

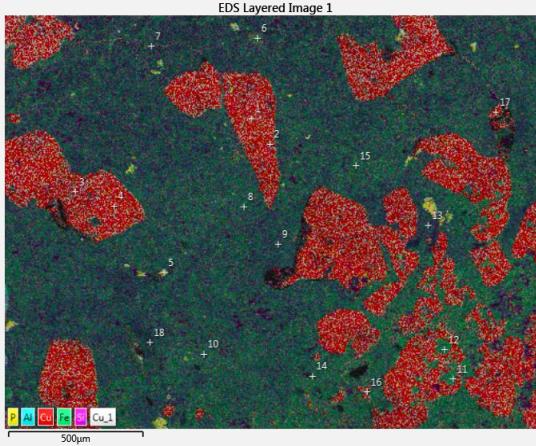
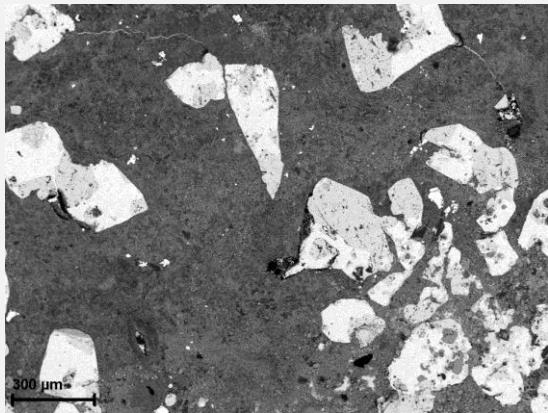


- PO hematite/magnetite
- BIF structural control
- Fe enrichment process

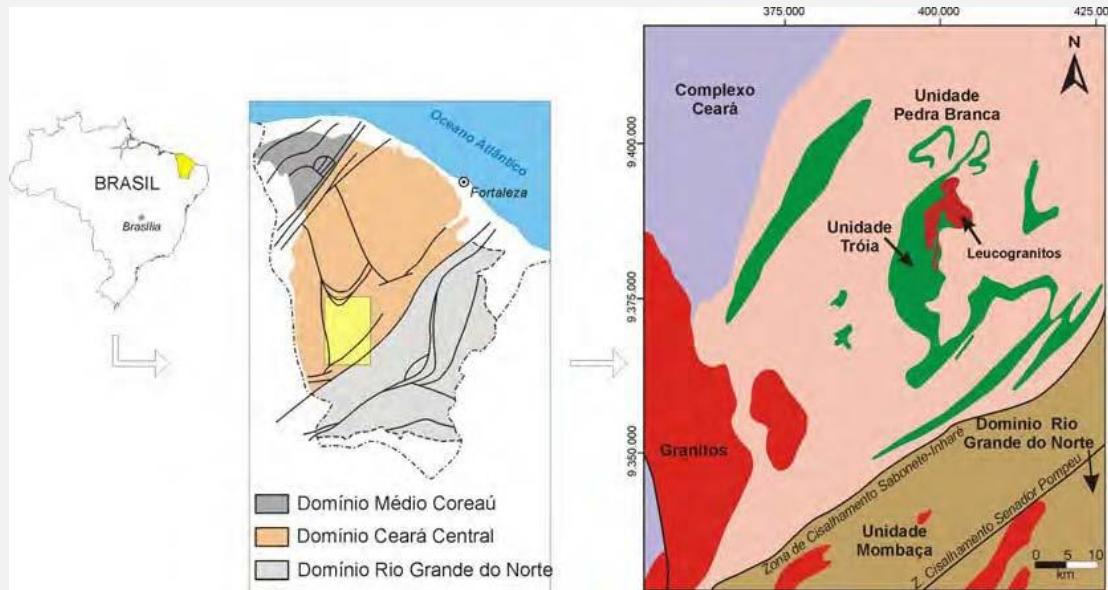
IOCG sample



- 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)

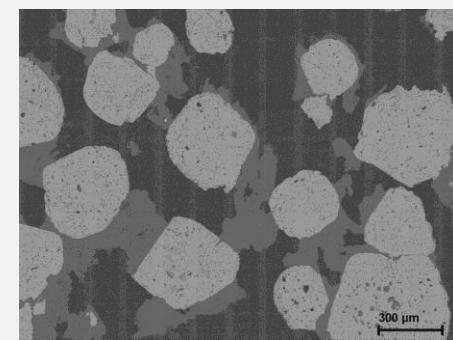
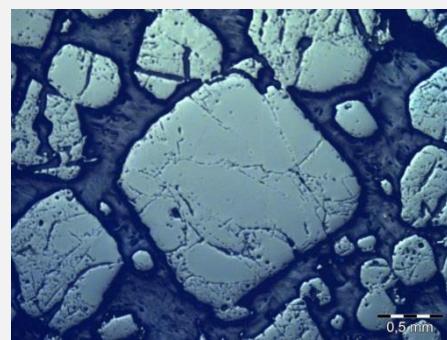
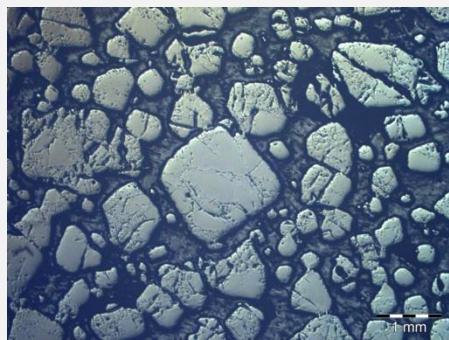
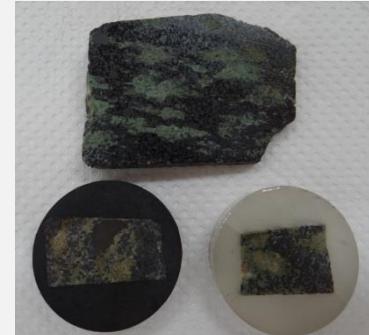
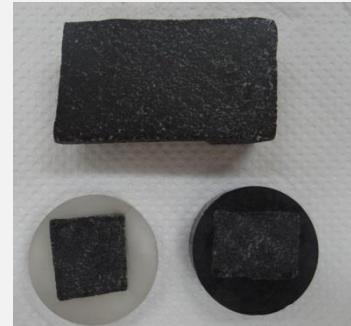


□ Metagabbro



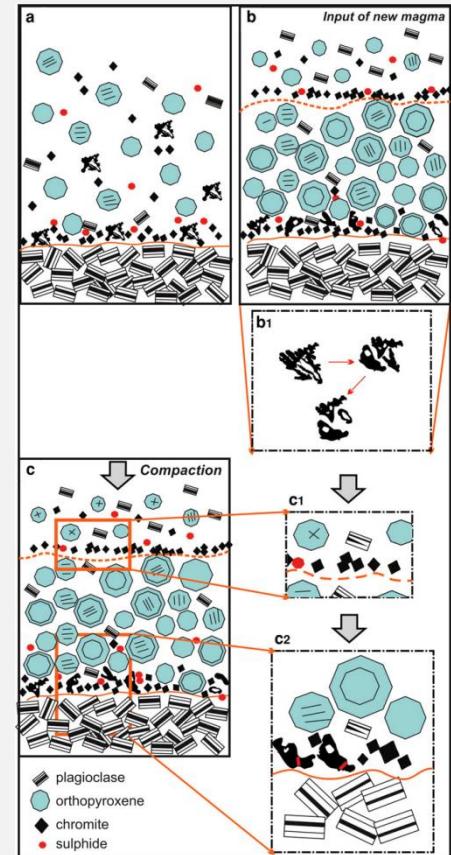
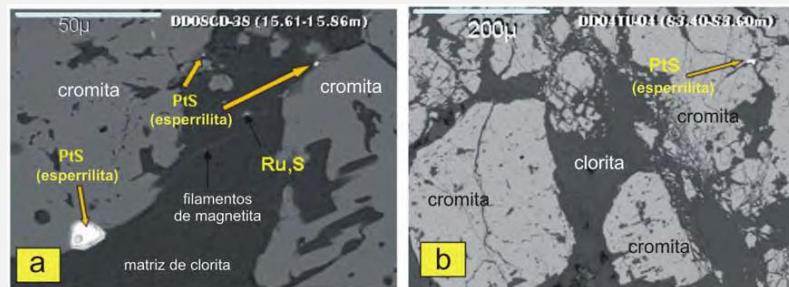
□ Chromitite layer

Cr-PGE Sample



EBSD Chromitites

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



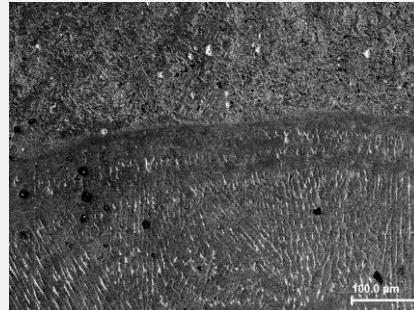
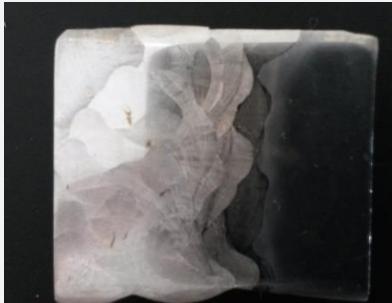
(Vukmanovic et al. 2013 - CMP 165)

PATERNSHIPS

UFPA

□ Mechanical Engeneering (stainless steel welding)

(Aguiar et al. 2015 - RM 20)



REVISTAMATÉRIA
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Microstructure characterization of a duplex stainless steel weld by electron backscattering diffraction and orientation imaging microscopy techniques

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modena@matemat.ufmg.br

ABSTRACT
This paper describes the electron backscatterer diffraction (EBSD) technique used to characterize the microstructure (especially the morphology and constitution) of the base metal (BM), the heat-affected zone (HAZ) and the fusion zone (FZ) of lean duplex stainless steel (LDS). This technique provides advantages due to its ability to obtain quantitative information about the microstructure and phase transformations induced by traditional characterization techniques such as optical microscopy (OM), scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS). The use of EBSD in conjunction with orientation imaging microscopy (OIM) as a tool to understand phase transformation paths and ferrite-austenite variant selection was discussed. Vickers microhardness measurements were performed and no significant difference between the different regions was observed. The results showed that the use of EBSD in conjunction with OIM can detect significant changes on the crystallographic texture of the samples after welding. The advantages of using SEM together with EBSD for microstructure analyzing and texture development were also discussed.

Key-words: Duplex stainless steel, welding, texture, EBSD, OIM

PCT GUAMÁ (<http://www.pctguama.org.br/>)
Science and Tecnology 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 Engenerating of UFPA** (stainless steel welding)
- PTC Guamá** (stainless steel welding)
- Chemtry of UFPA** (gold jewelry alloys)
- IGAMA** (gold jewelry alloys)

Geological Survey of Brazil – CPRM

ACKNOWLEDGMENT

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