4° SIMEXMIN

Ouro Preto - 26 de maio de 2010

Maciços Básico-Ultrabásicos: Potencial e Principais Depósitos de Níquel Sulfetado e Lateríticos no Brasil

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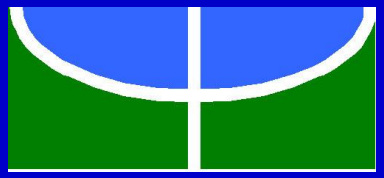
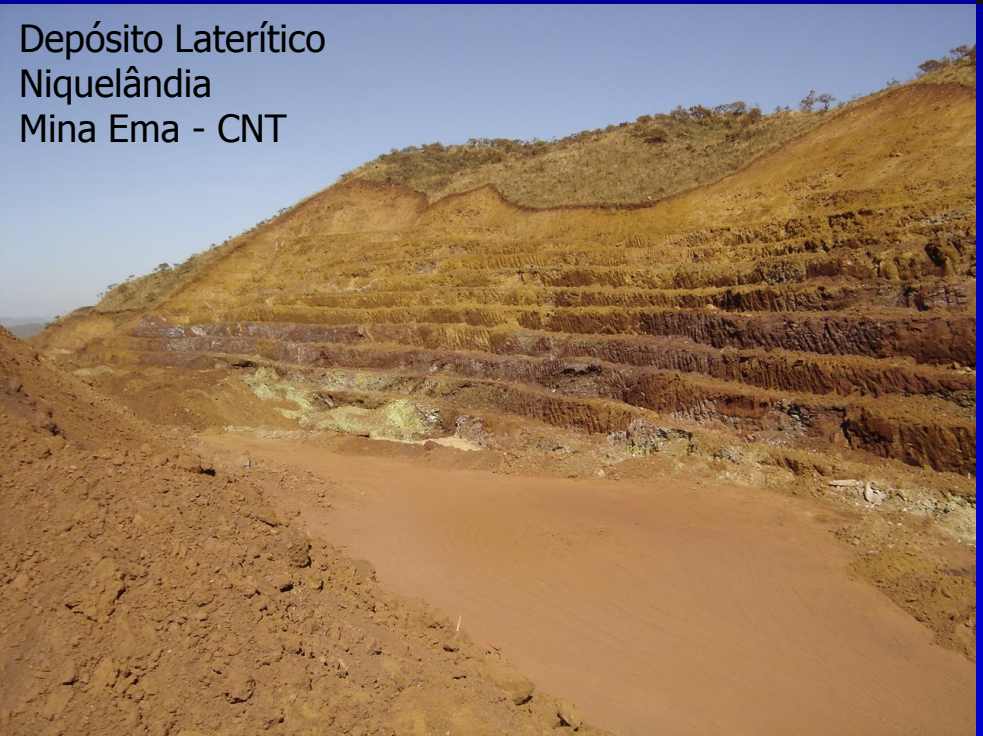


Outline
Overview of Ni in Brazil

- Ni deposits and resources in Brazil.
- Exploration for Ni in Brazil (laterite vs sulfide).
- Key characteristics of the Santa Rita Ni sulfide deposit. Highlight unusual features that challenge traditional concepts.

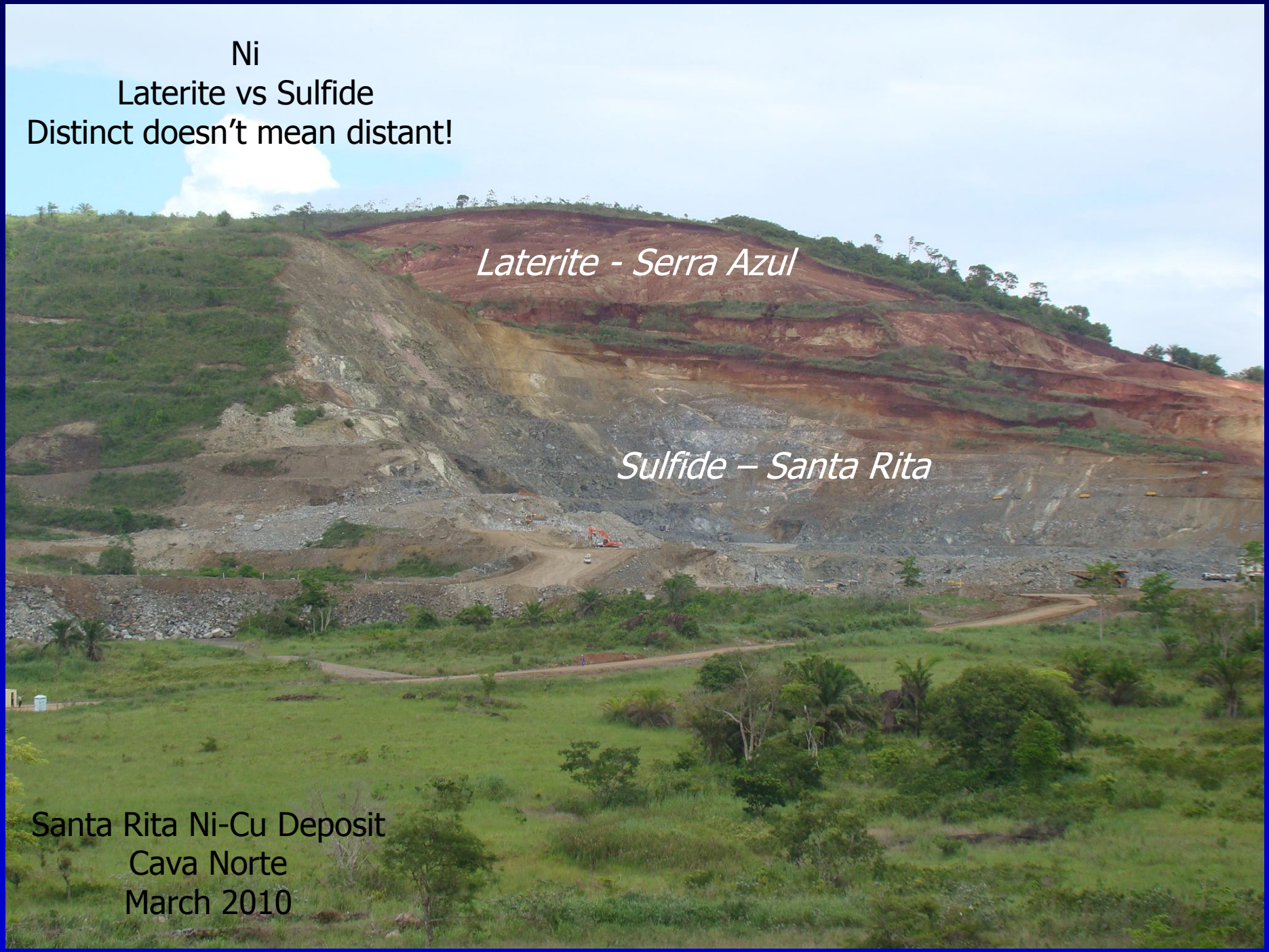
Ni deposits
Two distinct types
Laterite / Sulfide


Depósito Sulfetado
Americano do Brasil
Corpo S2


Depósito Laterítico
Niquelândia
Mina Ema - CNT

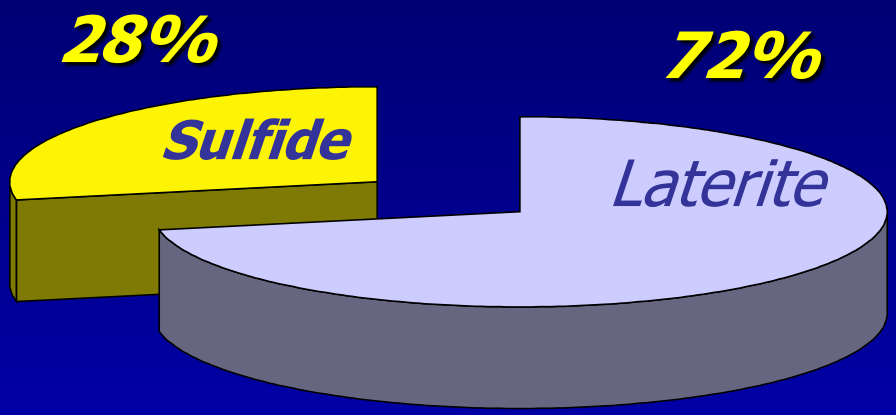
What's different?

- Metallogenesis
- Exploration
- Ore
- Processing
- Economics

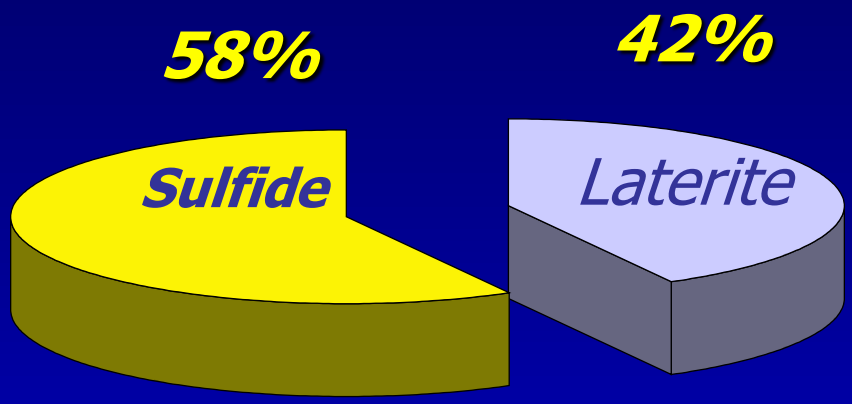

Ni
Laterite vs Sulfide
Distinct doesn't mean distant!
Laterite - Serra Azul
Sulfide – Santa Rita
Santa Rita Ni-Cu Deposit
Cava Norte
March 2010

Laterite / Sulfide

World Ni Resources



Primary Ni Production

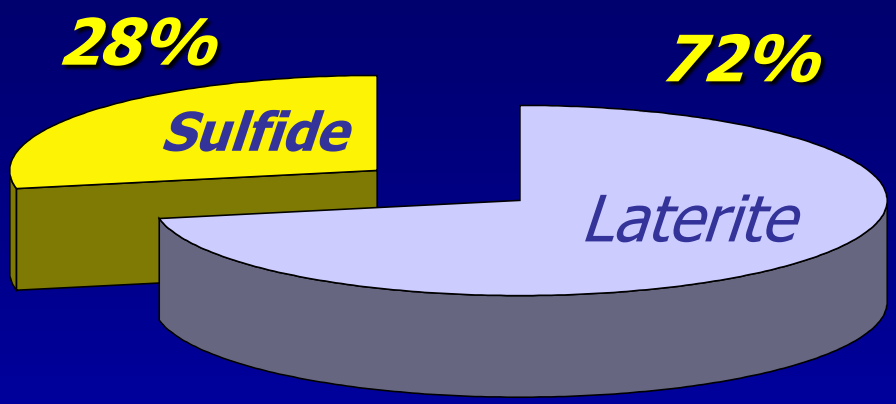


World Production (2009)	**~ 1300 kt Ni/year**
	~ 1.3 Mt Ni/year

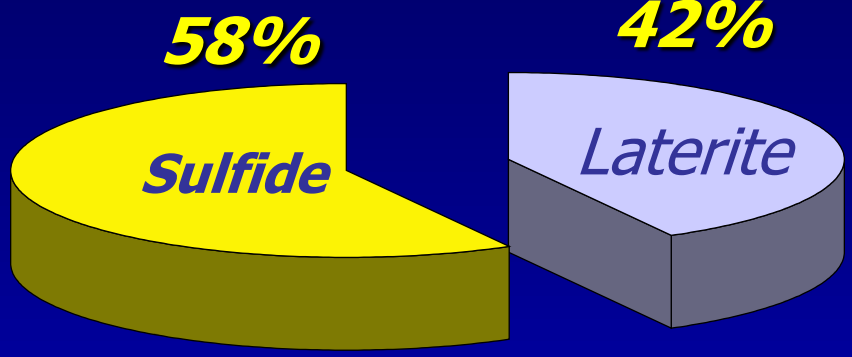
Several large-scale Ni laterite projects are being developed worldwide.
Expected in near future: Ni production from laterites > production from sulfides.

Laterite / Sulfide

World Ni Resources



Primary Ni Production



World Mining Production (2009)	~ 1300 kt Ni / year
Brazil Production (2009) (ca 3 %) (CNT. Codemin, Fortaleza de Minas, Americano)	38 kt Ni / year
Potential production by 2012 %) (Onça-Puma, Barro Alto, Santa Rita)	~ 150 kt Ni / year (> 10

Known/Potential Deposits/Districts Room to increase

Source: INSG World Nickel Statistics, 2009

Nickel
Deposits / Resources

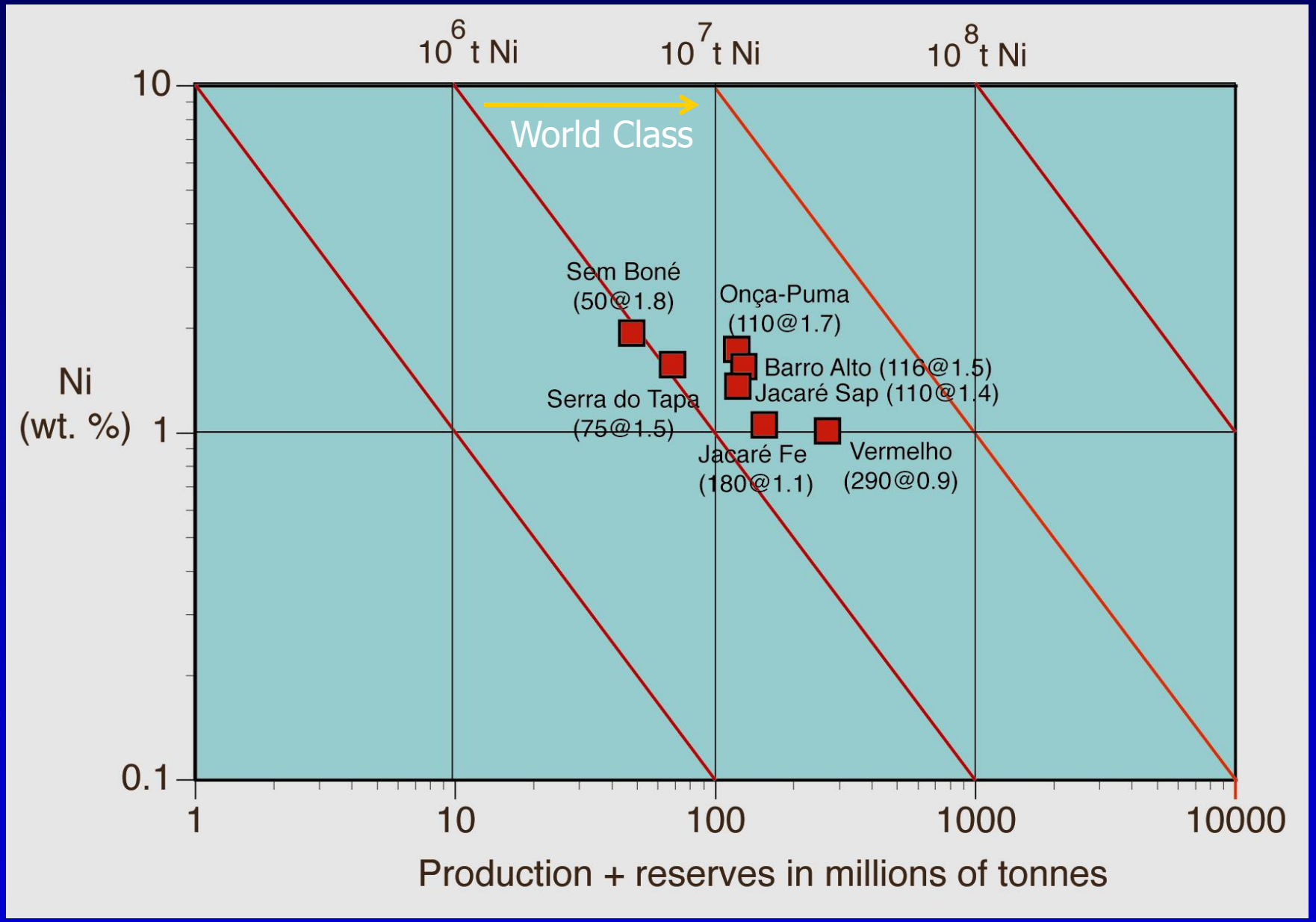
Lateritic nickel is the dominant resource (> 95 %).

Some geological settings contain both lateritic and sulfide nickel resources.

Several Ni Provinces
(specific geological setting)

- *Carajás*
- *Araguaia Belt*
- *Niquelândia-Barro Alto*
- *SW Goiás*
- *Aguapeí Belt*
- *Itabuna Salvador*

Examples of Ni laterite deposits / resources



Produção de Ni laterítico no Brasil e Projetos em Implantação

(May 2008 – crisis impact)

Planta/Projeto	UF	Ambiente Metalogenético	Processo	Produto	Capacidade	Início	Duração/Término
Morro do Níquel	MG	Greenstone Belt (2.9 Ga)	Pirometalurgia	Fe-Ni	2.5 Kt	1962	1998
CNT - Votorantim	GO	Intrusão M-UM (0.8 Ga)	Caron	Ni, Co	23 Kt	1981	
Codemin - Anglo American	GO	Intrusão M-UM (0.8 Ga)	Pirometalurgia	Fe-Ni	10 Kt	1982	
Onça-Puma	PA	Intrusão M-UM (2.7 Ga?)	Pirometalurgia	Fe-Ni	58 Kt	2008	36 anos
Barro Alto	GO	Intrusão M-UM (0.8 Ga)	Pirometalurgia	Fe-Ni	36 Kt	2009	
CNT - Votorantim	GO	Intrusão M-UM (0.8 Ga)	Pirometalurgia	Fe-Ni	10 Kt	2009	36 anos
Vermelho	PA	Intrusão M-UM (2.7 Ga?)	HPAL	Ni, Co	56 Kt	??	40 anos

Ultramafic bodies associated with Ni laterite deposits

• Ni laterite deposits are formed from weathering of distinct types of ultramafic rocks. They are not related to specific petro-tectonic settings.

• Ni laterite deposits demand an appropriate extension/volume of Ni-rich ultramafic rock (dunite/peridotite/komatiite) submitted to appropriate weathering process.

Petro-teconic association	Examples
Komatiites	Western Australia (Murrin Murrin) Morro do Níquel (MG)
Mantle Peridotite	New Caledonia, Cuba, Venezuela Serra do Tapa
Alkaline intrusions	SW de GO (Montes Claros, Água Branca, Santa Fé).
Layered intrusions	Niquelândia, Barro Alto, Vermelho, Onça-Puma, Jacaré, Brejo Seco

Nickel
Laterite

Lateritic nickel is the dominant resource (> 95 %).

Different geological setting:

- *Distinct districts*
- *Distinct MUM bodies within the same district*
- *Distinct ore types (and processes) within the same district and MUM body.*

- *Carajás*
- *Araguaia Belt*
- *Niquelândia-Barro Alto*
- *SW Goiás*
- *Aguapeí Belt*

Potential for Ni Laterite Deposits in Brazil

- Production of Ni from laterites will significantly increase in Brazil.

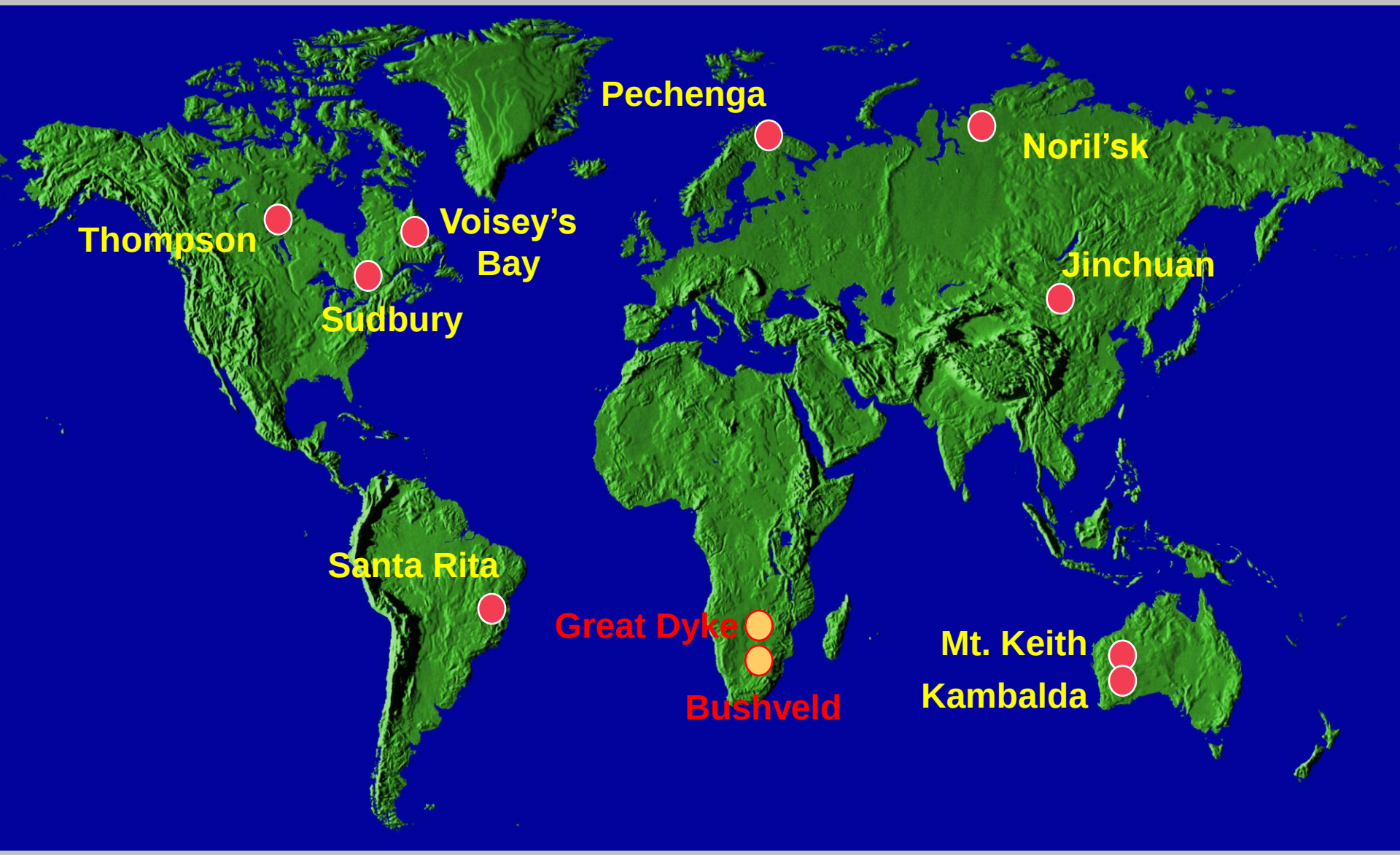
- New projects are being developed on re-evaluated known resources.
Barro Alto (40's, mining started in 2005, smelter planned for 2011)
Onça-Puma (1969, production planned for 2010)
Vermelho (1974, feasibility completed in 2005)
Niquelândia Fe-Ni (40's, Caron Plant since 1981, Fe-Ni planned originally for 2009).

- Several significant undeveloped resources (Serra do Tapa, SW de GO, Morro Sem Boné, among others)

- Potential for BRAND new discoveries are low (e.g. unknown ultramafic bodies). Potential targets are easily recognized (geology and/or aeromag).

- Significant increase in Ni resources are not expected to come from new discoveries of Ni laterite deposits.

Main Ni Sulfide Deposits



- Santa Rita is the first large Ni-sulfide deposit in South America
- Bushveld (PR e MR) and Great Dyke (MSZ) – Ni is a byproduct of PGE

Nickel Sulfide Deposits / Resources

- *Few small deposits*

Except for Santa Rita 121Mt@0.6%Ni

- *Variable ages (Precambrian) and petro-tectonic setting.*

- *The abundance of "fertile" MUM magmatism and low exploration maturity in many areas indicates a high potential for exploration.*

- *Where?*

- *Any "fertile" MUM association where a new concept and/or new exploration strategy can be applied.*

Brazilian Ni-Cu-PGE sulfide deposits.

(Ferreira Filho, C.F. 2010 – IPS – Sudbury)

Brazilian Ni-Cu-PGE sulfide deposits are reviewed and classified in four types:

(i)komatiite-associated Ni-Cu sulfide deposits

(i) stratiform-strababound Ni-Cu sulfide deposits in layered intrusions

(iii) Ni-Cu sulfide deposits in synorogenic intrusions

(iv) stratiform/stratabound PGE-Ni deposits.

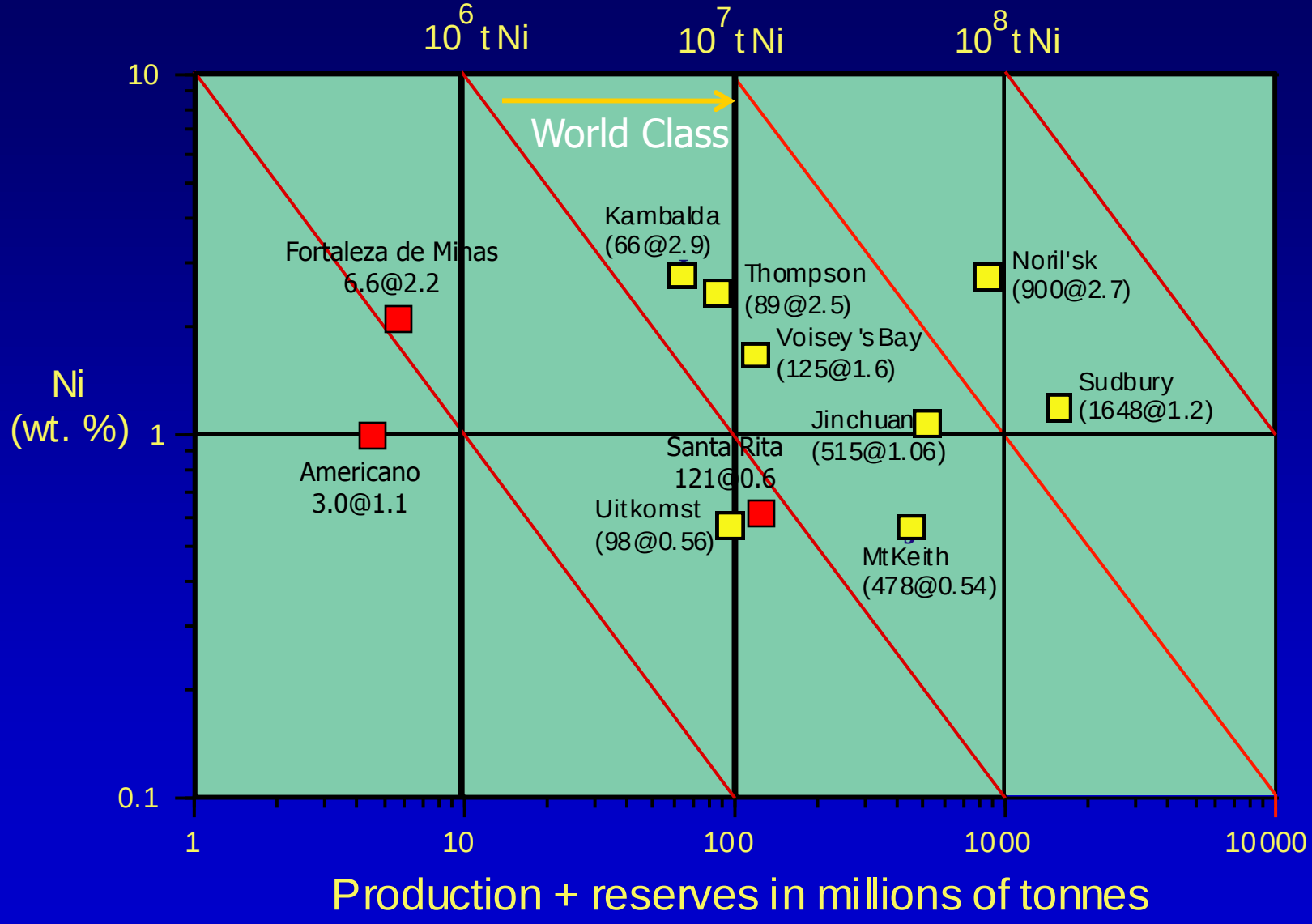
This review indicates that some Brazilian deposits have characteristics that are different from Ni-Cu-PGE deposits described elsewhere, suggesting different geological and petrological constraints on their origin.

One of them will be considered in this presentation.

Brazilian Ni-Cu-PGE sulfide deposits.

	Deposit		Age (Ga)	Petro-Tectonic Setting	Magma Type	Resources
komatiite-associated Ni-Cu sulfide deposits	Fortaleza de Minas	Ni-Cu	2.9	greenstone belt	?	6Mt@2.5%Ni, 0.4%Cu, 0.7g/t Pt+Pd+Au
	Boa Vista	Ni	2.9	greenstone belt	ADK	na
stratiform/stratabound PGE-Ni deposits	Luanga	PGE-Ni	2.7	MUM layered intrusion	TH	na
stratiform-strababound Ni-Cu sulfide deposits in layered intrusions	Santa Rita	Ni-Cu	2.1	MUM layered intrusion	TH	121Mt@0.6%Ni, 0.16%Cu
	Niquelândia	Ni-PGE	0.8	MUM layered intrusion	High MgO TH	na
Ni-Cu sulfide deposits in synorogenic intrusions	Americano do Brasil	Ni-Cu	0.6	synorogenic MUM intrusion	TH	3Mt@1.1%Ni, 1.0%Cu

Ni sulfide Deposits in Brazil



Santa Rita Ni-Cu sulfide deposit

(www.mirabela.com.au)

Key aspects:

The largest example of stratiform Ni-Cu-dominant sulfide mineralization hosted within the interior of a layered intrusion (121Mt@0.6Ni - potential for significant increase considering deep resources)

It is in fact the only mined deposit of this type (worldwide).

The deposit occurs in the medium-size (ca 8 km^2) mafic-ultramafic Fazenda Mirabela intrusion (Abram 1993), which consists of a continuously fractionated sequence of dunite, orthopyroxenite, websterite and gabbronorite.

The stratiform-stratabound disseminated sulfide (Pn-Py-Po-Cpy) mineralization occurs mainly in olivine pyroxenite and pyroxenite located in the transition from dunite in the footwall to gabbronorite in the hangingwall.

The deposit is characterized by the lateral continuity of the mineralization (ca 2 km), the great thickness of disseminated sulfides (ca 200 meters), the high nickel tenor of sulfides (ca 16-18 wt.%) and variable Ni/Cu ratios (average 3-4).

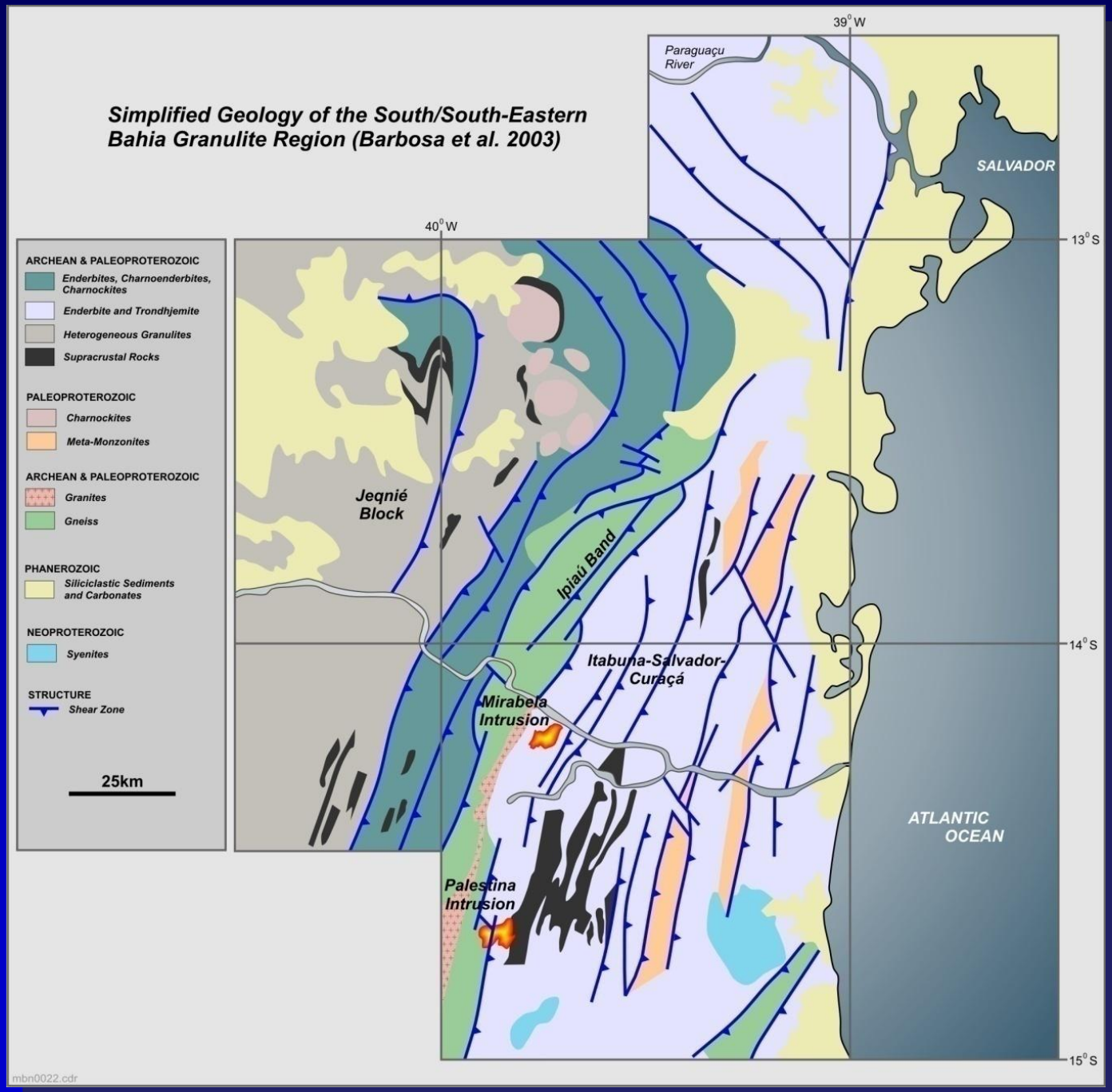
An integrated geological-petrological model for the origin of this unusual (unique) deposit is not yet available.

Santa Rita Ni-Cu Deposit
Cava Norte
March 2010

The only example of stratiform/stratabound Ni-Cu sulfide deposit hosted within the interior of a layered intrusion.

Geological Setting

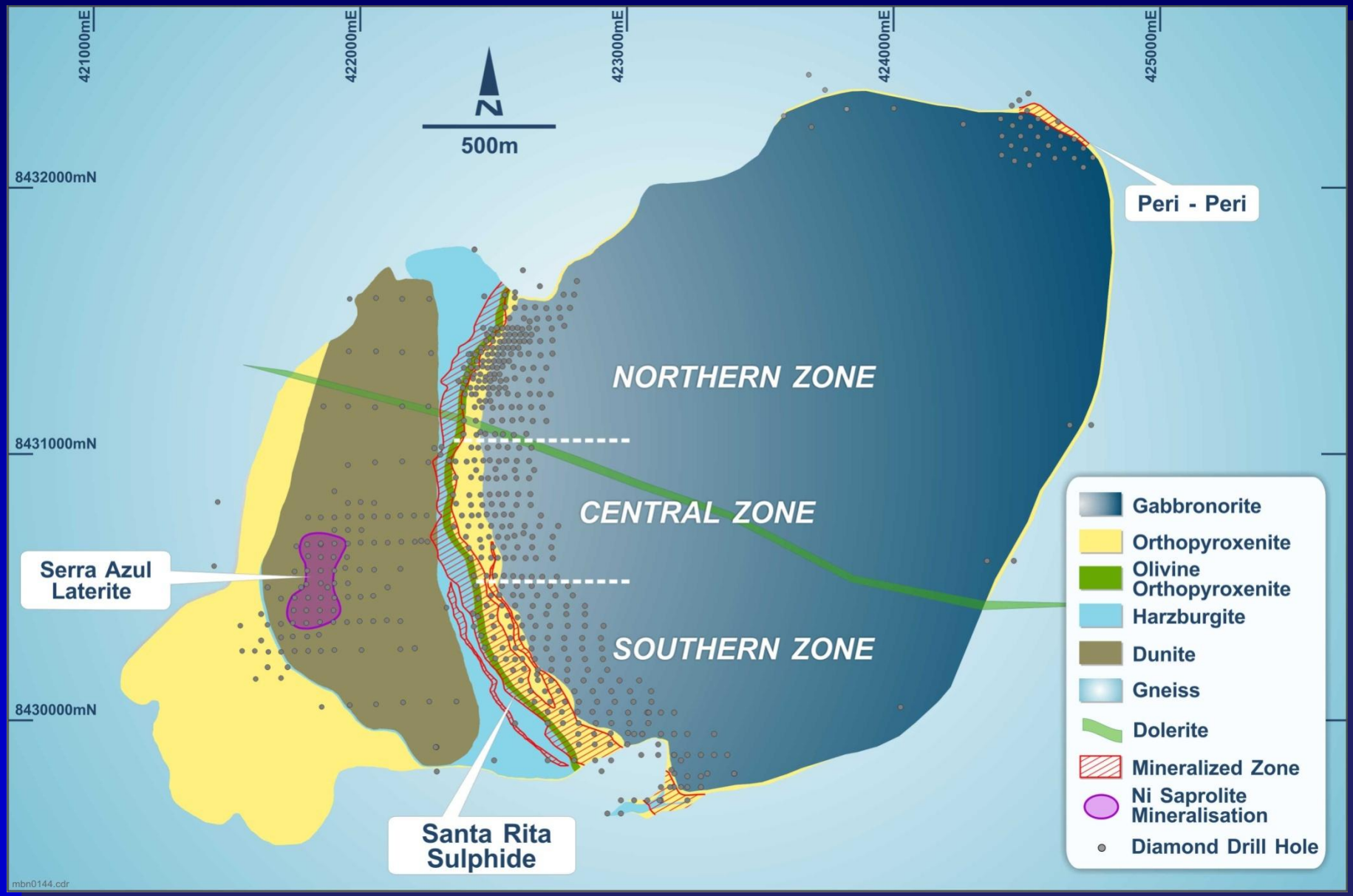
- Several mafic and mafic-ultramafic intrusions located close to the contact between the Itabuna-Salvador-Curaçá Orogen and the Jequié Block.
- The Fazenda Mirabela intrusion is considered to be emplaced during (or shortly after) the collision of these blocks during the ca 2.0-2.1Ga TransAmazonian Orogeny (Barbosa et al. 2003).
- Geochronological studies (zircon U-Pb LA-ICPMS) of layered intrusions (Mirabela and Palestina) and host rocks are being developed (Fausto Lazarin M.Sc – UnB).



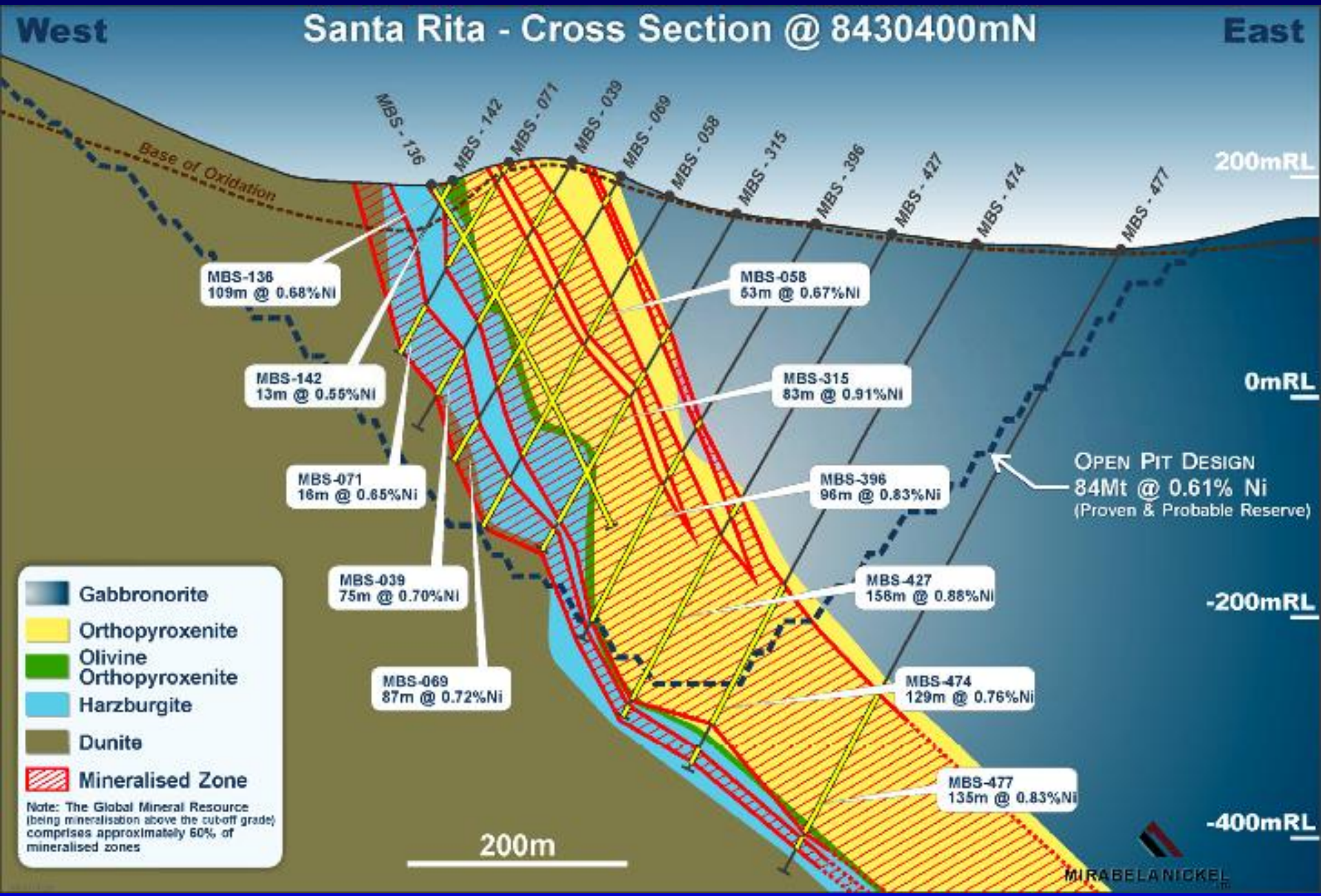
Santa Rita Ni-Cu Deposit

(www.mirabela.com.au)

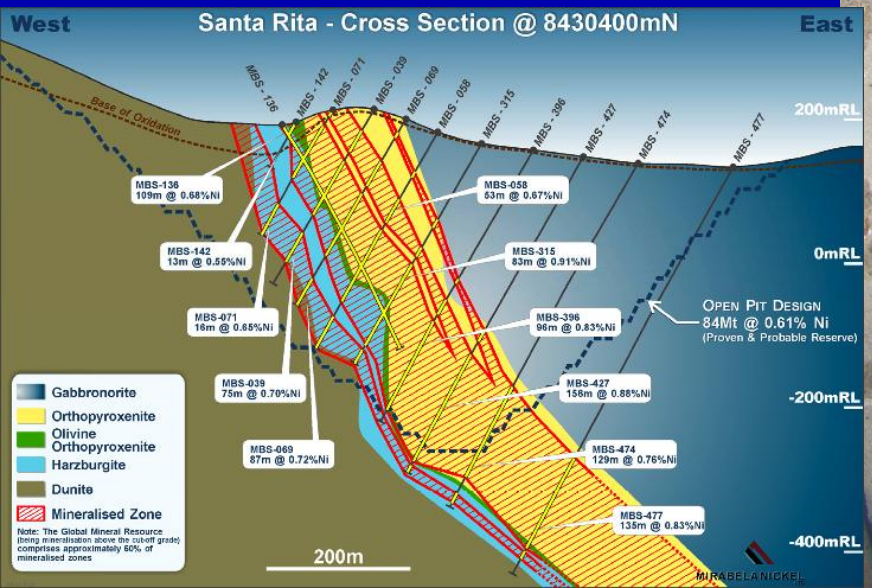
The stratiform/stratabound mineralization in the transition from dunite in the footwall to gabbronorite in the hangingwall.

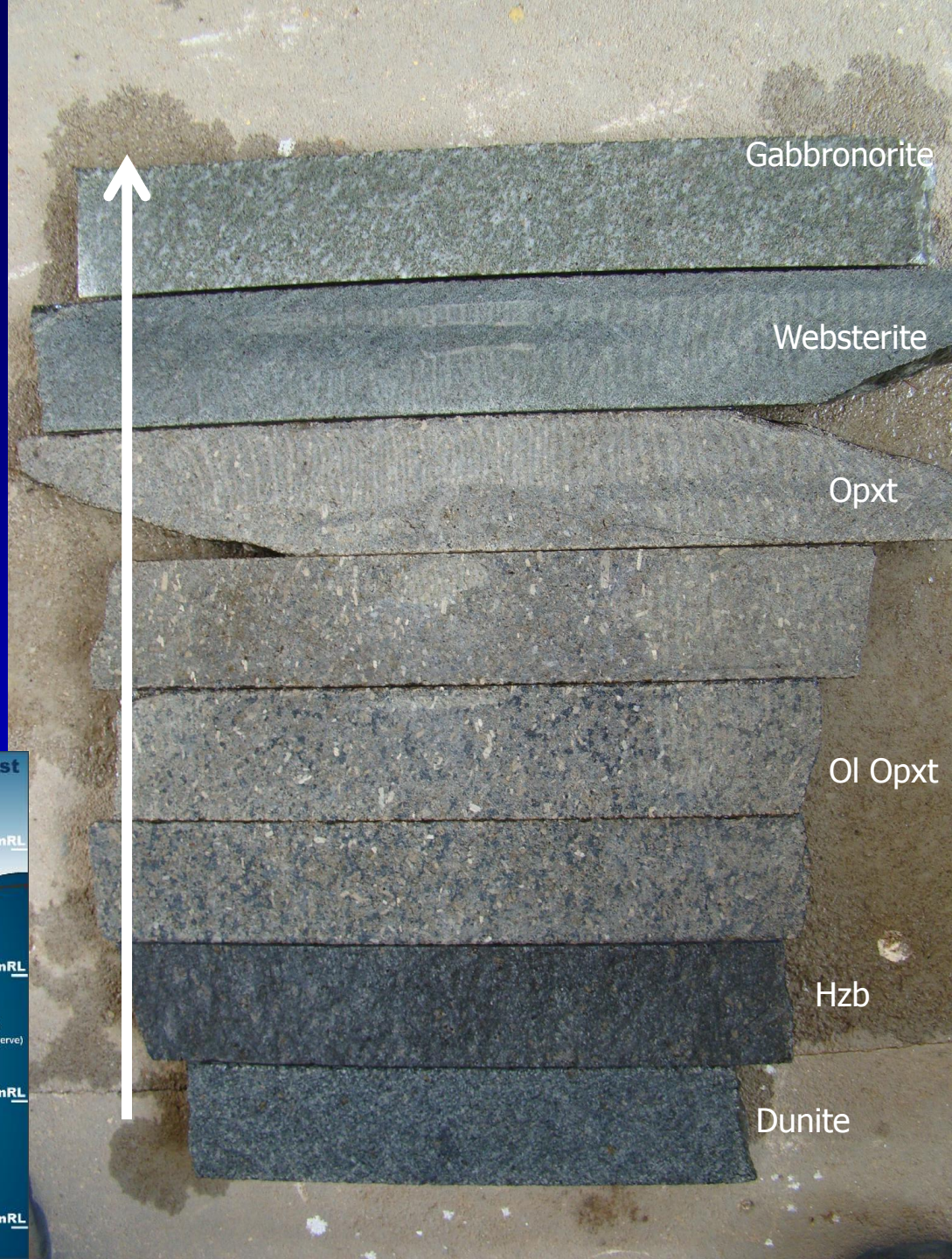


Disseminated sulfides (Pn-Py-Po-Cpy) occur mainly in harzburgite, olivine opxt and opxt.

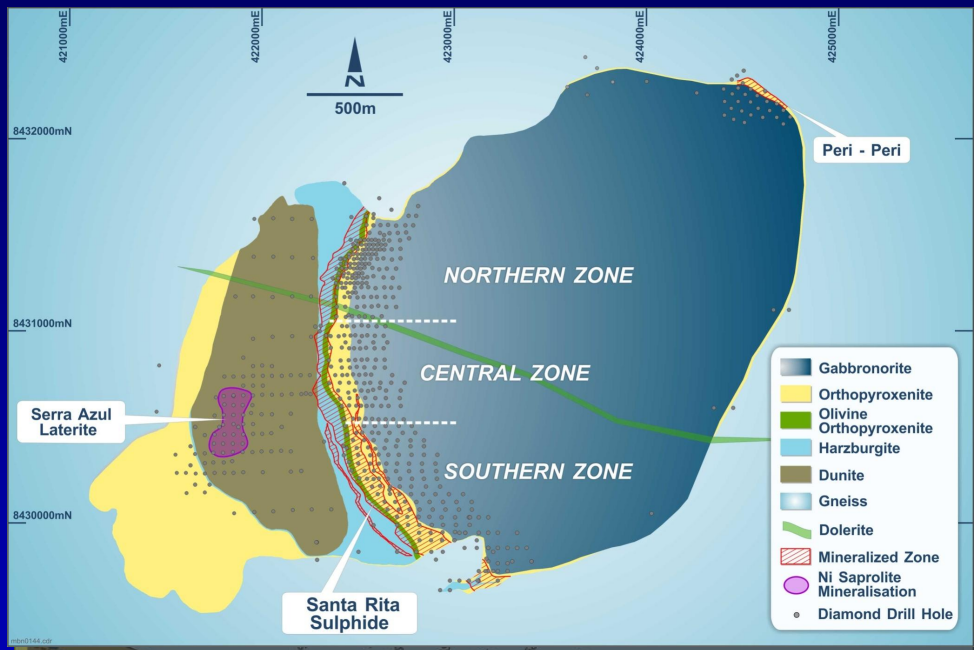


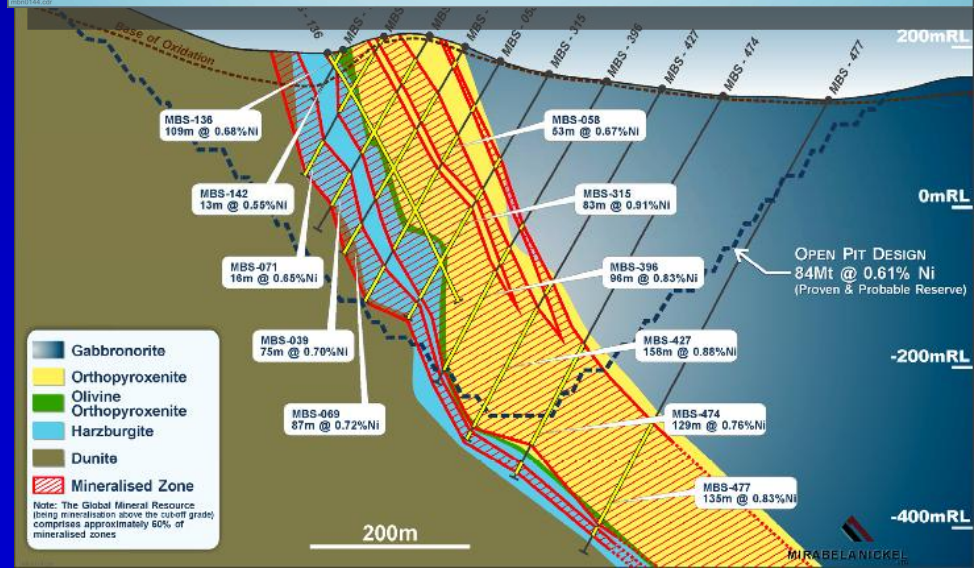
The mafic-ultramafic Fazenda Mirabela intrusion consists of a continuously fractionated sequence of dunite, olivine opxt, opxt websterite and gabbronorite.





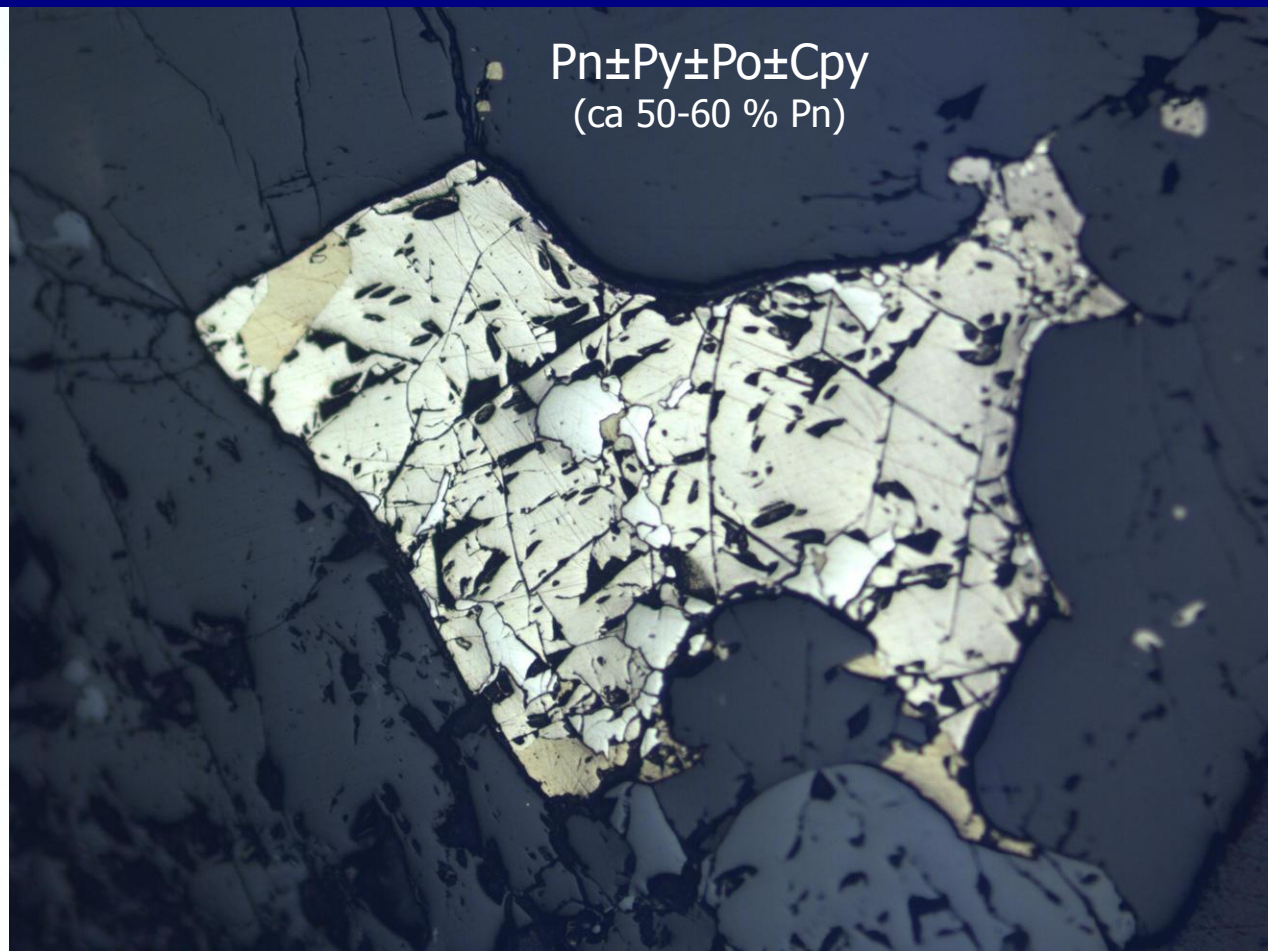
The Santa Rita deposit is characterized by the lateral continuity of the mineralization (ca 2 km) and the great thickness of disseminated sulfides (ca 200 meters).



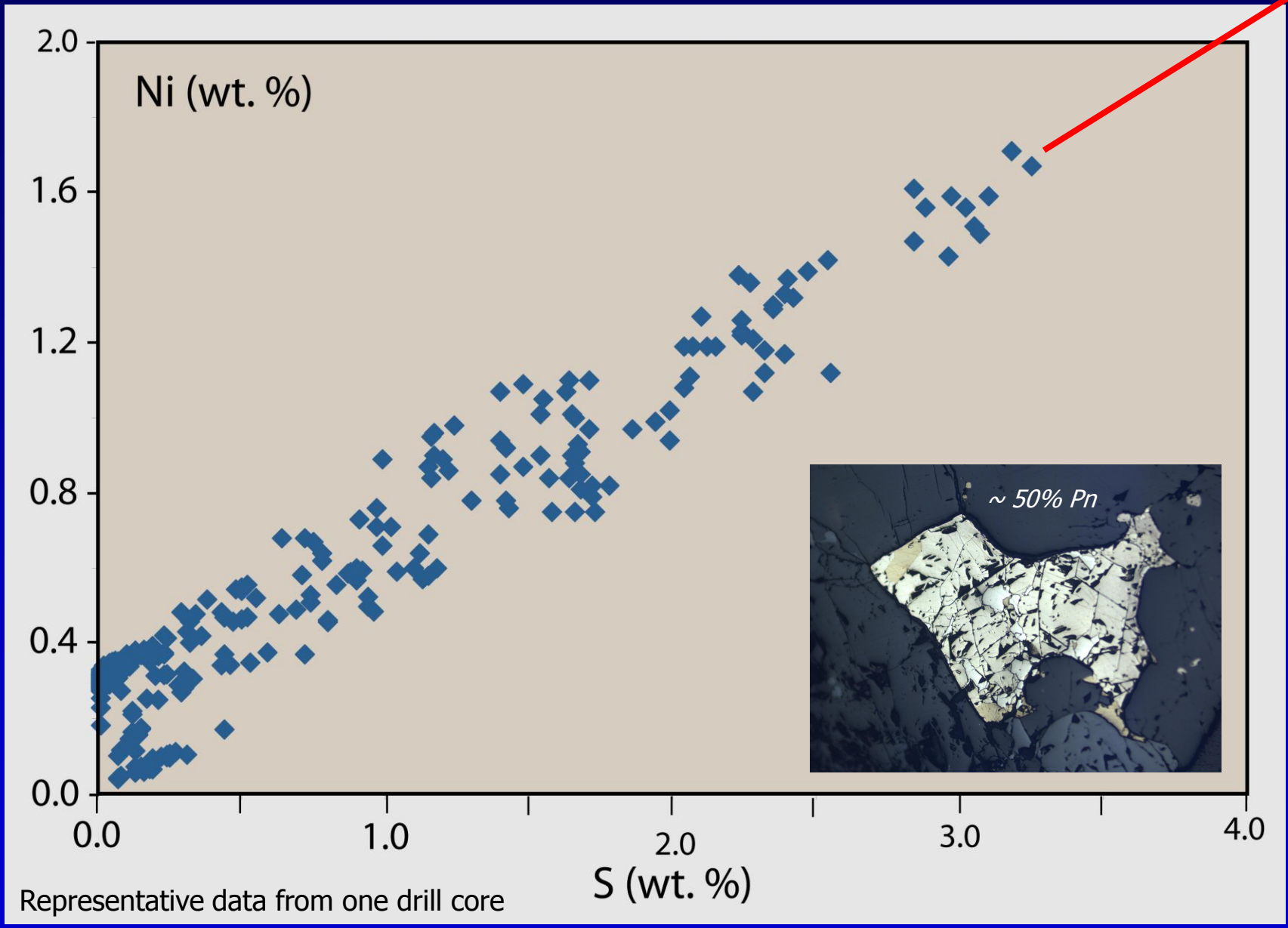


The Santa Rita deposit is characterized by the lateral continuity of the mineralization (ca 2 km) and the great thickness (ca 200 meters) of disseminated sulfides (2-5 vol.%), the high nickel tenor of sulfides (ca 16-18 wt.%) and variable Ni/Cu ratios (average 3-4).

High nickel tenor (16-18 wt.%)



High nickel tenor (16-18 wt.%)



Representative data from one drill core

The Santa Rita deposit is the only example of economic stratiform/stratabound Ni-Cu sulfide deposit hosted within the interior of a layered intrusion.

What makes it special (economic)?

The sum of three characteristics:

1.Lateral continuity of disseminated sulfides	(common in layered intrusions)
1.Great thickness of disseminated sulfides	(not unusual in layered intrusions)
1.Very high Ni tenors	(not unusual in layered intrusions)

The Santa Rita deposit is the only example of economic stratiform/stratabound Ni-Cu sulfide deposit hosted within the interior of a layered intrusion.

How sulfide segregation occurred?

Possibilities:

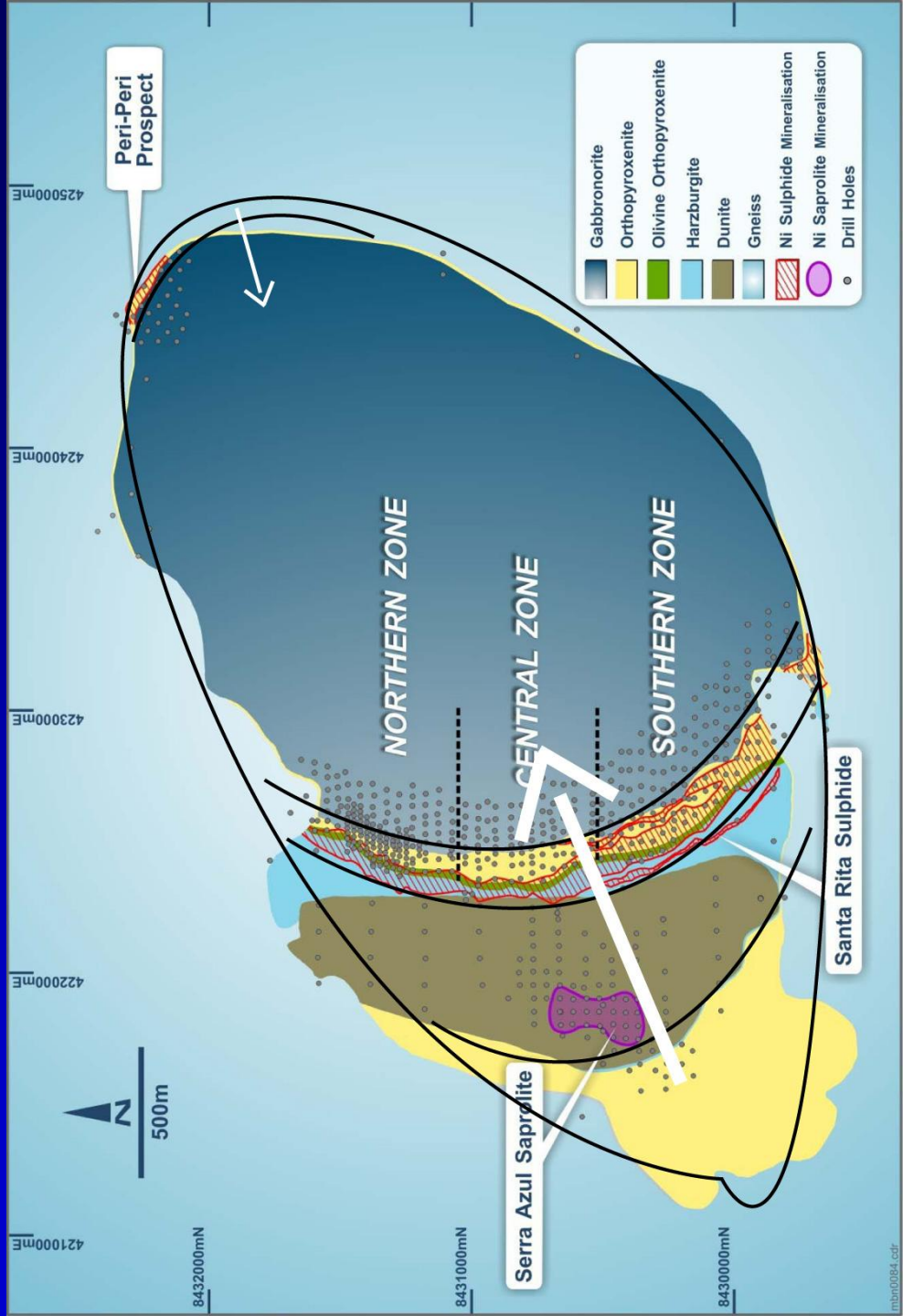
1.Sulfide segregation resulted from fractional crystallization in the magma chamber.
(consistent with progressive/transitional changes in the stratigraphy of the layered intrusion).

1.Sulfide segregation resulted from a new injection of a different magma (Gbn type) into the magma chamber (hosting a U-type) magma.
Barnes, S.J. et al. (2010) – 13° IAGOD – AUS

Does it matter?

1. Sulfide segregation resulted from fractional crystallization in the magma chamber.

"low potential for conduit type massive ore"



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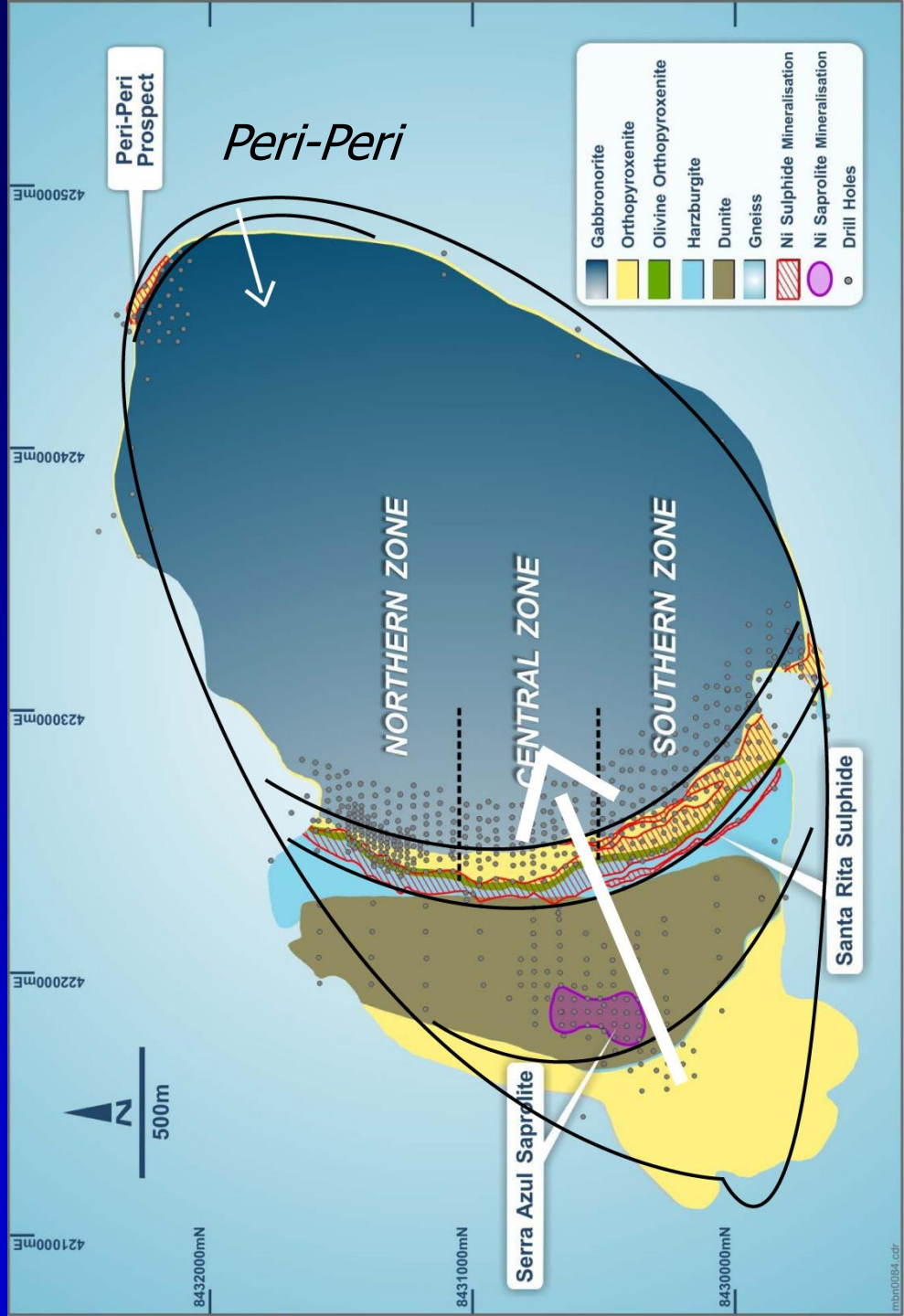
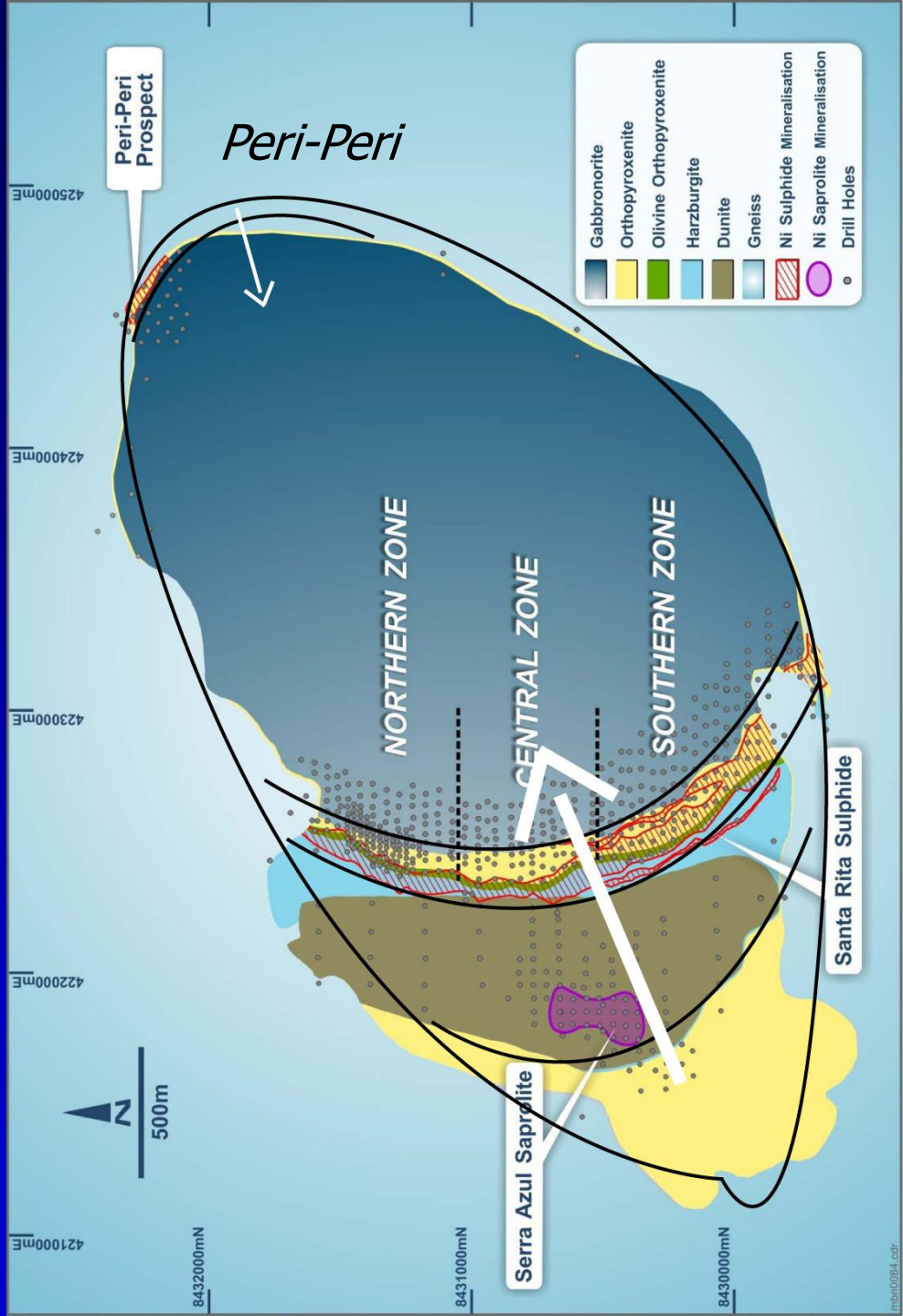


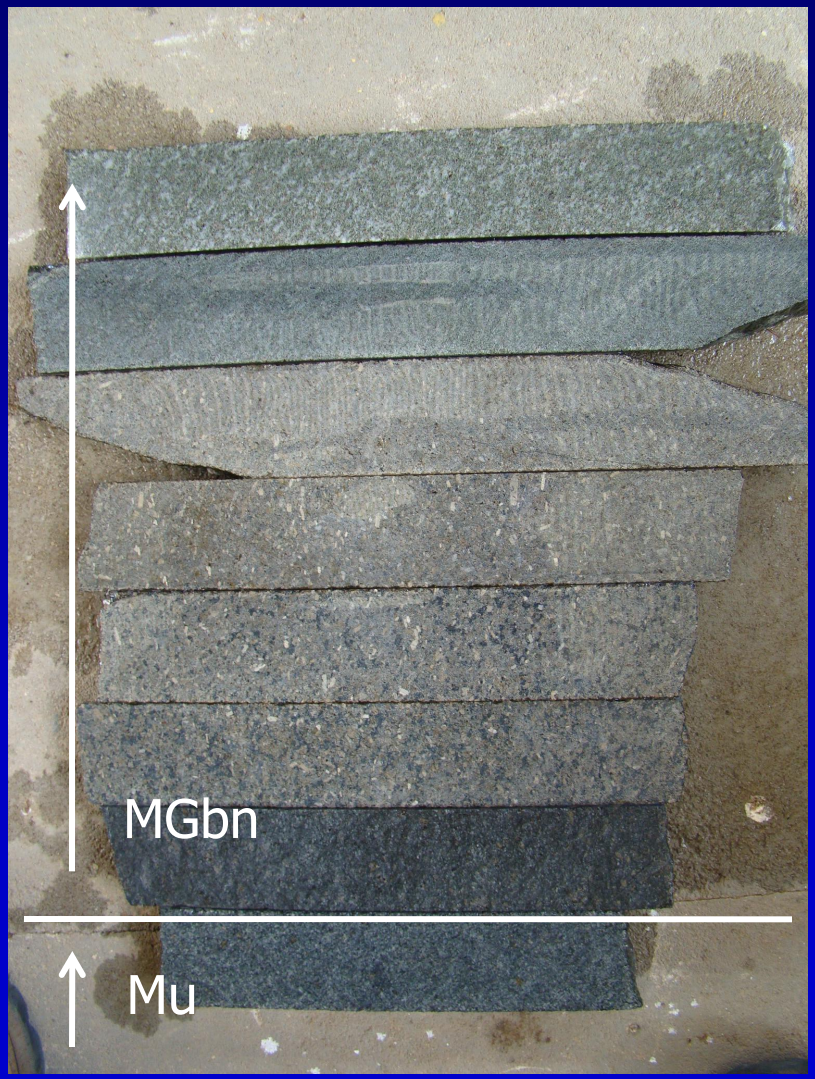
1. Sulfide segregation resulted from fractional crystallization in the magma chamber.

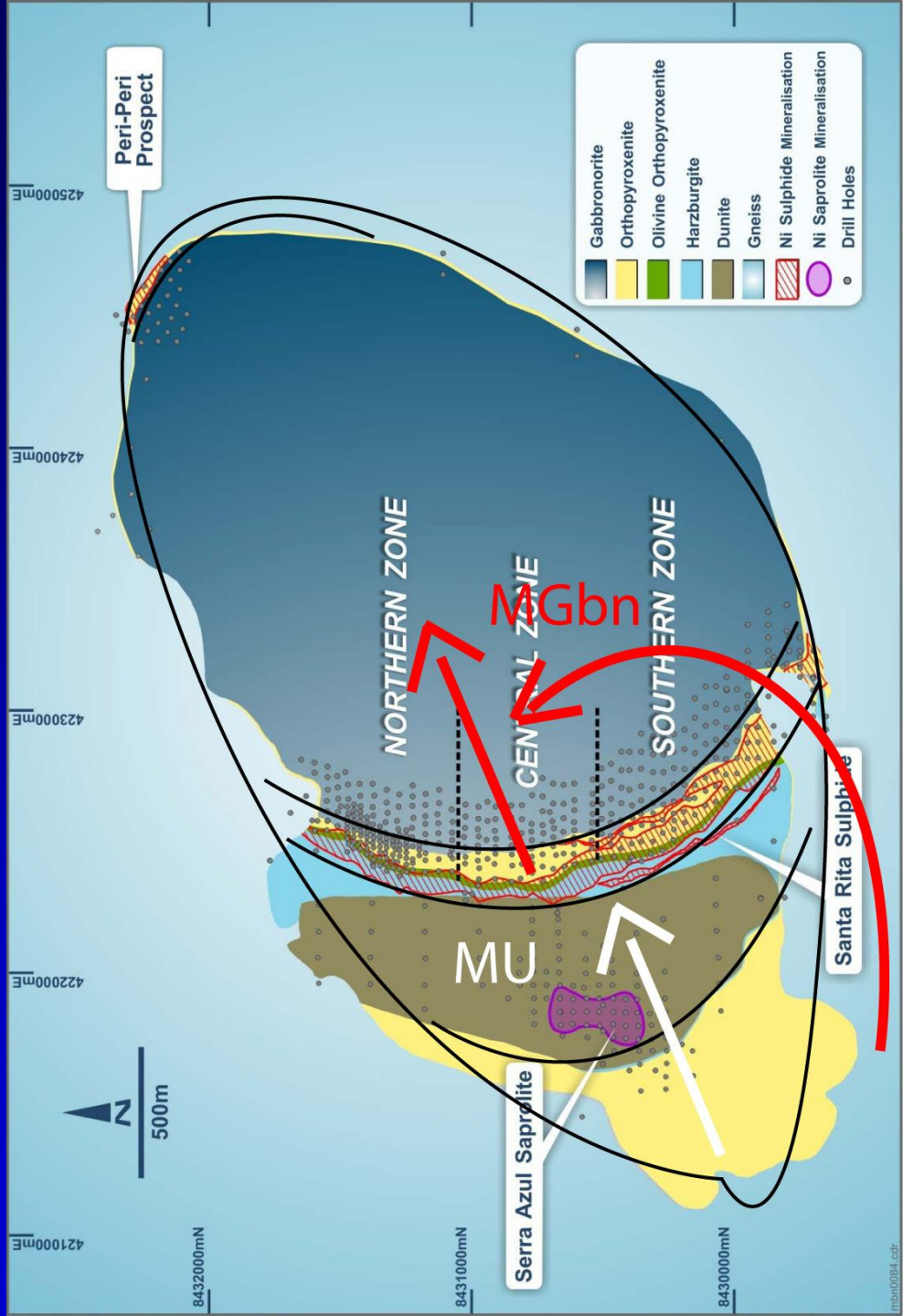
"low potential for conduit type massive ore"

Peri-Peri



2. Sulfide segregation resulted from a new injection of a different magma (Gbn type) into the magma chamber (hosting a U-type) magma.
"high potential for conduit type ore"





Santa Rita Ni-Cu Deposit
Plant
March 2010

26 kt Ni / year
19 years

Summary

• In few years (ca 2012) Brazil will become a significant mining producer of Ni (~ 150 kt/year; > 10 % of world production).

• Ni production in Brazil will be mainly based on Ni laterite deposits (> 75 %). Several undeveloped Ni laterite deposits (Jacaré, Serra do Tapa, SW de Goiás, Morro Sem Boné, SJPI) may be developed and increase the production of Ni whenever market conditions become favorable.

• The potential for exploration of Ni sulfide deposits in Brazil is high (abundant fertile MUM magmatism of different petro-teconic settings). New significant resources of Ni in Brazil should come from Ni sulfide deposits.

• Ni sulfide deposits are highly variable and difficult exploration targets. Traditional concepts provide guidelines but should not be used to rule out "unconventional" types. Get ready for surprises!

• Stick with your good anomalies.

Thank you!