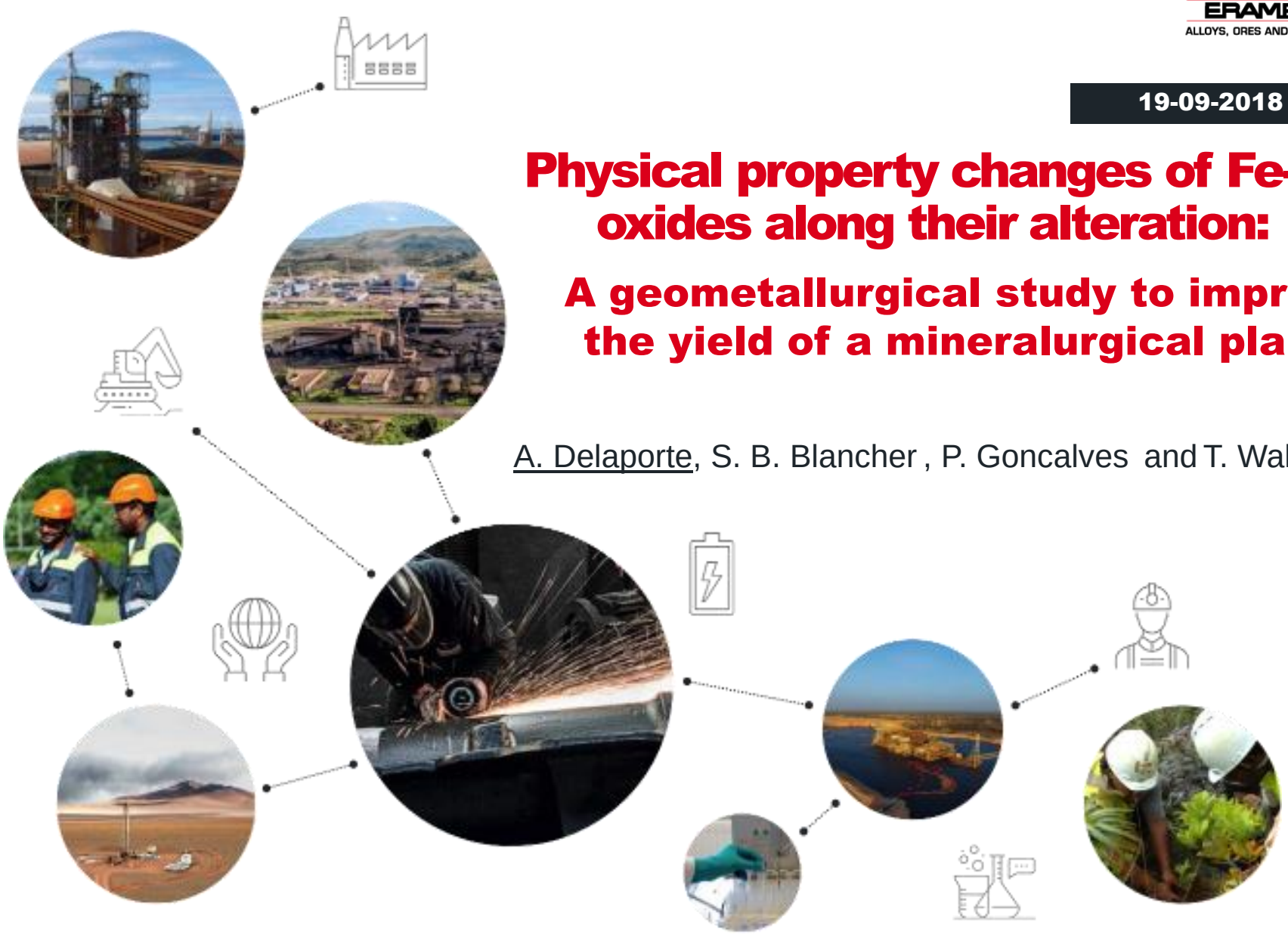
ERAMET
ALLOYS, ORES AND PEOPLE.

19-09-2018

Physical property changes of Fe-Ti oxides along their alteration:

A geometallurgical study to improve the yield of a mineralurgical plant.

A. Delaporte, S. B. Blancher , P. Goncalves and T. Wallmach



CONTENT

I. Introduction

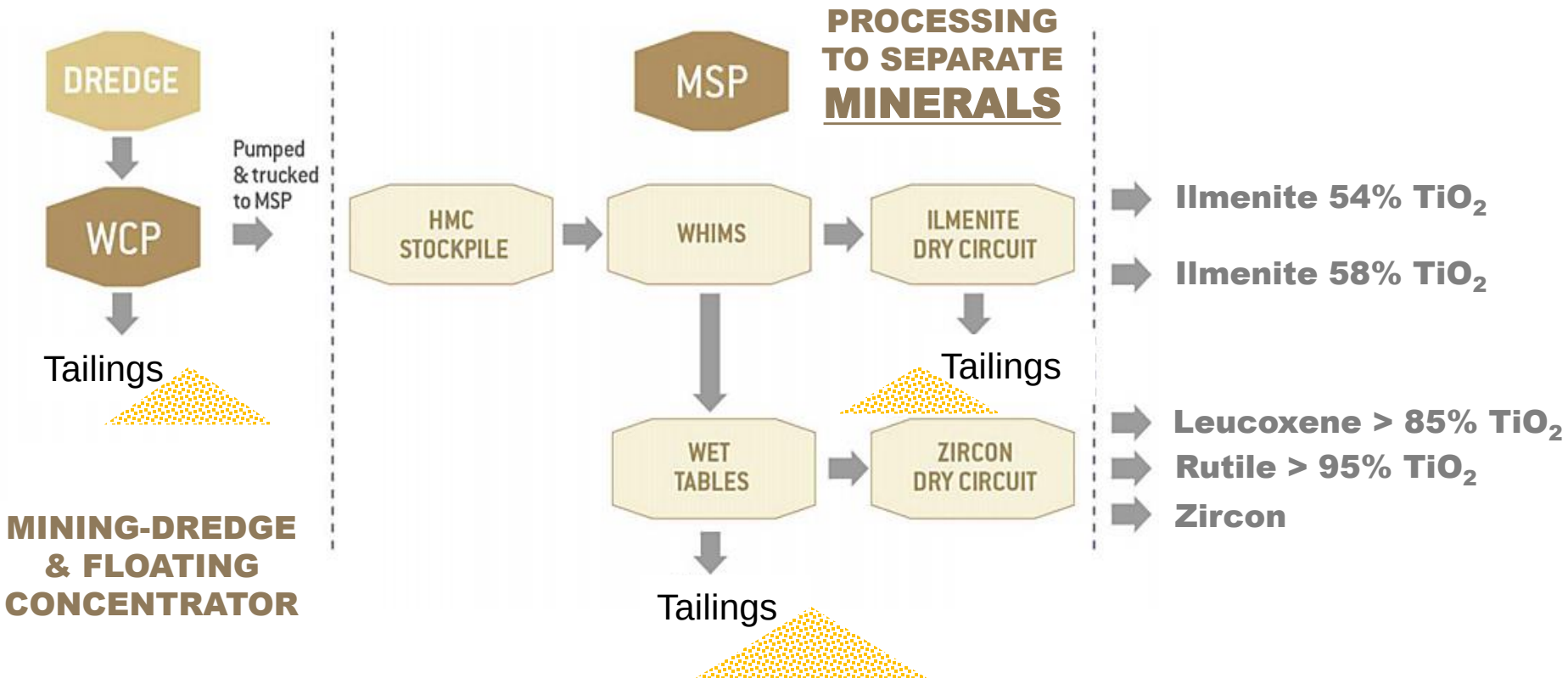
PhD thesis in partnership between **Eramet Ideas**, **TiZir Limited** and **Université de Franche Comté** (Besançon)

➔ Current objective of the thesis: To improve the understanding of Fe-Ti oxides to enhance the metallurgical processes.

*Grande Côte mineral sands Operation (**GCO**) in Senegal,*

I. Introduction

➢ TiZir Senegal plant Flow-Sheet



A mineral processing plant design to separate ilmenite, leucoxene, rutile and zircon.

I. Introduction

➢ The Fe-Ti oxides products

ILMENITE 1

- 54% TiO_2
- 325 000t/y
- Low Value
- Less strict chemical specification

ILMENITE 2

- 58% TiO_2
- 125 000 t/y
- Medium Value
- Very strict chemical specification:
  Cr, P, Al, S, U+Th

LEUCOXENE

- >85% TiO_2
- 6 000 t/y
- Medium Value

RUTILE

- >95% TiO_2
- 3 000 t/y
- High Value
- Very strict chemical specification:
  P, **Cr**, Fe, Al, Si

Data: GCO Dec 2016

TTI

GLOBAL CUSTOMERS

Stricts chemicals specifications constrain the production of high-value products

I. Introduction

➢ Problematic

➔ Difficulty in reaching chemical specifications for each commercial product

➔ Obligation to continuously change processing parameters

➔ Complex forecasting, loss of yield, tight workflow work

Probable causes:

- Poor understanding of the physical properties of minerals including Fe-Ti oxides

➔ Objective of the PhD: To improve the understanding of Fe-Ti oxides to enhance metallurgical processes

➔ A geometallurgical approach

I. Introduction

➢ Problematic

State of the art

Mineral	Formula	Stoichiometric TiO2-content (possible range)	Avg Density	Electro/Magnetic Susceptibility
Ilmenite	$Fe^{2+}TiO_3$	52.7% TiO_2 (46 – 56% TiO_2)	4,7	
Pseudorutile	$Fe^{3+}{}_2Ti_3O_9$	60.0% TiO_2 (57 - 65 % TiO_2)	3.8	
Ferropseudobrookite	$Fe^{2+}Ti_2O_5$	69.0% TiO_2 (66 – 75 % TiO_2)	4.2	
Leucoxene		?? (65 – 95 % TiO_2)	??	
Anatase	TiO_2	100% TiO_2 (94 – 100 % TiO_2)	3,9	
Rutile/	TiO_2	100% TiO_2 (98 – 100 % TiO_2)	4,9	

I. Introduction

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Leucoxene ?		?? (65 – 95 % TiO_2)	??	
Anatase	TiO_2	100% TiO_2 (94 – 100 % TiO_2)	3,9	
Rutile/	TiO_2	100% TiO_2 (98 – 100 % TiO_2)	4,9	

Knowing the real mineralogy in order to well adjust the processing parameters

II.

Characterization step: Qemscan, XRD, SEM and Microprobe analysis

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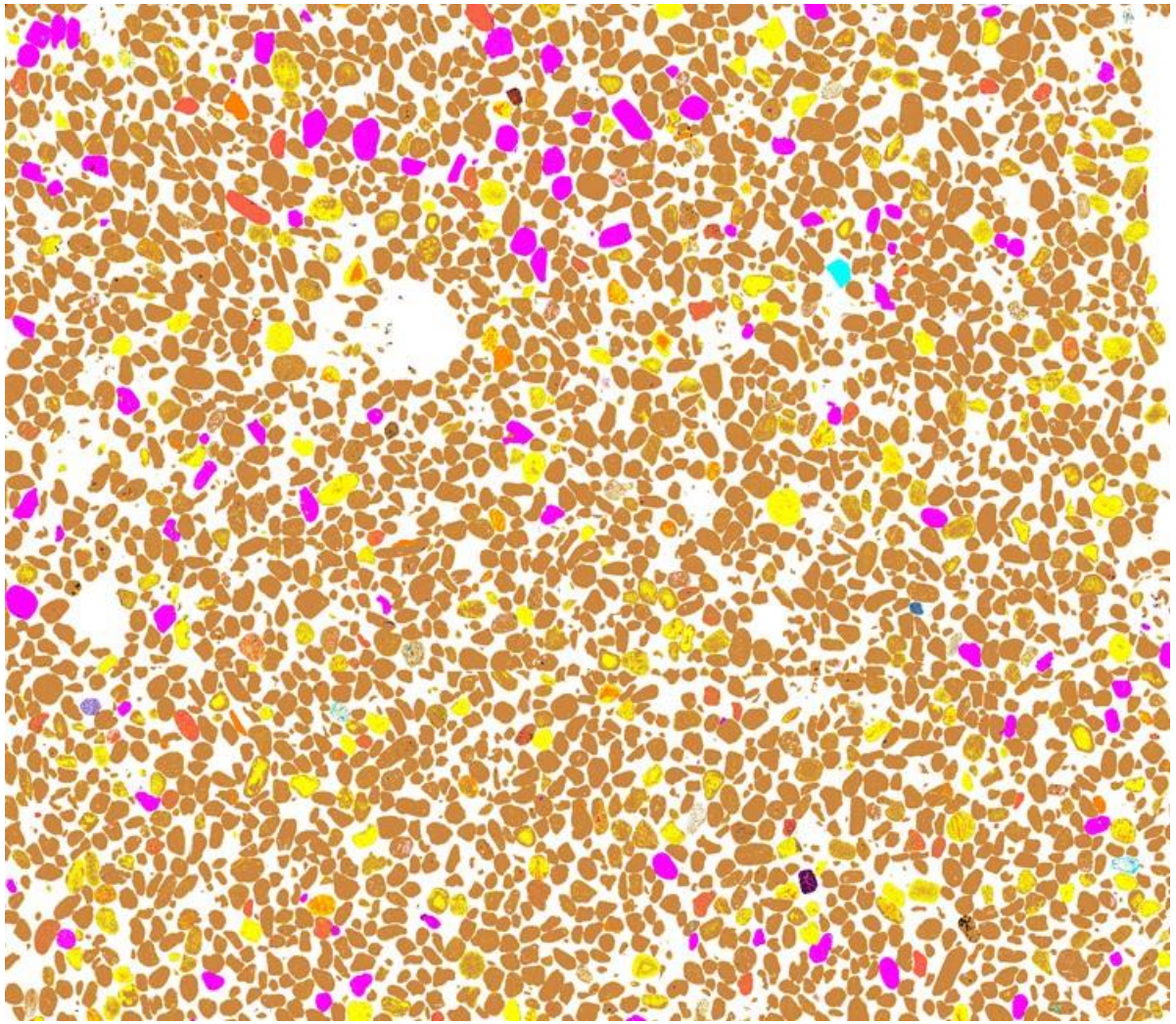
➢ Automated Mineralogical mapping using Qemscan

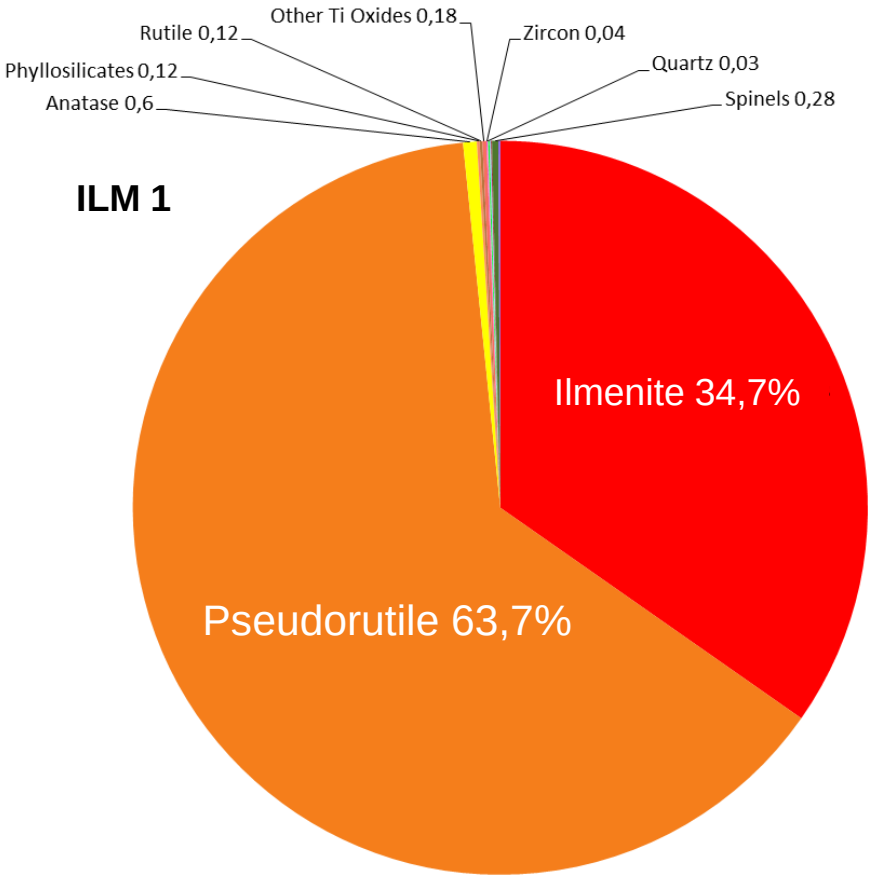
- XRD, phase identification
- Microprobe
- SEM (High resolution image)
- Qemscan process simulation

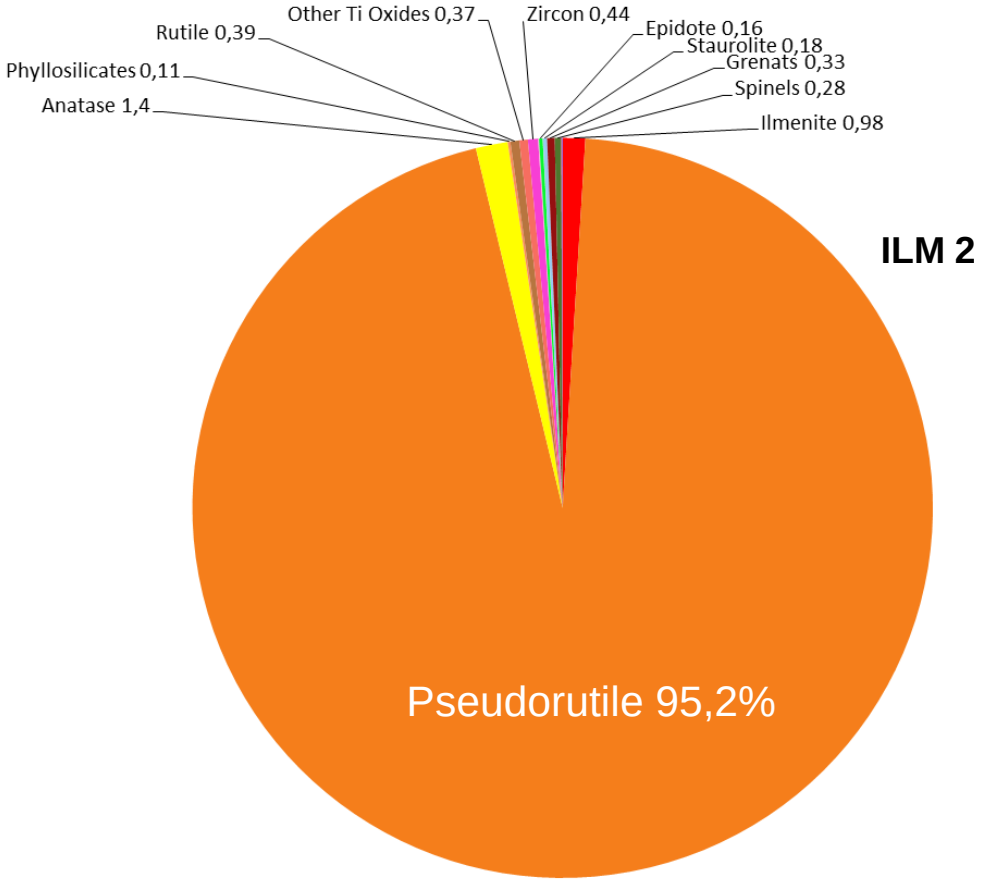


Qemscan mapping of a Leucoxene product sample

II. Characterization step

➢ Qemscan results

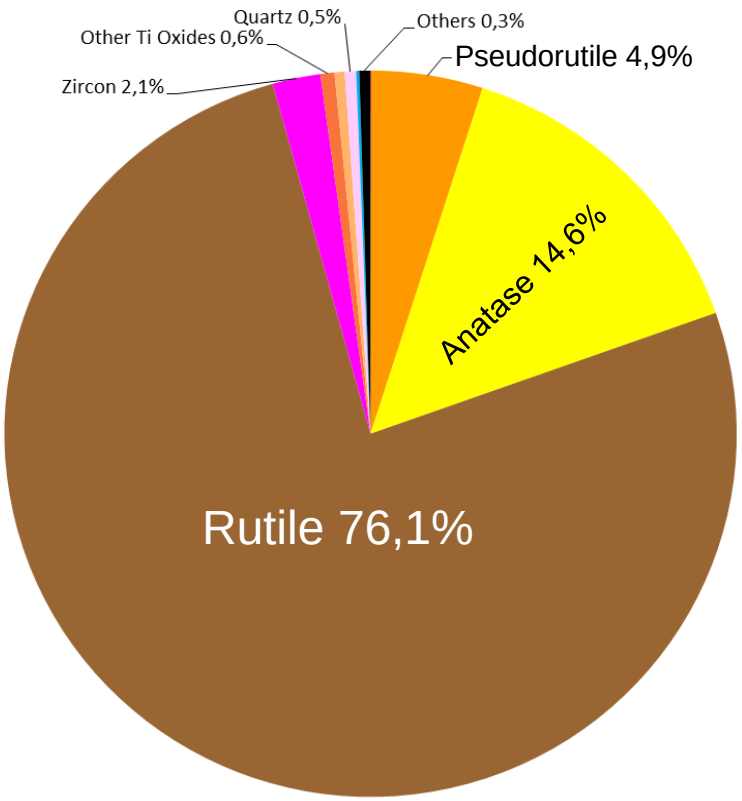




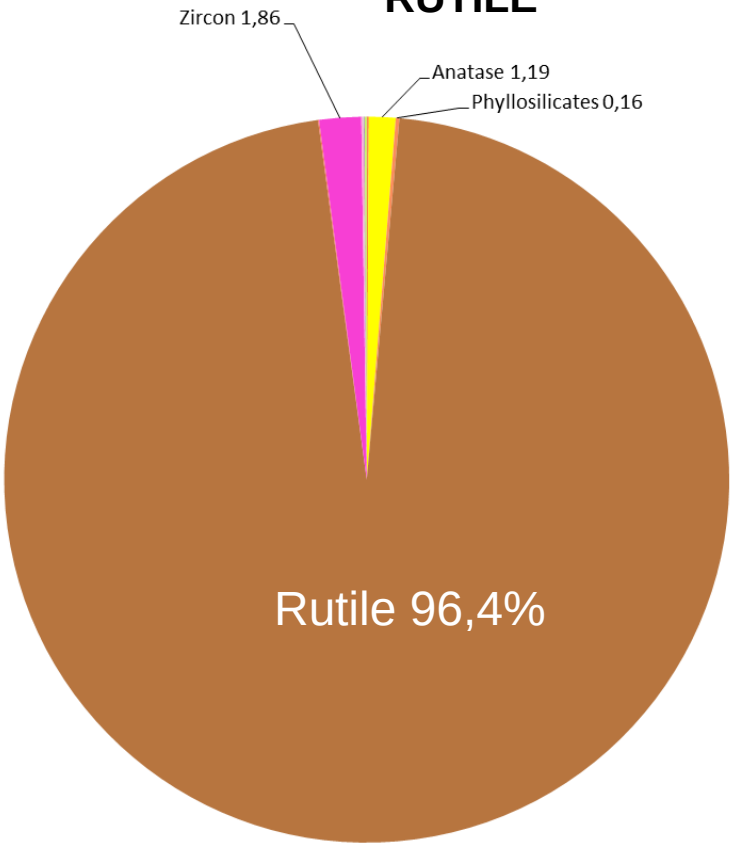
Only few ilmenite in the « ilmenite product »
Ilmenite/Pseudorutile = Not only a nomenclature, physical and chemical properties **are different**:
Fe/Ti, Fe^{2+}/Fe^{3+}, Density, Magnetic, Impurities (Cr, P, Al, Si, etc…)

II. Characterization step

LEUCOXENE

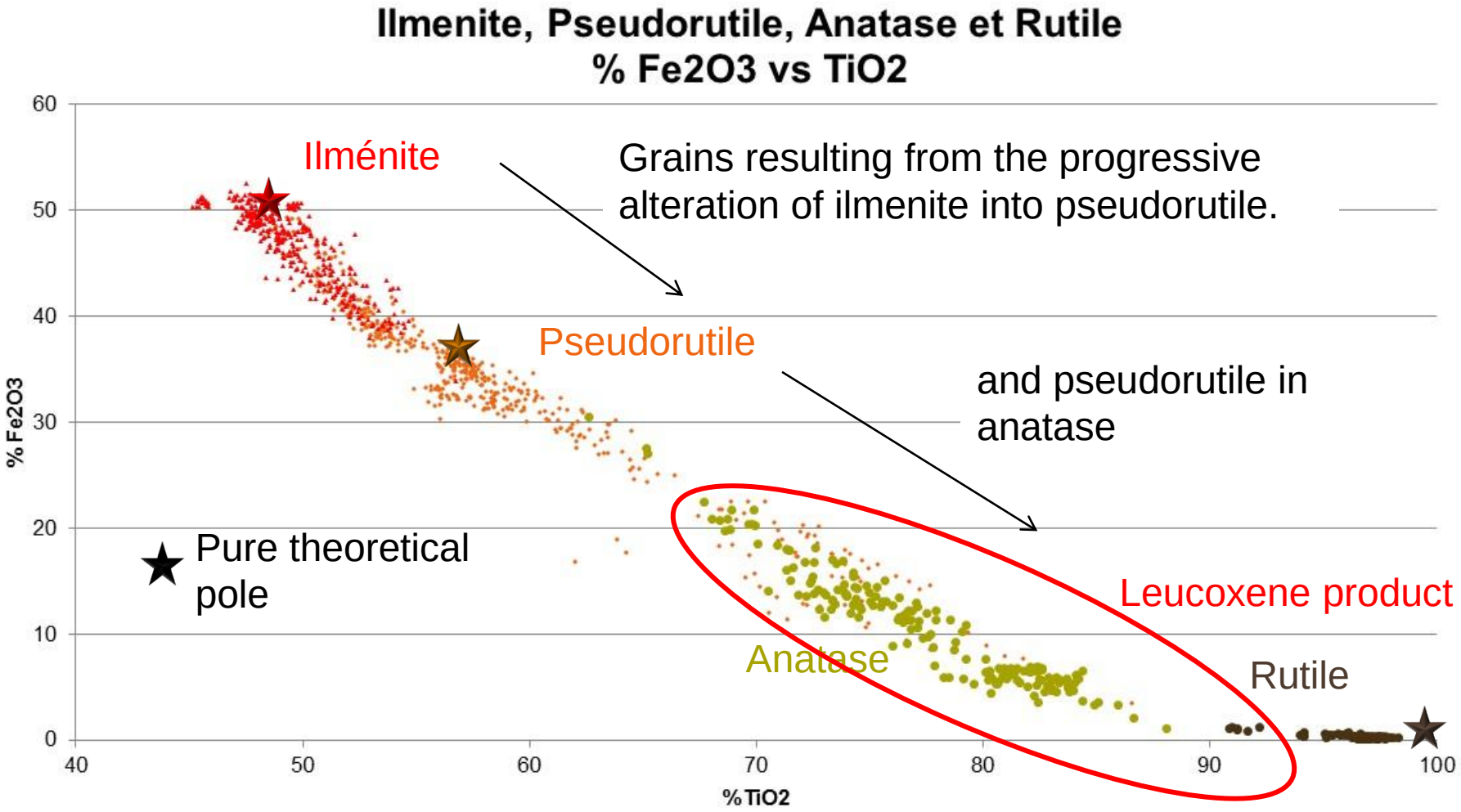


RUTILE



Leucoxene product: mainly composed of **rutile minerals** (>97 % TiO_2)
Chemical specification of **Rutile product**: >95% TiO_2
Possibility to recover the rutile minerals from the Leucoxene product by working on the process parameters

• II. Characterization step: Microprobe analysis



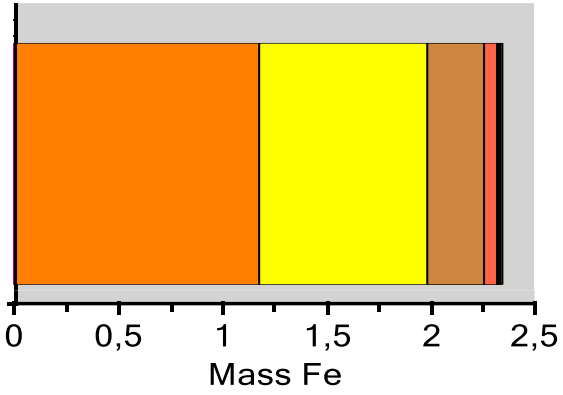
III.

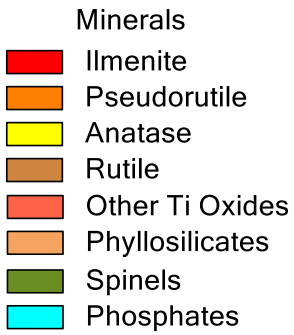
Leucoxene product:

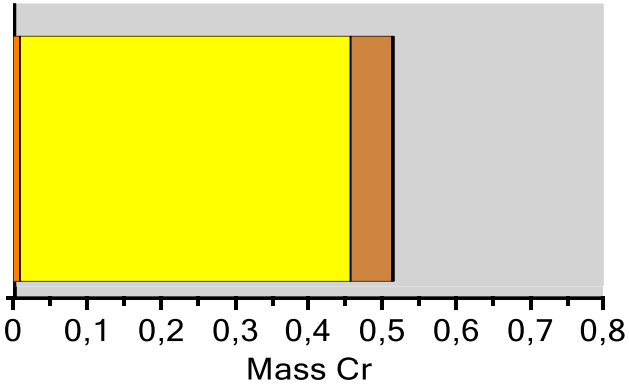
Chemical and mineralogical composition

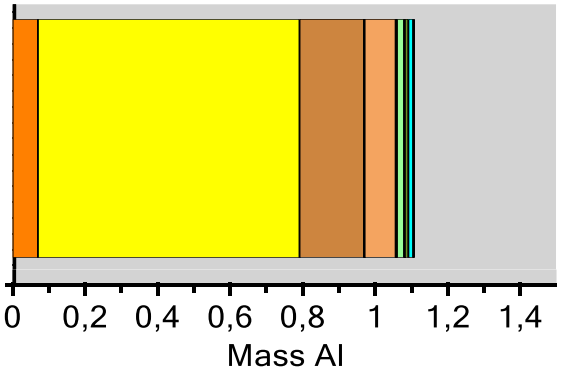
III. Simulation of chemical distributions by Qemscan

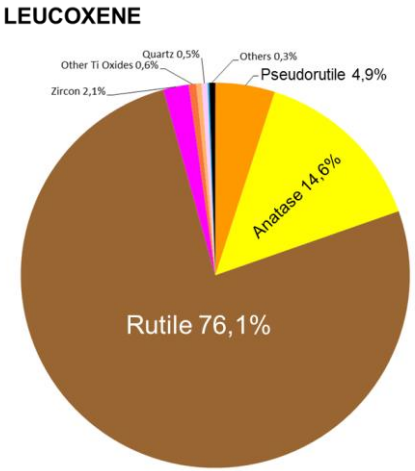
Leucoxene Product, Elemental impurities deportment**:**

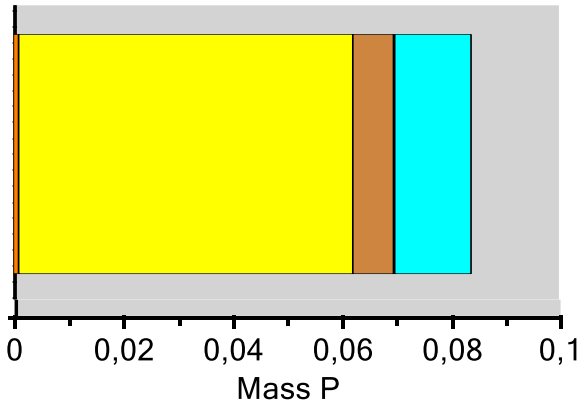






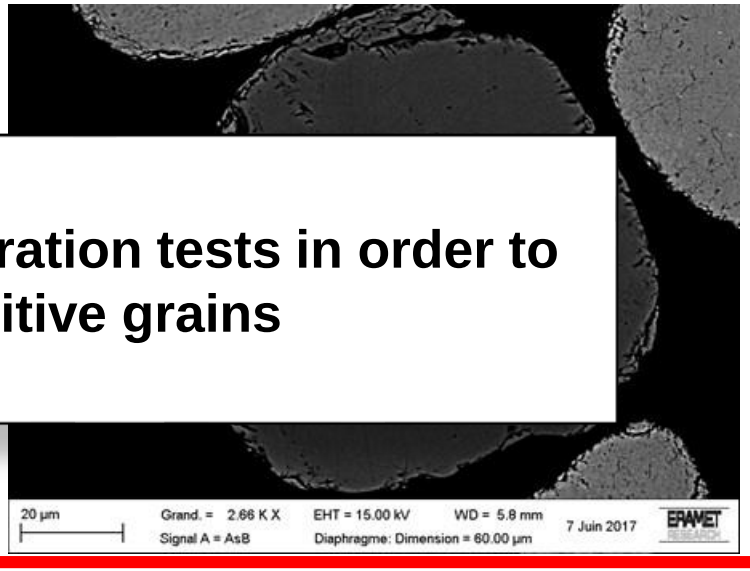




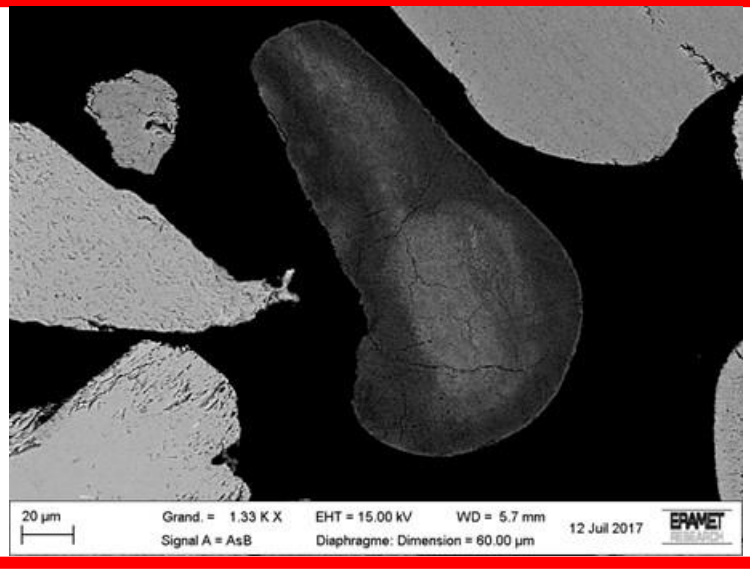


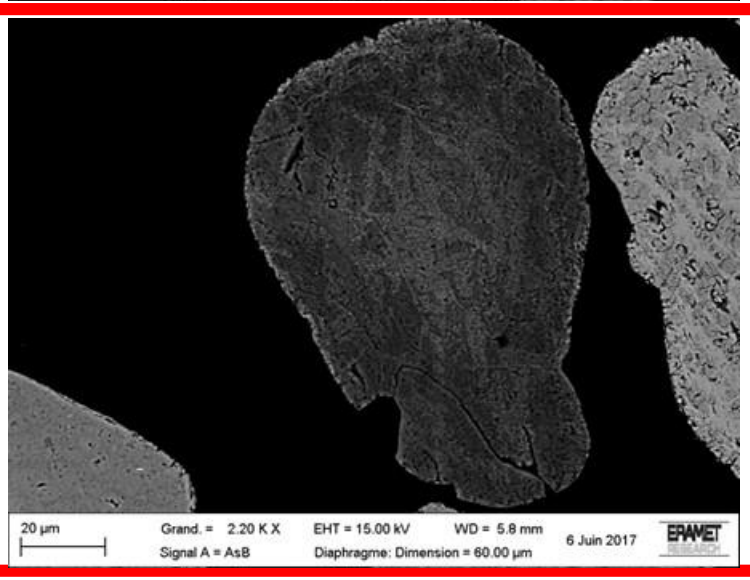
Removing the **chemical impurities** in order to recover the **rutiles** of the **Leucoxene** product
Main phases bearing impurities: Pseudorutiles, Phosphates and Anatases

III. Leucoxene: mineralogical composition



➔High intensity magnetic separation tests in order to remove the low sensitive grains





IV.

Mineral separation tests

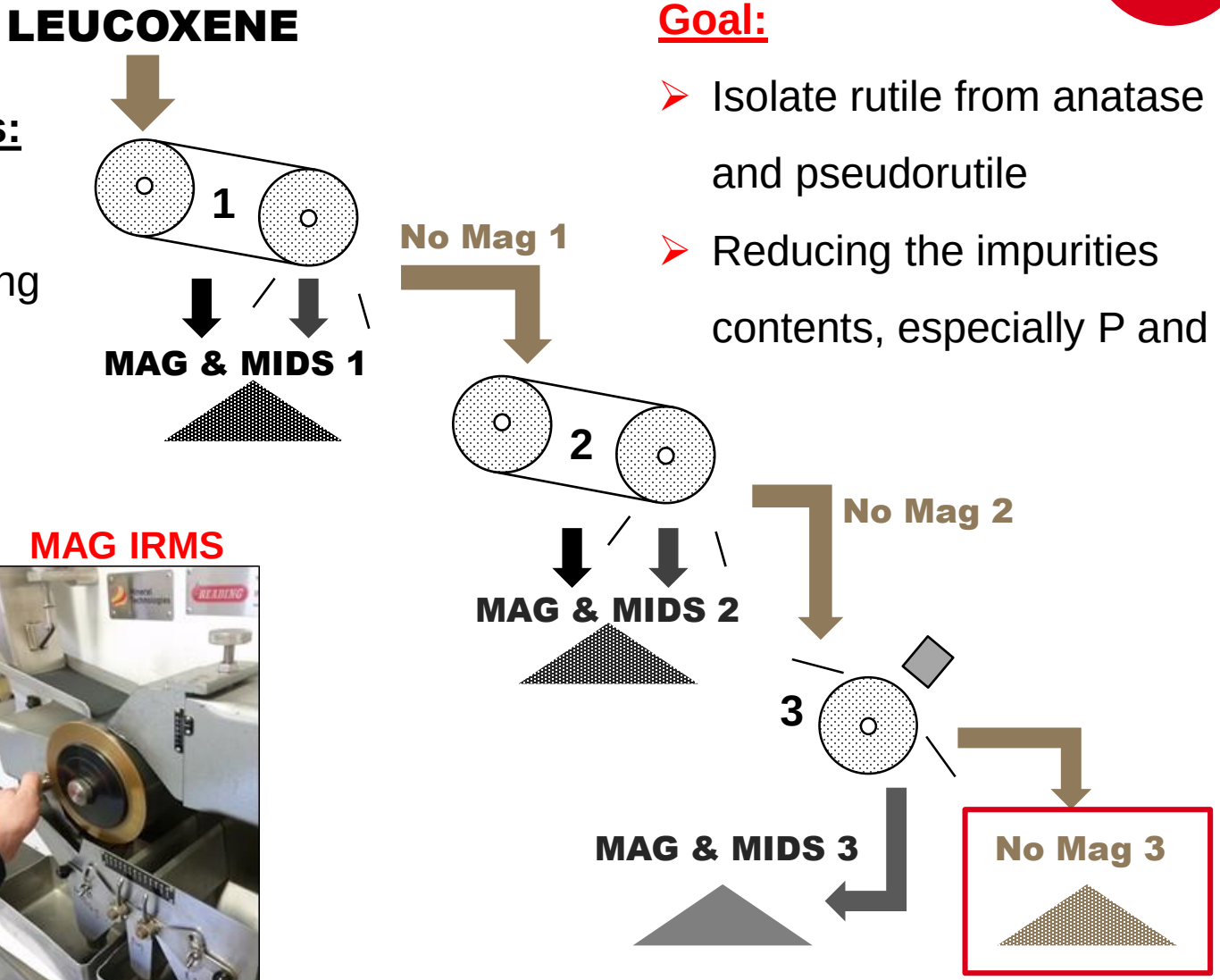
• IV. Mineral separation tests

3 Sepraration steps:

1: MAG RER

2: MAG RER Cleaning

3: MAG IRMS



Goal:

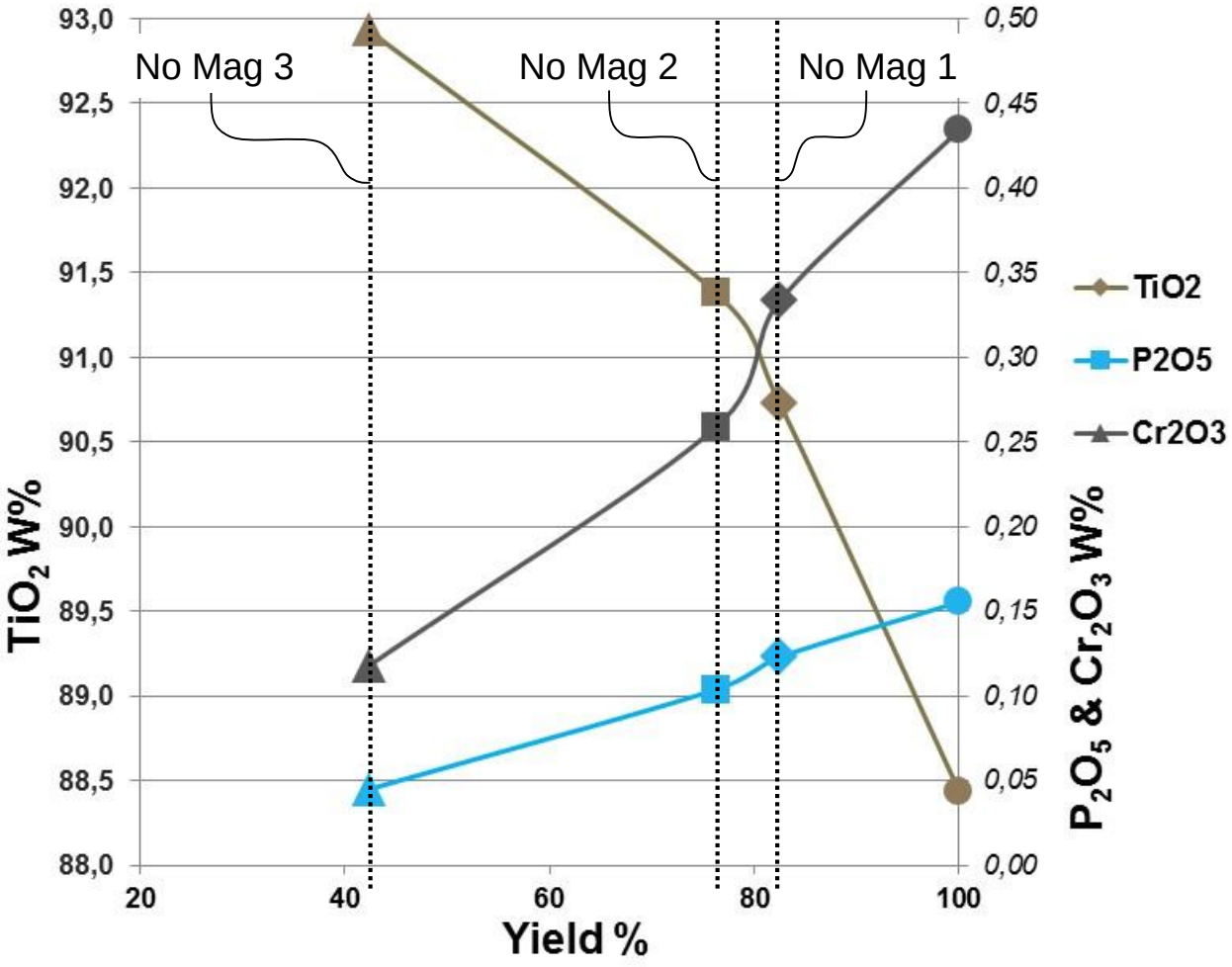
- Isolate rutile from anatase and pseudorutile
- Reducing the impurities contents, especially P and Cr

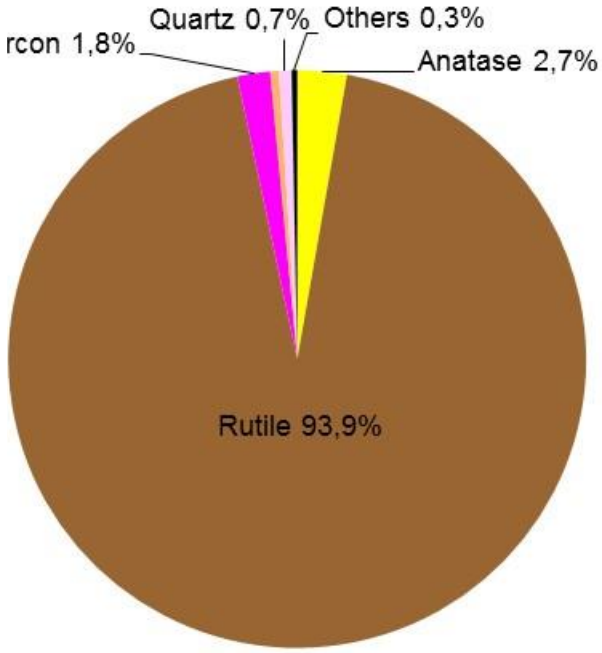
MAG RER

MAG IRMS

• IV. Mineral separation tests

➢ Chemical and mineralogical results:



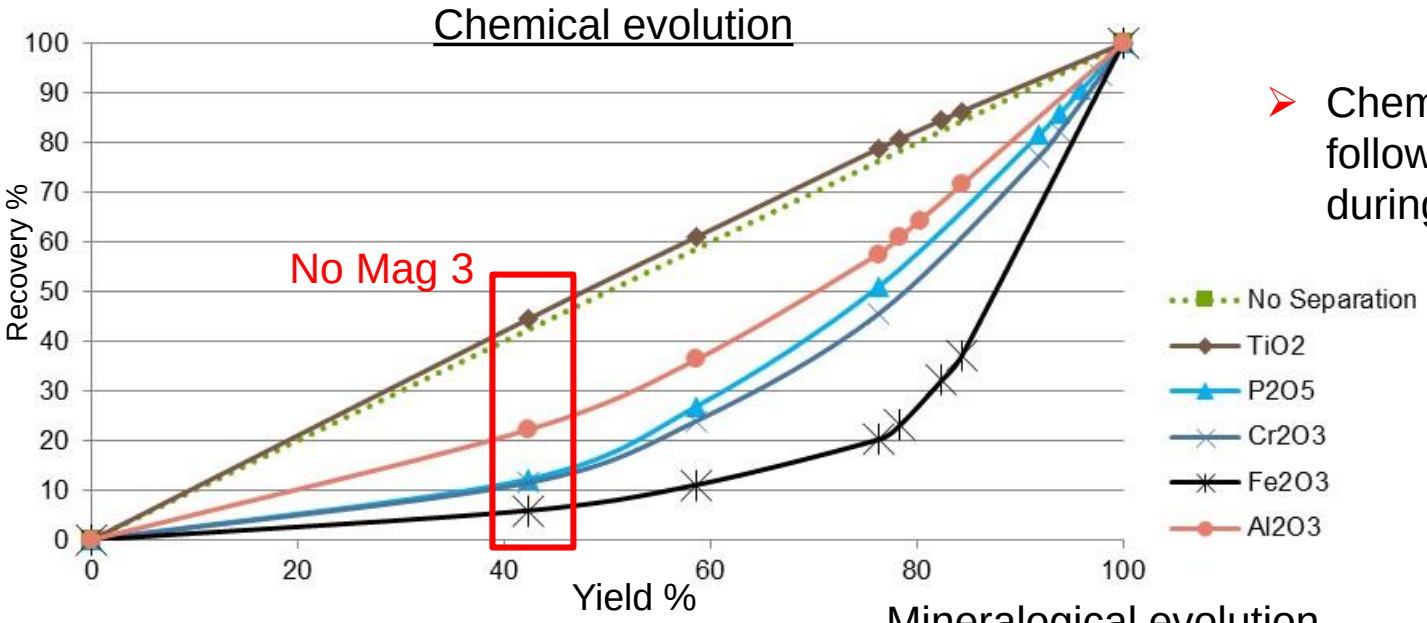


Final rutile concentrate with:

- Yield = 40%
- Cr_2O_3 & P_2O_5 under Rutile commercial specifications

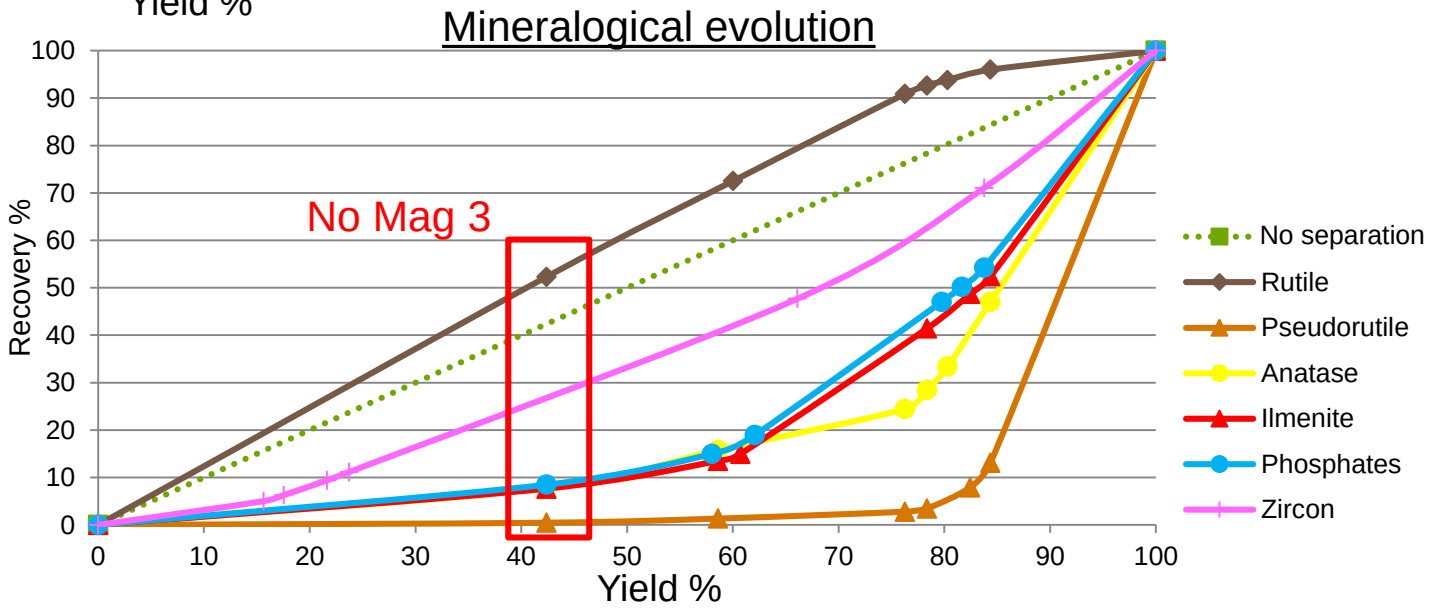
Capacity to create a rutile concentrate with impurities content under the commercial specifications

• IV. Mineral separation tests



- Chemical and mineralogical follow up of the output during the separation tests

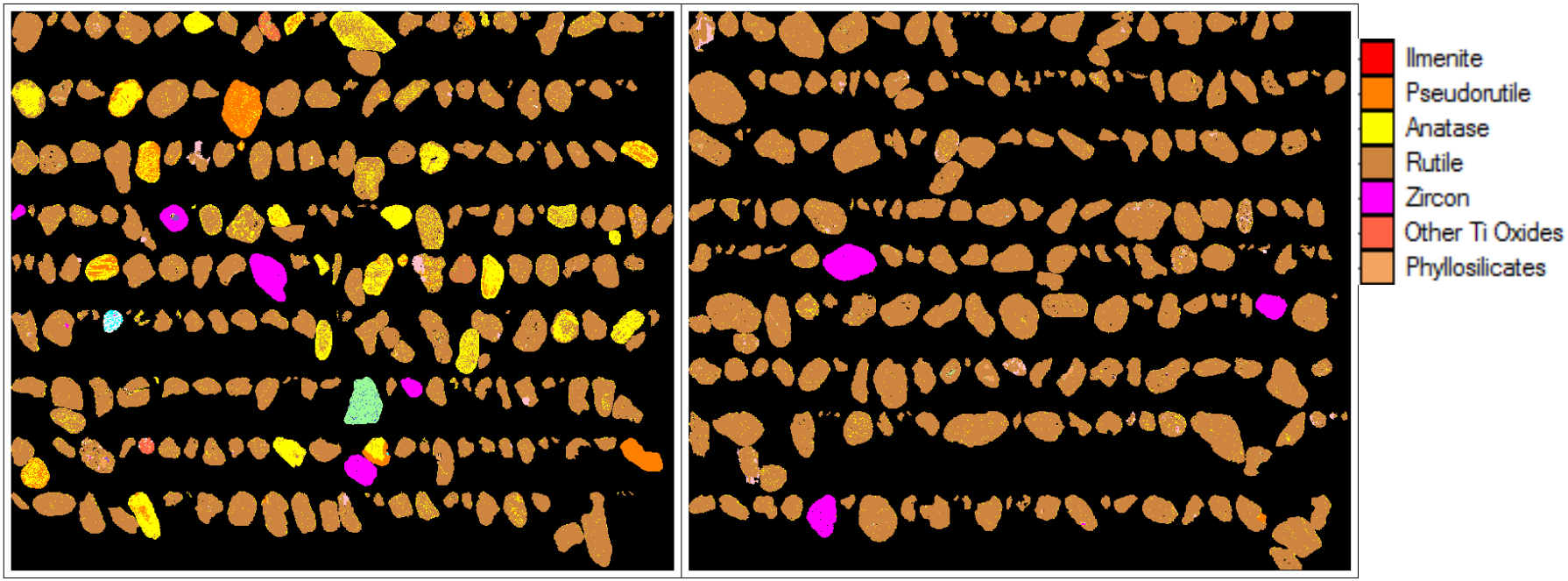
More a mineral separation than a chemical separation!



V. Conclusion

Leucoxene Product

No Mag 3



- Adjust the processing parameters from the **mineralogy** alowed us to create a rutile concentrate with **impurities content under** the commercial specifications
- **Cr, P, Al, Fe, Si** bearers isolated: pseudorutile and anatase
- **Industrial adaptation** of these process parameters
- **Electrostatic separation** test to collect the remaining **zircons**
- Same research work with **Ilmenite product**

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CONTACT

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THANKS FOR THE ATTENTION

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