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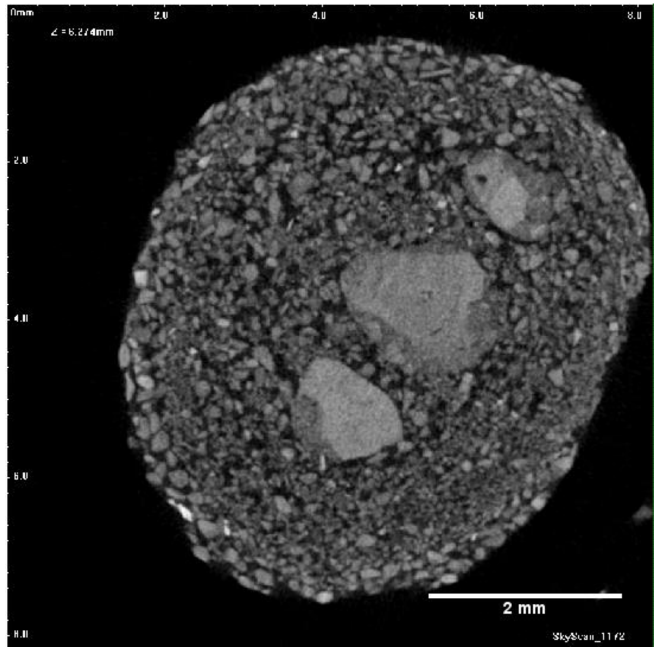
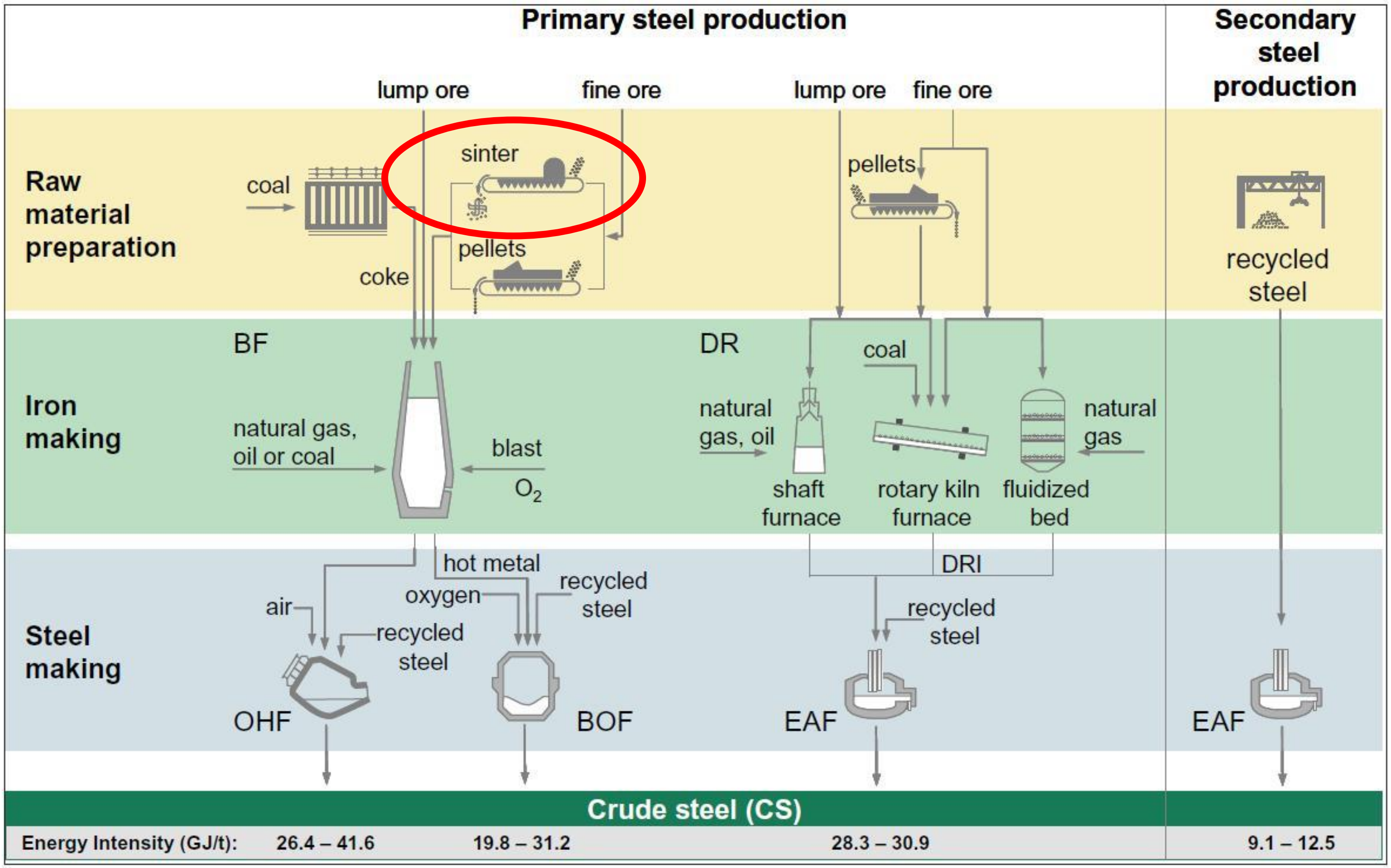


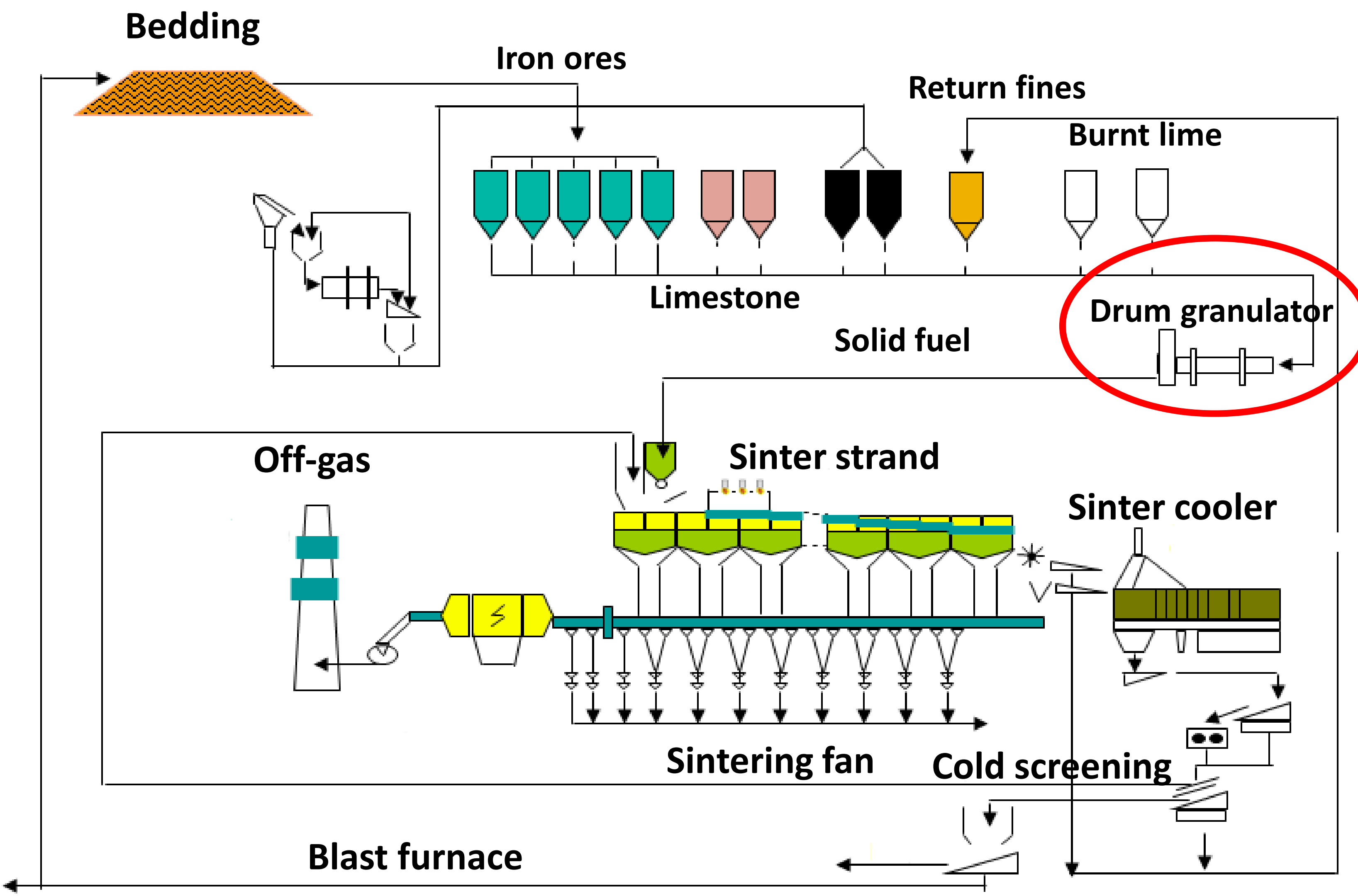
Application of X-ray microtomography to investigate the effect of raw material properties on the kinetics of iron ores granulation

Introduction: steelmaking routes

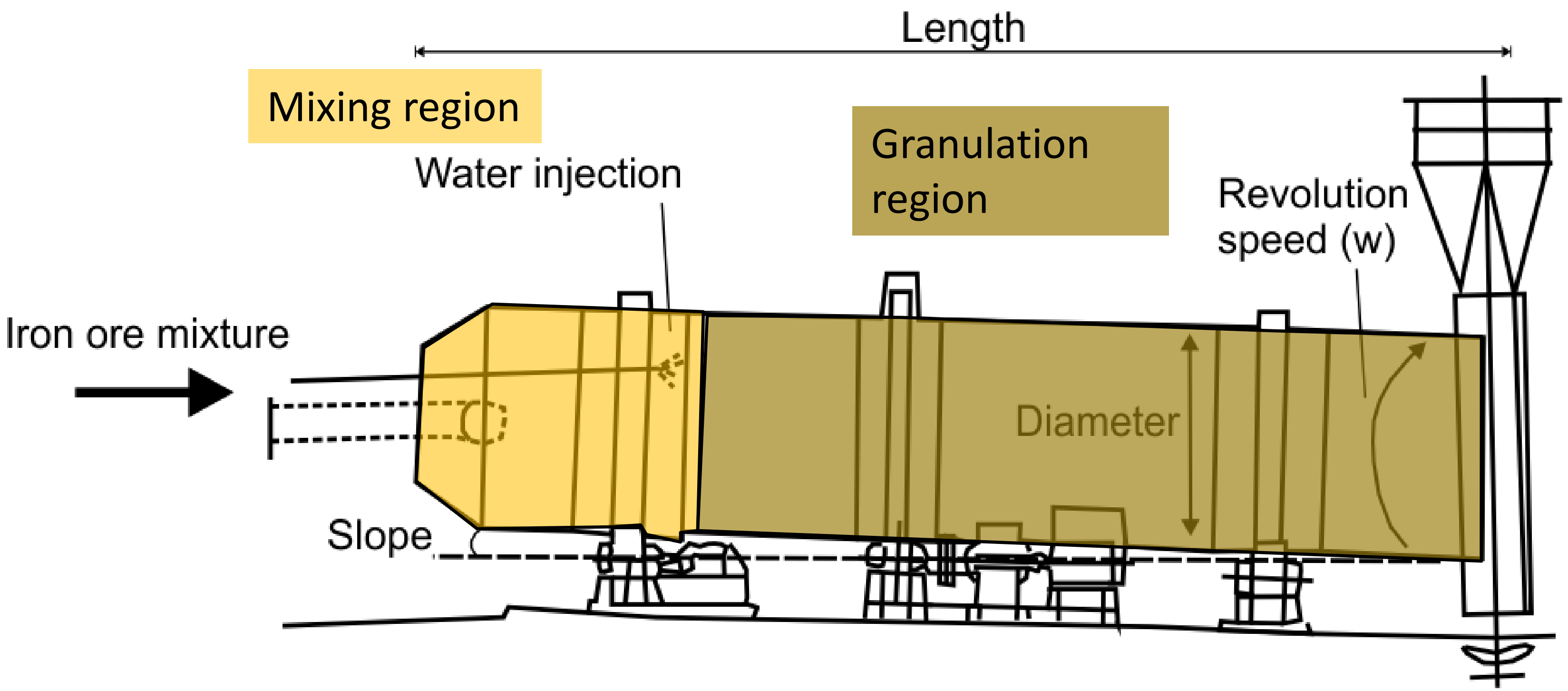


Source: World Steel Association, 2008

Introduction: sinter plant flowsheet



Introduction: drum granulator



Introduction: Iron ore granulation

Process of transforming finely divided particles to granular materials with controlled physical properties by the introduction of outside forces.

Industrial granulation processes are run with:

- Controlled parameters
  - Drum speed
  - Water addition Wt%
  - Binders
- Fluctuating parameters
  - Iron ore quality
  - Particle shape
  - Particle size distribution

MAIN OBJECTIVE

- Understand the impact of raw material properties on granulation

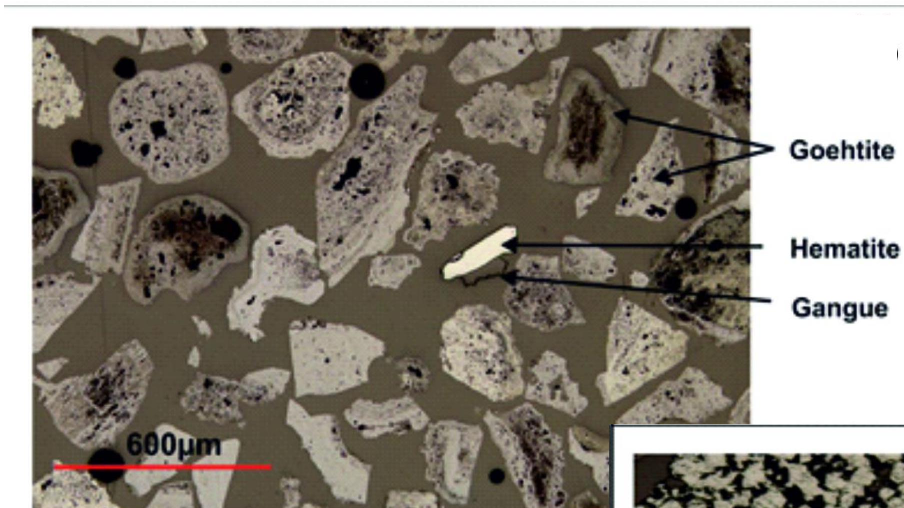
1 Characterization of primary particles

2 types of iron ore concentrates:

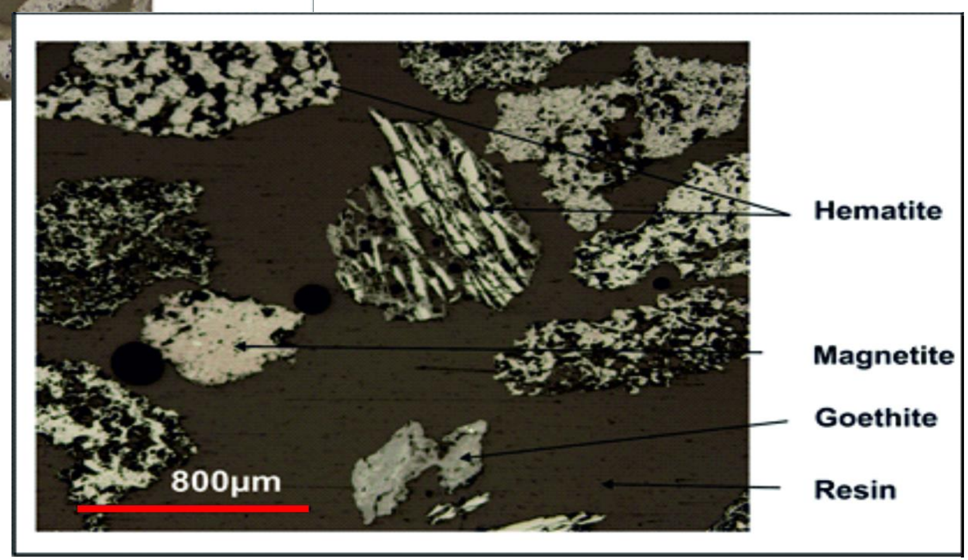
Mineral	Collection pieces	1 – 2 mm	< 0.25 mm
Hematite			
Goethite			

1 Characterization of primary particles

Qualitative analysis



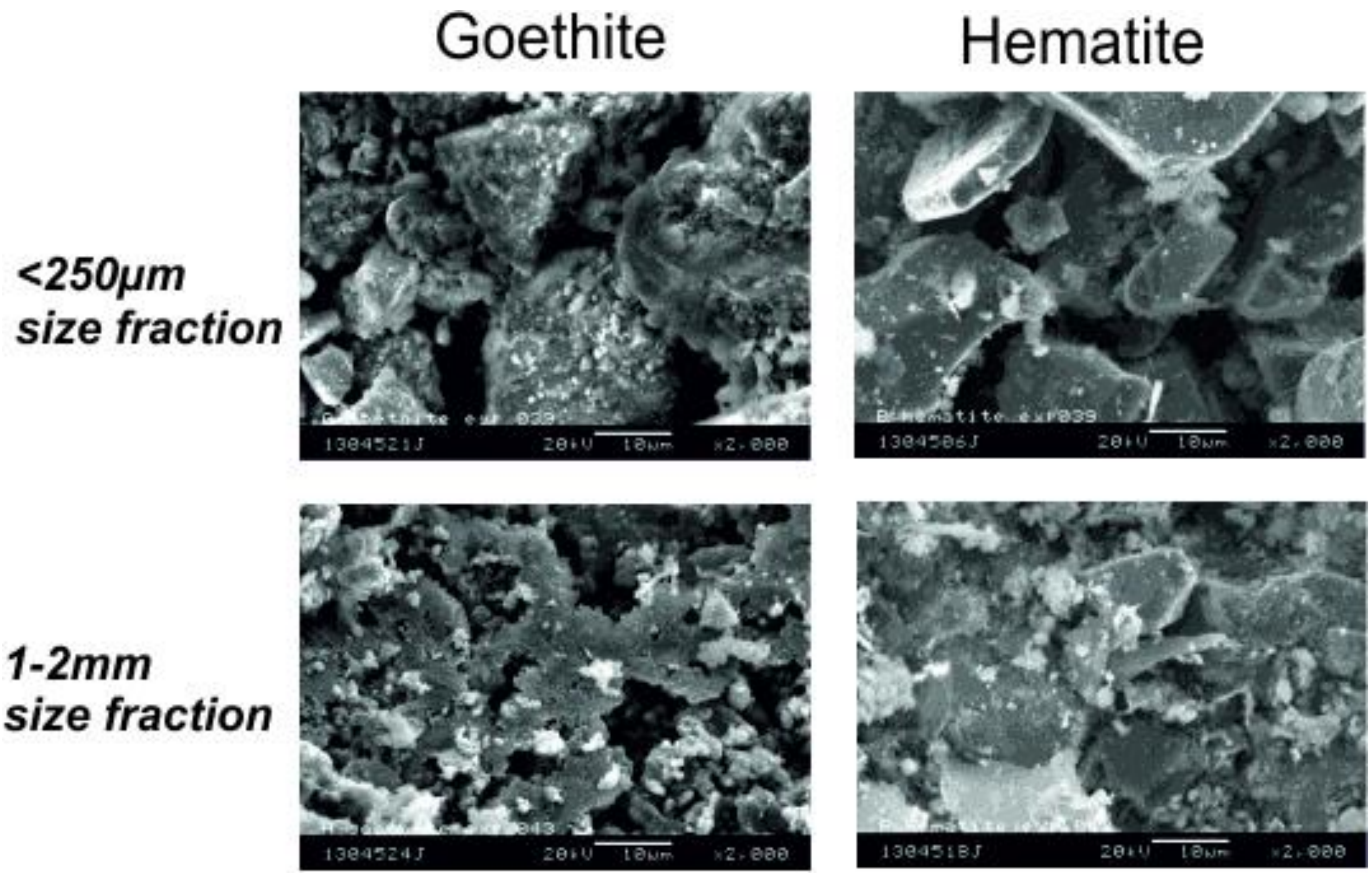
Goethitic iron ore concentrate



Hematitic iron ore concentrate

1 Characterization of primary particles

SEM images



1 Characterization of primary particles

Chemical composition of the iron ore concentrates

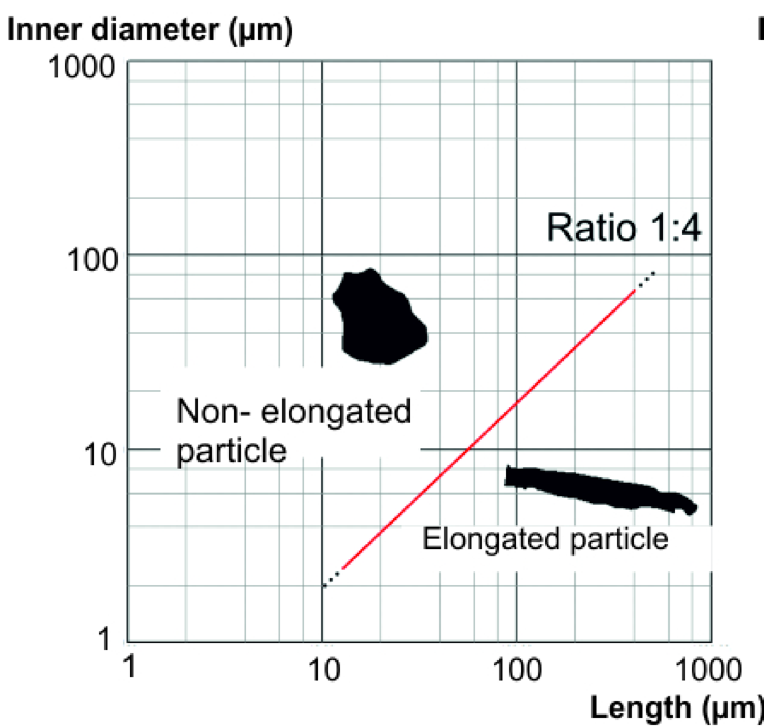
	%Fe	%Fe ++	% CaO	% SiO_2	% MgO	% Al_2O_3	% LOI
Goethitic Iron ore	56,13	0,05	0,16	5,55	0,119	2,699	10,68
Hematitic Iron ore	65,34	0,54	0,01	4,55	0,087	0,604	1,4

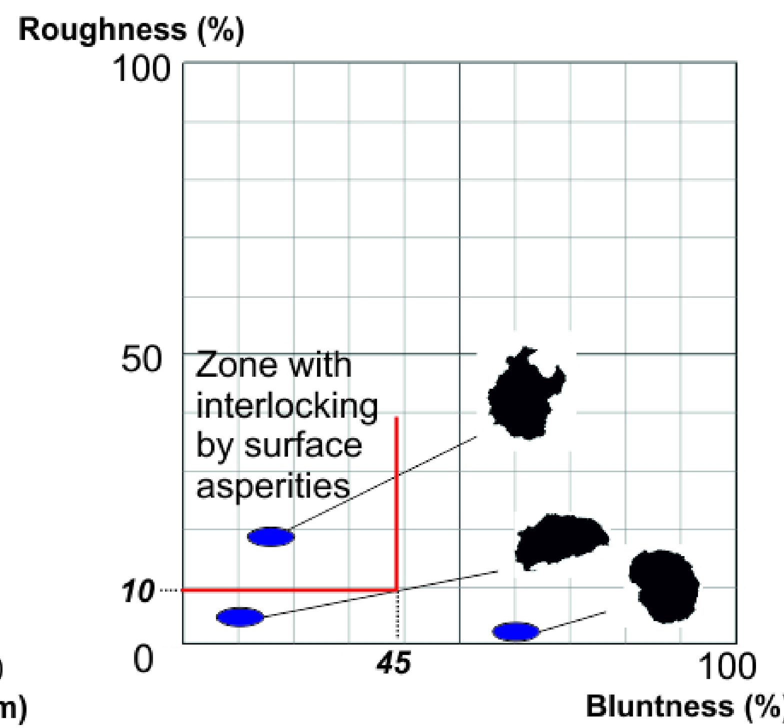
Mineralogical quantitative analysis of the iron ore concentrates

	goethite (wt %)	hematite (wt %)	magnetite (wt %)
Goethitic Iron ore	99,5	0,5	/
Hematitic Iron ore	1,3	98,6	0,1

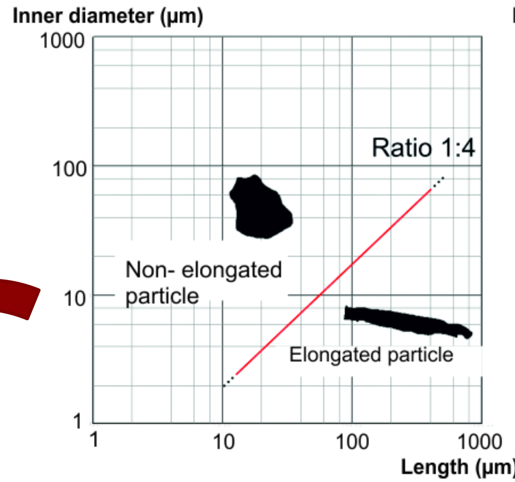
1 Characterization of primary particles

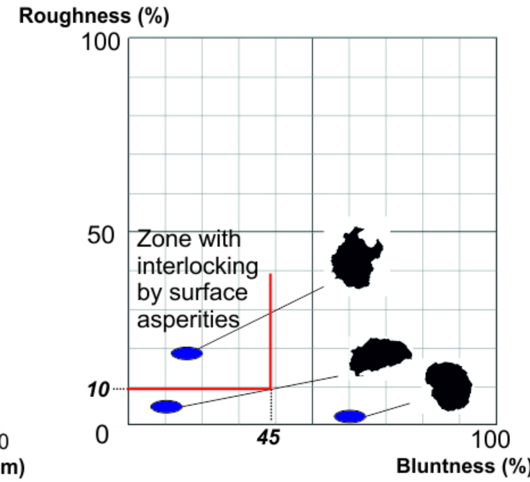
Shape of primary particles



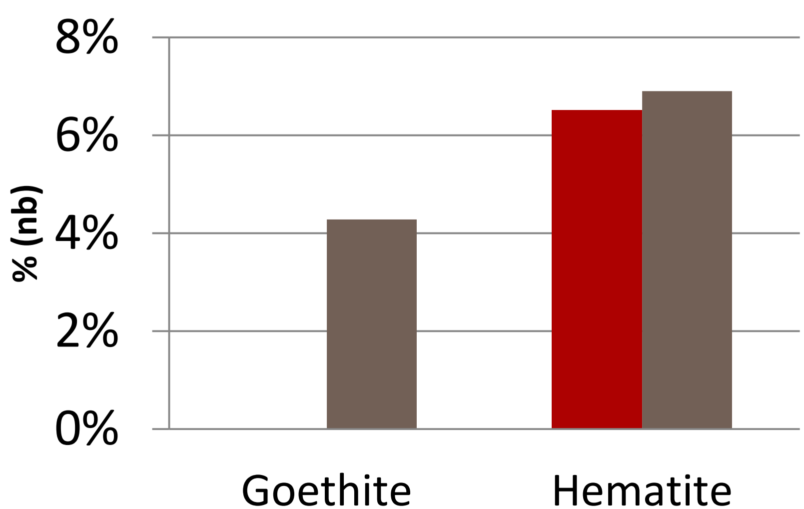


1 Characterization of primary particles

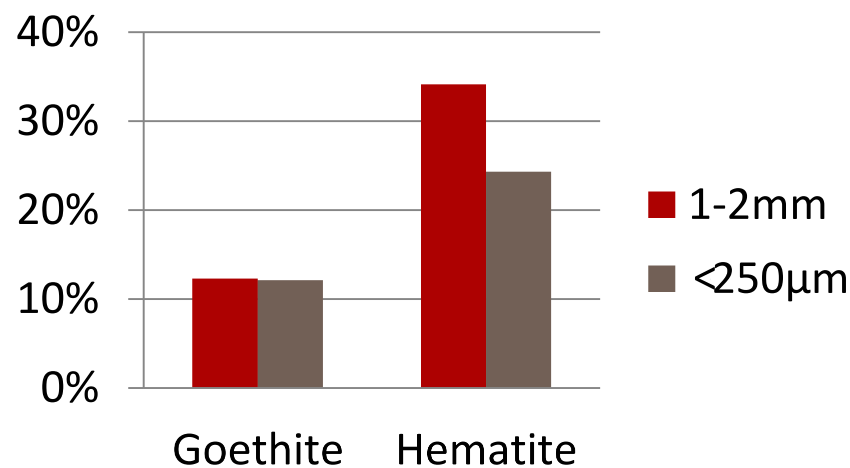




% elongated particles



% of particles in the zone with interlocking by surface asperities



2. Experimental methodology

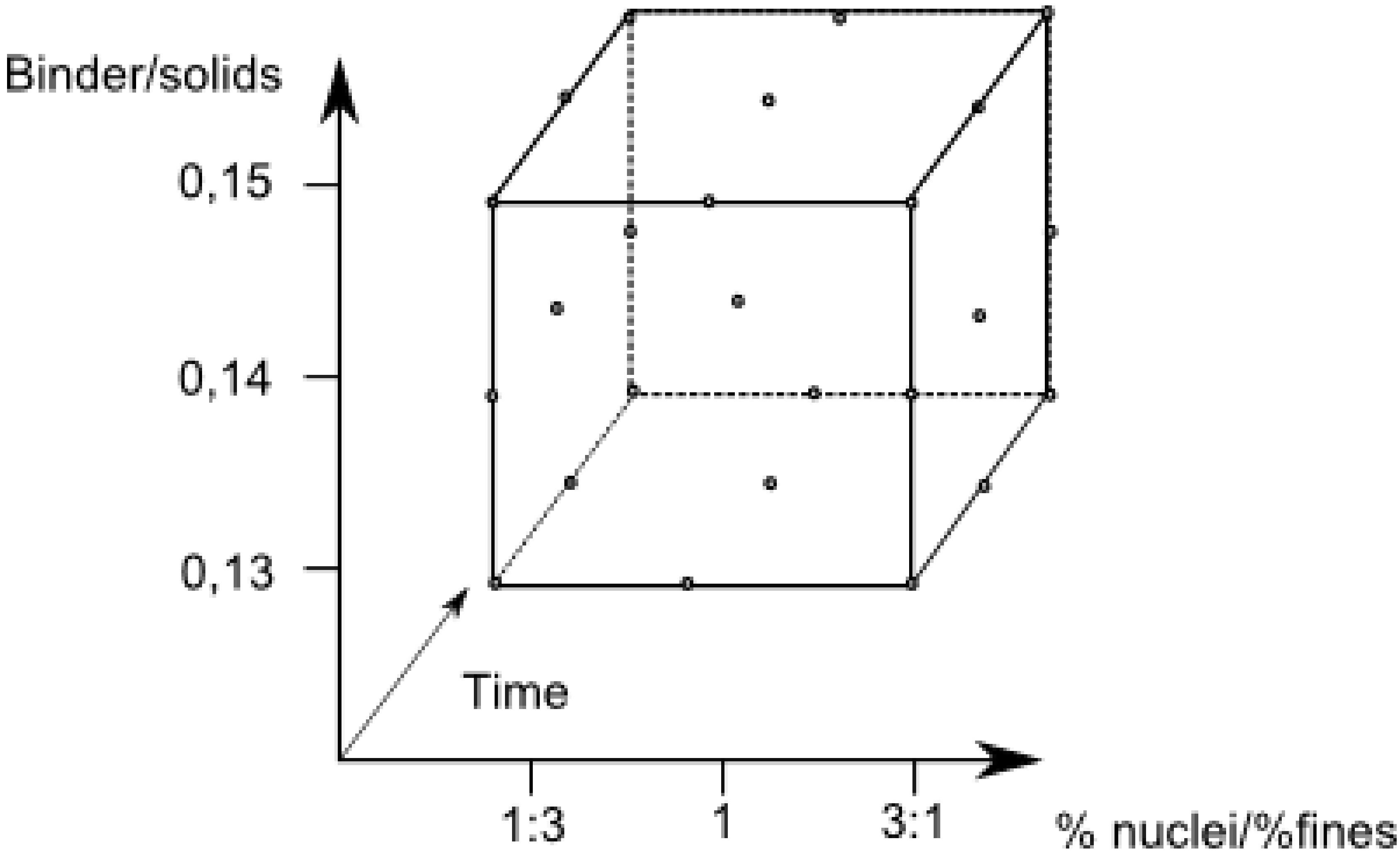
The residence time in 3 steps:

1: Rolling mode

2: Water addition

3: Granulation time

2. Experimental methodology



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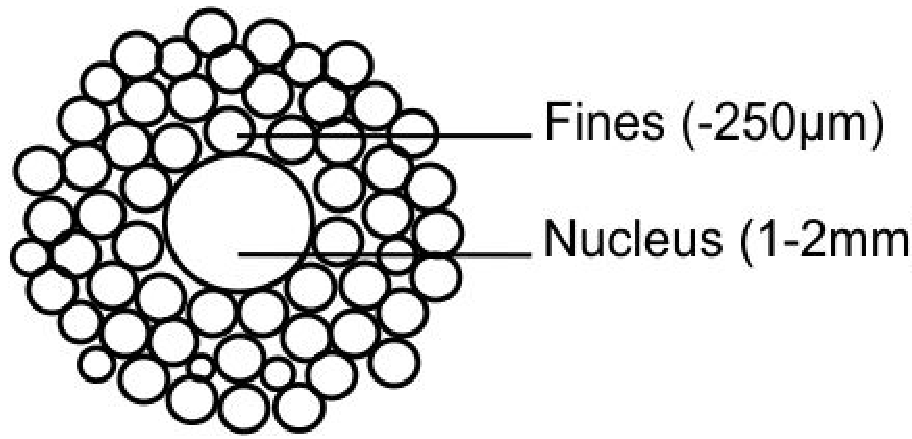

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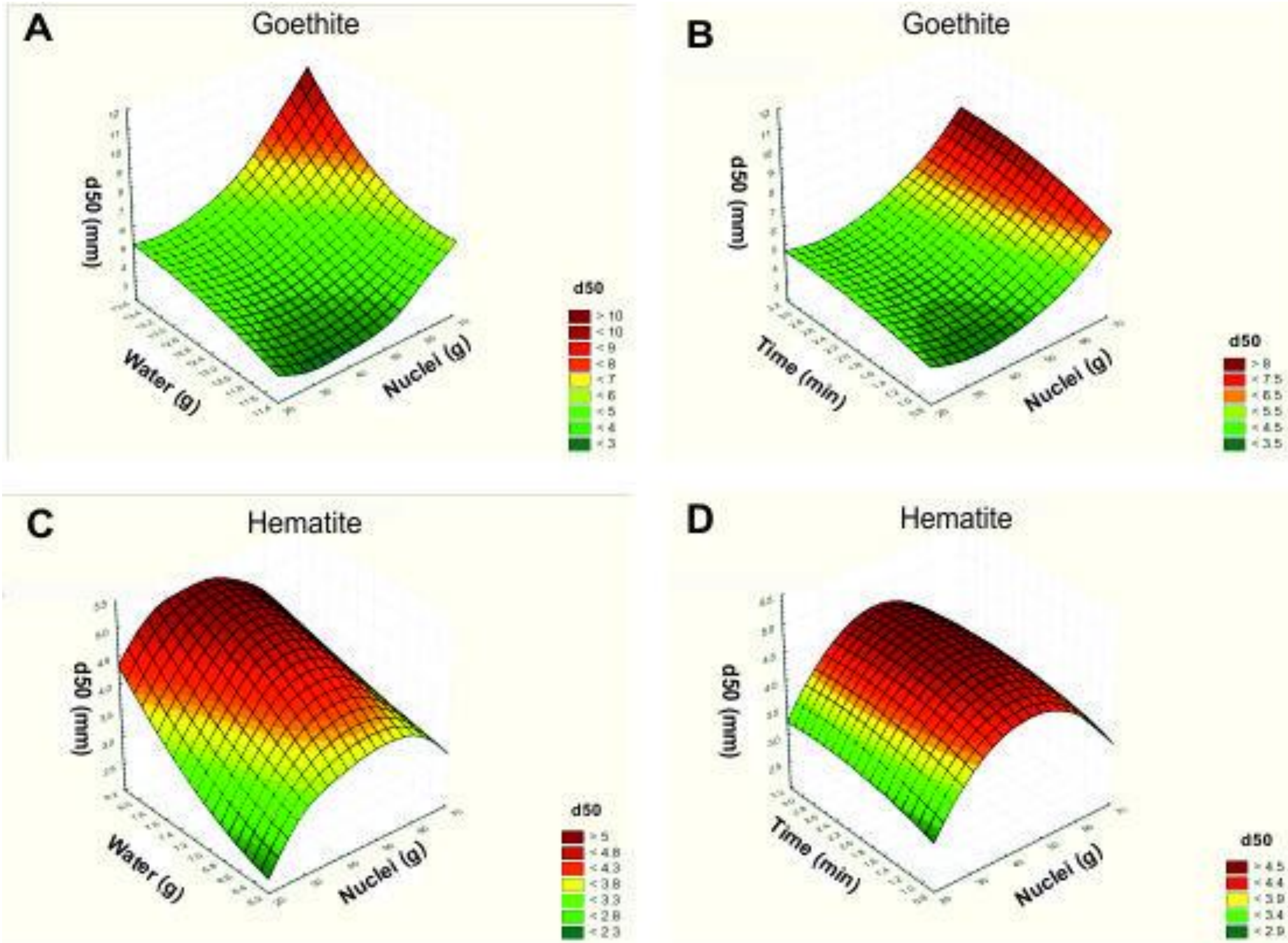
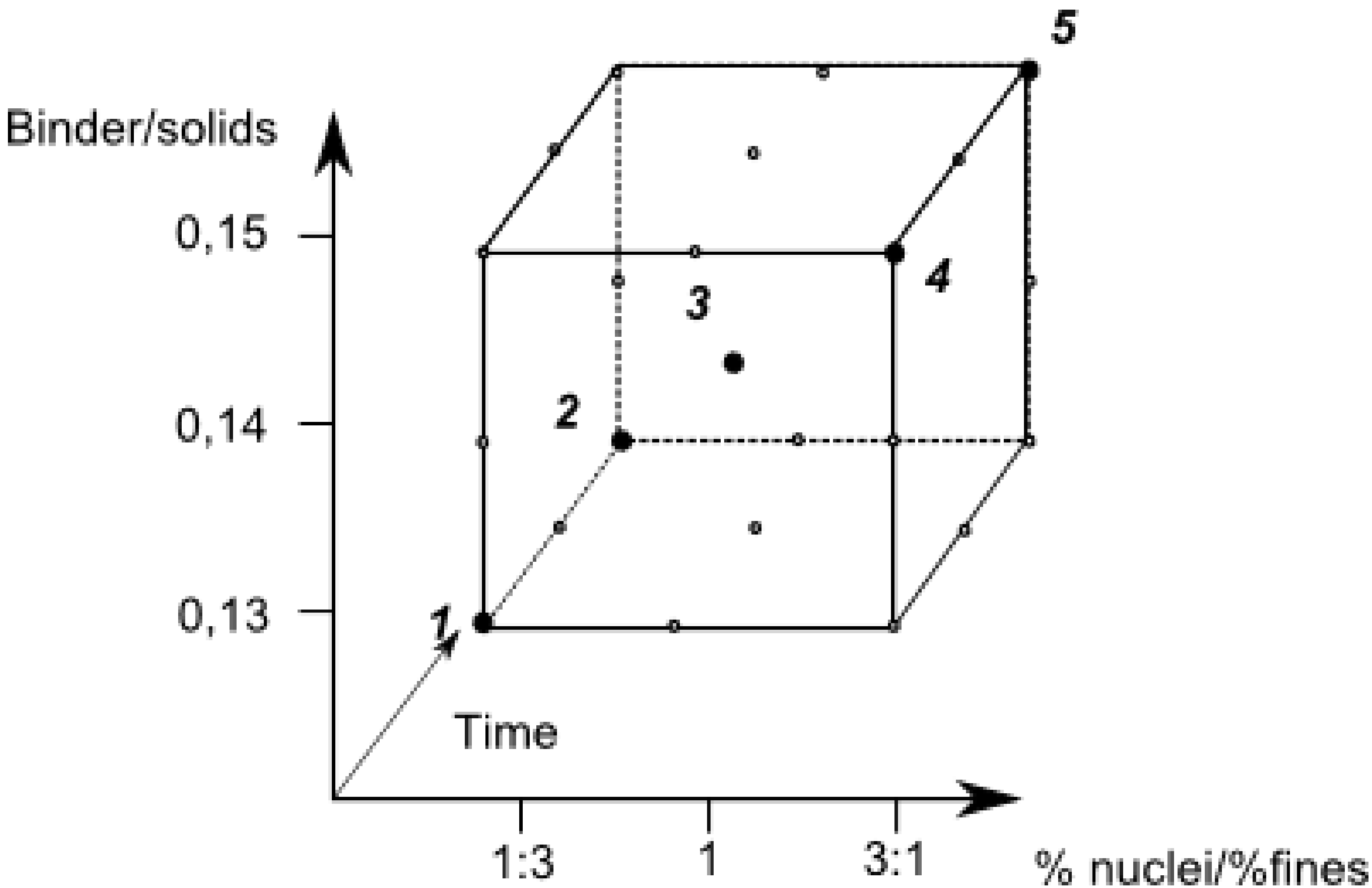


3. Characterization of the granules

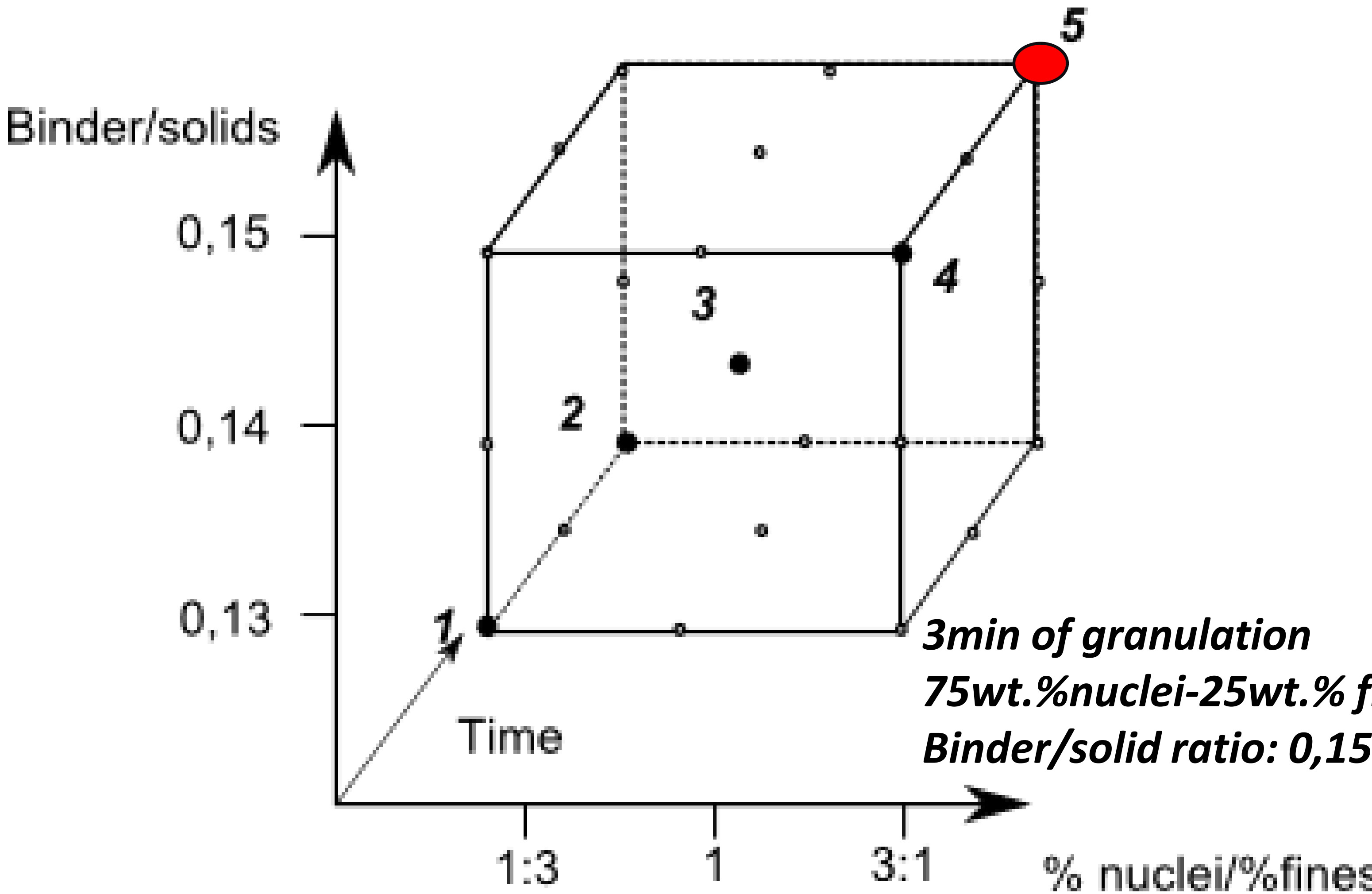
Bruker Skyscan 1172 X-ray scanner

100kv-100 µA
2D detector 4000x2300pixels
12 bit CCD camera
Al-Cu filter
Size of objects: 0,5x0,7cm
-> resolution of 4µm-6µm

3. Characterization of the granules



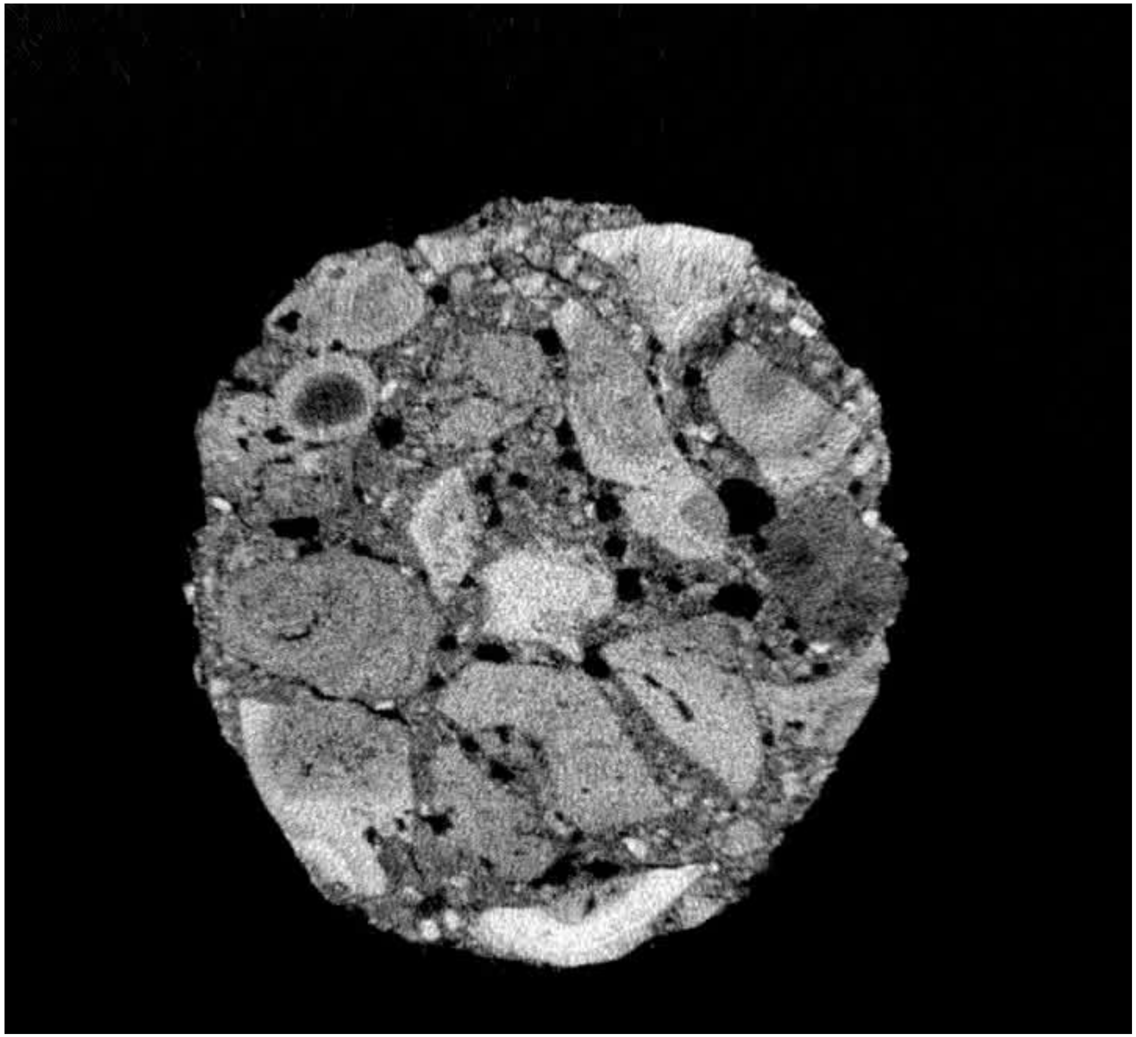
3. Characterization of the granules



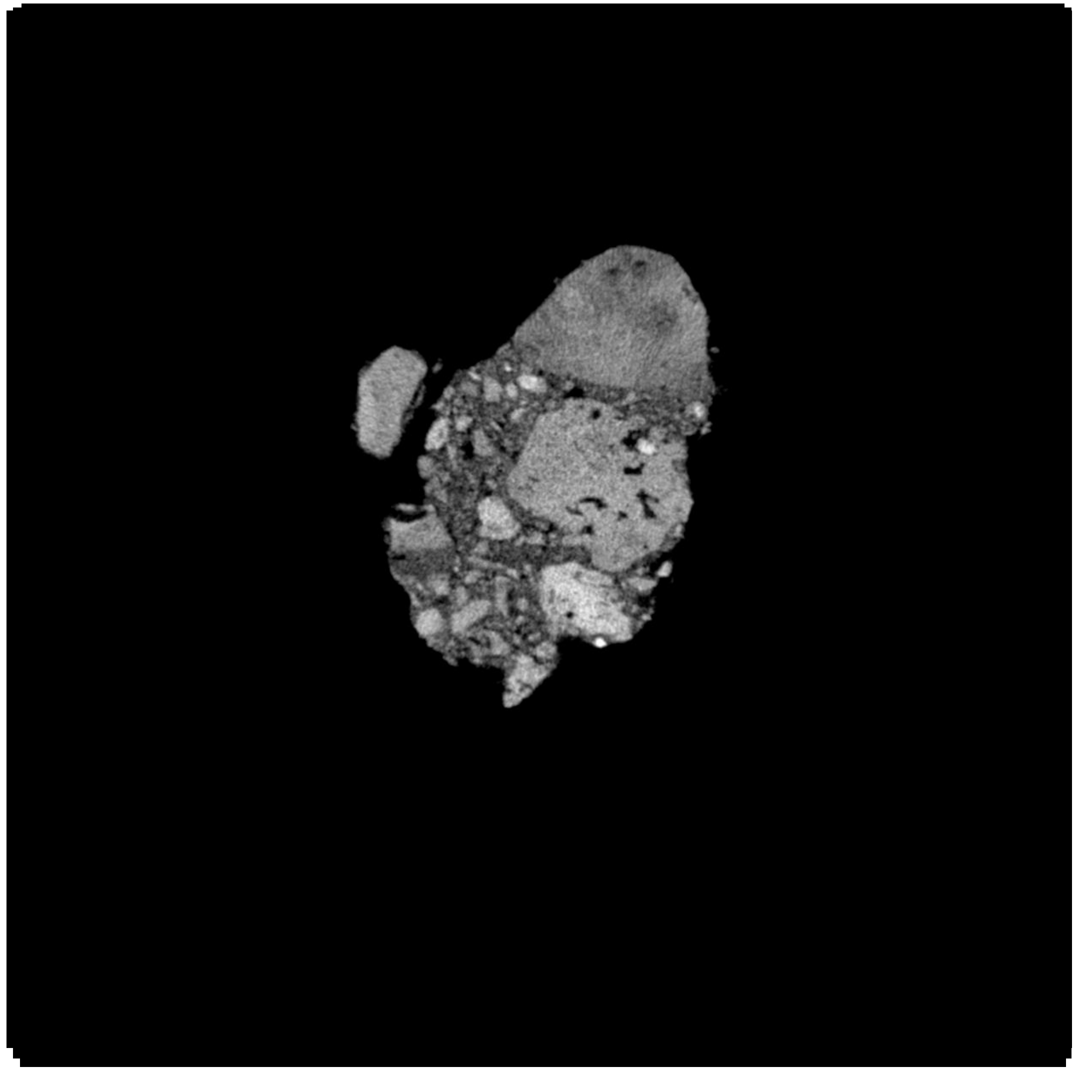
3min of granulation
75wt.%nuclei-25wt.% fines
Binder/solid ratio: 0,15

3. Characterization of the granules

Goethite « 5 »



3. Characterization of the granules



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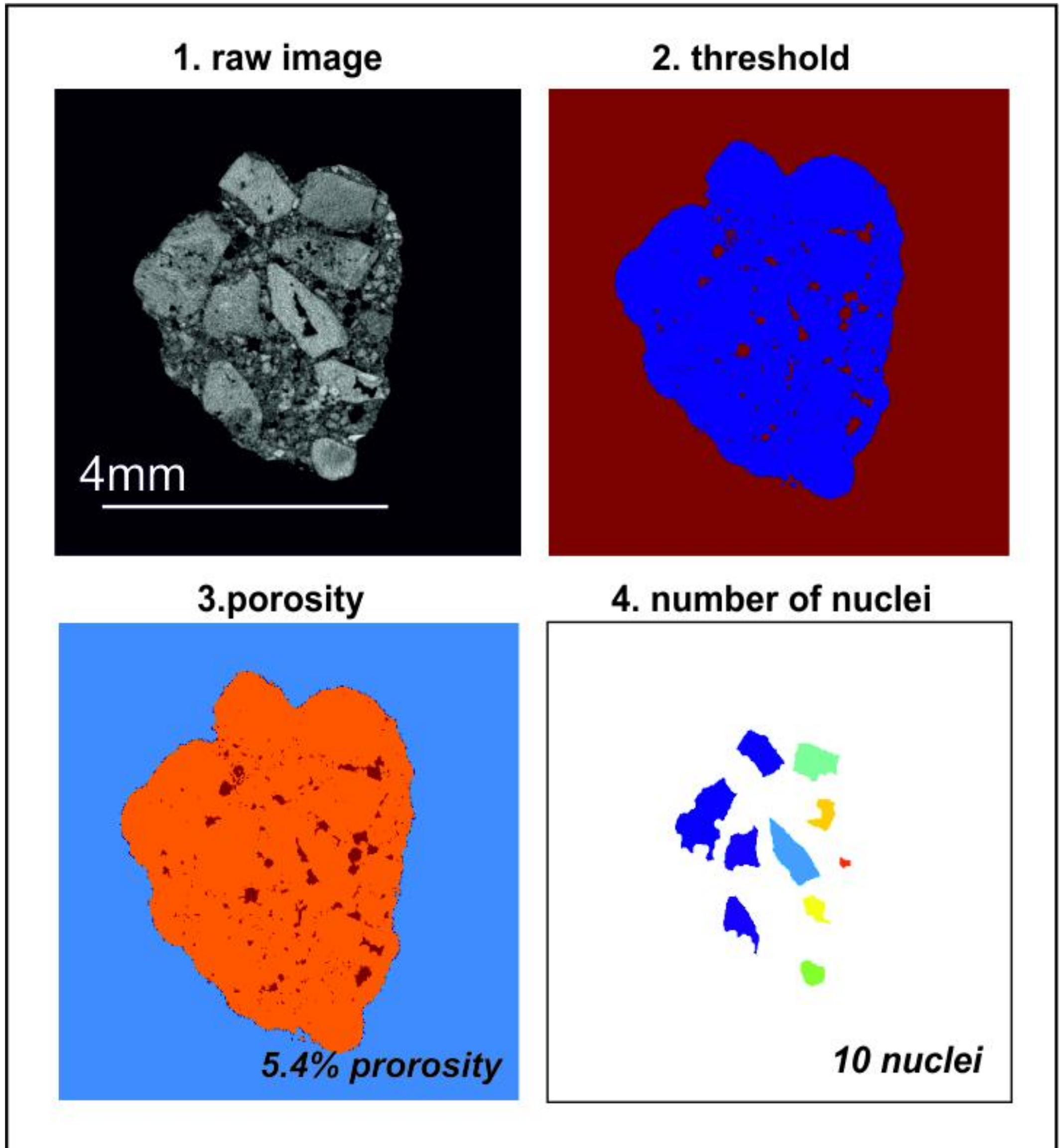

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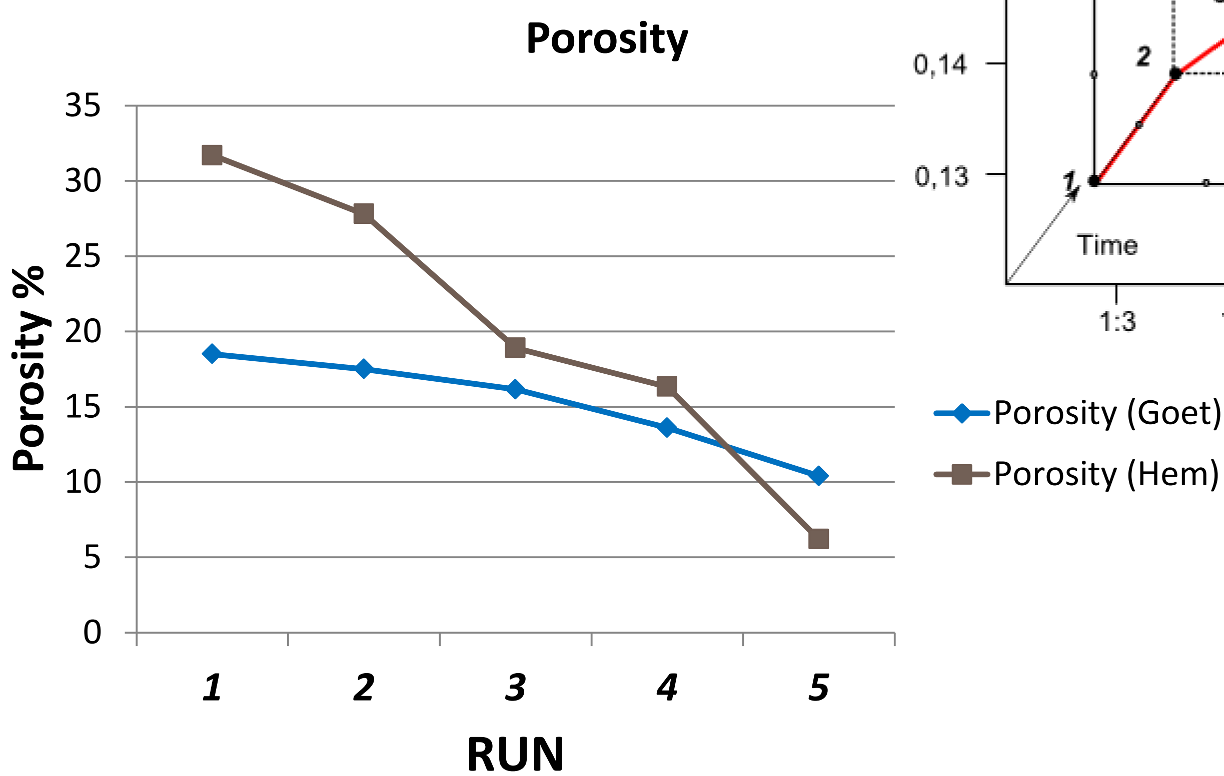

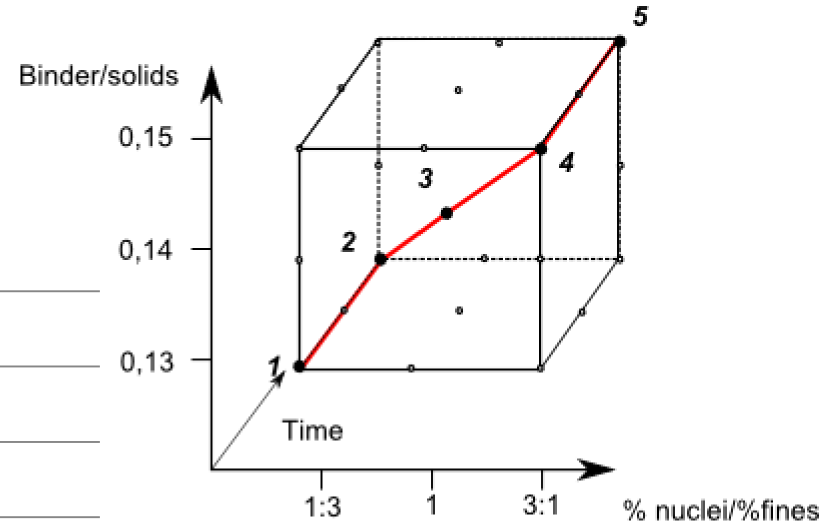

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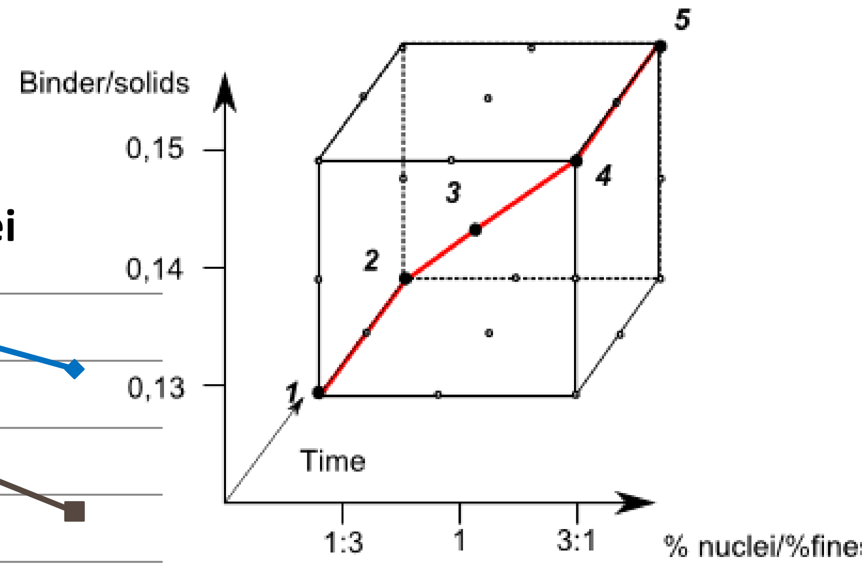

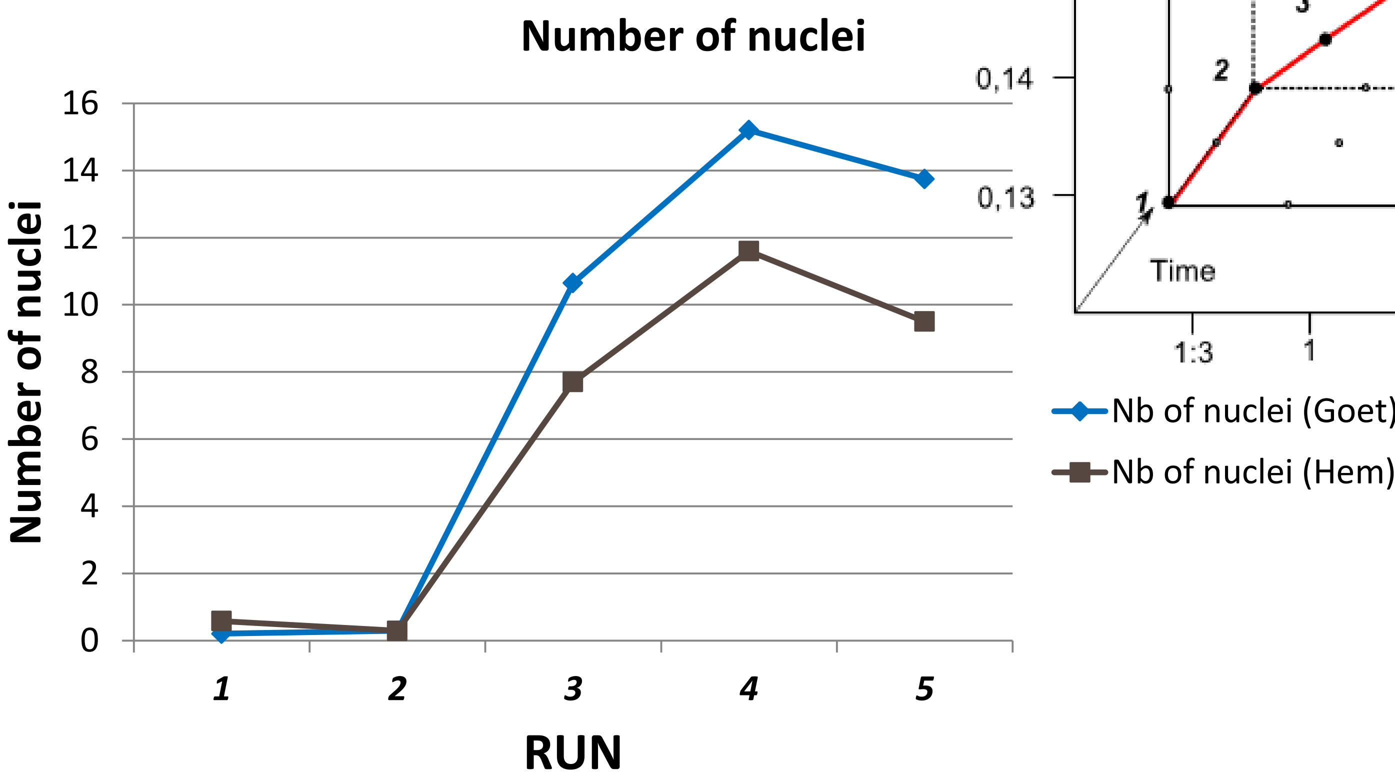

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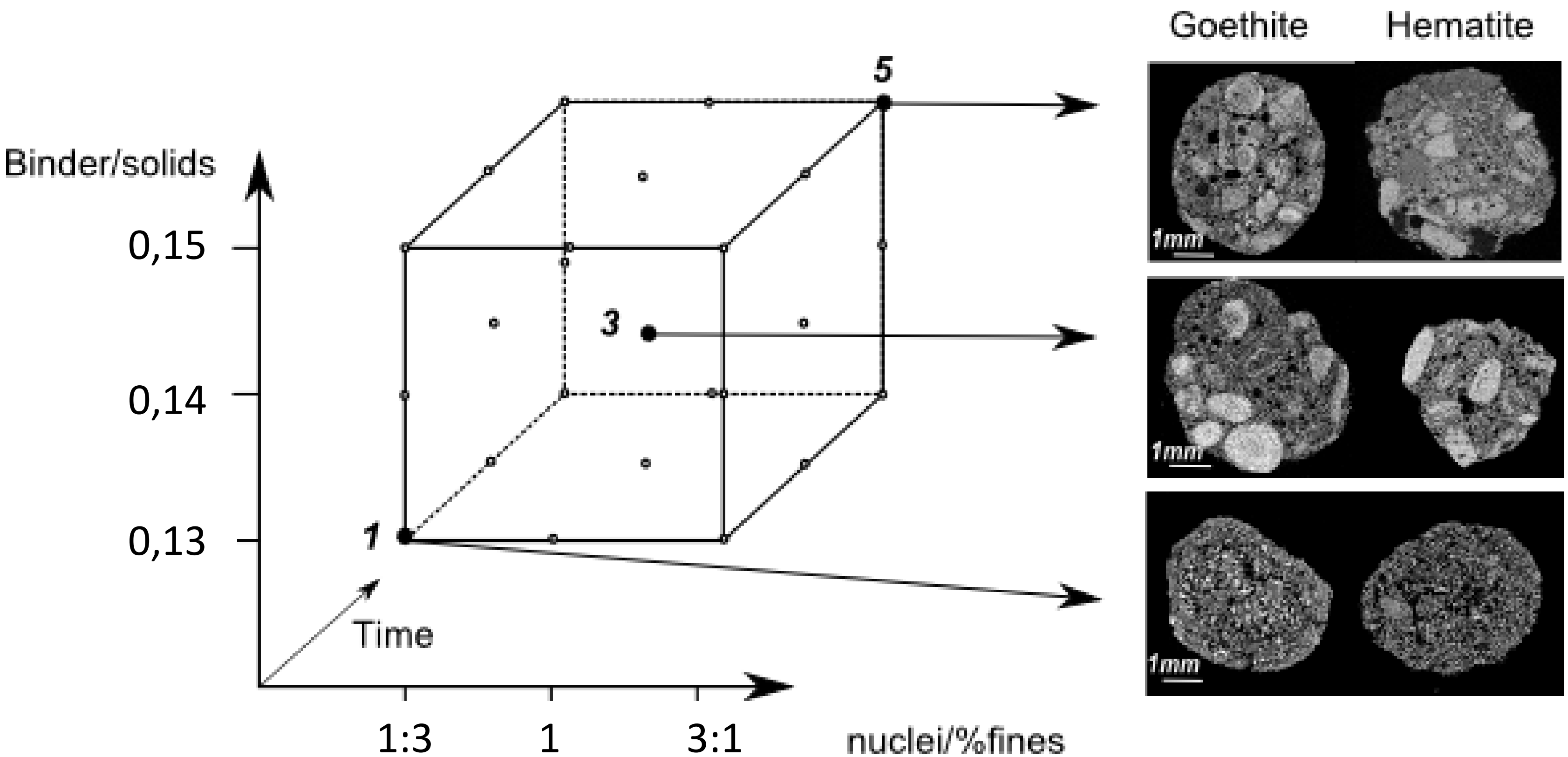
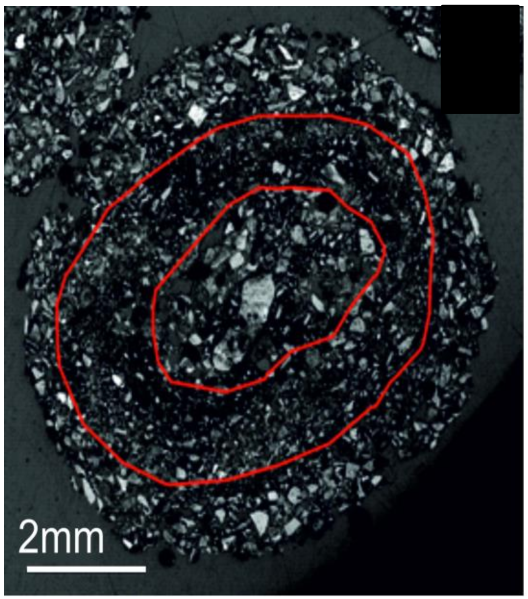
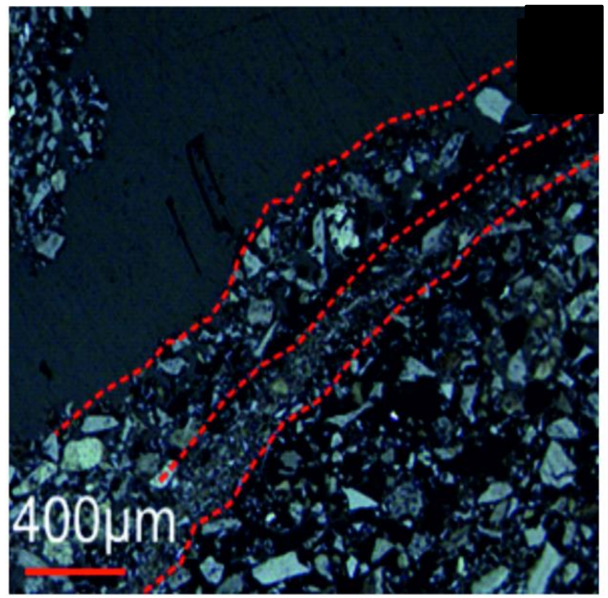


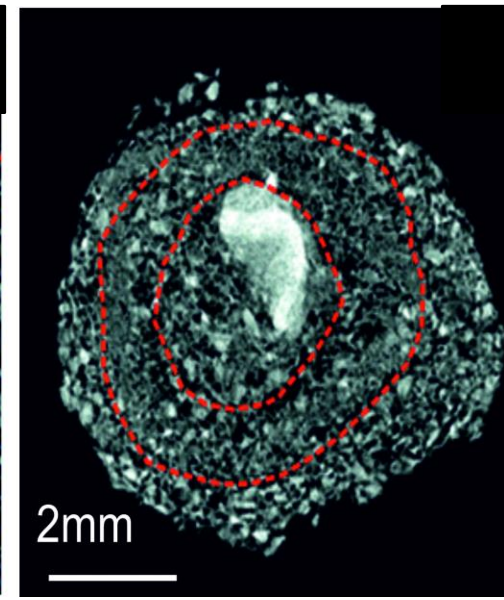
3. Characterization of the granules

Polished sections

X-ray tomography







4. Conclusion

Many parameters can be used to control the granulation process

- % water
- % nuclei
- %fines
- time of granulation
- …

BUT

-> Influence of these parameters on the d50 is strongly dependant of the mineralogy

4. Conclusion

X-Ray tomography is very useful for better understanding of granulation behavior in relation with the structure of granules, by providing 3D information on:

- texture
- porosity
- number of nuclei
- spatial distribution of primary particles

Future work

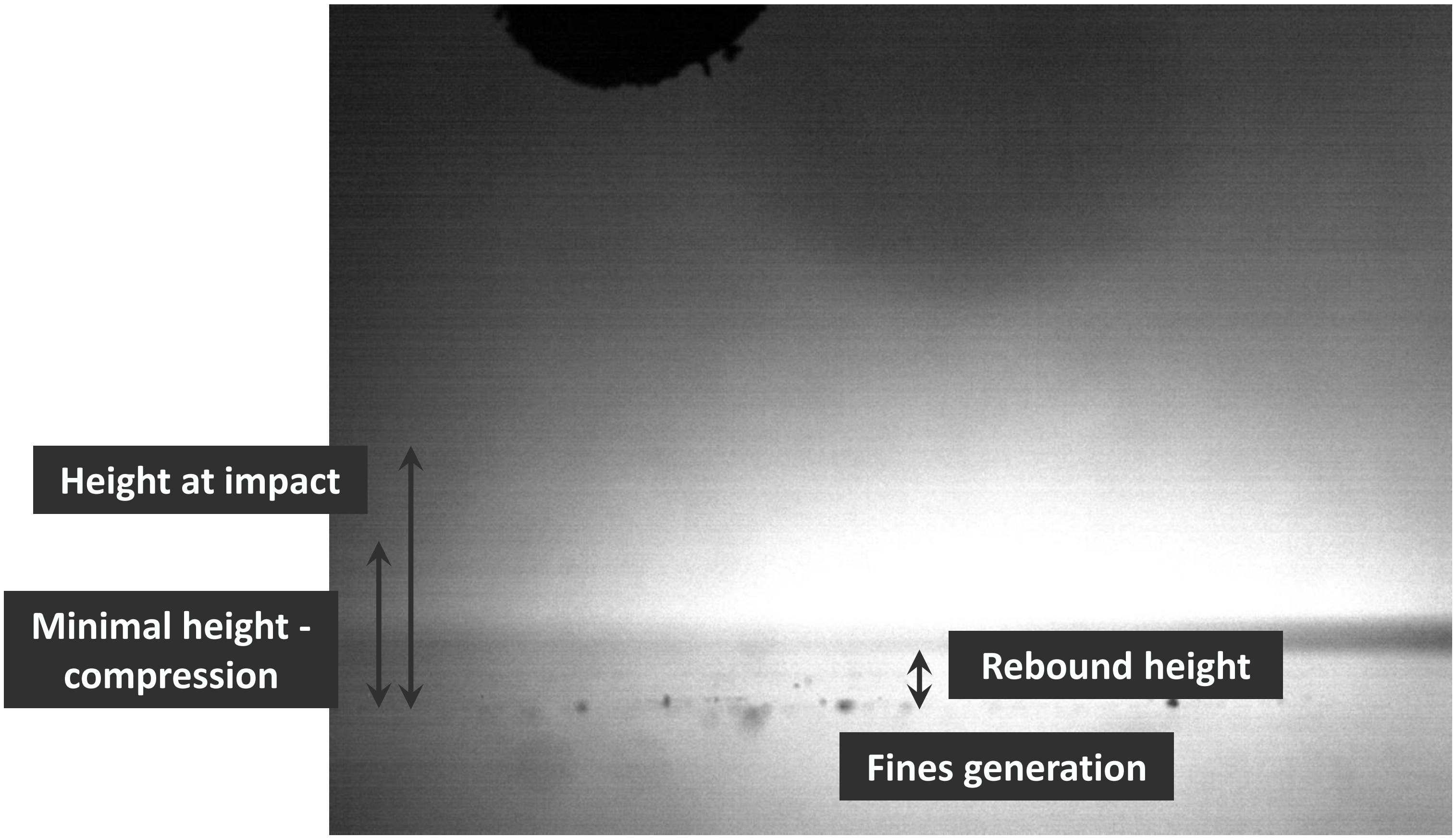
Test on particles closer to industrial mixtures:

- wider range of iron ore types
- lime(stone)
- solid fuel
- sinter return fines…

Evaluation of granule strength:

- link with structure of granules
- shock test with high speed camera

Shock test


Height at impact
Minimal height - compression
Rebound height
Fines generation

Thank you for your attention