

# **Pasek**

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## **MINERALES**

**Dunite – A cost effective raw material in  
basic refractory mixes for steel making**

**24<sup>th</sup> September 2009**

# Index

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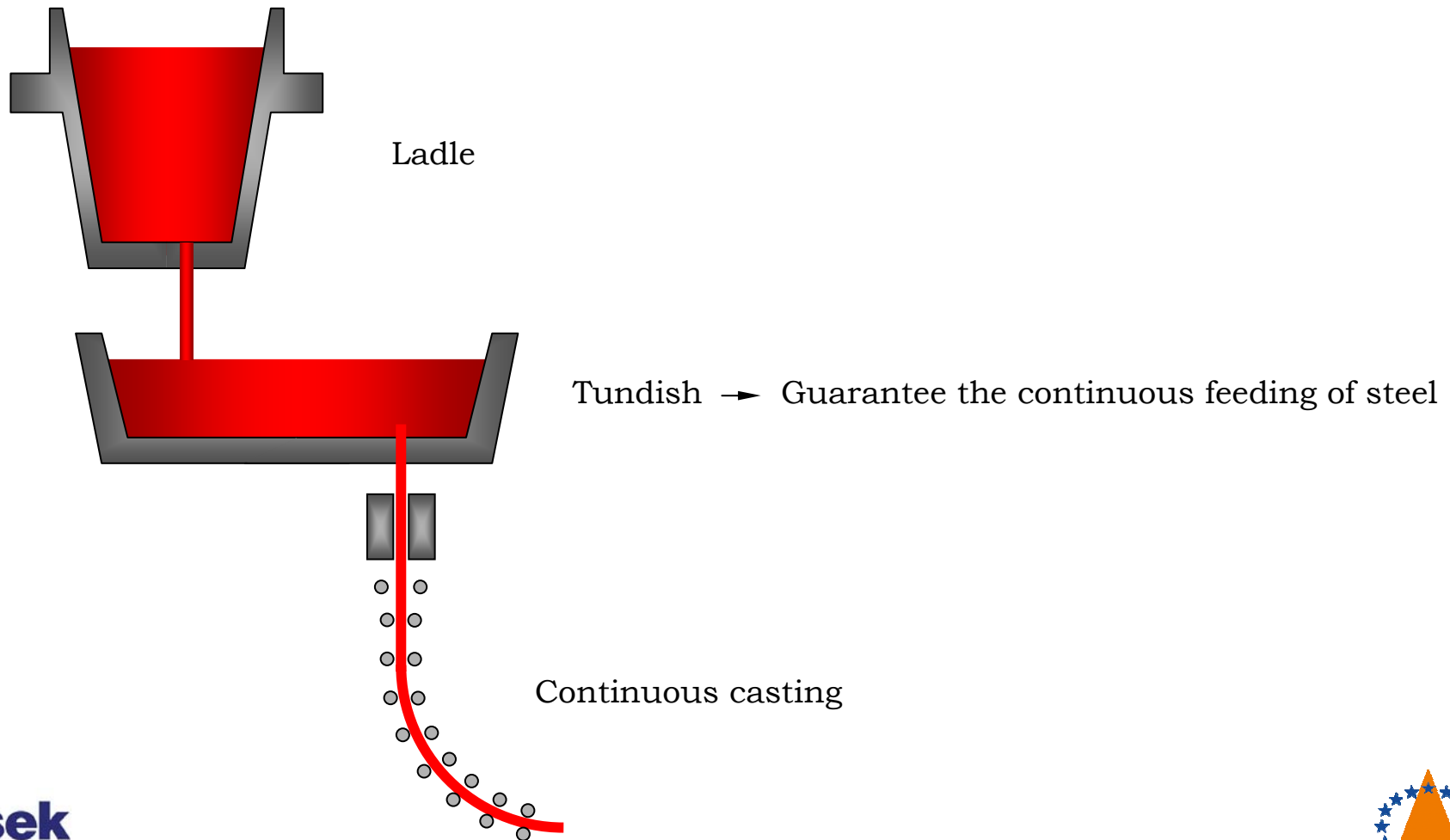
- ✓ Continuous casting in steel making
- ✓ Typical composition of tundish basic mixes
- ✓ Dunite PM
- ✓ Design of basic gunning mixes for tundish
- ✓ Laboratory results
- ✓ Industrial trial
- ✓ Conclusions



# Continuous casting in steel making

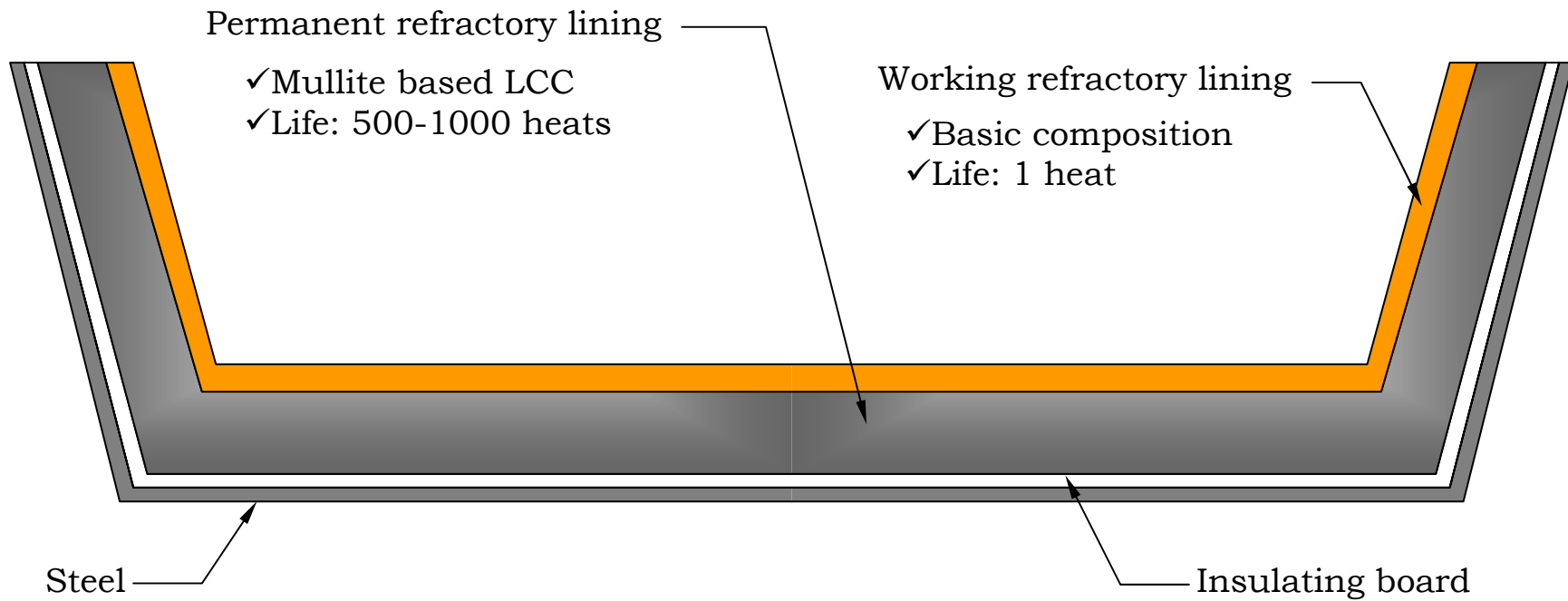
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## Scheme



# Continuous casting in steel making

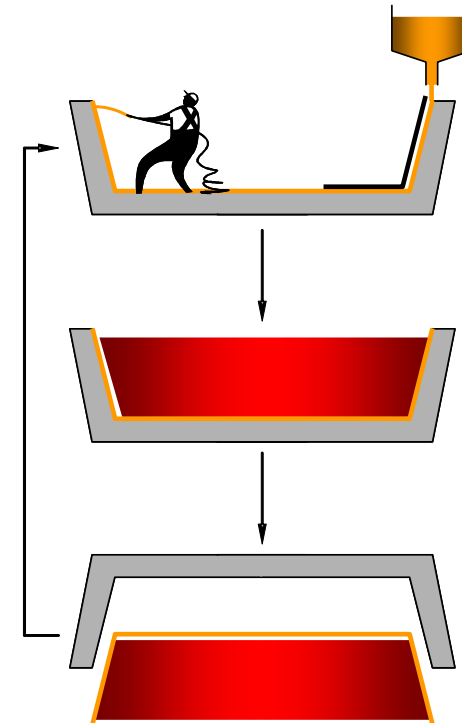
## Tundish refractory design



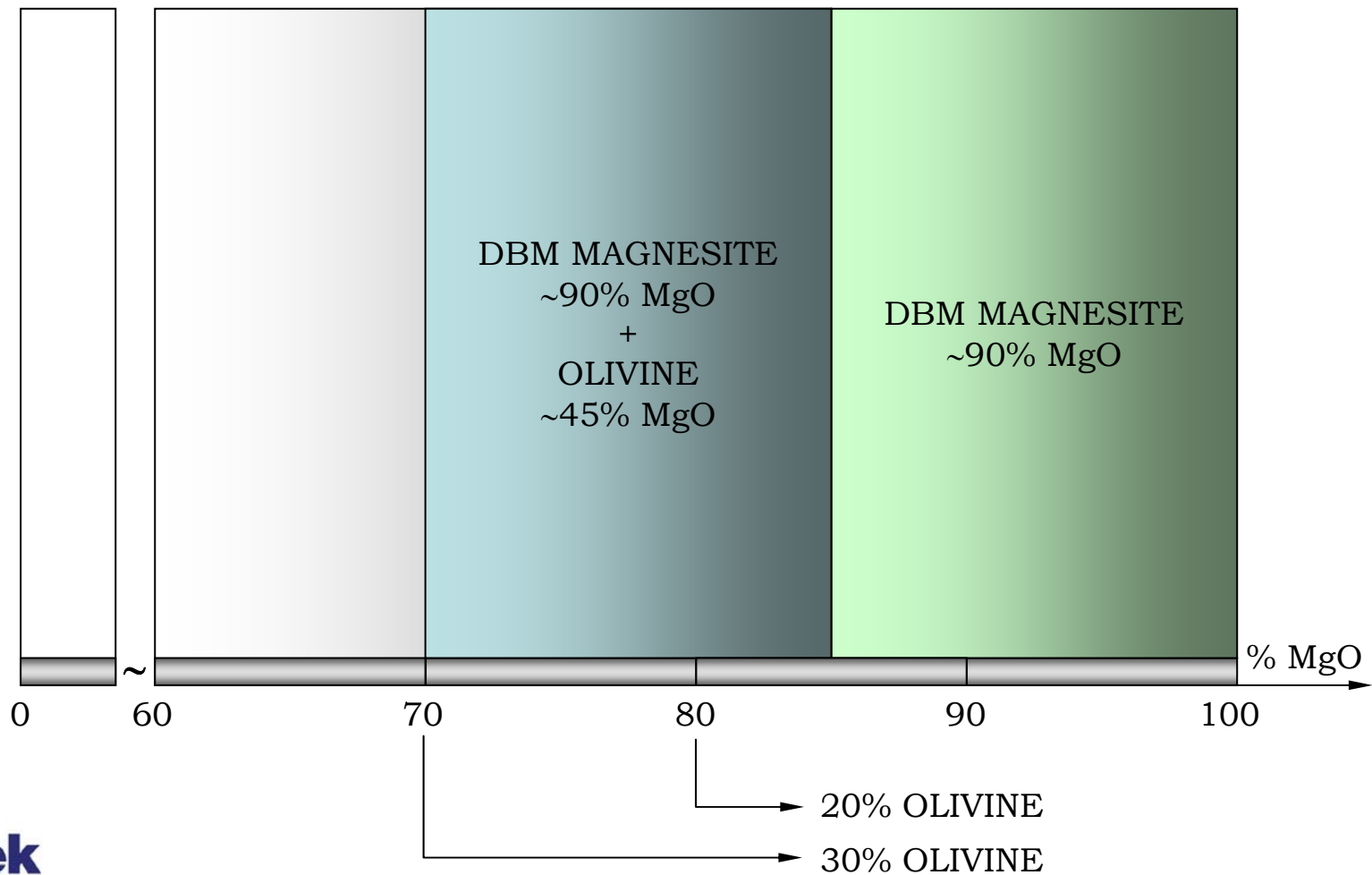
# Continuous casting in steel making

## Tundish basic mixes: Technical requirements

- ✓ Easy installation
- ✓ Steel resistance during operation
- ✓ Absence of steel contaminants
- ✓ Low adherence to permanent lining
- ✓ Easy loup elimination



# Typical composition of tundish basic mixes



# Typical composition of tundish basic mixes

Basic raw materials based in forsterite  $2\text{MgO}\cdot\text{SiO}_2$

	UNHYDRATED NATURAL ORES Olivine	HYDRATED NATURAL ORES Serpentinites with high MgO content
MgO	49,0	36,0
CaO	---	2,0
SiO <sub>2</sub>	41,8	40,7
Al <sub>2</sub> O <sub>3</sub>	0,6	2,6
Fe <sub>2</sub> O <sub>3</sub>	7,7	8,9
LOI	---	9,3



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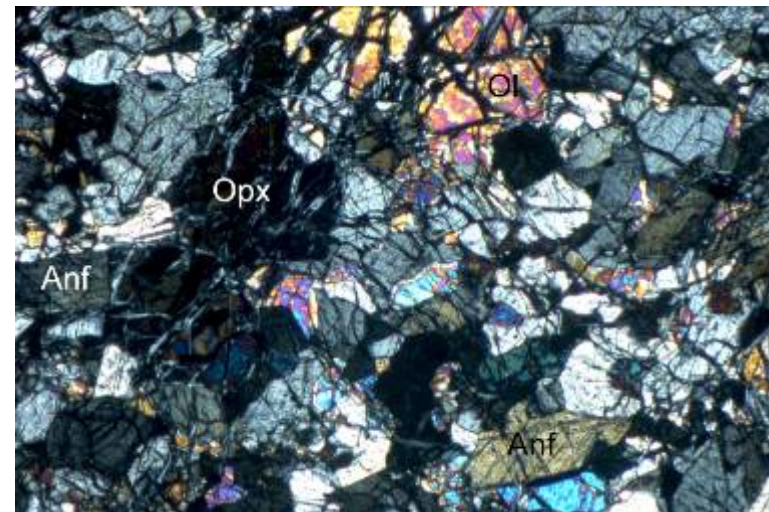
**DUNITE PM**



# Dunite PM

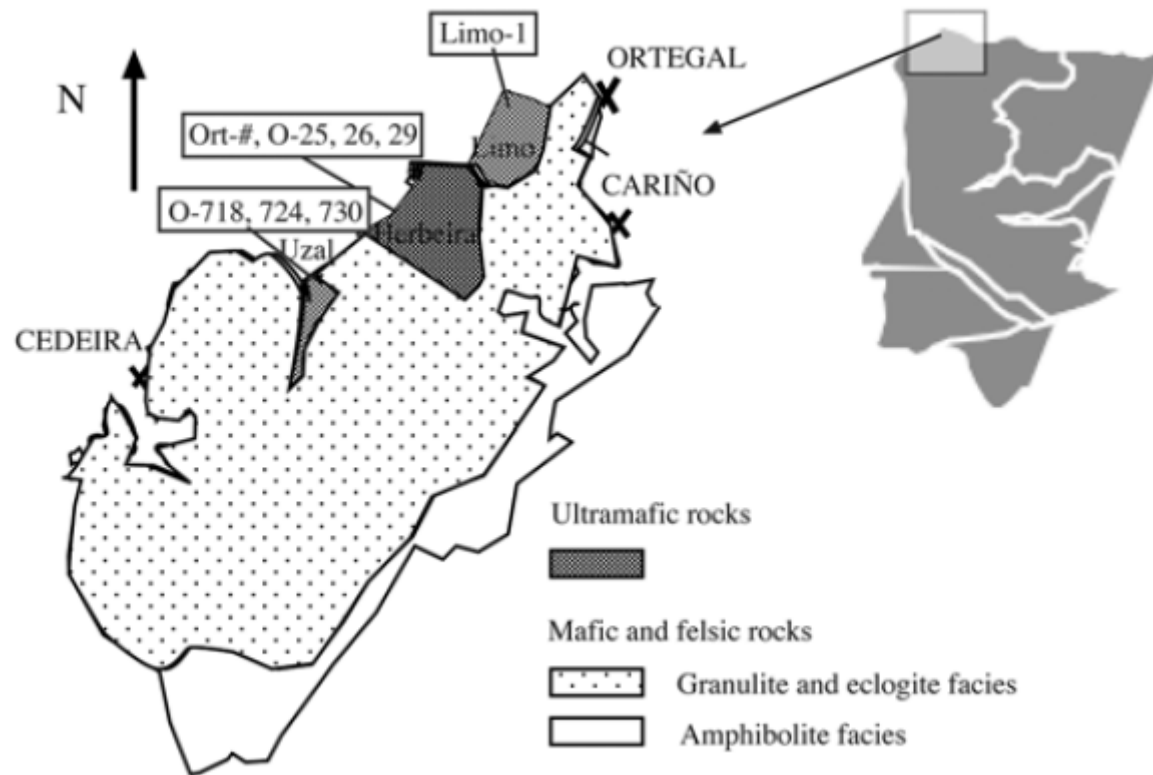
## Petrology

- ✓ Ultramaphic rock
  - Orthopyroxene
  - Clinopyroxene
  - Olivine
- ✓ Hydrothermal serpentinization
- ✓ Grain size medium to high
- ✓ Mesh texture
- ✓ Exploited area of the mine uses the material with lowest alteration



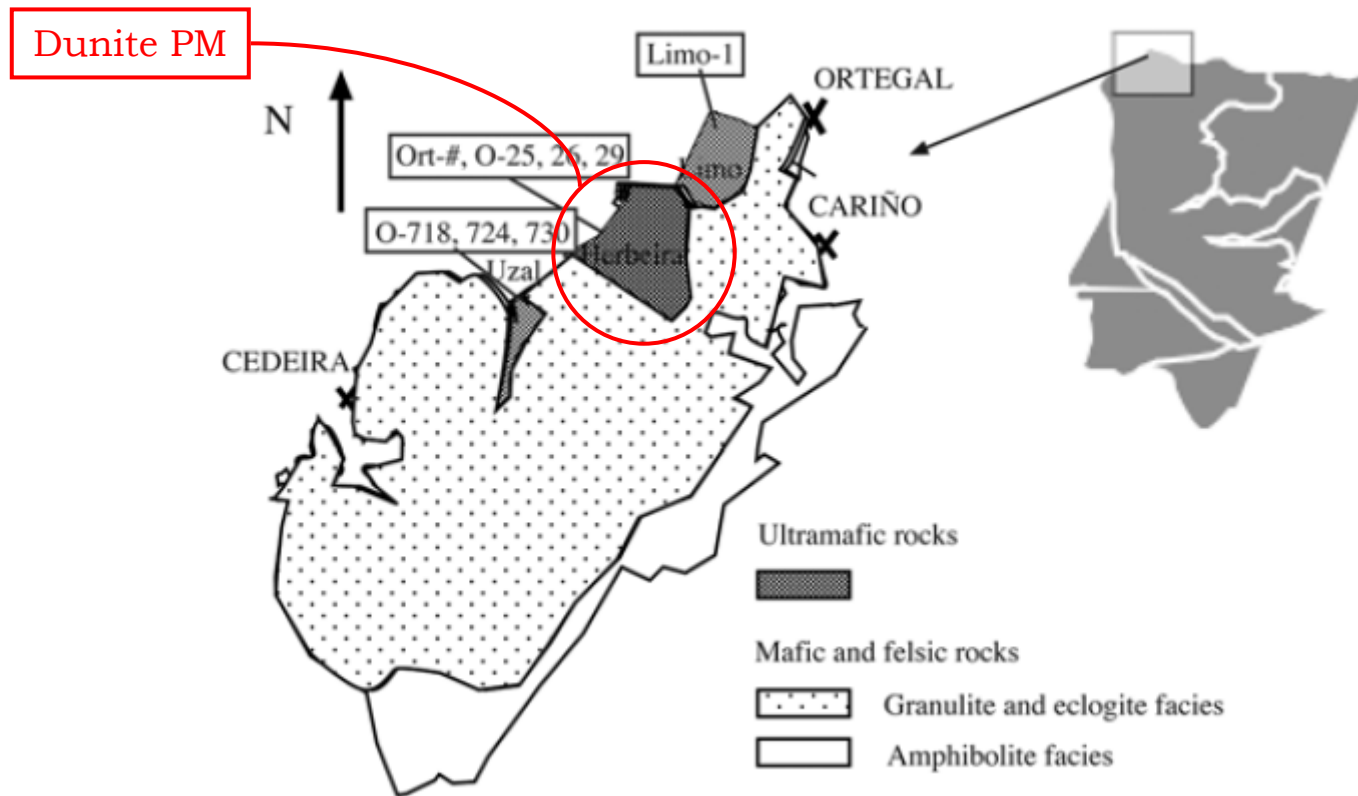
# Dunite PM

Deposit: Ultramaphic massif of Cabo Ortegal in north western Spain



# Dunite PM

Deposits: Ultramaphic massif of Cabo Ortegal in north western Spain



# Dunite PM

## Thermodynamics: Theoretical mix of periclase and Dunite PM

	PERICLASE DBM Chinese Magnesite	DUNITE PM
MgO	92,50	36,01
CaO	1,63	1,97
SiO <sub>2</sub>	3,28	40,66
Al <sub>2</sub> O <sub>3</sub>	0,24	2,60
Fe <sub>2</sub> O <sub>3</sub>	1,29	8,86
Cr <sub>2</sub> O <sub>3</sub>	---	0,34
Na <sub>2</sub> O	0,01	0,11
K <sub>2</sub> O	<0,5	0,05
LOI	1,01	9,33



# Dunite PM

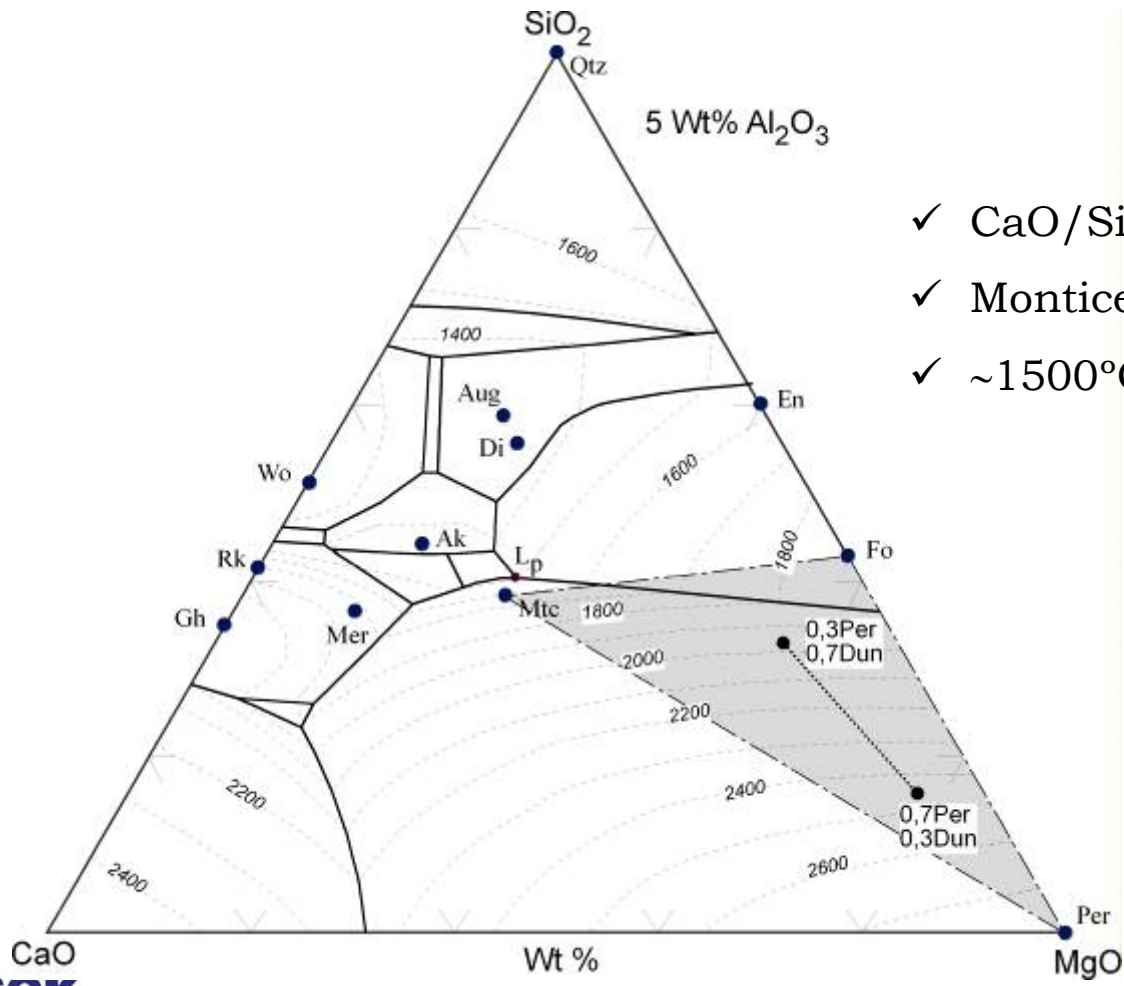
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# Dunite PM

## Thermodynamics: Theoretical mix of periclase and Dunite PM



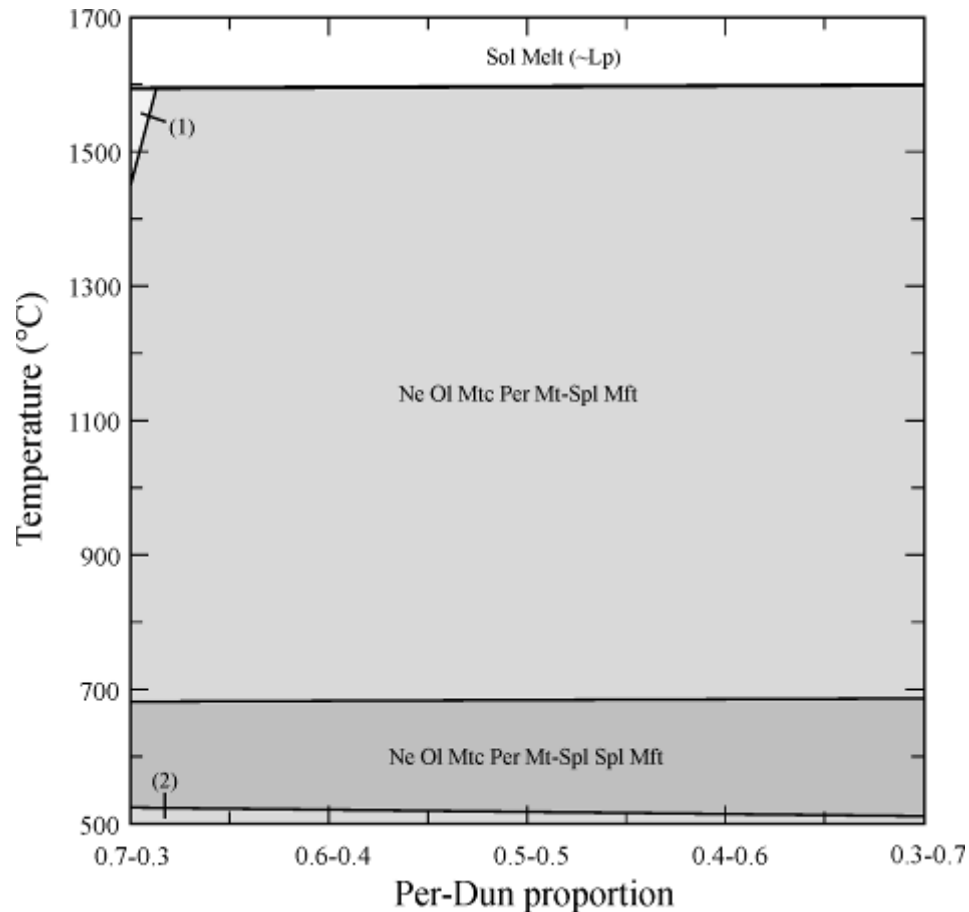
- ✓  $\text{CaO/SiO}_2 \rightarrow 0$  in the mix
- ✓ Monticellite (Mtc) precipitation
- ✓  $\sim 1500^\circ\text{C}$  first liquid formation





# Dunite PM

## Thermodynamics: Real system discussion through pseudosections



### Phases

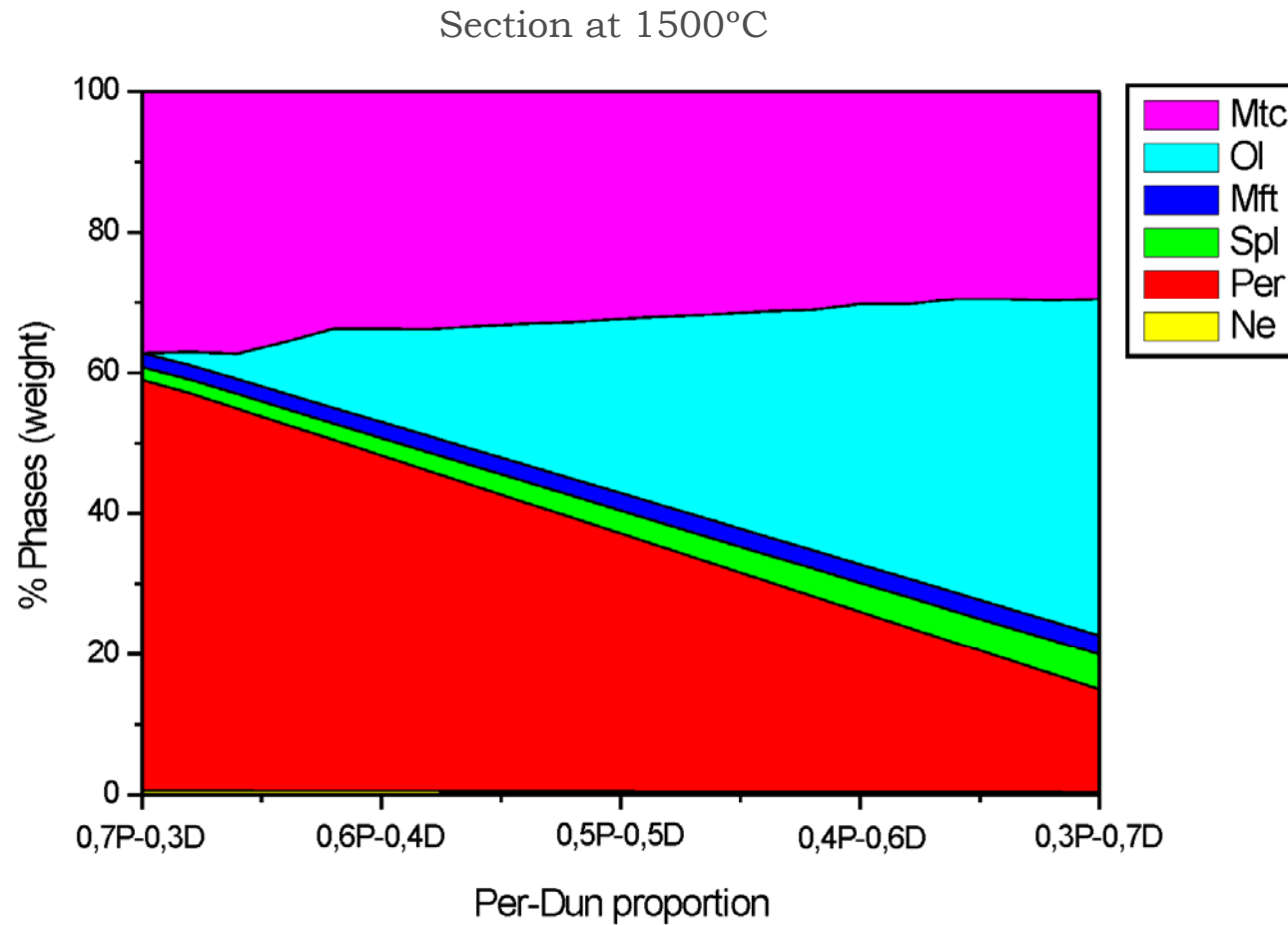
- Nepheline (Ne):  $\text{Na}_{0.01}\text{K}_{0.99}\text{AlSiO}_4$
- Monticellite (Mtc):  $\text{Ca}_{0.14}\text{Mg}_{1.86}\text{SiO}_4$
- Olivine (Ol):  $\text{Mg}_{1.93}\text{Fe}_{0.07}\text{SiO}_4$
- Periclase (Per):  $\text{Mg}_{0.98}\text{Fe}_{0.02}\text{O}$
- Spinel (Spl):  
 $[\text{Mg}_{1.5}\text{Fe}^{2+}_{0.5}][\text{Al}_{1.55}\text{Cr}_{0.32}\text{Fe}^{3+}_{0.1}]\text{O}_4$
- Magnetitespinel (MtSp):  
 $[\text{Fe}^{2+}_{0.31}\text{Mg}_{0.73}][\text{Ti}_{0.04}\text{Fe}^{3+}_{0.45}\text{Al}_{1.46}]\text{O}_4$
- Magnesioferrite (Mft):  $\text{MgFe}^{3+}_2\text{O}_4$

No liquid below 1600°C



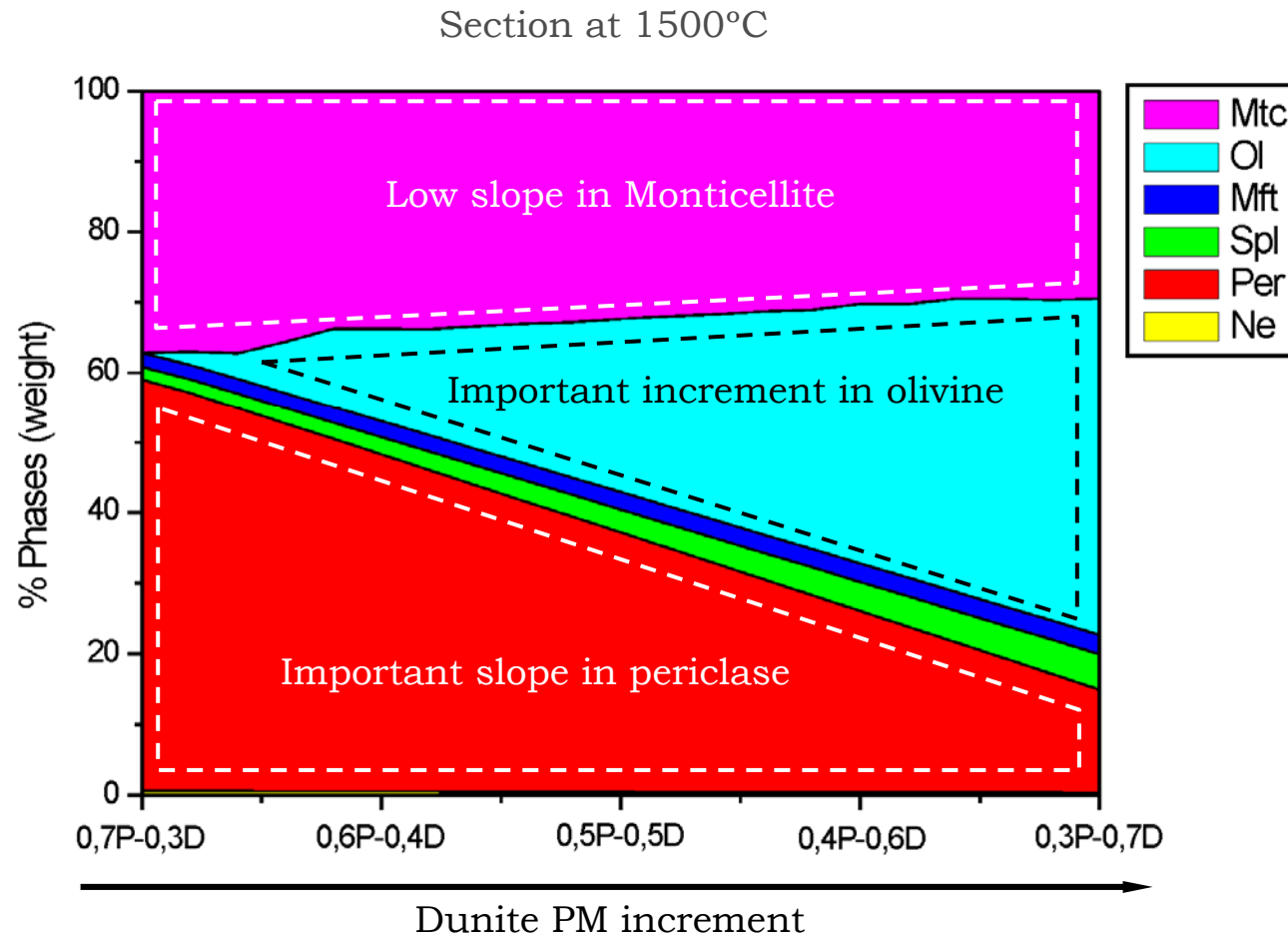
# Dunite PM

## Thermodynamics: Real system discussion through pseudosections



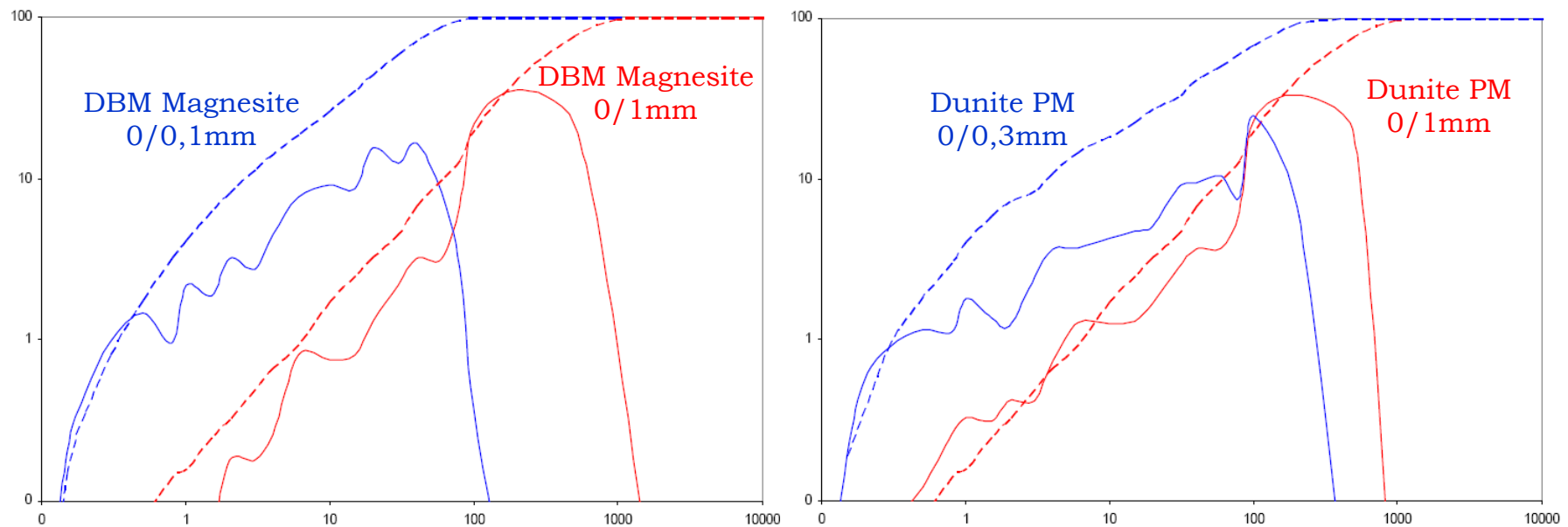
# Dunite PM

## Thermodynamics: Real system discussion through pseudosections



# Design of basic gunning mixes for tundish

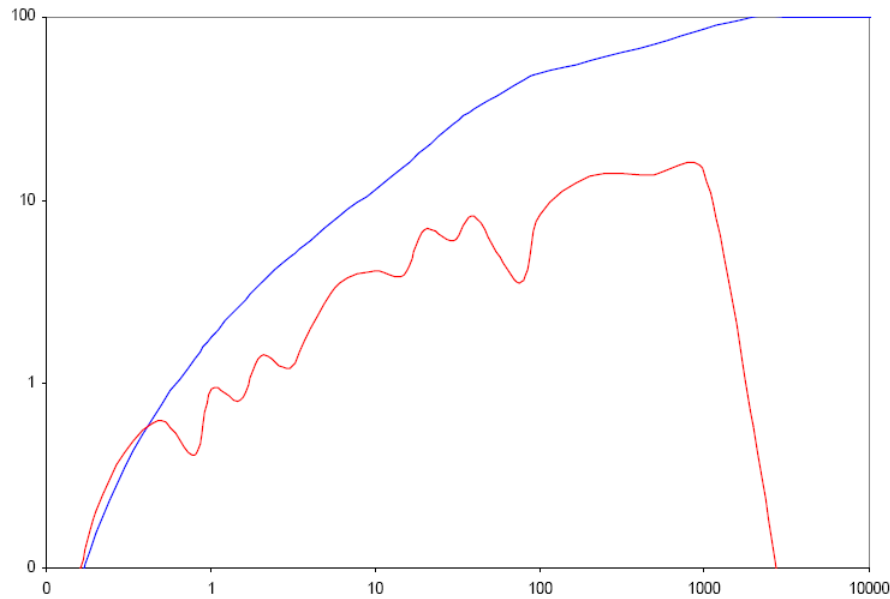
## Particle size of main raw materials



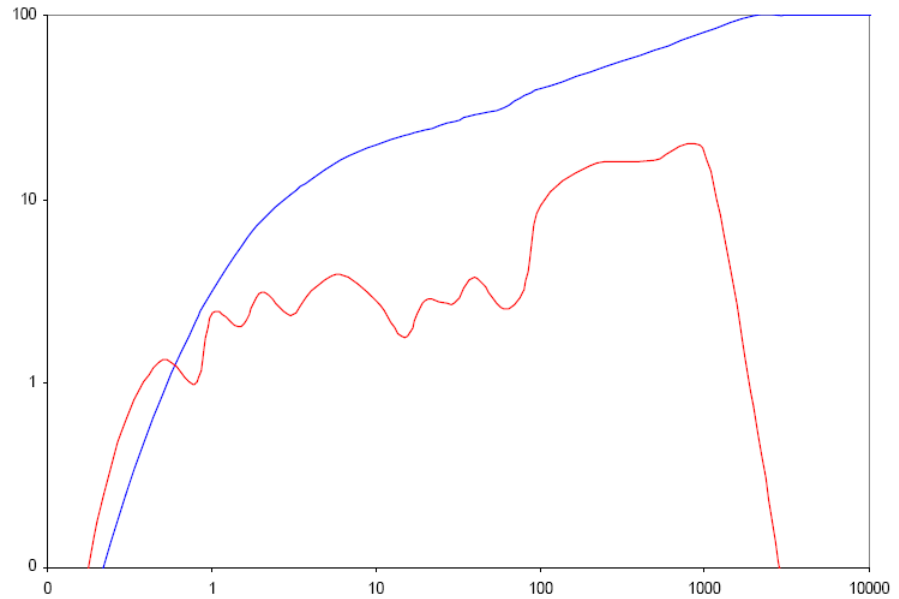
# Design of basic gunning mixes for tundish

## Particle size of mixes

70% Magnesite / 30% Dunite PM

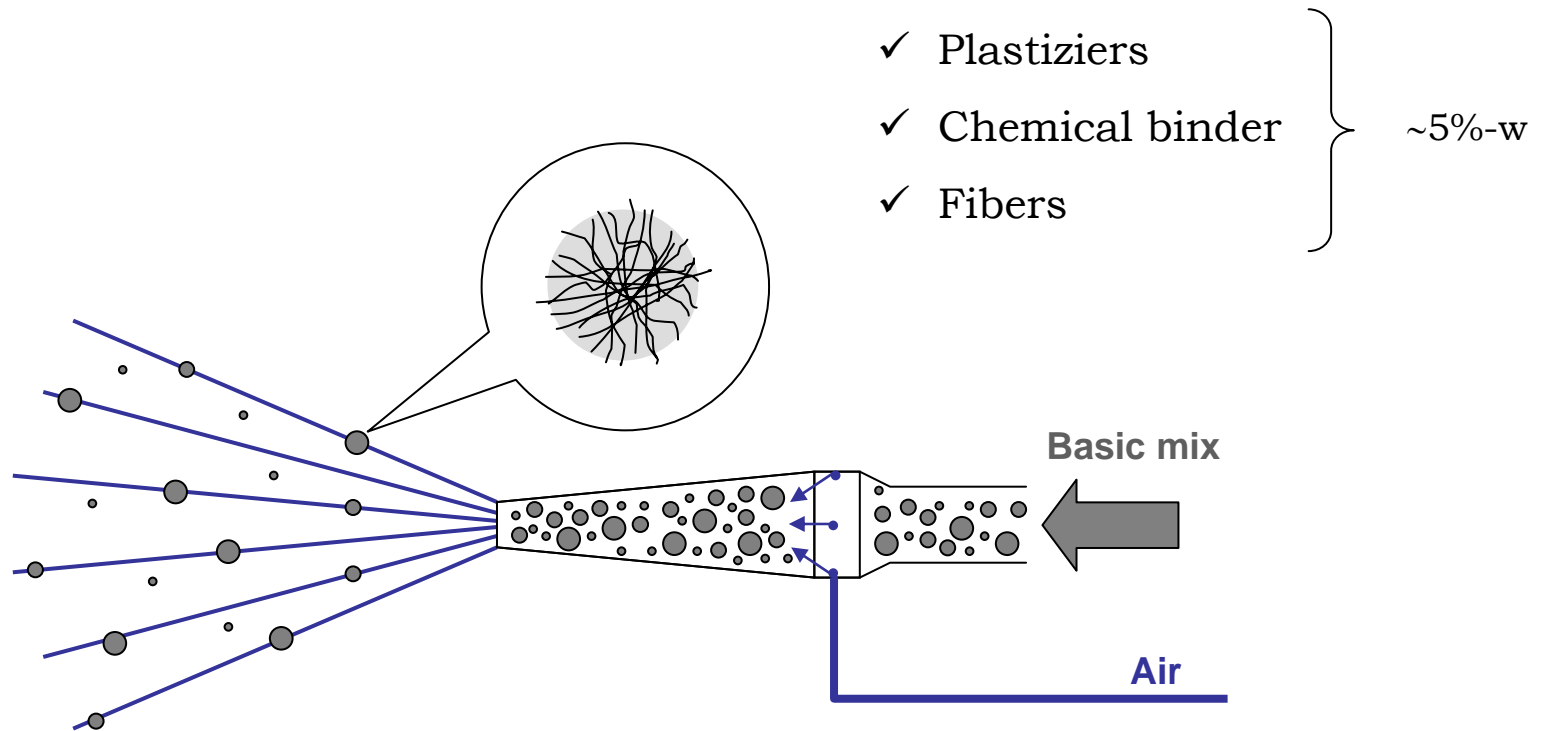


50% Magnesite / 50% Dunite PM



# Design of basic gunning mixes for tundish

## Additives for gunning and porosity performance



# Laboratory results

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Samples fired 5h at 1450°C



Dunite  
PM/DBM

30/70

40/60

50/50



# Laboratory results

Adherence to refractory substrate at 1500°C



Dunite  
PM/DBM

30/70

40/60

50/50

**Very low**

**Very low**

**Very low**





# Laboratory results

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## Industrial trial selection



Dunite  
PM/DBM

30/70

**Very low**

40/60

**Very low**

50/50

**Very low**



# Industrial trial

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## Steel plant process

- ✓ Spanish EAF Steel Plant
- ✓ Tundish Capacity: 32 Ton
- ✓ Permanent refractory lining: Andalusite based LCC
- ✓ Sprayable thickness: 30 mm
- ✓ Regular sequence: 10 ladles / 1300 Ton
- ✓ Sequence in the trial: 8 ladles / 1040 Ton



# Industrial trial

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## Installation performance



Before

Sprayed

After

# Industrial trial

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Adherence to permanent refractory lining



# Industrial trial

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## Loup elimination



# Conclusions

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- ✓ Dunite PM is a natural low cost basic raw material
- ✓ It can be used without preheating
- ✓ Magnesite substitution will reduce cost of typical mixes
- ✓ Results of this study can be used in any basic refractory mixes



**Thank you**

**Pasek**  

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**MINERALES**

