# Investigation of convertor slag properties and their influence on steel refining

*GTT user meeting 2018*

Lotte De Vos

Lotdvos.devos@ugent.be

ArcelorMittal

UNIVERSITEIT GENT

# Outline

Introduction

Background

Topics of the PhD

Highlight: Phase diagram

Conclusion

# Introduction: Involved partners

## Academic partner:

Research group Sustainable Materials Science (SMS)

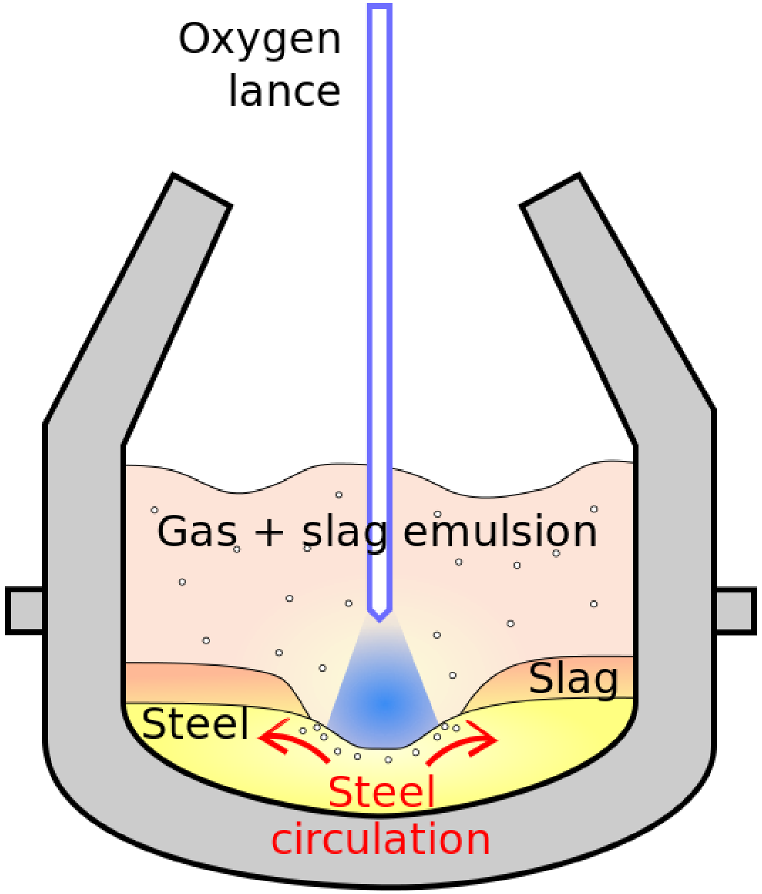
Department of Materials, Textiles and Chemical Engineering

Ghent University

## Industrial partner:

ArcelorMittal Gent

# Background: **BOF Steelmaking**






**Goal:**

Decrease carbon content & remove impurities

➔ Production of steel

**How:**

Liquid hot metal + scrap + fluxes into converter

Next oxygen is blown through it

**Formation of 3 "phases":**

1. Steel
2. Gas
3. Slag

# Background: **Slag in BOF steelmaking**

Slag present in converter has 3 important roles:

1. **Refining**
   Decrease [C], [P] and [Si]
2. **Protection refractory**
   less aggressive slag increases the lining life.
3. **Shielding through foaming**
   act as a barrier for e.g. metal droplets ➔ decreasing losses.

# Background: Goal

Gain fundamental and scientific **insights** about the influence of different slag components (MgO, $Al_2O_3$, $V_2O_5$, etc.) upon the slag 'functions'

# Topics of the PhD

General understanding influence of components

➔ Construction Phase Diagrams

Effect on refining

➔ Equilibrium calculations

Interaction Refractory

➔ Equilibrium calculations

Foaming behaviour

➔ Physical parameters

# Equilibrium calculations

Investigation of effect of different ‘slag’ components

Find way to ‘simulate’ process

- Closed calculations
- Open calculations
- Complexer approaches ?? (e.g. EERZ Model concepts proposed by Van Ende and Jung (*))

$V_2O_5$ ??

(*) M.-A. V. Ende en I.-H. Jung, “Applications of Thermodynamic Database to the Kinetic Steelmaking Process Simulations”, in Computational Materials System Design, Springer, Cham, 2018, pp. 47–66.

# Physical parameters

Foaming behaviour

1. Viscosity
   ➔ Model exists
2. Density
   ➔ Model exists
3. Surface tension
   ➔ ??

# Topics of the PhD

General understanding influence of components

- ➔ Construction Phase Diagrams

Effect on refining

- ➔ Equilibrium calculations

Interaction Refractory

- ➔ Equilibrium calculations

Foaming behaviour

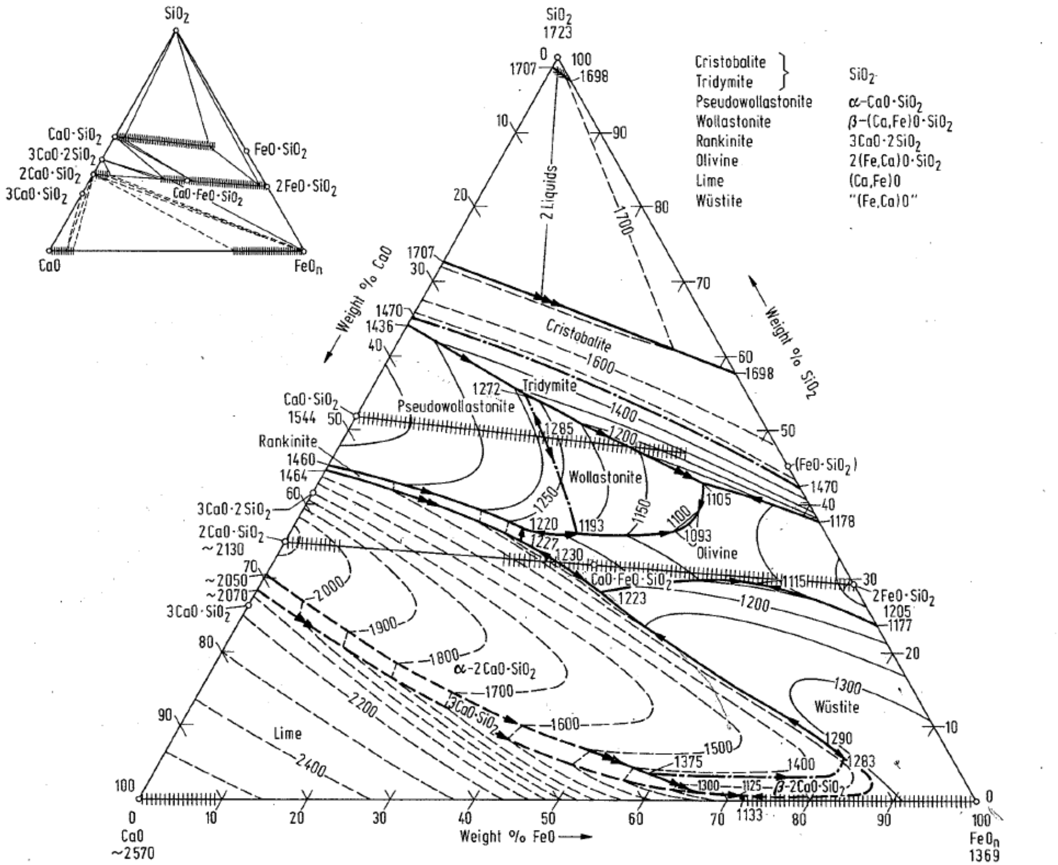
- ➔ Physical parameters

# Highlight: Phase diagram

Base ternary diagram: $CaO\text{-}SiO_2\text{-}FeO_n$

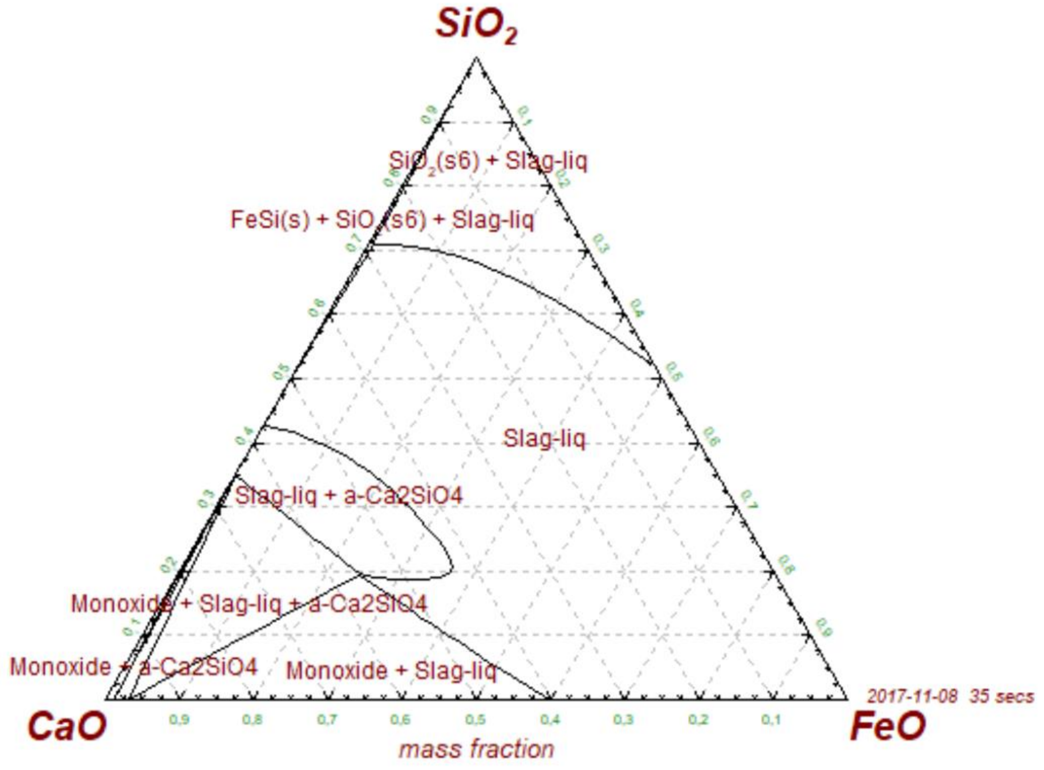
Equilibrium with ‘Pure Fe’

Addition of extra components




*Schlackenatlas*. Düsseldorf : Stahleisen, 1981.

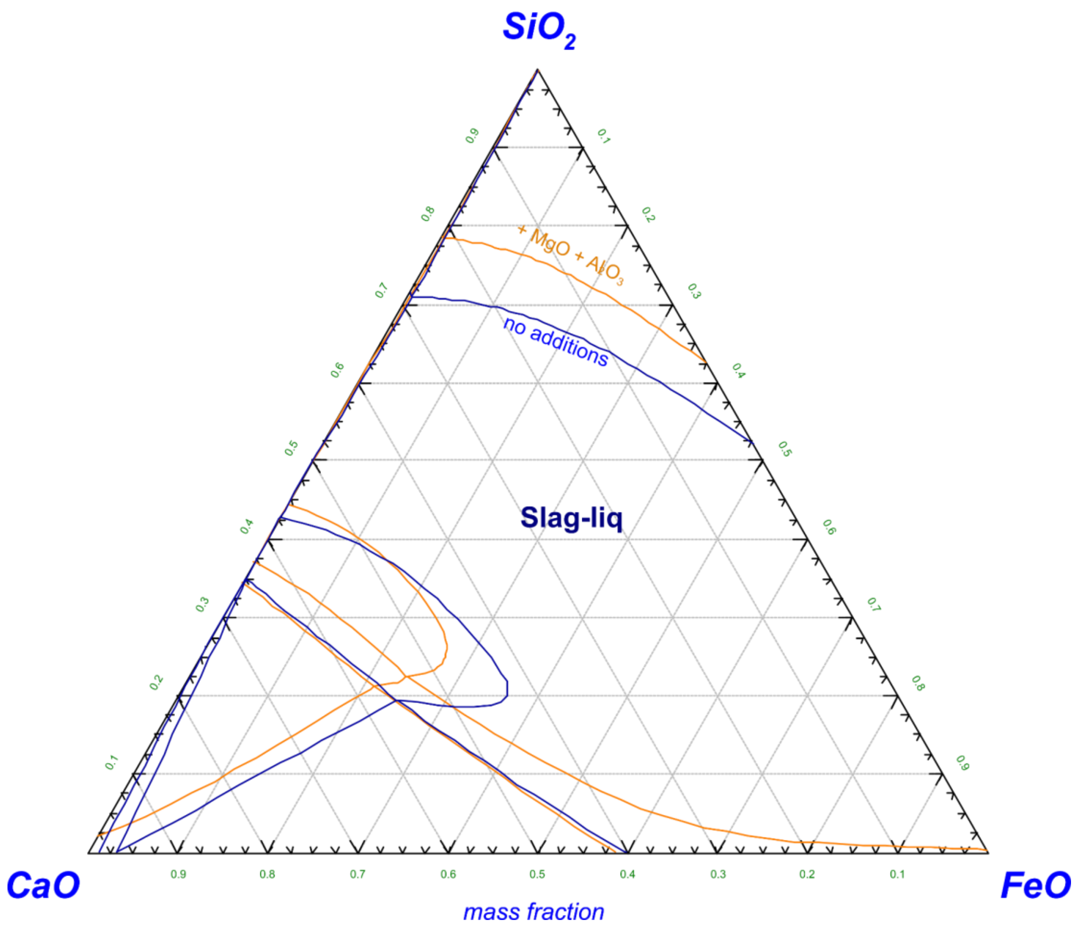
# Step 1: “Reproduction” base diagram




$CaO$-$FeO$-$SiO_2$-$Fe$ @ T = 1650°C

$Fe/(CaO+FeO+SiO_2)$=Cte
➔ approach to calculate equilibrium

# Step 2: Additions of components




Components of interest:

$Al_2O_3$, $MgO$, MnO, $Cr_2O_3$, $TiO_2$, $V_2O_5$

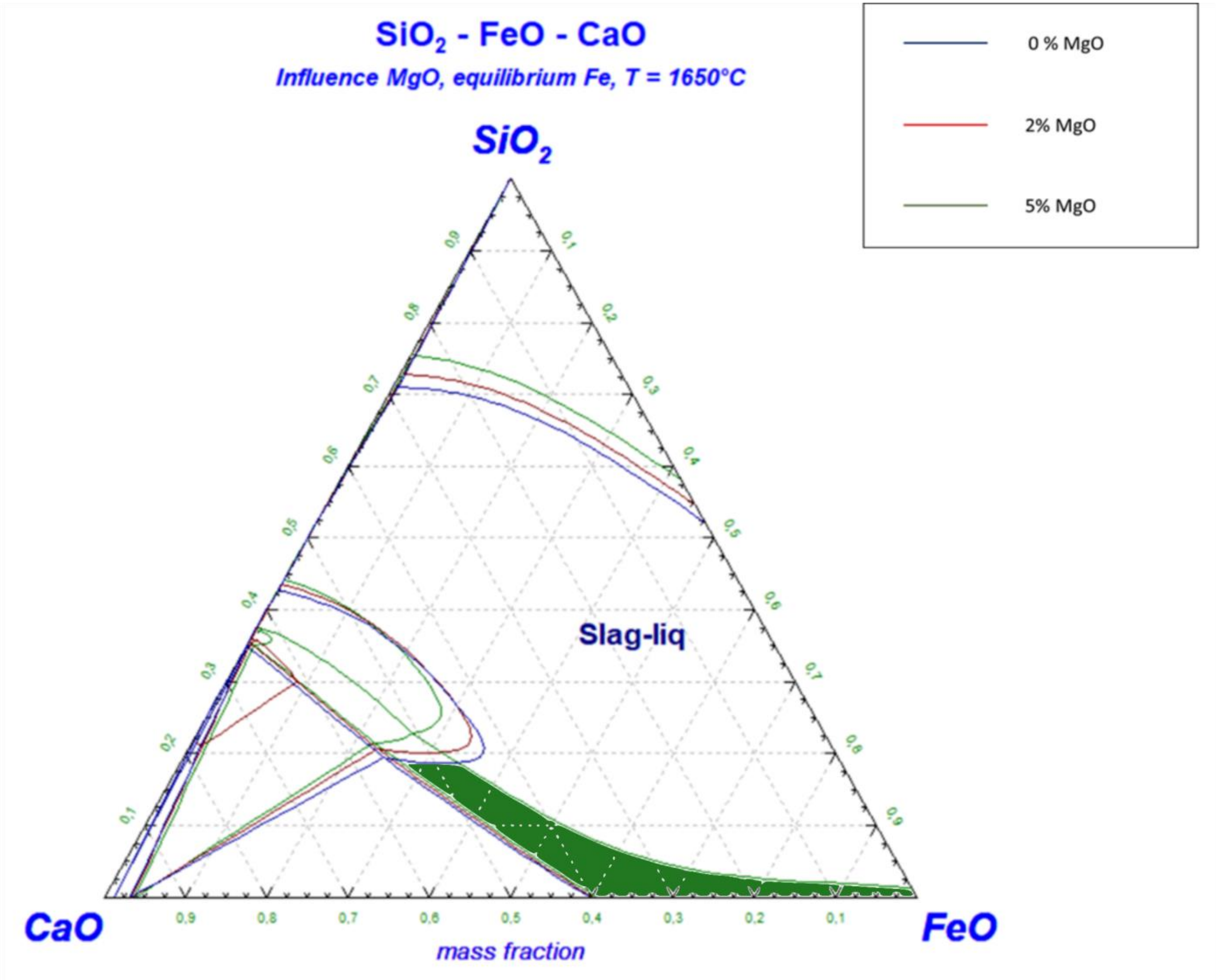
Addition:

$CaO+SiO_2+FeO = 100\%$

$x/(CaO+SiO_2+FeO) = value$

@T = 1650°C

# Example: Effect MgO and link industry




Most important: MgO saturation line!

+2% MgO ➔ No real influence

+5% MgO ➔ Clear MgO saturation line

Existence certain threshold value also observed in industry

# Conclusion

Opportunities to integrate thermodynamic databases in steel industry

Still a lot to learn: Suggestions and advice?

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