

# Working towards an increase in manganese ferroalloy production in South Africa - a research agenda

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Government-owned research council  
Employs ~750 people (250 professionals)  
Annual budget of ~R450m (£23.7m)  
State : Corporate funding (50 : 50)



Reijnders (2016) defined manganese as one of **relatively rare metals** (associated with steel-making):

‘geochemically relatively scarce (having an upper crustal abundance < ~0.025 (mass)%)’

OR

‘**subject to national stockpiling to prevent shortages in alloy**’



12<sup>th</sup> most abundant element in Earth’s crust  
average concentration of 0.1 per cent

Concentrations in ore of commercial use geographically limited

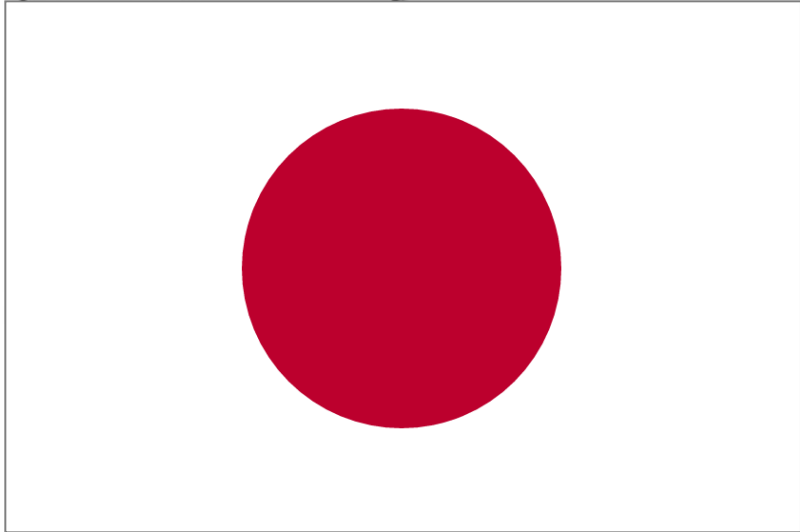
Reijnders (2016)

rare metal

'geochemically

abundant

Manganese



most abundant element in Earth's crust  
average concentration of 0.1 per cent

exists in ore of commercial use geographically  
limited



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# MANGANESE ORES IN SOUTH AFRICA

8



>75% of land-based Mn-deposit commercial use

★ Ore-body

Hotazel, Northern Cape Province

★ Harbour

Port Elizabeth, Eastern Cape Province





1937 HCFeMn in blast furnace

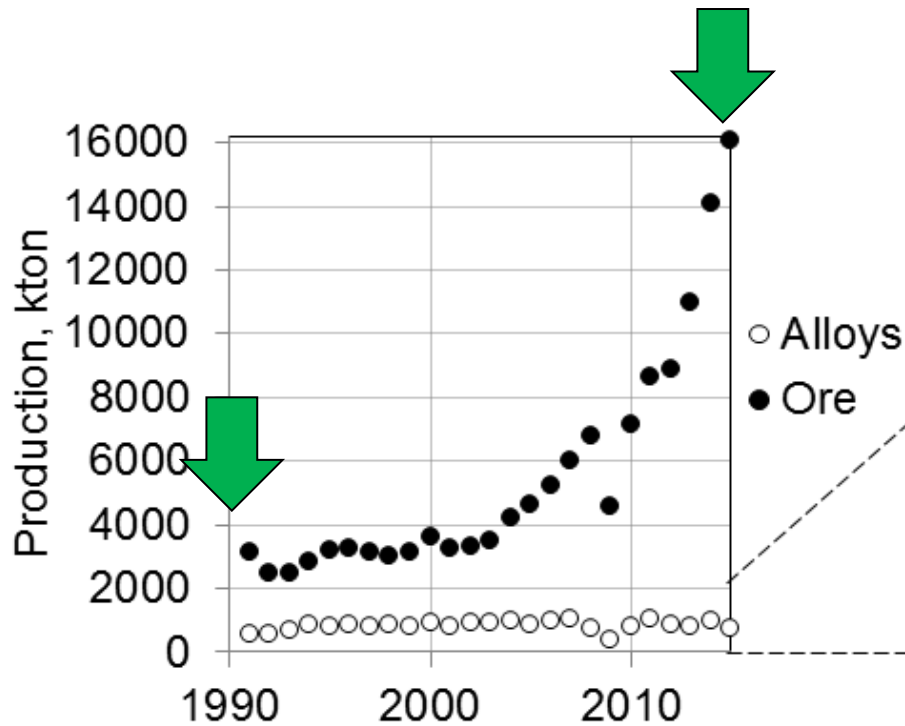
1942 HCFeMn in electric submerged-arc furnace

★ Alloy

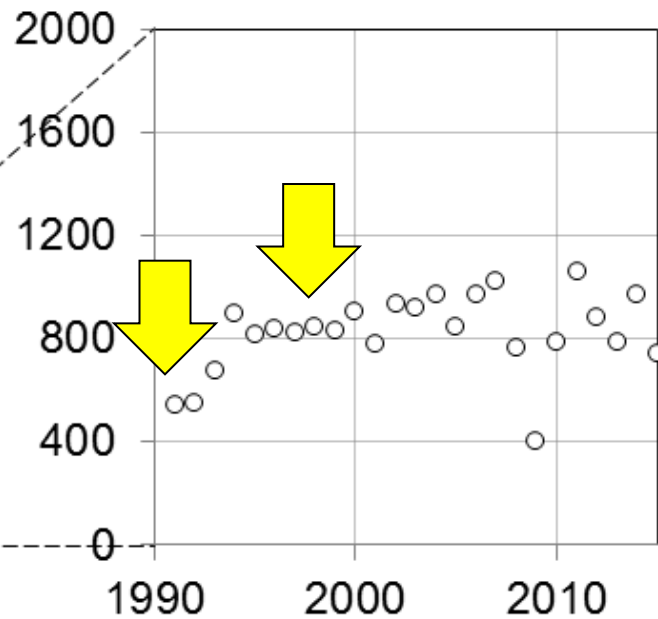
HCFeMn, refined FeMn:  
Metalloys, Assmang

SiMn:  
Transalloys, Mogale Alloys

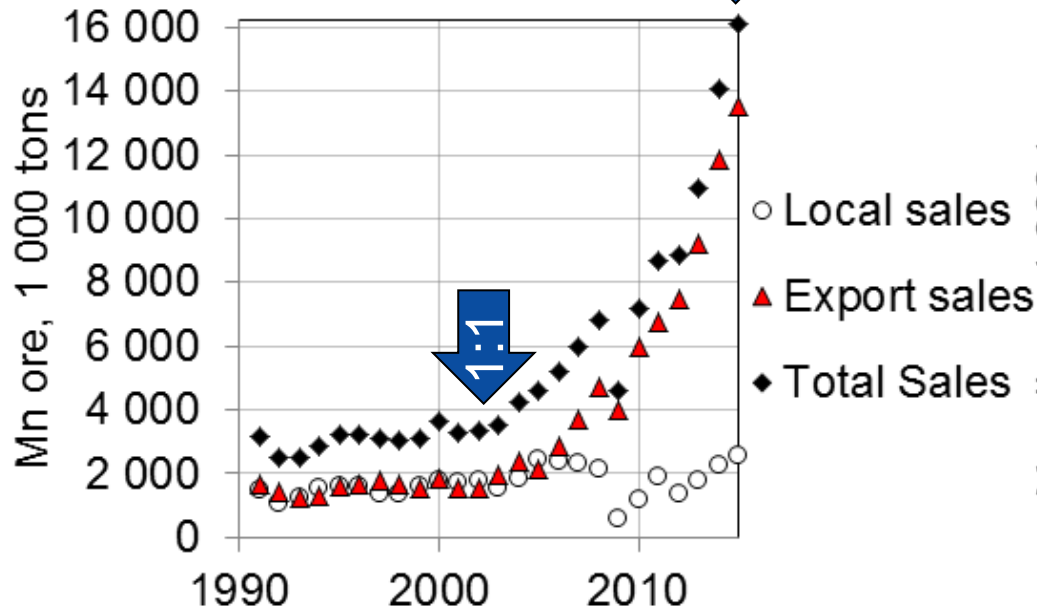
### Ore production quadrupled



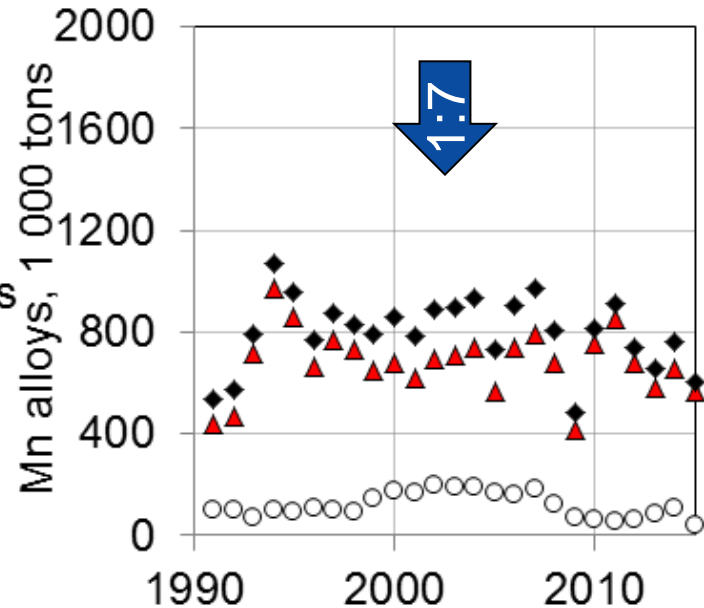
### Alloy production stagnant



### Ore production

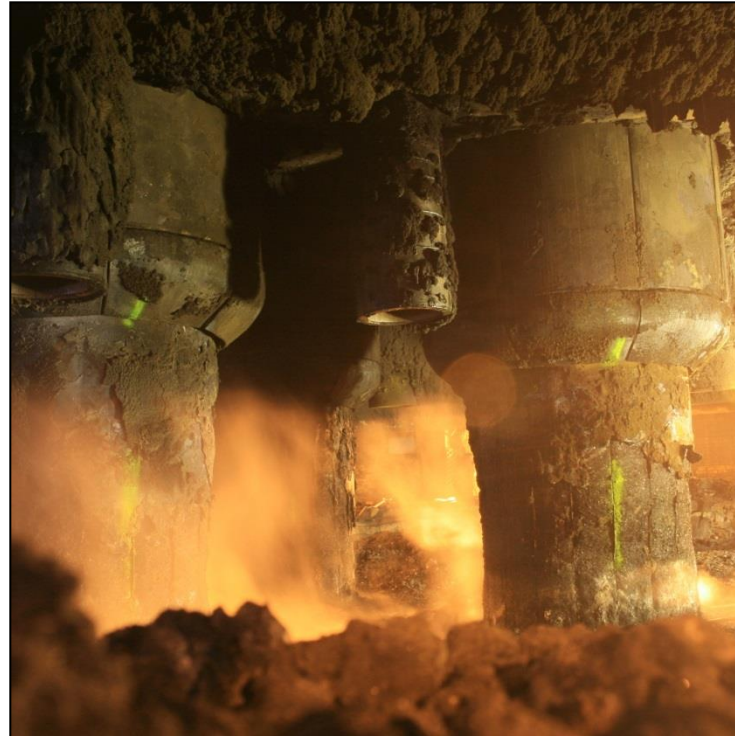


### Alloy production



Market for both ore and alloys lies outside of the country

We have the ore



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We have the  
technology,  
knowledge and skills  
to produce the alloys

Why are we not upgrading the ore?

*Identifying barriers faced by key role players in the SA manganese industry.*

M.Eng.  
(in progress)

We have the ore



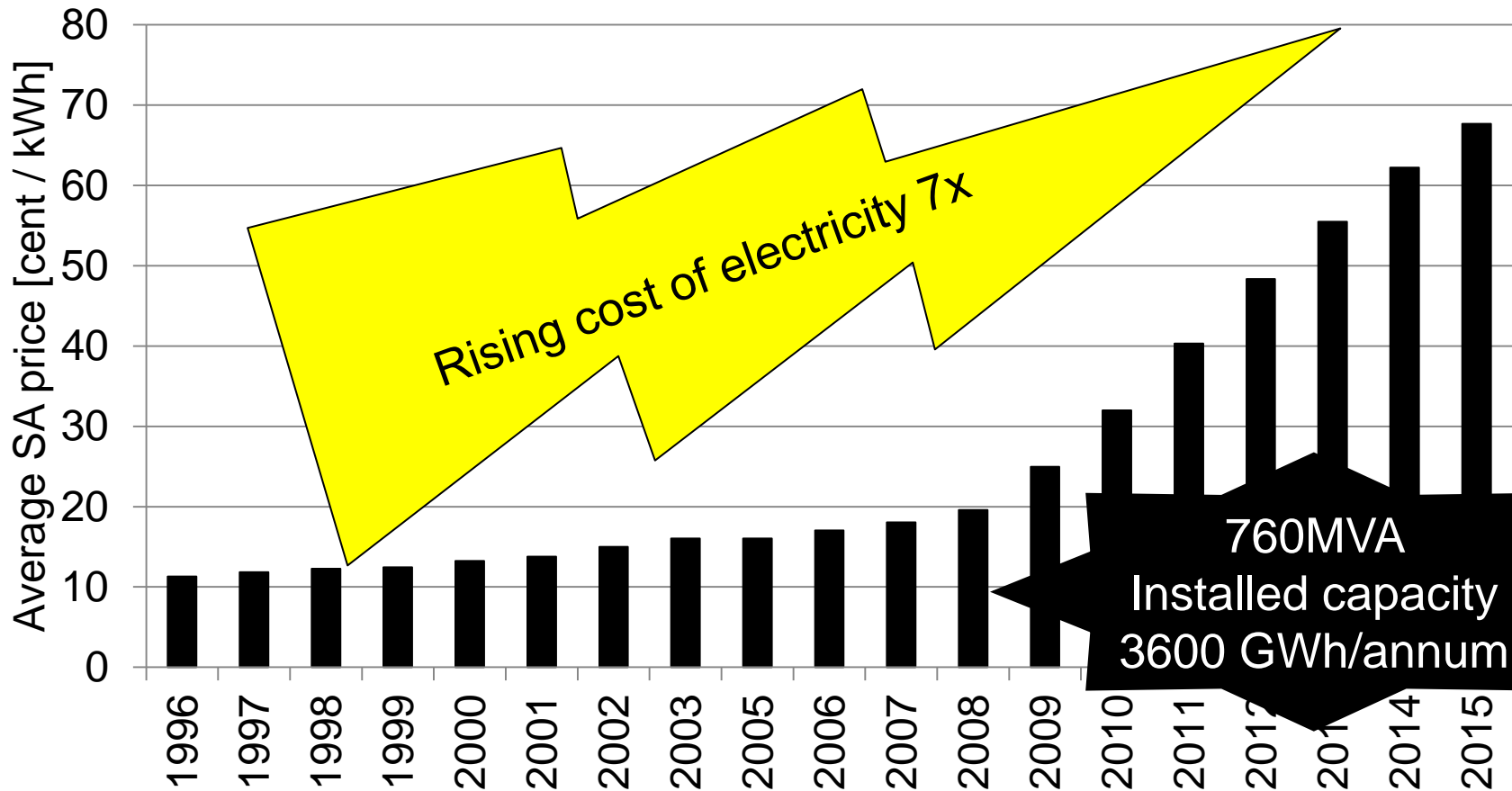
UNIVERSITEIT  
STELLENBOSCH  
UNIVERSITY



We have the  
technology,  
knowledge and skills  
to produce the alloys

Herman  
van Zyl

Why are we not upgrading the ore?





High cost of transportation

Low productivity of labour

Weak market conditions

What should the research agenda be, from a multi-organisation perspective – South Africa Incorporated (SA Inc) – to best support the development of the manganese ferroalloy industry in South Africa in the medium- to long-term.

The intention was to identify research opportunities that will:

- 1) Support existing operations,
- 2) Work towards step-change technologies.





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A1: Ore



B1: Primary alloy

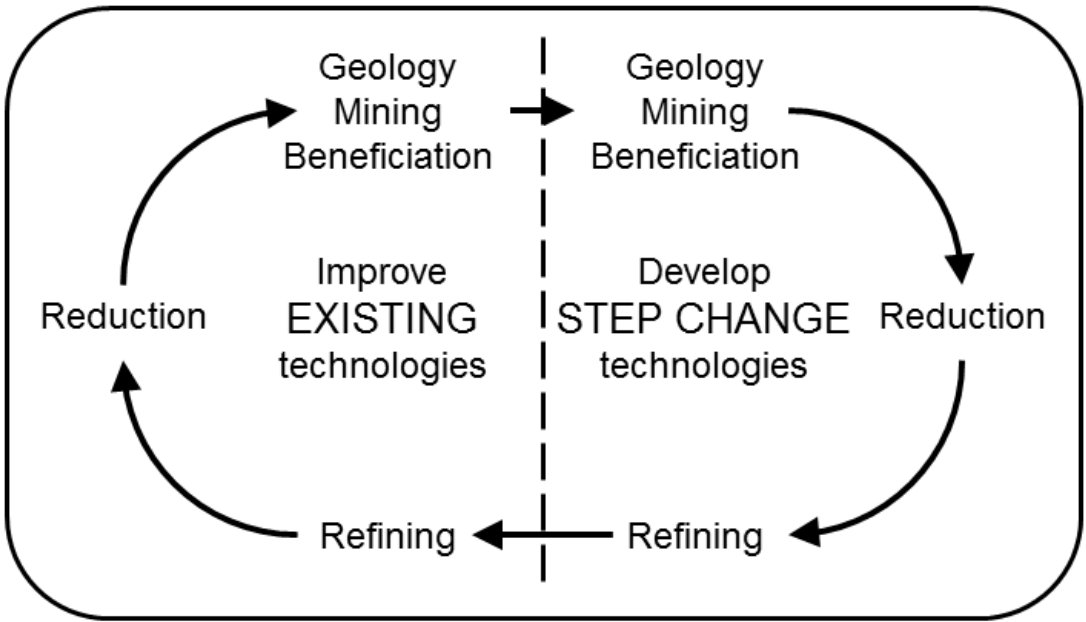
	<b>%Mn</b>	<b>%Si</b>	<b>%C</b>	<b>%P</b>	<b>%S</b>
HCFeMn	74 - 82	< 1.2	7.5	< 0.35	< 0.05
SiMn	65 - 68	12.5 - 21	1.5 - 3	< 0.2	< 0.04



C1: Refined alloy

	<b>%Mn</b>	<b>%Si</b>	<b>%C</b>	<b>%P</b>	<b>%S</b>
MCFeMn	80 - 85	0.35 - 1.5	1.5	< 0.3	< 0.02

PHASE 1: Initial Identification		
Categories of research opportunities identified Knowledge leaders identified	Desktop study	Per category, research opportunities identified: (1) Improve existing, (2) Develop step-change technology
PHASE 2: Further development		
Categories of research opportunities revised Per category, research opportunities revised: (1) Improve existing, (2) Develop step-change technology	Workshop at 2 <sup>nd</sup> School on Manganese Ferroalloy Production, SAIMM	Research opportunities prioritised
PHASE 3: Finalisation		
Final list of prioritised research opportunities	Validation	





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## PRIORITIES

1. Geometallurgy and mineralogy including a database to utilise for ore blending or product design, and data for smelters.
2. Renewable energy for mines including solar photo-voltaic, wind and concentrated solar power.
3. Training and skills development along the value chain.

## OTHER (highlights)

1. Pre-treatment at mines (pre-reduction, agglomeration) incl. Solar sinter.
2. Vertical integration of mining and smelting processes close to mine-site.
3. Tax benefit or other incentive for beneficiation or selling to local smelters.

## PRIORITIES

1. Closed furnaces with stand-alone pre-heating units.
2. Recycling and reuse of waste products.
3. Use of alternative reductants.

## OTHER (highlights)

1. Energy recovery from off-gas, slag and/or metal.
2. Improved refractory design for energy containment.
3. Technology to determine electrode tip position.
4. Alternative reduction technologies (less electricity).

## PRIORITIES

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Overall  
priorities



## PRIORITIES

1. Market and technology research for new refined products.
2. Research on the use of slag as a cement extender.
3. Heat recovery from off-gas.

### Clean Ferroalloys

(Synergy two SAIMM Schools: 2<sup>nd</sup> Mn-ferroalloy, Clean Steel)

## OTHER (highlights)

1. Product diversification (higher value products).
2. Ladle refining of SiMn by adding silicon (Si) and ferrosilicon (FeSi) fines to increase silicon content to approximately 30%.
3. Powdered SiMn to use as feed to electrolytic manganese dioxide (EMD) process.
4. Converter dust as alternative to electrolytic manganese.



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South Africa has a significant manganese resource and the intention to beneficiate it locally.

Challenges to overcome include cost of electricity, market conditions.

Research agenda presented here identified potential research areas along the value-chain.

Next steps include:

1. Publish results in the Journal of the Southern African Institute of Mining and Metallurgy ([www.saimm.co.za](http://www.saimm.co.za)).
2. Develop technology roadmap to execute research within MINTEK.
3. Identify research collaborators.
4. Source funding.

[www.saimm.co.za](http://www.saimm.co.za)



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