



MAGNETITE



# WORLD IRON MARKET

World Iron market dominated by two minerals

Hematite  $\text{Fe}_2\text{O}_3$  69.8% Fe

Magnetite  $\text{Fe}_3\text{O}_4$  72.3% Fe

60% world iron production comes from Hematite  
40% from Magnetite.

There are other minor Fe minerals, goethite,  
limonite and siderite.

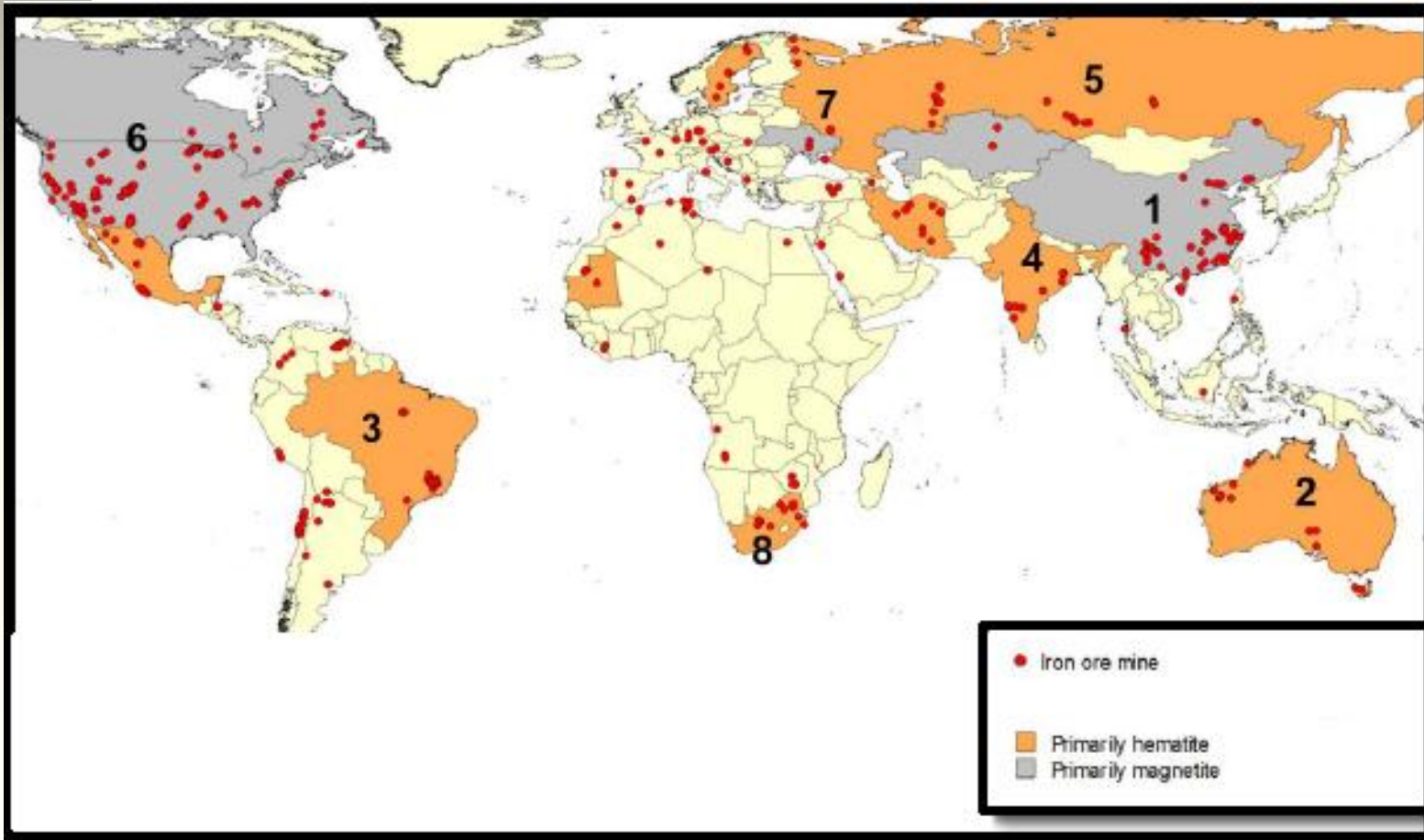
# Magnetite sources

China, North America, Ukraine and Kazakhstan are major miners of magnetite.

Deposits are relatively easy to find as they are dense and magnetic, two properties ideal for geophysical exploration.

There are large numbers of known unmined deposits on all continents. Magnetite is also present in skarn deposits and can be produced as a byproduct of mining skarns for metals.

# Magnetite sources



# Mining and processing

Mined by traditional open pit and underground methods. The host rock nearly always requires drilling and blasting but there are beach sand deposits.

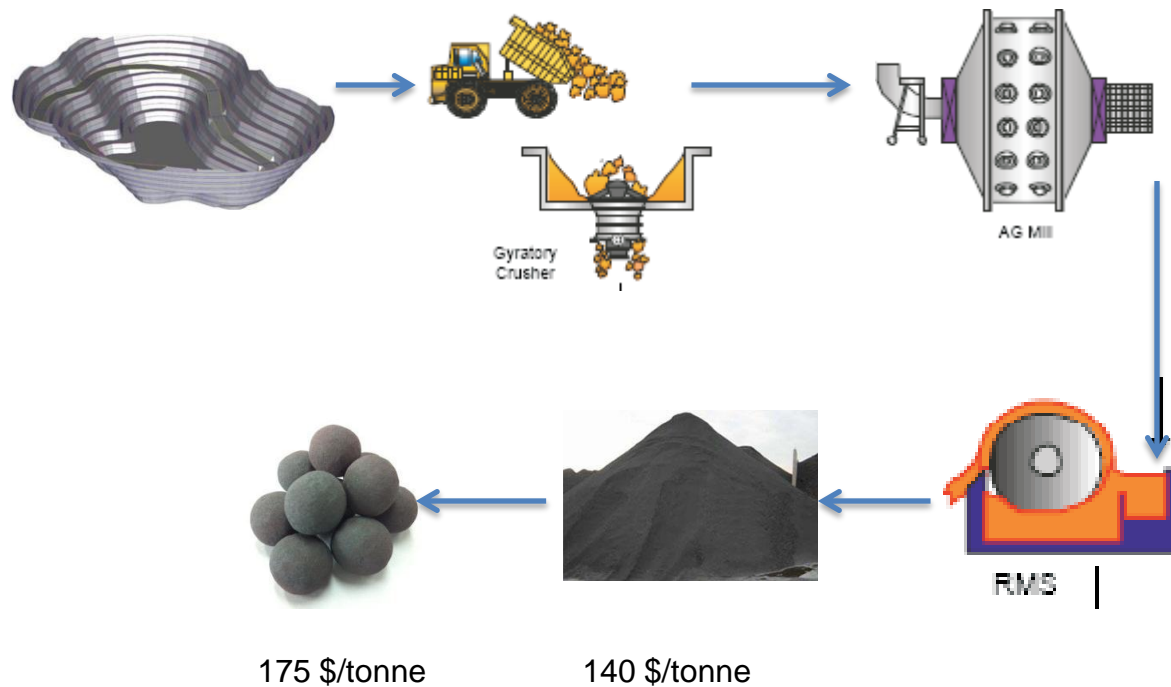
Due to magnetite's magnetic properties separation from the host rock is by low intensity magnetic methods.

A major cost is in crushing and grinding to liberate the magnetite from the surrounding rock.

Mining and processing of magnetite is simple technology and low risk.

# Mining and processing

## Iron Ore Processing scheme



# Grinding and Liberation

Magnetite liberation typically requires grinding to between 45 micron and 20micron.

The amount of power required to grind magnetite ores is dependent on the hardness of the host rock and how fine you have to grind the rock to liberate the magnetite.

Typical total circuit energy requirements:

Soft ore	40 kWhr/tonne
Typical	60 to 80 kWhr/tonne
High (USA Taconite)	100 kWhr/tonne

# Magnetite grades

Miners will sell either magnetite concentrate or iron pellets manufactured from magnetite.

The buyer of the magnetite is interested in the % of Fe in the concentrate or pellet.

The miner is interested in the % of recoverable magnetite in the rock. The grade measure of this is DTR, Davis Tube recovery, or DTC Davis tube concentrate.

Simply put  $\%Fe = \%DTR \times 72.3\%$  This is for pure magnetite but typically a miner will produce magnetite between 58% and 69% Fe.

Typical mine grades are from 25% DTR to 45% DTR



# Davis Tube operation

Magnetite concentrate sample recovered (DTR)

Head sample input (20g)

DTR or Mass Recovery  
=  $\text{Wt Mag(g)} / \text{Wt Head(g)}$



# Sample preparation

The Davis tube is a simple simulation of the magnetite processing circuit. Industrial scale recovery is about 96% of DTR grades.

The DTR grade is **Grind Dependant**.

**A detailed determination of the grind size is required early on in the exploration drilling phase of a project to specify the DTR procedure.**

The DTC is typically analyzed for Fe, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, CaO, MgO, TiO<sub>2</sub>, Na<sub>2</sub>O, K<sub>2</sub>O, P, S, Mn, V, LOI.

**The buyer of the concentrate needs this analysis.**

# Selling Magnetite

Miners can sell the concentrate as fines to a pelletising plant or build their own pelletising plant.

The margin on fines vs pellets is about \$35 /t CRF. The cost of making pellets is about \$20/t but the customer may not always want a pellet.

If the concentrate is good enough to make a DR pellet then the margin is about \$40 to \$50/t

# So what's the catch?

There are plenty of deposits, the price of iron concentrates and pellets is good, the technology is simple so what aren't we all mining magnetite?

## CAPITAL COST

Magnetite is a bulk commodity and it is expensive to get it to the customer. Many of the worlds deposits require very large capital expenditure before mining can be started.

# Typical capital items

The list of capital items that may be required is large:

- Roads
- Railway
- Concentrate pipeline
- Port
- Power stations for electricity
- Dams for water and tails
- Desalination plant for water
- Concentrator
- Pelletising plant
- Mining fleet
- Buildings and accommodation

# An example

CITIC PACIFIC – NW Western  
Australia \$6.1 B capital  
140 Mtpa ore @ 32% DTR

Capital required for:

- Concentrator & Fleet
- Port
- Desalination plant
- Conc & Gas Pipeline
- Power plant
- Barges



# Citic Pacific Cape Preston





# A guess at Citic's project economics

SRK has developed a simple financial model for early stage evaluation of magnetite deposits. Using this model and data from the internet we analyse CITIC's Cape Preston project using WACC of 10%.

Operating cost \$75/t concentrate (estimated)

**NPV \$6.4 Billion IRR 21%**

Using a concentrate sale price of \$140 for a 30 year project life. There are resources for a 42 year mine life.



# A capital cost curve for your magnetite deposit

Using our model we can derive the maximum capital that can be spent on a project of a certain size and DTR grade.

This can be used in the early stages of project development to model the economics of the deposit. Transport and infrastructure capital costs can be estimated early on from the projects location. As the size of the deposit is estimated from the drilling the other capital costs can be estimated.